**IE375 Fall 2020 Exercise Set # IV**

1) **Question from Chapter 4 of your text-book, 7th Edition, p. 245 – Problem 45 (6th Edition, p. 243 – Problem 45)**

Note that this problem is a "sort of real-sized" problem in the sense that you deal with a lot of items simultaneously. We recommend that you use a computerized tool (a spreadsheet or any programming language) to solve the problem.

45. Green's Buttons of Rolla, Missouri, supplies all the New Jersey Fabrics stores with eight different styles of buttons for men's dress shirts. The plastic injection molding machine can produce only one button style at a time and substantial time is required to reconfigure the machine for different button styles. As Green's has contracted to supply fixed quantities of buttons for the next three years, its demand can be treated as fixed and known. The relevant data for this problem appear in the following table.

| Button Type | Annual Sales | Production Rate (units/day) | Setup Time (hours) | Variable Cost |
|---|---|---|---|---|
| A | 25,900 | 4,500 | 6 | $0.003 |
| B | 42,000 | 5,500 | 4 | 0.002 |
| C | 14,400 | 3,300 | 8 | 0.008 |
| D | 46,000 | 3,200 | 4 | 0.002 |
| E | 12,500 | 1,800 | 3 | 0.010 |
| F | 75,000 | 3,900 | 6 | 0.005 |
| G | 30,000 | 2,900 | 1 | 0.004 |
| H | 18,900 | 1,200 | 3 | 0.007 |

Assume 250 working days per year. Green's accounting department has established an 18 percent annual interest rate for the cost of capital and a 3 percent annual interest rate to account for storage space. Setup costs are $20 per hour required to reconfigure the equipment for a new style. Suppose that the firm decides to use a rotation cycle policy for production of the buttons.

*a.* What is the optimal rotation cycle time?

*b.* How large should the lots be?

*c.* What is the average annual cost of holding and setups at the optimal solution?

*d.* What contractual obligations might Green's have with New Jersey Fabrics that would prevent them from implementing the policy you determined in parts (*a*) and (*b*)? More specifically, if Green's agreed to make three shipments per year for each button style, what production policy would you recommend?

**2) Question from Chapter 5 of your text-book, 7th Edition, p. 267 – Problem 12 (6th Edition, p. 266 – Problem 12)**

Another distribution is used to represent demand in the question.

12. The buyer for Needless Markup, a famous "high end" department store, must decide on the quantity of a high-priced woman's handbag to procure in Italy for the following Christmas season. The unit cost of the handbag to the store is $28.50 and the handbag will sell for $150.00. Any handbags not sold by the end of the season are purchased by a discount firm for $20.00. In addition, the store accountants estimate that there is a cost of $0.40 for each dollar tied up in inventory, as this dollar invested elsewhere could have yielded a gross profit. Assume that this cost is attached to unsold bags only.
    *a.* Suppose that the sales of the bags are equally likely to be anywhere from 50 to 250 handbags during the season. Based on this, how many bags should the buyer purchase? (Hint: This means that the correct distribution of demand is uniform. You may solve this problem assuming either a discrete or a continuous uniform distribution.)
    *b.* A detailed analysis of past data shows that the number of bags sold is better described by a normal distribution, with mean 150 and standard deviation 20. Now what is the optimal number of bags to be purchased?
    *c.* The expected demand was the same in parts (*a*) and (*b*), but the optimal order quantities should have been different. What accounted for this difference?

**3) Question from Chapter 5 of your text-book, 7th Edition, p. 281 – Problem 14 and Problem 15 (6th Edition, p. 279 – Problem 14 and Problem 15)**

14. Weiss's paint store uses a ($Q$, $R$) inventory system to control its stock levels. For a particularly popular white latex paint, historical data show that the distribution of monthly demand is approximately normal, with mean 28 and standard deviation 8. Replenishment lead time for this paint is about 14 weeks. Each can of paint costs the store $6. Although excess demands are back-ordered, the store owner estimates that unfilled demands cost about $10 each in bookkeeping and loss-of-goodwill costs. Fixed costs of replenishment are $15 per order, and holding costs are based on a 30 percent annual rate of interest.
    *a.* What are the optimal lot sizes and reorder points for this brand of paint?
    *b.* What is the optimal safety stock for this paint?
15. After taking a production seminar, Al Weiss, the owner of Weiss's paint store mentioned in Problem 14, decides that his stock-out cost of $10 may not be very accurate and switches to a service level model. He decides to set his lot size by the EOQ formula and determines his reorder point so that there is *no stock-out* in 90 percent of the order cycles.
    *a.* Find the resulting ($Q$, $R$) values.
    *b.* Suppose that, unfortunately, he really wanted to satisfy 90 percent of his demands (that is, achieve a 90 percent fill rate). What fill rate did he actually achieve from the policy determined in part (*a*)?

