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TIM 125

Final

Problem 1: Planning

Create a plan and time-schedule for completing the final exam. Use an appropriate table (see Problem 7 below) to track how well you execute your schedule and make notes on any obstacles and problems you encounter.

Step 1: Define the problem.

SP1: Create a plan and time-schedule for completing the final exam.

Step 2: Plan how to solve the problem.

Assumptions: I am starting the exam on Friday afternoon, so I have 4 days to complete it. The estimated time for the exam is 8 hours, so it will likely take me about 10 hours to complete it. I will create the schedule trying to spend about 2.5 hours per day.

Available Information: The SCM textbook, lecture notes, and information on the internet.

SP1: Create a plan and time-schedule for completing the final exam.

Step 1: Create a table and label what each column will represent.

Step 2: Create the plan and fill in the table.

Step 3: Execution of the plan.

SP1: Create a plan and time-schedule for completing the final exam.

Step 1: Create a table and label what each column will represent.

Date	Plan	Execution	Reasons for difference between plan and execution
3/16			
3/17			
3/18			
3/19			

Step 2: Create the plan and fill in the table.

Date	Plan	Execution	Reasons for difference between plan and execution
3/16	Problems 1,3,4		
3/17	Problems 2,5		

3/18	Problems 6,7		
3/19	Extra Credit		

Step 4: Check Your Work.

I am confident my work is correct.

Step 5: Learn and Generalize.

Planning how to solve a set of problems is important for understanding how the problems relate to each other, and how to solve them efficiently. Failing to create a plan will lead to sloppiness and decrease the overall quality of your work.

Problem 2: SCM Design/Analysis Framework

You have been hired as a consultant by Plantronics, a medium-sized company "headquartered" in Santa Cruz, which is the world leader in communication headsets. You have been asked to design their supply chain all the way from "high-level" concerns (e.g., competitive strategy, "alignment") through analysis/procedures (e.g., inventory management models) to the actual integrated software that will be used to manage their supply chain.

Before you start, Plantronics has asked you to do the following:

a) Describe the framework (process) you would use to solve supply chain management/design problems.
b) Draw appropriate diagrams to show the structure of your frameworks and procedures.

Step 1: Define the problem.

SP1: Describe the framework (process) you would use to solve supply chain management/design problems and draw appropriate diagrams to show the structure of your frameworks and procedures.

SP2: Apply the framework to Plantronics.

Step 2: Plan how to solve the problem.

Assumptions: I am a consultant at Plantronics designing their supply chain from high-level integration all the way to integrating software to manage the supply chain.

Available information: The SCM textbook, lecture notes, and information on the internet.

SP1: Describe the framework (process) you would use to solve supply chain management/design problems and draw appropriate diagrams to show the structure of your frameworks and procedures.

Step 1: How would I determine "high-level" concerns for a supply chain.

Step 2: How would I determine "mid-level" concerns for a supply chain.

Step 3: How would I design an integrated software system for a supply chain.

SP2: Apply the framework to Plantronics.

Step 1: Determine Plantronics competitive strategy and supply chain strategy.

Step 2: Give a high-level description of the six supply chain drivers.

Step 3: How will the demand forecasting be performed, and how will the cycle and safety inventory be calculated?

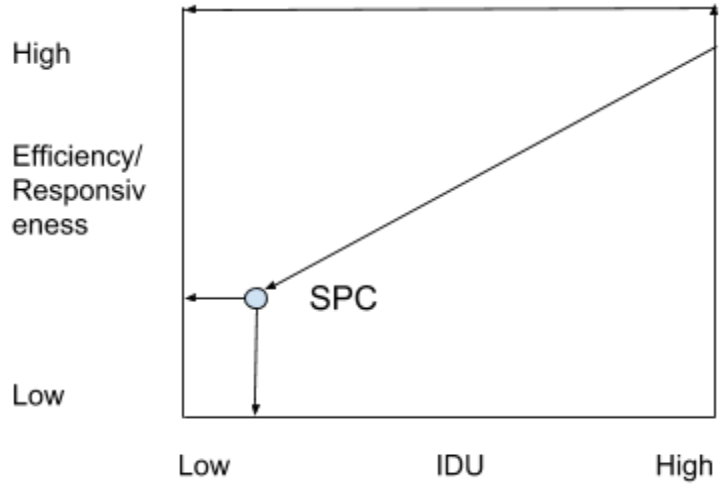
Step 4: How will software be integrated to automate parts of the supply chain?

Step 3: Execute the plan.

SP1: Describe the framework (process) you would use to solve supply chain management/design problems and draw appropriate diagrams to show the structure of your frameworks and procedures.

Step 1: How would I determine “high-level” concerns for a supply chain.

First, determine the company’s competitive strategy and the customer needs they satisfy. Based on these needs and the company’s competitive strategy, determine how efficient or responsive the company’s supply chain needs to be. Determine the companies Implied Demand Uncertainty based on the age of the company. Combine the efficiency/responsiveness spectrum and the IDU spectrum to achieve the zone of strategic fit for the company’s supply chain. The zone of strategic fit for SPC would look like:



Based on this zone of strategic fit, give a high-level description of the six supply chain drivers. The six drivers are facilities, transportation, inventory, information, sourcing, and pricing.

Step 2: How would I determine “mid-level” concerns for a supply chain.

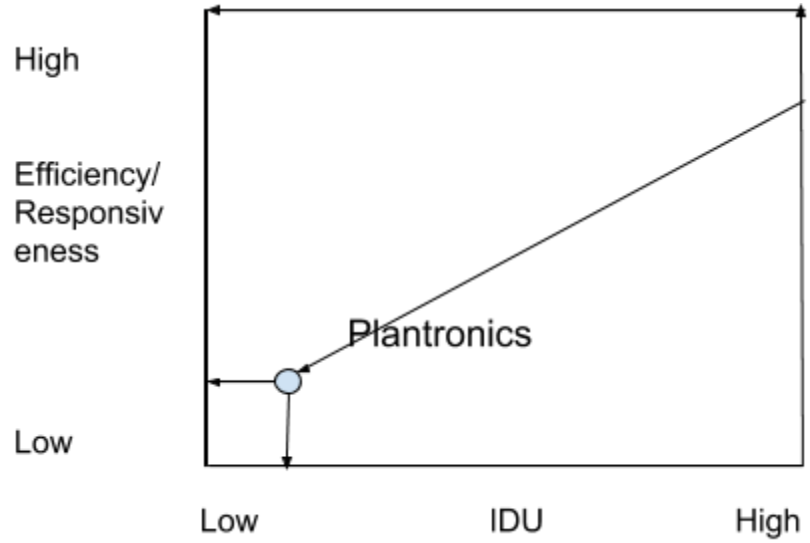
To accurately understand what the company’s inventory models will look like, a company needs to understand what their expected demand for the next year is. To obtain the best demand forecast, use all five forecasting methods, and determine which gives you the smallest error. Using that method, forecast demand for the next year (or some number of years). Based on this forecast, calculate the cycle and safety inventory metrics. Now that we understand what our demand forecast is and our inventory metrics, we need to create a detailed description of each driver. We need to determine who we will source from, where our facilities are, what the capacity of those facilities is, and what type of information system to create.

Step 3: How would I design an integrated software system for a supply chain.

Determine what functions the software should perform. Determine where to place the clients and servers for the information system. Determine what can be automated by the software, and create the system.

