Département de gestion
des opérations et de la logistique

HEC MONTRÉAL

OPER20525A.A2019 - LOGISTICS

Supply Chain Game Part I

Guidelines and Scenario 1

Context:

The game consists in managing the supply chain of a company that manufactures a single product, drums of a given chemical foam. The company operates in the fictional continent of Pangea. The continent is made up of 5 different regions: Calopeia, Sorange, Entworpe, Tyran, and Fardo. For this first assignment, we will only consider one of the regions: Calopeia.

At the beginning of the game the company has a single factory and a single warehouse located in Calopeia. The game begins at day **730** and ends at day **1460**. Therefore, at the beginning of the game, you will have historical records of the demand in Calopeia for the last two years. In a nutshell, the demand is cyclical but does not have any systematic trends upward or downward. The expected demand in a sine wave with a period of one year, and a minimum at the beginning of each year. The size of orders is very random, with an average size of 7 or 8 drums. Orders arrive randomly throughout each 24-hour day.

Manufacturing

The chemical foam is manufactured in **batches** at the factory and packed in small plastic drums. The production capacity of the factory (here after called C) is **20 drums/day**.

Example 1: producing a batch of 100 drums takes 5 days (=100 drums / 20 (drums / day)).

You can increase C as much as you want, whenever you want. Increasing C costs **$50,000** per drum/day. Capacity expansion costs are incurred **as soon as** the expansion begins. It takes **90 days** to complete a capacity expansion independently of size of the expansion. The decision to expand capacity cannot be rolled back. In other words, once new capacity is built, you cannot retire it.

Example 2: Expanding C from 20 drums/day to 30 drums/day (i.e., an increase of 10 drums per day) would costs $500,000 (=10 x $50,000).

Example 3: If you decide to expand C by 10 drums/day at the very begging of the game (i.e., beginning of day 731) the capacity will be operational at the beginning of day 821. Similarly, if you decide to expand C by 30 drums/day at beginning of day 731, the capacity will be operational at the beginning of day 821.

The size of a batch (here after referred to as Q) is a decision that you can adjust as many times as you want and whenever you want during the game.

Setting up the factory to produce a batch costs **$1,500**. Producing each drum costs an additional **$1,000**.

Example 4: producing a batch of 10 drums costs $11,500 (=10×$1,000 + $1,500).

Distribution

The factory **does not** dispatch directly to customers. The distribution is done exclusively through the warehouse. Each batch of finished drums is shipped from the factory to the warehouse **as soon** as the production of the batch is completed. To transport batches between the factory and the warehouse, you have two options: truck and mail. **Only one** transportation mode can be active at any given time. You can, however, change the active mode (here after called `M`) as many times as you want and whenever you want during the game. The **default transportation mode is truck**.

Trucks: there is an unlimited number of available trucks but each truck has a limited capacity of **200 drums**. Transporting products from the factory to the warehouse using a truck takes **7 days** and costs **$15,000**. Note that the cost of the truck is independent of the number of drums being transported.

Example 5: The factory completes the production of a 100-drum batch at the end of day 735 and dispatches the batch by truck to the warehouse. The batch will reach the warehouse at the end of day 742 and the total cost of the shipment will be $15,000 (=1 x $15,000).

Example 6: The factory completes the production of a 200-drum batch at the end of day 741 and dispatches the batch by truck to the warehouse. The batch will reach the warehouse at the end of day 748 and the total cost of the shipment will be $15,000 (=1 x $15,000).

Example 7: The factory completes the production of a 300-drum batch at the end of day 746 and dispatches the batch by truck to the warehouse. Note that in this case, two trucks are needed to transport the batch from the factory to the warehouse. The batch will reach the warehouse at the end of day 753 and the total cost of the shipment will be $30,000 (=2 x $15,000).

Mail: contrary to trucks, mail is not limited by capacity. Transporting products from the factory to the warehouse using mail takes only **1 day** but costs **$150 per drum**.

Example 8: The factory completes the production of a 100-drum batch at the end of day 735 and dispatches the batch by mail to the warehouse. The batch will reach the warehouse at the end of day 736 and the total cost of the shipment will be $15,000 (=100 x $150).

