Module 9: Relevant costs for decision making and inventory management

**Required reading**

- Chapter 12, pages 562-585
- Online Appendix 9A: Reading 9-1: "Inventory Decisions"
- Online Appendix 9A: Reading 9-2: "Reorder Point and Safety Stock"

**Overview**

This module addresses one of the central purposes of managerial accounting: providing information for management decision-making. While it is touched on in other modules, decision-making provides the main focus of the readings and notes in this module.

You also have an opportunity to analyze a relevant cost situation using a spreadsheet program in Computer illustration 9.4-1. The topic of economic order quantity (EOQ) is introduced in Topic 9.8.

**Assignment reminder**

Assignment 3 is due this week (see Course Schedule). Please allocate sufficient time to complete and submit the assignment by the deadline.

**Topic outline and learning objectives**

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<th>Description</th>
</tr>
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<tr>
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<td>9.2</td>
<td><strong>Adding and dropping product lines</strong> Prepare an analysis showing whether a product line or other organizational segment should be dropped or retained. (Level 1)</td>
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<td>9.3</td>
<td><strong>The make-or-buy decision</strong> Explain make-or-buy decisions, and prepare a make-or-buy analysis. (Level 1)</td>
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<td>9.4</td>
<td><strong>Computer illustration 9.4-1: Relevant costs</strong> Construct a worksheet to analyze the relevant costs of a decision to retain or close a store. (Level 1)</td>
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<td><strong>Joint product costs and the contribution approach</strong> Prepare an analysis showing whether joint products should be sold at the split-off point or processed further. (Level 1)</td>
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<td>9.8</td>
<td><strong>Economic order quantity (EOQ) and the reorder point</strong> Compute the optimum inventory level and order size. (Level 1)</td>
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**Module summary**
INVENTORY DECISIONS

Inventory planning and control decisions are an important aspect of the management of many organizations. Inventory levels are not left to chance but rather are carefully planned. Major questions left unanswered are: How does the manager know what inventory level is right for the firm? and Won’t the level that is right vary from organization to organization? The purpose of this section is to examine the inventory control methods available to the manager to answer these questions and the relevant costs for these decisions.

Costs Associated with Inventory

Three groups of costs are associated with inventory. The first group, known as inventory ordering costs, consists of costs associated with the acquisition of inventory. Examples include:

1. Clerical costs.
2. Transportation costs.

The second group, known as inventory carrying costs, consists of costs that arise from having inventory on hand. Examples include:

1. Storage space costs.
2. Handling costs.
3. Property taxes.
4. Insurance.
5. Obsolescence losses.
6. Interest on capital invested in inventory.

The third group, known as costs of not carrying sufficient inventory, consists of costs that result from not having enough inventory on hand to meet customers’ needs. Costs in this group are more difficult to identify than costs in the other two groups, but nevertheless they can include items that are very significant to a firm. Examples of costs in this group are:

1. Customer ill will.
2. Quantity discounts foregone.
3. Erratic production (expediting of goods, extra setup, etc.)
4. Inefficiency of production runs.
5. Added transportation charges.
6. Lost sales.

In a broad conceptual sense, the right level of inventory to carry is the level that minimizes the total of these three groups of costs. Such a minimization is difficult to achieve, however, because certain of the costs involved are in direct conflict with one another. Notice, for example, that as inventory levels increase, the costs of carrying inventory also increase, but the costs of not carrying sufficient inventory decrease. In working toward total cost minimization, therefore, the manager must balance off the three groups of costs against one another. The
problem really has two dimensions — how much to order (or how much to produce in a production run) and how often to do it.

Computing the Economic Order Quantity

The how-much-to-order question is commonly referred to as the economic order quantity. It is the order size that results in a minimization of the first two groups of costs just described. We consider two approaches to computing the economic order quantity — the tabular approach and the formula approach.