SP2: Apply the framework to Plantronics.

Step 1: Determine Plantronics competitive strategy and supply chain strategy. Plantronics competitive strategy is differentiated. They need an efficient supply chain since they have a standardized set of products and don't have to respond specific customer requests, and have a relatively low IDU as they are an established company. Their zone of strategic fit is:



Step 2: Give a high-level description of the six supply chain drivers.

SC Driver	High-level Strategy
Facilities	Efficient supply chains have fewer facilities, and since Plantronics does not need to be super responsive to customer needs, SPC can have fewer facilities.
Transportation	Plantronics will transport by land as it is more cheaper and more efficient than transporting by air or sea. Plantronics will transport along major highways as this will help decrease route times and inventory loss due to accidents.
Inventory	Plantronics will maintain lower inventory levels in order to be more efficient and avoid holding costs as cutting costs is extremely important for a differentiated provider. Therefore, Plantronics will not hold large amounts of safety inventory, but they will hold seasonal inventory. During periods when we are capable of producing more than is demanded we will build up this seasonal inventory, which will work since Plantronics has relatively low percent holding costs.

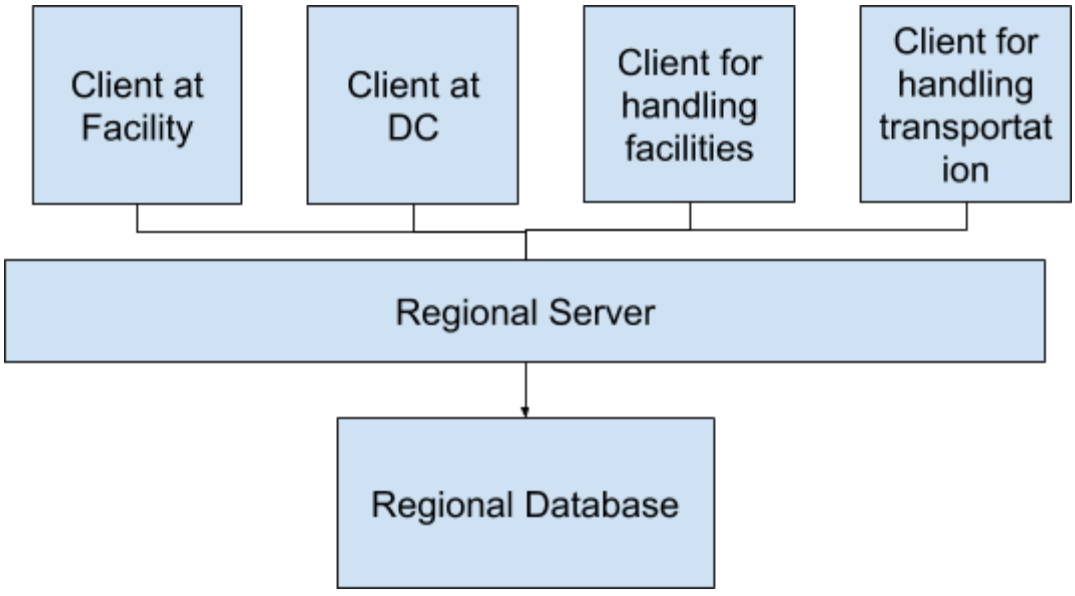
Information	Demand forecasting will be extremely important for Plantronics since they won't hold large amounts of safety or seasonal inventory. This will be the primary role of the information system. We will also develop supplier relationship management technology as obtaining input materials at good prices will be key to maintaining a competitive advantage.
Sourcing	Plantronics will purchase raw materials from outside suppliers as the raw materials we use as inputs are widely available at cheap prices. Plantronics will negotiate directly with suppliers.
Pricing	Plantronics will use everyday low prices as they don't offer any products that should be sold at higher prices. This should give us relatively stable demand except for the period where seasonal trends occur, helping us be more efficient. Plantronics will use fixed pricing and offer one delivery method to customers as it allows them to be more efficient.

Step 3: How will the demand forecasting be performed, and how will the cycle and safety inventory be calculated?

Demand forecasting will be performed by the software. All five forecasting methods will be performed, the one that produces the smallest error will used to forecast for the next year. Based on that forecast, our cycle and safety inventory will be calculated. The software will also be used to determine where to source from and what mode of transportation to use.

Step 4: How will software be integrated to automate parts of the supply chain?

Each phase of the supply chain will maintain its own cycle and safety inventory so we can take advantage of economies of scale. This means each driver in the supply chain will have a client that can perform the necessary calculations, and will send data to a centralized database with a server to access the data. The general form will look like:



Step 4: Check Your Work.

I am confident my work is correct.

Step 5: Learn and Generalize.

Companies can use a general framework to solve problems with their supply chain. Using a set framework for solving supply chain problems standardizes the process making it more stable.

Problem 3: Optimal lot size and Cycle inventory for Specialty Packaging COmpany (SPC)

If, in Problem 4 of the midterm, the holding cost h = 0.15 (rather than h = 0.10), what is optimal lot size and the required cycle inventory for clear plastic? Use these new numerical values in the problems below.

Step 1: Define the problem.

SP1: What is SPC's lot size per shipment to minimize total cost?

SP2: What is SPC's number of shipments/year for polystyrene resin in order to meet the forecasted demand for clear plastic in 2007?

SP3: What is SPC's cycle inventory?

SP4: What is SPC's cycle inventory holding cost.

SP5: What is SPC's replenishment cycle time.

SP6: What is SPC's average flow time.

Step 2: Plan how to solve the problem.

Assumptions: I am an engineer at SPC determining how to structure our cycle inventory for the next year to make our supply chain as profitable as possible.

Available information: The SCM textbook, lecture notes, and information on the internet.

SP1: What is SPC's lot size per shipment to minimize total cost?

Step 1: Determine the demand for 2007, cost per unit, fixed cost incurred per order, and holding cost as a percentage of cost.

Step 2: Determine the costs associated with cycle inventory.

Step 3: Calculate the optimal lot size (EOQ).

SP2: What is SPC's number of shipments/year for polystyrene resin in order to meet the forecasted demand for clear plastic in 2007?

Step 1: Write down the annual demand for 2007 and the lot size.

Step 2: Calculate the number of shipments per year to meet the forecasted demand for clear plastic in 2007.

SP3: What is SPC's cycle inventory?

Step 1: Write down the annual demand for 2007.

Step 2: Calculate the cycle inventory for 2007.

SP4: What is SPC's cycle inventory holding cost.

Step 1: Write down the cycle inventory, holding cost, and the cost per unit.

Step 2: Calculate the cycle inventory holding cost.

SP5: What is SPC's replenishment cycle time.

Step 1: Calculate the replenishment cycle time.

SP6: What is SPC's average flow time.

Step 1: Write down the lot size, and annual demand for 2007.

Step 2: Calculate the average flow time.

Step 3: Execute the plan.

SP1: What is SPC's lot size per shipment to minimize total cost?

Step 1: Determine the demand for 2007, cost per unit, fixed cost incurred per order, and holding cost as a percentage of cost.

Annual Demand for 2007, D = 32,036 units.
Cost per unit, C = $20
Fixed cost incurred per order, S = fixed cost incurred per order = $300
Holding cost, h = 15% = 0.15

Step 2: Determine the costs associated with cycle inventory.