**4) Question from Chapter 5 of your text-book, 7th Edition, p. 297 – Problem 28 and Problem 31 (6th Edition, p. 294 – Problem 28 and Problem 31)**

28. An artist's supply shop stocks a variety of different items to satisfy the needs of both amateur and professional artists. In each case described, what is the appropriate inventory control model that the store should use to manage the replenishment of the item described? Choose your answer from the following list and be sure to explain your answer in each case:

| | |
|---|---|
| Simple EOQ | Newsboy model with service level |
| Finite production rate | $(Q, R)$ model with stock-out cost |
| EOQ with quantity discounts | $(Q, R)$ model with Type 1 service level |
| Resource-constrained EOQ | $(Q, R)$ model with Type 2 service level |
| Newsboy model | Other type of model |

*a.* A highly volatile paint thinner is ordered once every three months. Cans not sold during the three-month period are discarded. The demand for the paint thinner exhibits considerable variation from one three-month period to the next.

*b.* A white oil-base paint sells at a fairly regular rate of 600 tubes per month and requires a six-week order lead time. The paint store buys the paint for $1.20 per tube.

*c.* Burnt sienna oil paint does not sell as regularly or as heavily as the white. Sales of the burnt sienna vary considerably from one month to the next. The useful lifetime of the paint is about two years, but the store sells almost all the paint prior to the two-year limit.

*d.* Synthetic paint brushes are purchased from an East Coast supplier who charges $1.60 for each brush in orders of under 100 and $1.30 for each brush in orders of 100 or greater. The store sells the brushes at a fairly steady rate of 40 per month for $2.80 each.

*e.* Camel hair brushes are purchased from the supplier of part (*d*), who offers a discount schedule similar to the one for the synthetic brushes. The camel hair brushes, however, exhibit considerable sales variation from month to month.

31. Answer the following true or false.

*a.* The lead time is always less than the cycle time.

*b.* The optimal lot size for a Type 1 service objective of $X$ percent is always less than the optimal lot size for a Type 2 service objective of $X$ percent for the same item.

*c.* The newsboy model does not include a fixed order cost.

*d.* ABC analysis ranks items according to the annual value of their demand.

*e.* For a finite production rate model, the optimal lot size to produce each cycle is equal to the maximum inventory each cycle.

**5) Question from Chapter 5 of your text-book, 7th Edition, p. 301 – Problem 42 (6th Edition, p. 298 – Problem 42)**

Note that this problem represents what we'll do in real-life: use a computerized tool (a spreadsheet or any programming language) to solve the problem. Note that we have an approximation that we actually do not need if we use a software such as MATLAB.

42. Consider the equation giving the expected average annual cost of the policy $(Q, R)$ in a continuous-review inventory control system from Section 5.4:

$$G(Q, R) = h\left(\frac{Q}{2} + r - \lambda T\right) + \frac{K\lambda}{Q} + \frac{P\lambda n(R)}{Q}.$$

Design a spreadsheet to compute $G(Q, R)$ for a range of values of $Q \geq$ EOQ and $R \geq \mu$. Use the following approximation formula for $L(z)$ to avoid table look-ups:

$$L(z) = \exp(-0.92 - 1.19z - 0.37z^2).$$

(This formula is from Parr, 1972.) Store the problem parameters $c$, $h$, $p$, $\mu$, $\sigma$, and $\lambda$ in cell locations. Visually search through the tabled values of $G(Q, R)$ to discover the minimum value and estimate the optimal $(Q, R)$ values in this manner. Compare your results to the true optimal found from manual calculation.

*a.* Solve Example 5.4.

*b.* Solve Problem 13 in this manner.

*c.* Solve Problem 14 in this manner.

**Example *5.4***

Harvey's Specialty Shop is a popular spot that specializes in international gourmet foods. One of the items that Harvey sells is a popular mustard that he purchases from an English company. The mustard costs Harvey \$10 a jar and requires a six-month lead time for replenishment of stock. Harvey uses a 20 percent annual interest rate to compute holding costs and estimates that if a customer requests the mustard when he is out of stock, the loss-of-goodwill cost is \$25 a jar. Bookkeeping expenses for placing an order amount to about \$50. During the six-month replenishment lead time, Harvey estimates that he sells an average of 100 jars, but there is substantial variation from one six-month period to the next. He estimates that the standard deviation of demand during each six-month period is 25. Assume that demand is described by a normal distribution. How should Harvey control the replenishment of the mustard?