Example 9: The factory completes the production of a 300-drum batch at the end of day 746 and dispatches the batch by mail to the warehouse. The batch will reach the warehouse at the end of day 747 and the total cost of the shipment will be $45,000 (=300 x $150).

Example 10: The factory completes the production of a 200-drum batch at the end of day 741 and dispatches the batch by mail to the warehouse. The batch will reach the warehouse at the end of day 742 and the total cost of the shipment will be $30,000 (=1 x $150).

The drums are dispatched from the warehouse to the final customer using the services of a private carrier. The cost of fulfilling an order, including the fees of the private carrier, is **$150 per drum**. When an order is received, you have **24h** to fulfill it. Orders can be fulfilled using the inventory stored in the warehouse or/and the in-transit inventory, as long as the latter is scheduled to arrive to the warehouse within 24h of the reception of the order. Orders can be partially fulfilled if there not enough available inventory. However, there are no backorders; the unfulfilled part of an order will translate into lost sales.

Example 11: we receive an order for 10 drums at 8h00 on day 740. The current inventory in the warehouse is 50 drums. The order is immediately fulfilled using the inventory in the warehouse. The cost of fulfilling the order is $1,500 (10 x $150). The lost sales are $0. The new inventory level in the warehouse is 40 drums.

Example 12: we receive an order for 10 drums at 8h00 on day 740. The current inventory in the warehouse is 5 drums but there is a truck carrying 100 drums scheduled to arrive to the warehouse at 5h00 on day 741. The fulfilment of the order is delayed until 5h00 on day 741. The cost of fulfilling the order is $1,500 (10 x $150). The lost sales are $0. The new inventory level in the warehouse is 95 drums (assuming no more orders arrived between 8h00 on day 740 and 5h00 on day 741).

Example 13: we receive an order for 10 drums at 8h00 on day 740. The current inventory in the warehouse is 5 drums and there is a truck carrying 100 drums scheduled to arrive to the warehouse at 10h00 on day 741. Note that arrival of the new inventory is scheduled to happen more than 24h00 after the reception of the order. The order is partially fulfilled using the 5 drums available at the warehouse. The cost of fulfilling the order is $750 (5 x $150). The lost sales are $7250 (5 x $1450 – see Section sales and finances below). The new inventory level in the warehouse is 0 drums.

Warehousing

There is **no limit** on the number of drums that can be stored in the warehouse. The holding costs for one drum for one year is **$100**, whether the drum is *en route* to a warehouse or physically stored in the warehouse. On the other hand, there **are not** holding costs for work-in-process inventory in the factory.

Inventory management is done using a continuous review system. You control the value of reorder point (hereafter called `R`). You can adjust it as many times as you want and whenever you want during the game. The reorder point is evaluated every time the warehouse finishes fulfilling and order and every time the factory completes the production of a batch. To evaluate the reorder point, the system takes into account both the inventory in the warehouse and the inventory in transit (i.e., on its way from the factory to the warehouse). When `R` is reached, (if possible) the factory immediately schedules the production of a new batch of size `Q`. A batch that is scheduled for production cannot be cancelled.

Example 14: The current batch size `Q` is 150. There are currently 200 drums in inventory at the warehouse and 150 on a truck traveling between the factory and the warehouse. The reorder point `R` is 200. We receive an order for 20 drums. The order is then fully fulfilled using the inventory in the warehouse. The new level of inventory in the warehouse is 180. The total level of inventory is then 330. Since the reorder point is not reached, no batch is scheduled for production at the factory.

Example 15: The current batch size `Q` is 150. There are currently 200 drums in inventory at the warehouse and 150 on a truck traveling between the factory and the warehouse. The reorder point `R` is 350. We receive an order for 20 drums. The order is then fully fulfilled using the inventory in the warehouse. The new level of inventory in the warehouse is 180. The total level of inventory

is then 330. Since the reorder point is reached, (if possible) a batch of 150 drums is immediately schedule for production at the factory.