Annual Material Cost = annual demand * cost per unit = D*C = 32,036 * $20 = $6,405,520
Annual Shipping Cost = (D/Q)*S = (32,036/Q)*300
Inventory Holding Costs = (Q/2)*hC = (Q/2)*0.15*20 = $3(Q/2) = Q or in other words, the inventory holding costs for the year is the average amount of inventory * $3 per unit.

Step 3: Calculate the optimal lot size (EOQ).

The economic order quantity EOQ = sqrt((2*D*S)/(h*C)) = sqrt((2*32,036*300)/(0.15*20)) = sqrt(19,221,600/3) = sqrt(6,407,200) = 2,531.24 units = 2,532 units.

SP2: What is SPC's number of shipments/year for polystyrene resin in order to meet the forecasted demand for clear plastic in 2007?

Step 1: Write down the annual demand for 2007 and the lot size.

D = 32,036 units
Lot Size, Q = 2,532 units

Step 2: Calculate the number of shipments per year to meet the forecasted demand for clear plastic in 2007.

Number of shipments per year (n*) = D/lot size = 32,036/2,532 = 12.65 shipments per year. This will obviously have to be rounded up to 13 shipments per year.

SP3: What is SPC's cycle inventory?

Step 1: Write down the annual demand for 2007.

D = 32,036

Step 2: Calculate the cycle inventory for 2007.

Cycle inventory is the average inventory throughout the year. It's equal to the lot size divided by two.

Cycle inventory = lot size/2 = 2,532/2 = 1,266 units.

SP4: What is SPC's cycle inventory holding cost.

Step 1: Write down the cycle inventory, holding cost, and the cost per unit.

Cycle Inventory = 1,266 units
Holding Cost, h = 0.15
Cost per unit, C = $20

Step 2: Calculate the cycle inventory holding cost.

Cycle inventory holding cost is the cost of holding the average amount of inventory throughout the year, or the annual holding cost.

Cycle inventory holding cost = cycle inventory * h * C = 1,266 * 0.15 * $20 = $3,798.

SP5: What is SPC's replenishment cycle time.

Step 1: Calculate the replenishment cycle time.

n* = 12.65 shipments per year. Replenishment cycle time = 365/n* = 365/12.65 = 28.85 days. So a new shipment will have to sent every 28.85 days.

SP6: What is SPC's average flow time.

Step 1: Write down the lot size, and annual demand for 2007.

D = 32,036 units

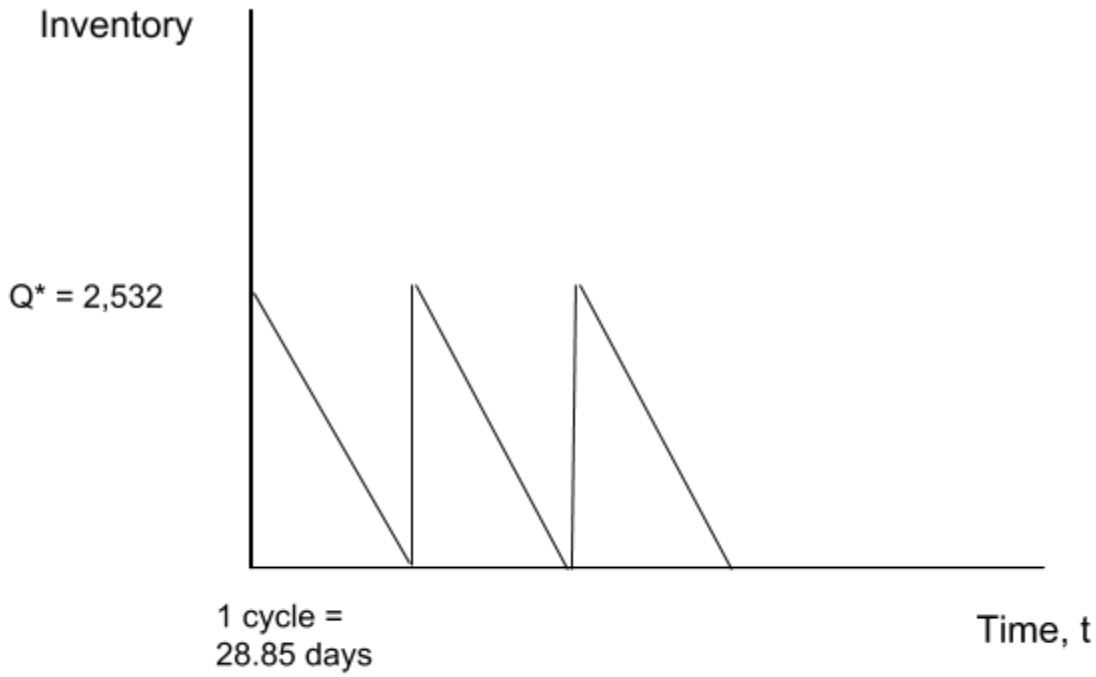
Lot Size, Q = 2,532 units

Step 2: Calculate the average flow time.

Average flow time = Q/2D = 2,532/(2*32,036) = 0.0395 year = 0.47 months = 14.7 days.

Each unit of inventory is held for about 15 days before being used.

Metric	Value	Description
Lot size (Q*)	2,532 units	The lot size that minimizes the total costs the company will incur throughout the year.
Number of shipment per year (n*)	12.65 shipments/year	The number of shipments (n*) is the number of times SPC will have polystyrene delivered in 2007 to meet to the expected demand.
Cycle inventory	1,266 units	The average inventory SPC will be holding at any given time.
Cycle inventory holding cost	$3,798	The average holding cost SPC faces throughout the year.
Replenishment Cycle Time	28.85 days	SPC goes through their inventory in 28.85 days on average.
Average Flow Time	15 days	SPC's products are held for 15 days on average.



Step 4: Check Your Work.

I am confident my work is correct.

Step 5: Learn and Generalize.

We can calculate the optimal lot size and order frequency to minimize the costs at any part of the supply chain. Doing so allows each part of the supply chain to take advantage of economies of scale, minimizing costs throughout the supply chain making it as profitable as possible. Increasing the holding cost from 15% to 10% decreases the cycle inventory, cycle inventory, replenishment cycle time, and average flow time. The number of shipments per year and cycle inventory holding cost both increase. This make sense, as increasing the holding cost means a company will decide to hold less inventory at any given time instead opting to pay for more frequent shipments to continue fulfilling demand.

Problem 4: Safety Inventory for Polystyrene Resin at SPC

Answer the following questions about safety inventory for polystyrene resin at SPC:

a) Why should SPC have a safety inventory? What is the average weekly demand for clear plastic (and therefore polystyrene) for 2007? If the coefficient of variation for clear plastic is 0.15, what is the standard deviation in the weekly demand?
b) The polystyrene supplier has a lead-time of 2 weeks. SPC would like its Cycle Service Level (CSL) to be 0.90. Determine the necessary safety inventory (safety stock) level for a continuous replenishment policy. What is the Re-order Point (ROP)? What is the fill rate? What is the average inventory? What is the average flow time?
c) Create a diagram that shows all the relevant quantities from part (b).

d) In general, is the demand during the lead-time greater than or less than the les lot size? Explain your answer using the diagram from part (c).

Step 1: Define the problem.

SP1: Why should SPC have a safety inventory?