13. An automotive warehouse stocks a variety of parts that are sold at neighborhood stores. One particular part, a popular brand of oil filter, is purchased by the warehouse for $1.50 each. It is estimated that the cost of order processing and receipt is $100 per order. The company uses an inventory carrying charge based on a 28 percent annual interest rate.

The monthly demand for the filter follows a normal distribution with mean 280 and standard deviation 77. Order lead time is assumed to be five months.

Assume that if a filter is demanded when the warehouse is out of stock, then the demand is back-ordered, and the cost assessed for each back-ordered demand is $12.80. Determine the following quantities:

*a.* The optimal values of the order quantity and the reorder level.

*b.* The average annual cost of holding, setup, and stock-out associated with this item assuming that an optimal policy is used.

*c.* Evaluate the cost of uncertainty for this process. That is, compare the average annual cost you obtained in part (*b*) with the average annual cost that would be incurred if the lead time demand had zero variance.

14. Weiss's paint store uses a $(Q, R)$ inventory system to control its stock levels. For a particularly popular white latex paint, historical data show that the distribution of monthly demand is approximately normal, with mean 28 and standard deviation 8. Replenishment lead time for this paint is about 14 weeks. Each can of paint costs the store $6. Although excess demands are back-ordered, the store owner estimates that unfilled demands cost about $10 each in bookkeeping and loss-of-goodwill costs. Fixed costs of replenishment are $15 per order, and holding costs are based on a 30 percent annual rate of interest.

*a.* What are the optimal lot sizes and reorder points for this brand of paint?

*b.* What is the optimal safety stock for this paint?

**6) Question from Chapter 5 of your text-book, 7th Edition, p. 282 – Problem 20 (6th Edition, p. 280 – Problem 20)**

20. Bobbi's Restaurant in Boise, Idaho, is a popular place for weekend brunch. The restaurant serves real maple syrup with french toast and pancakes. Bobbi buys the maple syrup from a company in Maine that requires three weeks for delivery. The syrup costs Bobbi $4 a bottle and may be purchased in any quantity. Fixed costs of ordering amount to about $75 for bookkeeping expenses, and holding costs are based on a 20 percent annual rate. Bobbi estimates that the loss of customer goodwill for not being able to serve the syrup when requested amounts to $25. Based on past experience, the weekly demand for the syrup is normal with mean 12 and variance 16 (in bottles). For the purposes of your calculations, you may assume that there are 52 weeks in a year and that all excess demand is back-ordered.

*a.* How large an order should Bobbi be placing with her supplier for the maple syrup, and when should those orders be placed?

*b.* What level of Type 1 service is being provided by the policy you found in part (*a*)?

*c.* What level of Type 2 service is being provided by the policy you found in part (*a*)?

*d.* What policy should Bobbi use if the stock-out cost is replaced with a Type 1 service objective of 95 percent?

*e.* What policy should Bobbi use if the stock-out cost is replaced with a Type 2 service objective of 95 percent? (You may assume an EOQ lot size.)

*f.* Suppose that Bobbi's supplier requires a minimum order size of 500 bottles. Find the reorder level that Bobbi should use if she wishes to satisfy 99 percent of her customer demands for the syrup.

**7) Question from Chapter 5 of your text-book, 7th Edition, p. 291 – Problem 25 (6th Edition, p. 288 – Problem 25)**

Not covered in class, yet. You have to read the related section.

25. Consider the following list of retail items sold in a small neighborhood gift shop.

| Item | Annual Volume | Average Profit per Item |
|---|---|---|
| Greeting cards | 3,870 | $ 0.40 |
| T-shirts | 1,550 | 1.25 |
| Men's jewelry | 875 | 4.50 |
| Novelty gifts | 2,050 | 12.25 |
| Children's clothes | 575 | 6.85 |
| Chocolate cookies | 7,000 | 0.10 |
| Earrings | 1,285 | 3.50 |
| Other costume jewelry | 1,900 | 15.00 |

*a.* Rank the item categories in decreasing order of the annual profit. Classify each in one of the categories as A, B, or C.

*b.* For what reason might the store proprietor choose to sell the chocolate cookies even though they might be her least profitable item?