Example 16: The current batch size `Q` is 150. There are currently 200 drums in inventory at the warehouse and 150 on a truck traveling between the factory and the warehouse. The reorder point `R` is 350. The factory completes the fabrication of a 150-drum batch that is immediately shipped by truck. The new inventory level is then 500 (=200+150+150). Since the reorder point is not reached, the factory idles.

Example 17: The current batch size `Q` is 150. There are currently 200 drums in inventory at the warehouse and 150 on a truck traveling between the factory and the warehouse. The reorder point `R` is 600. The factory completes the fabrication of a 150-drum batch that is immediately shipped by truck. The new inventory level is then 500 (=200+150+150). Since the current inventory is still under the reorder point, (if possible) the factory immediately schedules the production of a new batch.

Sales and finances

A drum is sold for $1,450 to the final customers. The teams are not competing for the market and each simulation is independent. At the beginning of the game every team has a cash position of (around) $2 Million. The cash position earns the company a **10%** per year interest rate, compounded daily.

Both the costs of producing a batch and the cost of shipping the batch to the warehouse are incurred **as soon as** the production of the batch starts. If there is insufficient cash to pay for the production and shipping of the batch, the factory will remain idle.

Example 18: The current batch size `Q` is 150. The active mode of transportation `M` is truck. Our current cash position is $200.000. The factory is idle. We just fulfilled an order and reached the reorder point. Therefore, a new 150-drum batch should be scheduled for production. Producing and transporting this batch costs $166,500 (=$1500 + 150 x $1,000 + $15,000). Since our cash position is $200.000, the batch is scheduled for production and our new cash position drops to $33,500.

Example 19: The current batch size `Q` is 150. The active mode of transportation `M` is truck. Our current cash position is $150.000. The factory is idle. We just fulfilled an order and reached the reorder point. Therefore, a new 150-drum batch should be scheduled for production. Producing and transporting this batch costs $166,500 (=$1500 + 150 x $1,000 + $15,000). Since our cash position is only $150.000, the batch **cannot** be scheduled for production, so the factory remains idle.

The game

Your objective is to maximize **the cash** generated by the company over the remaining two years. On day 1460 the game will end and all inventory and capacity **will be obsolete**. The winning team is the one with the highest cash position at the end of the game. You will have control of the game from day 730 to day 1460, or 730 days total.

The four main decisions that you need to make during the game are:

1. The transportation mode (`M`)
2. The size of production batch (`Q`)
3. The reorder point (`R`)
4. The capacity of the factory (`C`)

Please remember that, with the notable exception of increasing the capacity of the factory, you can revise your decisions as many times as you want and whenever you what during the game.

The following figure summarizes the main parameters of the game.

Current capacity: 20 drums per day Capacity increase: $50,000 for each additional unit per day Lead time (construction delay) of 90 days Produce according to batch size (*quantity*) Fixed cost: $1,500/batch Variable cost: $1,000/unit	Truck: $15,000 Lead time of 7 days Mail: $150/unit Lead time of 1 day Unlimited capacity	Unlimited capacity Order point: Order when the order point is reached (sum of the inventory in transit and in the DC) Order quantity: Order based on the batch size (*quantity*) Warehousing and storage costs: $100/unit per year Interest rate = 10 %	$150/unit No decision to make	Perform demand forecast Review the demand file (*plot demand*) Sale price: $1450/unit

Registering your team

You should make sure that you have a valid code (available for sale at COOP). To register your team, follow the link: http://op.responsive.net/sc/hecmontreal/start.html. When you reach the main menu (see Figure 1 below), click on “English Group”. In the next screen, enter the code “logistics”, as shown in Figure 2, and click on “ok” to continue. Next, enter the name of the team and a password. Please select a password that is easy to remember for the 4 members of the team. Click on the “submit” button to advance to the next and last step. Write the name and the code for each of the 4 team members using (if possible) the following convention: `LAST_NAME,FIRST_NAME.`

To **register** please click on your section:

Groupe français

English group

Figure 1: team registration 1/3

If you have not purchased an individual code, you can purchase one with a credit card here and following the instructions.

Do **not** type in the individual code that you purchased. You will be asked for that code later.