SP2: What is the average weekly demand for clear plastic (and therefore polystyrene) for 2007? If the coefficient of variation for clear plastic is 0.15, what is the standard deviation in the weekly demand?

SP3: The polystyrene supplier has a lead-time of 2 weeks. SPC would like its Cycle Service Level (CSL) to be 0.90. Determine the necessary safety inventory (safety stock) level for a continuous replenishment policy.

SP4: What is the Re-order Point (ROP)? What is the fill rate? What is the average inventory? What is the average flow time?

SP5: Create a diagram that shows all the relevant quantities from part (b).

SP6: In general, is the demand during the lead-time greater than or less than the les lot size? Explain your answer using the diagram from part (c).

Step 2: Plan how to solve the problem.

Assumptions: I am an engineer at SPC deciding on what level of safety inventory the company should maintain, and the associated metrics related to that level of safety inventory.

Available information: The SCM textbook, lecture notes, and information on the internet.

SP1: Why should SPC have a safety inventory?

Step 1: Why do companies carry a safety inventory?

SP2: What is the average weekly demand for clear plastic (and therefore polystyrene) for 2007? If the coefficient of variation for clear plastic is 0.15, what is the standard deviation in the weekly demand?

Step 1: What is the annual demand for 2007.

Step 2: Divide it by the 52 weeks of the year to get the weekly demand.

Step 3: Calculate the standard deviation in weekly demand.

SP3: The polystyrene supplier has a lead-time of 2 weeks. SPC would like its Cycle Service Level (CSL) to be 0.90. Determine the necessary safety inventory (safety stock) level for a continuous replenishment policy.

Step 1: Calculate the demand statistics during the lead time.

Step 2: Calculate the necessary amount of safety inventory for a continuous replenishment policy given a CSL of 0.90 and a supplier lead-time of 2 weeks.

SP4: What is the Re-order Point (ROP)? What is the fill rate? What is the average inventory? What is the average flow time?

Step 1: Calculate the Re-order Point (ROP).

Step 2: Calculate the fill rate.

Step 3: Calculate the average inventory.

Step 4: Calculate the average flow time.

SP5: Create a diagram that shows all the relevant quantities from part (b).

SP6: In general, is the demand during the lead-time greater than or less than the les lot size? Explain your answer using the diagram from part (c).

Step 3: Execute the plan.

SP1: Why should SPC have a safety inventory?

Step 1: Why do companies carry a safety inventory?

Safety inventory is inventory carried to satisfy demand that exceeds the amount forecasted for a given period. Safety inventory is carried because demand is uncertain and a product shortage may result if actual demand exceeds the forecast demand.

SP2: What is the average weekly demand for clear plastic (and therefore polystyrene) for 2007? If the coefficient of variation for clear plastic is 0.15, what is the standard deviation in the weekly demand?

Step 1: What is the annual demand for 2007.

Annual Demand, D = 32,036 units

Step 2: Divide it by the 52 weeks of the year to get the weekly demand.

Weekly Demand, Dw = 32,036/52 = 616.08 units

Step 3: Calculate the standard deviation in weekly demand.

Standard Deviation in weekly demand, Sw = coefficient of variation * Dw = 0.15 * Dw = 0.15 * 616.08 = 92.41 units.

SP3: The polystyrene supplier has a lead-time of 2 weeks. SPC would like its Cycle Service Level (CSL) to be 0.90. Determine the necessary safety inventory (safety stock) level for a continuous replenishment policy.

Step 1: Calculate the demand statistics during the lead time.

We have a lead time of two weeks so:

Demand during the lead time, DL = Dw * 2 = 616.08 * 2 = 1,232.16 units.

Standard Deviation during the lead time, SL = Sw * sqrt(2) = 92.41 * sqrt(2) = 130.69 units.

Step 2: Calculate the necessary amount of safety inventory for a continuous replenishment policy given a CSL of 0.90 and a supplier lead-time of 2 weeks.

Safety Inventory, ss = NORMSINV(0.90) * SL = NORMSINV(0.90) * 130.69 = 167.49 units.

Thus, the required safety inventory to achieve a CSL of 90% is 167.49 units.

SP4: What is the Re-order Point (ROP)? What is the fill rate? What is the average inventory? What is the average flow time?

Step 1: Calculate the Re-order Point (ROP).

The Re-order Point, ROP = DL + ss = 1,232.16 + 167.49 = 1,399.65 units = 1,400 units.

Step 2: Calculate the fill rate.

First I calculate the expected shortage per replenishment cycle, ESC.

ESC = -ss[1-NORMDIST(ss/SL,0,1,1)] + SL*NORMDIST(ss/SL,0,1,0)

= -167.49[1-NORMDIST(167.49/130.69,0,1,1)] + 130.69*NORMDIST(167.49/130.69,0,1,0)

= 6.19

Fill Rate = (Q - ESC)/Q = (2,532-6.19)/2,532 = 0.9976 = 99.76%

Step 3: Calculate the average inventory.

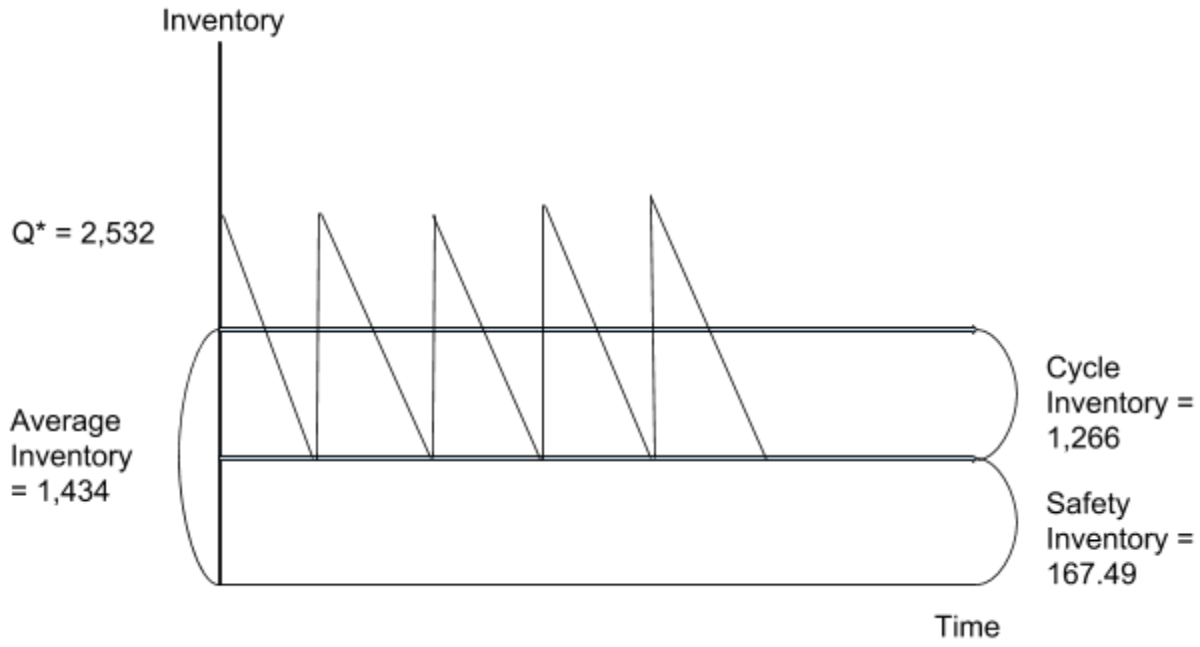
The average inventory is equal to the cycle inventory + safety inventory = 1,266 + 167.49 = 1,433.49 units or 1,434 units.