The Tabular Approach

Given a certain annual consumption of an item, a firm might place a few orders each year of a large quantity each, or it might place many orders of a small quantity each. Placing only a few orders will result in low inventory ordering costs but in high inventory carrying costs, as the average inventory level would be very large. On the other hand, placing many orders would result in high inventory ordering costs but in low inventory carrying costs; in this case the average inventory level would be quite small. As stated earlier, the economic order quantity seeks the order size that balances off these two groups of costs. To show how it is computed, assume that a manufacturer used 3,000 subassemblies (manufactured parts inserted in other manufactured items) in the manufacturing process each year. The subassemblies are purchased from a supplier at a cost of $20 each. Other cost data are given below:

| Inventory carrying costs, per unit, per year | $0.80 |
| Cost of replacing a purchase order | $10.00 |

EXHIBIT 13-8

Tabulation of Costs Associated with Various Order Sizes

| Symbol* | Order Size in Units |
| --- | --- | --- | --- | --- | --- | --- | --- |
| | 25 | 50 | 100 | 200 | 250 | 300 | 400 | 1,000 | 3,000 |
| $E/2$ | Average inventory in units | 12.5 | 25 | 50 | 100 | 125 | 150 | 200 | 500 | 1,500 |
| $Q/E$ | Number of purchase orders | 120 | 60 | 30 | 15 | 12 | 10 | 7.5 | 3 | 1 |
| $C(E/2)$ | Annual carrying cost at $0.80 per unit | $10 | $20 | $40 | $80 | $100 | $120 | $160 | $400 | $1,200 |
| $P(Q/E)$ | Annual purchase order cost at $10 per order | 1,200 | 600 | 300 | 150 | 120 | 100 | 75 | 30 | 10 |
| $T$ | Total annual cost | $1,210 | $620 | $340 | $230 | $220 | $220 | $235 | $430 | $1,210 |

*Symbols:

$E = \text{order size in units (see headings above).}$  
$Q = \text{Annual quantity used in units (3,000 in this example).}$  
$C = \text{Annual cost of carrying one unit in stock.}$  
$P = \text{Cost of placing one order.}$  
$T = \text{Total annual cost = } P(Q/E) + C(E/2)$

Exhibit 13-8 contains a tabulation of the total costs associated with various order sizes for the subassemblies. Notice the total annual cost is lowest (and is equal) at the 250- and 300-unit order sizes. The economic order quantity lies somewhere
between these two points. We could locate it precisely by adding more columns to
the tabulation, and we would in time zero in on 274 units as being the exact
economic order quantity.

The cost relationships from this tabulation are shown graphically in Exhibit 13-9.
Notice from the graph that total annual cost is minimized at that point when
annual carrying costs and annual purchase order costs are equal. The same point
identifies the economic order quantity, because the purpose of the computation is
to find the point of exact trade-off between these two classes of costs.

EXHIBIT 13-9

Graphical Solution to Economic Order Size

Observe from the graph that total cost shows a tendency to flatten out between
200 and 400 units. Most firms look for this minimum cost range and choose an
order size that falls within it, rather than choosing the exact economic order
quantity. The primary reason is that suppliers will often ship goods only in round-
lot sizes.

The table in Exhibit 13-8 is based on the formula:

\[ T = P\left(\frac{Q}{E}\right) + C\left(\frac{E}{2}\right) \]
where \( P \) is a constant cost per order, and \( C \) is a unit cost of carrying a unit of inventory for the period of time under consideration. If quantity discounts can be obtained for orders of a certain size, another term representing the purchase costs of the particular lot size should be added to the formula or another line to the table. Other complications arise where annual or period demand is not known, lead times vary, or multiple deliveries are necessary for each order.