Instead, please type in the course access code given by your instructor and click OK button: logistics

OK

Figure 2: team registration 2/3

Team Registration

If you are creating a new team, you must make up a team name and a password. Enter your new team name and password (twice) below. Your team will be identified by your team name.

If you are modifiying an existing team, enter the team name and password (twice) below.

Your team name must and password must conform to the following requirements:

- *must consist only of numbers and lower case letters*
- *must not contain spaces or punctuation*

Team Name:

Password:

Re-enter Password:

submit

Figure 3: team registration 3/3

Playing the game

To connect to the platform, click on this link. Click on “English group” (see Figure 2) and enter your team’s name and password. Figure 4 shows your company’s interface.

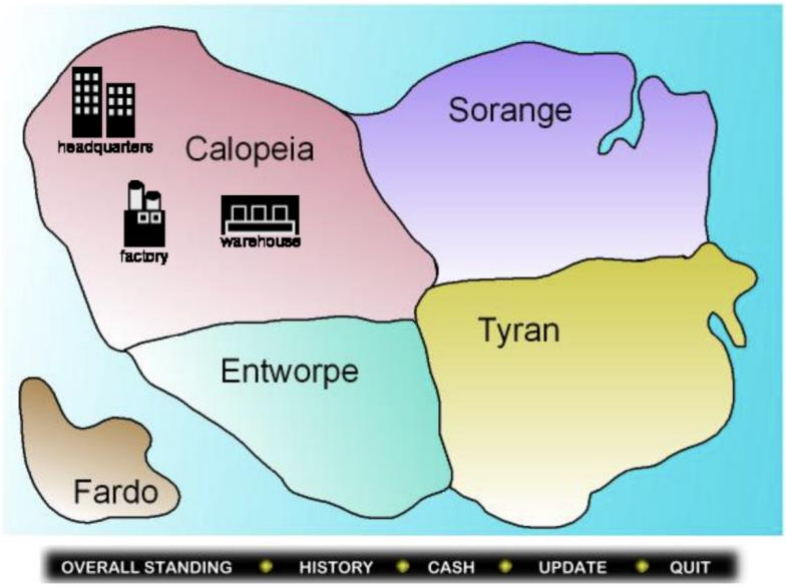

Figure 4: main game interface

Headquarters: gives you access to the “corporate” data. The latter includes plots showing historical information about i) the demand, ii) the lost demand, and iii) the cash balance. At the beginning of the game, you will have access to data corresponding to the first 730 days of operation. As the game advances and new data is generated, the plots will be automatically updated. Figure 5 shows the plot for demand data. The data can visualized also as a table. To access this visualization mode, click on the “Data” button under the graphic. The data can also be downloaded to an MS Excel file by clicking on the download button on the top right corner of the screen. Similar operations can be performed with the lost demand and cash flow data.

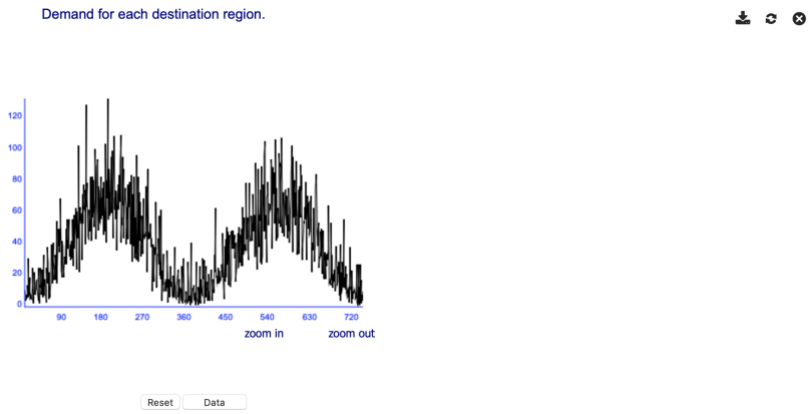

Figure 5: demand data

Factory: this icon gives you access to the “configuration” and data of the factory. The menu is shown in Figure 6.

The “plot wip” buttong gives you access to historical data of work in progress inventory. This data can also be downloaded for further analysis following the procedure explained above.