Step 4: Calculate the average flow time.

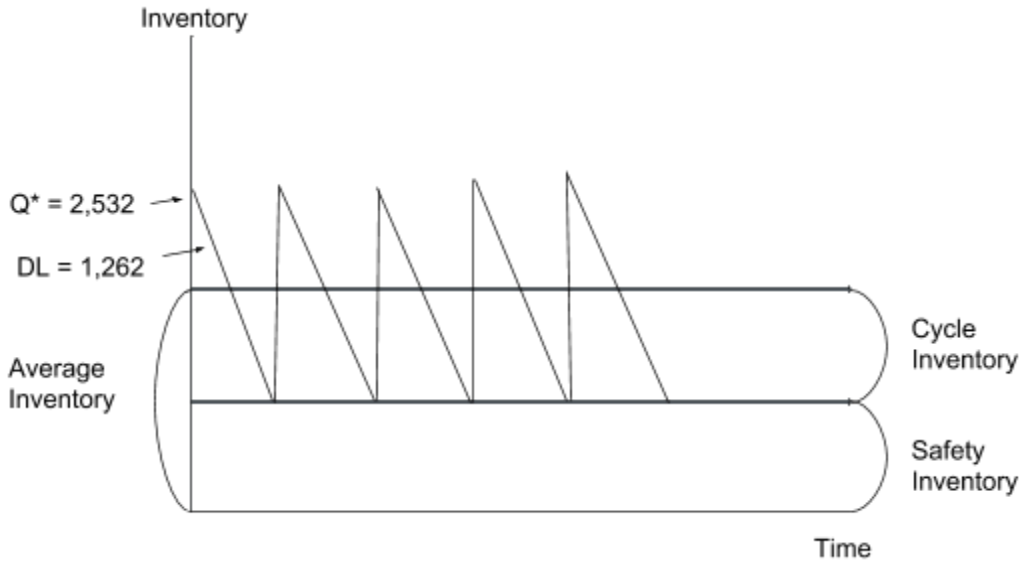
Flow Time = Average Inventory/Weekly Demand = 1,433.49/616.08 = 2.33 weeks.

Metric	Value	Description
Safety Inventory, ss	167.49 units	The amount of excess inventory carried by SPC to handle excess demand beyond what was forecasted.
Re-order Point, ROP	1,399.65 units	SPC needs to reorder inventory when the amount in storage drops to 1,400 units.
Expected Shortage per Replenishment Cycle, ESC	6.19 units	The average units of demand that are not satisfied from inventory in stock per replenishment cycle.
Fill Rate	99.76%	The percentage of orders filled.
Average Inventory	1,433.49 units	SPC has 1,434 units of inventory in storage on average.
Flow Time	2.33 weeks	Inventory is held on average for 2.33 weeks.

SP5: Create a diagram that shows all the relevant quantities from part (b).



SP6: In general, is the demand during the lead-time greater than or less than the lot size? Explain your answer using the diagram from part (c).
Demand during the lead time, DL = 1,232.16 units.
Lot Size, Q* = 2,532 units.



So the demand during the lead time is less than the lot size, which makes sense as we need to maintain positive levels of inventory at all times.

Step 4: Check Your Work.

I am confident my work is correct.

Step 5: Learn and Generalize.

Companies carry safety inventory to handle unexpected demand. SPC needs to carry 168 units of safety inventory to achieve a CSL of 90%, which will give them a fill rate of 99.76%. The inventory sits in storage for 2.33 weeks on average and SPC needs to reorder inventory when their storage levels drop to 1,400 units.

Problem 5: Sourcing for SPC

Julie Williams needs to make a choice between the following 2 suppliers:

- Supplier 1: selling price = $12.0 per unit (1 unit = 1,000lbs.); average lead time = 1 week; standard deviation of lead time = 0.5 weeks; Batch or lot size = 2,000 units.

- Supplier 2: selling price = $10 per unit (1 unit = 1,000 lbs.); average lead time = 2 weeks; standard deviation of lead time = 1 week; Batch or lot size = 4,000 units.

Answer the following questions:

a) Which supplier should Julie choose, based on minimizing total cost, if her inventory holding cost h = 0.15 and her desired target CSL = 90%?

b) Create a supplier scorecard that Julie can use to compare different suppliers. (Hint: Use the Utility Function approach developed in Tim-105/205 for choosing between alternatives as well as ideas from the text.)

Step 1: Define the problem.

SP1: Which supplier should Julie choose, based on minimizing total cost, if her inventory holding cost h = 0.15 and her desired target CSL = 90%?

SP2: Create a supplier scorecard that Julie can use to compare different suppliers.

Step 2: Plan how to solve the problem.

Assumptions: I am an engineer working at SPC deciding which supplier to obtain polystyrene from to minimize total cost. I will be using the demand statistics for SPC from 2007. Weekly demand is 616.08 units and the standard deviation of weekly demand is 92.41 units.

Available Information: The SCM textbook, lecture notes, and information on the internet.

SP1: Which supplier should Julie choose, based on minimizing total cost, if her inventory holding cost h = 0.15 and her desired target CSL = 90%?

Step 1: Calculate the associated costs for Supplier 1.

Step 2: Calculate the associated costs for Supplier 2.

SP2: Create a supplier scorecard that Julie can use to compare different suppliers.

Step 1: Determine the selection criteria.

Step 2: Assign relative weights to each selection criteria and calculate the absolute weight for each criteria.

Step 3: Select the supplier based on the overall score for each supplier.

Step 3: Execute the plan.

SP1: Which supplier should Julie choose, based on minimizing total cost, if her inventory holding cost h = 0.15 and her desired target CSL = 90%?

Step 1: Calculate the associated costs for Supplier 1.

The total cost of using supplier one is equal to the annual material cost + the annual cost of holding cycle inventory + the annual cost of holding safety inventory. To find all these costs I must calculate the annual material cost, cycle inventory, annual cycle inventory holding cost, standard deviation of demand during lead time, safety inventory, annual safety inventory holding cost, and finally total annual cost.

First I will write down the associated variables for supplier 1:

Weekly Demand, Dw = 616.08 units

Standard Deviation of weekly demand, Sw = 92.41 units

Lead time = 1 week so Demand during lead time, DL = 616.08 units and Standard Deviation of demand during lead time, SL = 92.41 units.

Price per unit = $12.00

Lot size = 2,000 units

Holding cost, h = 0.15

Annual Material Cost = weekly demand * # weeks per year * cost per unit = 616.08 * 52 * 12 = $384,433.92

Average Cycle Inventory = lot size/2 = 2,000/2 = 1,000 units
Annual cycle inventory holding cost = cycle inventory * h * cost per unit = 1,000 * 0.15 * 12 = $1,800
Standard deviation of demand during lead time = sqrt(L*Sw^2 + Dw^2*0.5^2) = sqrt(1*92.41^2 + 616.08^2 * 0.5^2) = sqrt(8,539.61 + 94,888.64) = 321.61 units.
Safety Inventory, ss = NORMSINV(0.90) * 321.61 = 412.16 units.
Annual safety inventory holding cost = safety inventory * h * cost per unit = 412.16 * 0.15 * 12 = $741.89
Total cost for supplier 1 = Annual Material Cost + Annual cycle inventory holding cost + Annual safety inventory holding cost = $384,433.92 + $1,800 + $741.89 = $386,975.81

Step 2: Calculate the associated costs for Supplier 2.