**The Formula Approach.** The economic order quantity can also be found by means of a formula. The formula is derived by solving the minimization of \( T = P(Q/E) + C(E/2) \) for \( E \) using calculus. The result is

\[
E = \sqrt{\frac{2QP}{C}}
\]

where

- \( E \) = order size in units
- \( Q \) = annual quantity used in units
- \( P \) = cost of placing one order
- \( C \) = annual cost of carrying one unit in stock

Substituting with the data used in our preceding example, we have:

- \( Q = $3,000 \) subassemblies used per year
- \( P = $10 \) cost to place one order
- \( C = $0.80 \) cost to carry one subassembly in stock for one year

\[
E = \sqrt{\frac{2(3,000)($10)}{0.80}} = \sqrt{\frac{60,000}{0.80}} = \sqrt{75,000}
\]

\( E = 274 \) (the economic order quantity)

Although data can be obtained very quickly using the formula approach, it has the drawback of not providing as great a range of information as the method discussed previously, and it cannot be used where changes in purchase prices occur with changes in lot sizes.

**Focus on Current Practice**  
Research suggests that companies do, indeed, understate the cost of carrying a unit in stock. The reason for the understatement is that companies tend to consider only the variable costs of carrying goods and to ignore other costs such as depreciation (or rent) on facilities, material handling, accounting, and administration. Yet these other costs can be more significant in the EOQ computation than the variable costs. Indeed, one factor that has propelled the Japanese toward JIT has been the extremely high cost of storage space in Japan. Real estate is so costly that companies can’t afford to use valuable space to store inventory. In effect, the high inventory carrying costs in Japan have pushed the EOQ downward to the point where JIT is the only feasible alternative.
JIT and the Economic Order Quantity

The EOQ will decrease under either of these circumstances:

1. The cost of placing an order decreases.
2. The cost of carrying inventory in stock increases.

Managers who advocate JIT purchasing argue that the cost of carrying inventory in stock is much greater than generally realized because of the waste and inefficiency that inventories create. These managers argue that this fact, combined with the fact that JIT purchasing dramatically reduces the cost of placing an order, is solid evidence that companies should purchase more frequently in smaller amounts. Assume, for example, that a company has used the following data to compute its EOQ:

\[
Q = 1,000 \text{ units needed each year} \\
P = $60 \text{ cost to place one order} \\
C = $3 \text{ cost to carry one unit in stock for one year}
\]

Given these data, the EOQ would be:

\[
E = \sqrt{\frac{2QP}{C}} = \sqrt{\frac{2(1,000)($60)}{$3}} = \sqrt{40,000} = 200 \text{ units}
\]

Now assume that as a result of JIT purchasing the company is able to decrease the cost of placing an order to only $10. Also assume that because of the waste and inefficiency caused by inventories, the true cost of carrying a unit in stock is $8 per year. The revised EOQ would be:

\[
E = \sqrt{\frac{2QP}{C}} = \sqrt{\frac{2(1,000)($10)}{$8}} = \sqrt{2,500} = 50 \text{ units}
\]

Under JIT purchasing, the company would not necessarily order in 50-unit lots since purchases would be geared to current demand. This example shows quite dramatically, however, the economics behind the JIT concept as far as the purchasing of goods is concerned.

Production Lot Size

The economic order quantity concept can also be applied to the problem of determining the economic production lot size. Deciding when to start and when to stop production runs is a problem that has plagued manufacturers for years. The problem can be solved quite easily by inserting the setup cost for a new production lot into the economic order quantity formula in place of the purchase order cost. The setup cost includes the labour and other costs involved in making facilities ready for a run of a different production item.

To illustrate, assume that Chittenden Company has determined that the following costs are associated with one of its product lines:
\( Q = 15,000 \) units produced each year
\( P = 150 \) setup costs to change production from one product to another
\( C = 2 \) to carry one unit in stock for one year

What is the optimal production lot size for this product line? It can be determined by using the same formula used to compute the economic order quantity:

\[
O = \sqrt{\frac{2(Q)(P)}{C}} = \sqrt{\frac{2(15,000)(150)}{2}} = \sqrt{2,250,000} = 1,500 \text{ (economic production lot size in units)}
\]

The Chittenden Company will minimize its overall costs by producing in lots of 1,500 units each. Tabular analysis of the form presented in Exhibit 14-8 can be used to provide a more flexible model for the planning of production lot sizes.