The “add” button allows you increase the capacity of the factory. As shown in Figure 7, you just need to insert into the text field the capacity that you want to add to the factory (given in number of drums per day) and click on “begin”. The system will ask you to confirm you choice before start expanding the capacity. Please remember that this decision cannot be rolled back, so use this menu with caution. After the capacity expansion has begun, the “add” button allows you to check the number of days remaining until the capacity being built becomes operational.

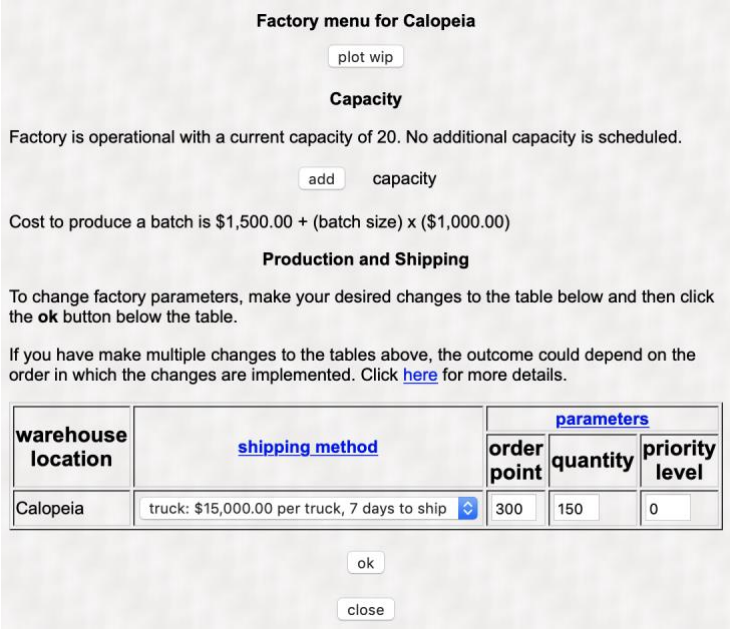

Figure 6: demand data

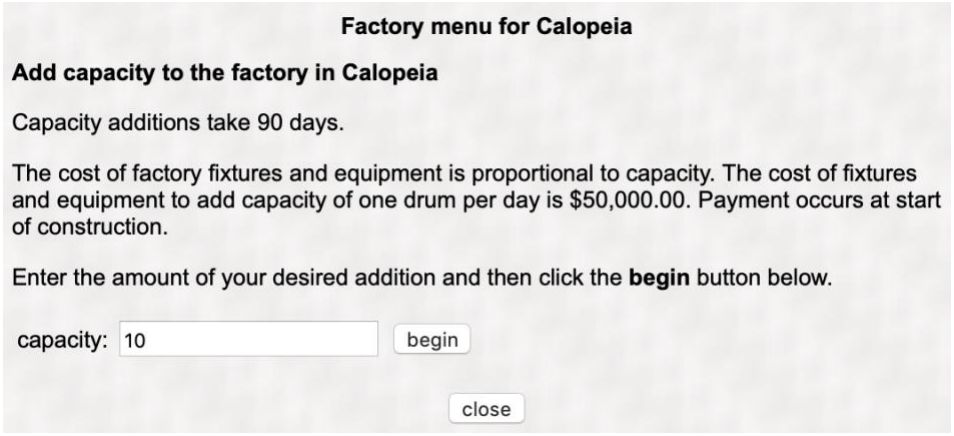

Figure 7: expand factory capacity menu

The “production and shipping method” table allows you to define your active transportation mode M (column shipping method), your reorder point R (column order point), and your batch size Q (column quantity). The “priority level” parameter will not be used on Part I of the game, you can simply set this parameter to its default value. For instance, according to the set of parameters shown in Figure 6, the reorder point is 300, the batch size is 150, and the transportation mode is truck. In other words, every time the total inventory (warehouse + transit) reaches 300 drums, (provided the cash position allows it) the factory will start manufacturing a new 150-drum batch that will be shipped to the warehouse by truck. Remember, that you can change the value of these three parameters as many times as you want and anytime you want during the game.