First I will write down the associated variables for supplier 2:
Weekly Demand, Dw = 616.08 units
Standard Deviation of weekly demand, Sw = 92.41 units
Lead time = 2 week so Demand during lead time, DL = 1,232.16 units and Standard Deviation of demand during lead time, SL = 130.69 units.
Price = $10.00
Lot size = 4,000 units
Holding cost, h = 0.15
Annual Material Cost = weekly demand * # weeks per year * cost per unit = 616.08 * 52 * 10 = $320,361.60
Average Cycle Inventory = lot size/2 = 4,000/2 = 2,000 units
Annual cycle inventory holding cost = cycle inventory * h * cost per unit = 2,000 * 0.15 * 10 = $3,000
Standard deviation of demand during lead time = sqrt(L*Sw^2 + Dw^2*1^2) = sqrt(2*92.41^2 + 616.08^2 * 1^2) = sqrt(17,079.2162 + 379,554.5664) = 629.79 units.
Safety Inventory, ss = NORMSINV(0.90) * 629.79 = 807.11 units.
Annual safety inventory holding cost = safety inventory * h * cost per unit = 807.11 * 0.15 * 10 = $1,210.67
Total cost for supplier 1 = Annual Material Cost + Annual cycle inventory holding cost + Annual safety inventory holding cost = $320,361.60 + $3,000 + $1,210.67 = $324,572.27

Metric	Supplier 1	Supplier 2
Annual Material Cost	$384,433.92	$320,361.60
Average Cycle Inventory	1,000 units	2,000 units
Annual cycle inventory holding cost	$1,800	$3,000

Standard deviation of demand during lead time	321.61 units	629.79 units
Safety Inventory	412.16 units	807.11 units
Annual safety inventory holding cost	$741.89	$1,210.67
Total cost	$386,975.81	$324,572.27

Julie Williams should order from supplier 2 since they will provide a lower cost. Despite the fact that more cycle and safety inventory will be held when ordering from supplier 2 because they ship more infrequently, the price difference makes supplier 2 the better option.

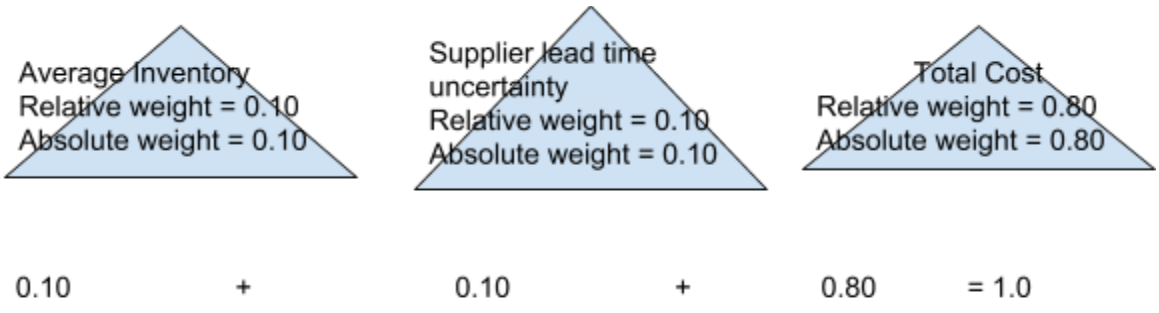
SP2: Create a supplier scorecard that Julie can use to compare different suppliers.

Step 1: Determine the selection criteria.

The set of selection criteria is:

Criteria	Reason for Criteria
Total Cost	Each company wants to minimize cost at all parts of the supply chain.
Average Inventory	SPC may not want to hold extra inventory even if it means lower costs.
Supplier lead time uncertainty	SPC may not want to deal with higher levels of supplier lead time uncertainty because it can hinder their ability to fulfill orders.

Step 2: Assign relative weights to each selection criteria and calculate the absolute weight for each criteria.



Step 3: Select the supplier based on the overall score for each supplier.

Selection Criteria	Absolute weight	Supplier 1	Supplier 2
Total Cost	0.80	4 | 3.2	5 | 4.0
Average Inventory	0.10	5 | .50	3 | .30
Supplier lead time uncertainty	0.10	5 | .50	4 | .40
Cumulative Value	1.00	4.2	4.7

Based on my values for each selection criteria, Julie Williams should select Supplier 2, as the difference in total cost outweighs the reduction in inventory held and lead time uncertainty that would occur by selecting Supplier 1.

Step 4: Check Your Work.

I am confident my work is correct.

Step 5: Learn and Generalize.

Based on my values for each selection criteria, Julie Williams should select Supplier 2, as the difference in total cost outweighs the reduction in inventory held and lead time uncertainty that would occur by selecting Supplier 1.

Problem 6: Transportation Design for SPC

Answer the following questions about transportation design for SPC:

a) Create the appropriate table in Excel for comparing rail versus truck delivery options for modes of transportation.
b) Use the table from (a) to select the optimal mode of transportation. Provide quantitative evidence to support your selection. (Use information on costs given in the case-study, and make appropriate assumptions about transportation costs).

Step 1: Define the problem.

SP1: Create the appropriate table in Excel for comparing rail versus truck delivery options for modes of transportation.

SP2: Use the table from SP1 to select the optimal mode of transportation. Provide quantitative evidence to support your selection.

Step 2: Plan how to solve the problem.

Assumptions: I am an engineer at SPC determining what mode of transportation we will use to deliver our products.

Available Information: The SCM textbook, lecture notes, and information on the internet.

SP1: Create the appropriate table in Excel for comparing rail versus truck delivery options for modes of transportation.

Step 1: Identify the costs associated with selecting a mode of transportation.

Step 2: Create an empty Excel sheet showing the costs that will be calculated when determining the mode of transportation to use.

Step 3: Fill in the Excel sheet.

SP2: Use the table from SP1 to select the optimal mode of transportation. Provide quantitative evidence to support your selection.

Step 1: Which mode of transportation has the lowest cost.

Step 3: Execute the plan.

SP1: Create the appropriate table in Excel for comparing rail versus truck delivery options for modes of transportation.

Step 1: Identify the costs associated with selecting a mode of transportation. Each mode of transportation will have a lot size, transportation cost, cycle inventory cost, safety inventory cost, in-transit inventory cost, total inventory cost, and total cost.

Step 2: Create an empty Excel sheet showing the costs that will be calculated when determining the mode of transportation to use.

	A	B	C	D	E	F	G	H	I
1	Mode	Lot Size	Transportation Cost	Cycle Inv. Cost	Safety Inv. Cost	In-transit Inv. Cost	Total Inv. Cost	Total Cost	
2	Rail								
3	Truck								
4									
5									
6									

Step 3: Fill in the Excel sheet.

I will use the shipping costs from the example in section 13.5 in the text, where the cost per 100 pounds is $6.50 for rail and $7.50 for truck. SPC faces a holding cost of 15%, annual demand of 32,036 units, and we will ship based on the lot size given from supplier 2 in problem 5, or 4,000 units. The lead time in each case is 14 days.

I will now calculate the costs associated with transporting by rail.

Cycle inventory = 4000/2 = 2,000 units.

Cycle inventory holding cost = 2,000 * 0.15 * 10 = $3,000

Safety inventory = (L/2)*(32,036/365) = (14/2)*(32,036/365) = 7*87.77 = 614.39 units.

Safety inventory holding cost = 614.39*.15*10 = $921.59

In-transit Inventory = 32,036*(14/365) = 1,228.77 units.

In-transit Inventory cost = 1,228.77 * .15 * 10 = $1,843.15

Total inventory costs = $3,000 + $921.59 + $1,843.15 = $5,764.74

AM Rail charges $65 per unit so the Annual Transportation Cost for AM Rail = 32,036 * 65 = $2,082,340

The total cost for AM Rail = $5,764.74 + $2,082,340 = $2,088,104.74

The Excel sheet now looks like:

	A	B	C	D	E	F	G	H
1	Mode	Lot Size	Transportation Cost	Cycle Inv. Cost	Safety Inv. Cost	In-transit Inv. Cost	Total Inv. Cost	Total Cost
2	Rail	4000	2,082,340.00	3,000.00	921.59	1,843.15	5,764.74	2,088,104.74
3	Truck							
4								
5								
6								
7								

I will now calculate the costs for Northeast Trucking:
Cycle inventory = 4000/2 = 2,000 units.
Cycle inventory holding cost = 2,000 * 0.15 * 10 = $3,000
Safety inventory = (L/2)*(32,036/365) = (14/2)*(32,036/365) = 7*87.77 = 614.39 units.
Safety inventory holding cost = 614.39*.15*10 = $921.59
In-transit Inventory = 32,036*(14/365) = 1,228.77 units.
In-transit Inventory cost = 1,228.77 * .15 * 10 = $1,843.15
Total inventory costs = $3,000 + $921.59 + $1,843.15 = $5,764.74
Northeast Trucking charges $75 per unit so the Annual Transportation Cost for AM Rail = 32,036 * 75 = $2,402,700
The total cost for AM Rail = $5,764.74 + $2,082,340 = $2,408,464.74
The final Excel sheet now looks like:

	A	B	C	D	E	F	G	H
1	Mode	Lot Size	Transportation Cost	Cycle Inv. Cost	Safety Inv. Cost	In-transit Inv. Cost	Total Inv. Cost	Total Cost
2	Rail	4000	2,082,340.00	3,000.00	921.59	1,843.15	5,764.74	2,088,104.74
3	Truck	4000	2,402,700	3,000.00	921.59	1,843.15	5,764.74	2,408,464.74
4								
5								
6								
7								

SP2: Use the table from SP1 to select the optimal mode of transportation. Provide quantitative evidence to support your selection.

Step 1: Which mode of transportation has the lowest cost.

The total cost using AM Rail is $2,088,104.74 and the total cost using Northeast Trucking is $2,408,464.74, so we will choose AM Rail as our method of transportation.

Step 4: Check Your Work.

I am confident my work is correct.

Step 5: Learn and Generalize.

SPC will ship using AM rail, as it is the cheapest shipping option. Since SPC faces the same holding costs regardless of the mode of transportation they use, the option with the lower

shipping cost is cheaper. If we had to ship in different lot sizes, that would affect which mode of transportation we would use.

Problem 7: Execution of Your Plan

Use a table to compare your plan from Problem 1 with its execution (column 2). Indicate the reasons for the difference between the plan and its execution. Add additional columns to capture recommendations for improved execution of your plans in the future. Write down three key lessons you learned in this course.

Step 1: Plan how to solve the problem.

SP1: Complete the table from problem 1.
SP2: Add additional columns to capture recommendations for improved execution.
SP3: Write down three key lessons from the course.

Step 2: Plan how to solve the problem.

Assumptions: I will have finished all the problems I set out to do, and will be done on time.
Available Information: The SCM textbook, lecture notes, and information on the internet.
SP1: Complete the table from problem 1.
SP2: Add additional columns to capture recommendations for improved execution.
SP3: Write down three key lessons from the course.

Step 3: Execute the plan.

SP1: Complete the table from problem 1.

Date	Plan	Execution
3/16	Problems 1,3,4	Problems 1,3,4
3/17	Problems 2,5	Problem 5
3/18	Problems 6,7	Problems 2, 6
3/19	Extra Credit	Problem 7

SP2: Add additional columns to capture recommendations for improved execution.

Date	Plan	Execution	Reasons for difference between plan and execution
3/16	Problems 1,3,4	Problems 1,3,4	No difference between plan and execution
3/17	Problems 2,5	Problem 5	Was studying for other exams, decided

			to spend time on those other exams.
3/18	Problems 6,7	Problems 2, 6	Had to do problem 2 since I didn't get to it Saturday, so I didn't have time to get to problem 7.
3/19	Extra Credit	Problem 7	Had to finish problem 7

SP3: Write down three key lessons from the course.

Lesson #	Lesson
1	Companies need to align their supply chain strategy with their competitive strategy if they want to maximize their potential profit. This means finding the proper zone of strategic fit for their supply chain given their demand uncertainty and their need for efficiency or responsiveness.
2	Companies need to maintain a certain amount of safety inventory in case demand exceeds what was forecasted.
3	To maximize supply chain profitability, a company must maximize the profits at each point in the supply chain.

Step 4: Check Your Work.

I am confident my work is correct.

Step 5: Learn and Generalize.

Various obstacles will stop you from being able to execute your work plan exactly as expected.

Extra Credit: Project SCM Software Application

- Apply the SCM software developed in your group project to solve all the quantitative problems on the Midterm and Final Exams. What was your contribution to the development of the SCM software.
- Explain how the company from your group project could use the SCM software to manage their supply chain. You may want to start with the supply chain network from your project to describe the information inputs and outputs for the SCM software.
- Develop an IT architecture for your SCM software to manage the information for your supply chain. How would you use this IT system to minimize the bull-whip effect?

Step 1: Define the problem.

SP1: Apply the SCM software developed in your group project to solve all the quantitative problems on the Midterm and Final Exams.

SP2: What was your contribution to the development of the SCM software.

SP3: Explain how the company from your group project could use the SCM software to manage their supply chain.

SP4: Develop an IT architecture for your SCM software to manage the information for your supply chain.

SP5: How would you use this IT system to minimize the bull-whip effect?

Step 2: Plan how to solve the problem.

Assumptions: I am determining how to use IT systems properly.

Available Information: The SCM textbook, lecture notes, and information on the internet.

SP1: Apply the SCM software developed in your group project to solve all the quantitative problems on the Midterm and Final Exams.

SP2: What was your contribution to the development of the SCM software.

Step 1: What parts of the SCM software did I design.

Step 2: What parts of the SCM software did I produce.

SP3: Explain how the company from your group project could use the SCM software to manage their supply chain.

Step 1: What aspects of a supply chain can be managed by SCM software.

Step 2: Of those aspects, which can our supply chain perform.

SP4: Develop an IT architecture for your SCM software to manage the information for your supply chain.

Step 1: What type of architecture will we use.

Step 2: Develop the architecture.

SP5: How would you use this IT system to minimize the bull-whip effect?

Step 1: What is the bull-whip effect?

Step 2: How can our IT system be used to minimize it.

Step 3: Execute the plan.