Warehouse: this icon gives you access to the configuration and data for the warehouse. The “plot inventory” button shows the warehouse and in-transit inventory (for each of the two possible transportation modes). For instance, the data in Figure 8 shows that at the beginning of the game (day 731) there are 260 drums in the warehouse and 0 drums in transit.

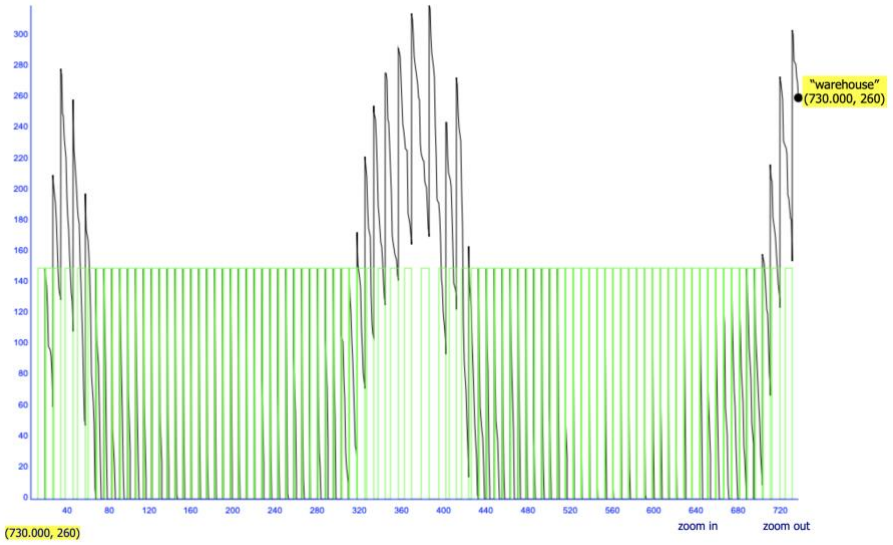

Figure 8: inventory plot

The “plot shipments” button gives you access to the data on the shipments made from the warehouse to final customers. Note that this plus the lost demand should equal the total demand.

Finally, the “Inbound Shipments from Factories” table gives you access to the reorder point, batch size, and transportation mode parameters explained above. In other words, you can change the value for these parameters either through the “factory” menu or the “warehouse” menu.

A part from the “headquarters”, “factory”, and “warehouse” icons, the main menu also gives you access to the “overall standings”, “history”, and “cash” menus. As the name suggests, the first shows you your current ranking in the competition. The second presents a detailed account of your decisions since the beginning of the game. The third shows you your current cash position.

Figure 9 shows an example. “Starting cash” simply reports your cash position at the beginning of the game (this should be around 2M for every). “Revenues” shows the total income generated by your sales (this should be equal to the number of shipments to final customers multiplied by $1450). “Interest” shows the earns generated by your cash position. “Outbound shipping” shows the money you have expended on dispatches from the warehouse to the final customers (this should be equal to the number of shipments multiply by $150). “Inbound shipping” shows the money you have expended moving drums from the factory to the warehouse (this should be equal to the number of dispatched trucks times $15,000 plus the number of drums sent by mail times $150). The “FGI holding” row shows the inventory holding costs at the warehouse (this depends on the number of days each drum was stored in the warehouse). The “Pipeline inventory holding” row shows the holding cost of inventory during transit from the factory to the warehouse (this depends on the mode used to transport each drum). The “Production” row shows the total production costs (this should be equal to the number of produced batches times $1,500 plus the number of produced drums times $1,000).

The Supply Chain Game:
Sources and Uses of Cash

Description	Amount ($)
Starting Cash	$500,000.00
Cash Sources	.
revenues	$18,763,000.00
interest	$273,110.57
Cash Uses	.
outbound shipping	-$1,941,000.00
inbound shipping	-$1,335,000.00
FGI holding	-$12,428.45
Pipeline inventory holding	-$25,315.07
production	-$13,483,500.00
Cash Balance	$2,738,867.06

If you have any questions regarding the rules or operation of the game, do not hesitate to post on the course forum on ZoneCours.

Enjoy the game!