SP1: Apply the SCM software developed in your group project to solve all the quantitative problems on the Midterm and Final Exams.

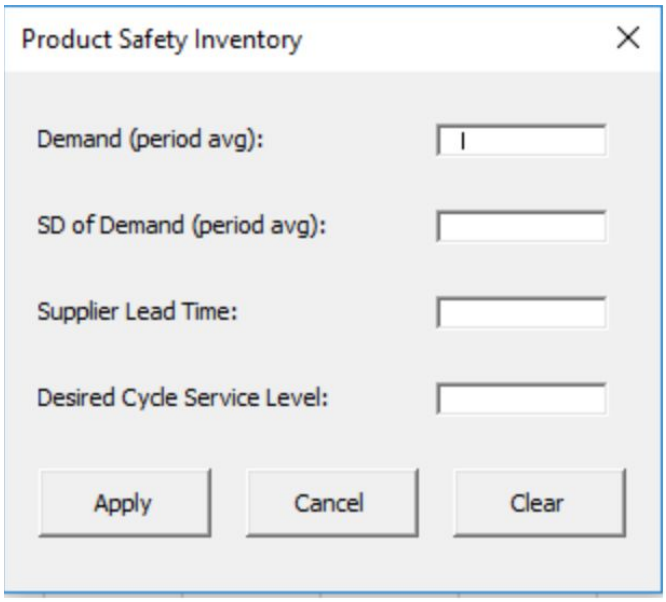
SP2: What was your contribution to the development of the SCM software.

Step 1: What parts of the SCM software did I design.

I created the high-level design for the SCM software including the design of the functions it would perform, determination of the components that would be used, and the general plan for the software including the layout for the software.

Step 2: What parts of the SCM software did I produce.

I created the part of the software that calculated the safety inventory for the various components in our product, and the product itself. I created the layout of the initial module that prompted the user for the inputs into the model:



I also wrote the software that calculated the values for the safety inventory and displayed them appropriately in an Excel sheet.

SP3: Explain how the company from your group project could use the SCM software to manage their supply chain.

Step 1: What aspects of a supply chain can be managed by SCM software.

SCM software can calculate demand forecasts, cycle and safety inventory, the proper transportation choices to minimize cost, and the location and capacity of facilities to minimize the total cost of that aspect of the supply chain.

Step 2: Of those aspects, which can our supply chain perform.

Our Supply Chain consists of the suppliers we purchase parts from, the facilities where we assemble the products, the distribution centers where we send products to retailers, and the customers who will purchase the products. I will describe how our SCM software can be used at each phase of the Supply Chain.

Suppliers: We will not be sourcing any materials or inputs ourselves so the SCM software will not be used in this phase of the Supply Chain.

Facilities: We will use the software to perform demand forecasting to understand what our expected demand is for the next year. We will use the software to calculate our cycle and safety inventory, including the reorder point when the software will automatically order a new lots worth of inventory. We will also use the SCM software to determine where to place these facilities and what their capacity will be.

Distribution Centers: We will use the software to determine where to place these facilities and what mode of transportation to use for them.

Retailers: We will use the software to track what areas are seeing increases in demand so we can ship more products to retailers in those areas.

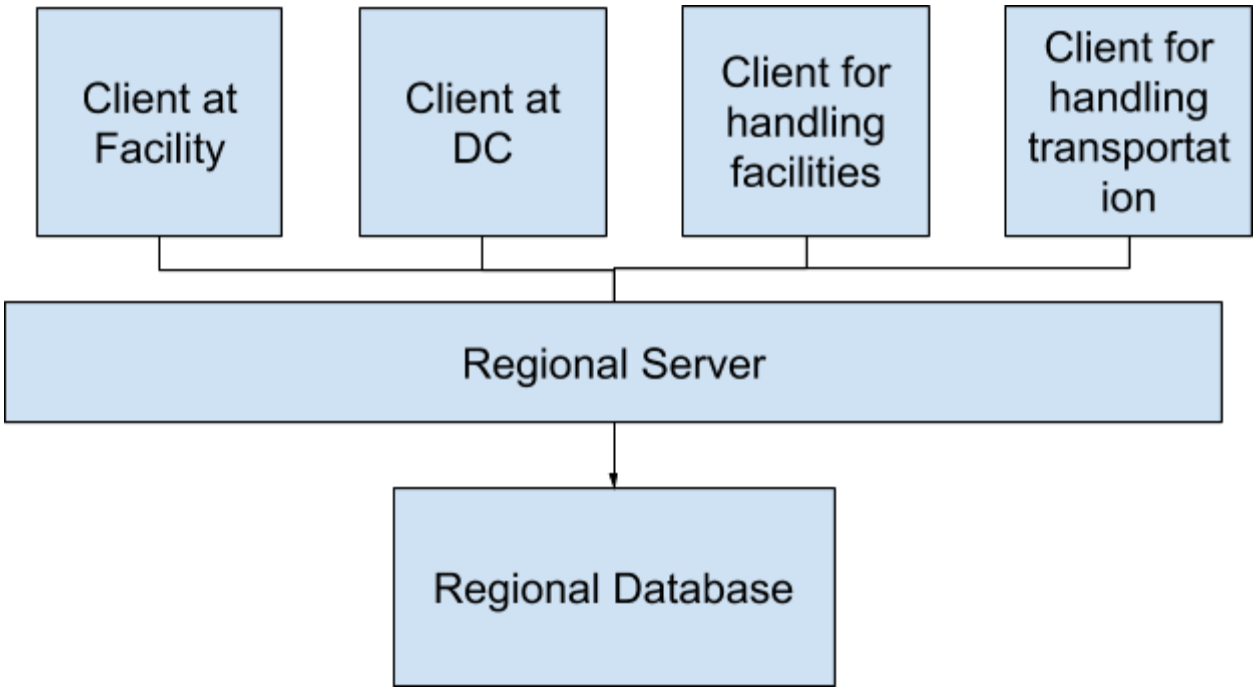
Customers: We can use the software to target advertisements at customers who are more likely to purchase our product.

SP4: Develop an IT architecture for your SCM software to manage the information for your supply chain.

Step 1: What type of architecture will we use.

We will use a client-server architecture with clients located at each facility and distribution center we operate and these clients will connect to the servers at that regional headquarter. We will also have clients at each of our regional headquarters tracking where demand is increasing and searching for potential new customers. We will maintain servers at each of our regional headquarters and we will have databases located near each regional headquarter. The clients will be thick since handle application logic and presentation logic.

Step 2: Develop the architecture.



SP5: How would you use this IT system to minimize the bull-whip effect?

Step 1: What is the bull-whip effect?

The bullwhip effect is a phenomenon that represents the instabilities and fluctuations in product and supplier orders throughout various stages of the supply chain. As we move farther up the supply chain away from the customer the uncertainty of demand increases. Lack of communication and coordination throughout the supply chain increase the bull-whip effect.

Step 2: How can our IT system be used to minimize it.

Our IT system can be used to coordinate all phases of the supply chain limiting the impact of human error and decreasing the variabilities in lead times and demand uncertainties at each phase. This will minimize the bull-whip effect.

Step 4: Check Your Work.

I am confident my work is correct.

Step 5: Learn and Generalize.

SCM software can be used to automate and manage large parts of a supply chain, eliminating confusion and other sources of uncertainty. This will minimize the bull-whip effect and make the supply chain more efficient and profitable.