JIT systems are being touted as a total manufacturing system for repetitive manufacturing environments such as those used to produce food and beverages, electrical products, textiles, and automobiles. Small lot production and flexible manufacturing are key elements to the system. Distances in Canada may pose a problem for some industries but not necessarily for all. The seasonal nature of some businesses may preclude the use of JIT because additional production capacity is simply too costly to permit production only when the need is evident in the form of customer orders. However, the potential improvements in productivity and quality together with the reduction in needed investment in inventory make JIT production an option to be seriously investigated for manufacturers and processors.

JIT production philosophy, when it was originated, examined carefully the assumptions in economic production lot size analysis. The typical analysis as presented earlier assumes setup time is a known fixed cost, for example, \$150 per setup in the preceding example. JIT approached this production lot size problem by attempting to reduce setup costs to zero. If setup costs in the Chittenden Company example were \$0.0, the economic production lot size in units would be one, a JIT production approach. The less the setup cost, the smaller the production lots. Production approaches have been redesigned in some operations so that many different products can be manufactured at little or no setup costs. For example, a world-class automobile manufacturer has been noted as being able to change from one model to another in 2.5 minutes, a complete retooling operation.

ENDNOTES


Reorder Point and Safety Stock

We stated earlier that the inventory problem has two dimensions — how much to order and how often to do it. How often to do it involves what are commonly termed the reorder point and the safety stock, and seeks to find the optimal tradeoff between the second two groups of inventory costs outlined earlier (the costs of carrying inventory and the costs of not carrying sufficient inventory). First, we will discuss the reorder point and the factors involved in its computation. Then, we discuss the circumstances under which a safety stock must be maintained.

The reorder point tells the manager when to place an order or when to initiate production to replenish depleted stocks. It is dependent on three factors — the economic order quantity (or economic production lot size), the lead time, and the rate of usage during the lead time. The lead time can be defined as the interval between the time that an order is placed and the time that the order is finally received from the supplier or from the production line.

**Constant Usage during the Lead Time.** If the rate of usage during the lead time is known with certainty, the reorder point can be determined by the following formula:

\[
\text{Reorder point} = \text{Lead time} \times \text{Average daily or weekly usage}
\]

To illustrate the formula’s use, assume that a company’s economic order quantity is 500 units, that the lead time is 3 weeks, and that the average weekly usage is 50 units.

\[
\text{Reorder point} = 3 \text{ weeks} \times 50 \text{ units per week} = 150 \text{ units}
\]

The reorder point would be 150 units. That is, the company automatically places a new order for 500 units when inventory stock drops to a level of 150 units, or three weeks’ supply, left on hand.

**Variable Usage during the Lead Time.** The previous example assumed that the 50 units per week usage rate was constant and was known with certainty. Although some firms enjoy the luxury of certainty, the more common situation is to find considerable variation in the rate of usage of inventory items from period to period. If usage varies from period to period, the firm that reorders in the way computed earlier may soon find itself out of stock. A sudden spurt in demand, a delay in delivery, or a snag in processing an order may cause inventory levels to be depleted before a new shipment arrives.

Companies that experience problems in demand, delivery, or processing of orders have found that they need some type of buffer to guard against stock-outs. Such a buffer is usually called a safety stock. A safety stock serves as insurance against greater-than-usual demand and against problems in the ordering and delivery of goods. Its size is determined by deducting average usage from the maximum
usage that can reasonably be expected during a period. For example, if the firm in the preceding example was faced with a situation of variable demand for its product, it would compute a safety stock as follows:

- Maximum expected usage per week: 73.3 units
- Average usage per week: 50
- Excess: 23.3 units
- Lead time: × 3 weeks
- Safety stock: 70 units

The reorder point is then determined by adding the safety stock to the average usage during the lead time, in formula form, the reorder point will be:

Reorder point = (Lead time × Average daily or weekly usage) + Safety stock

Computation of the reorder point by this approach is shown both numerically and graphically in Exhibit 13-10. As shown in the exhibit, the company places a new order for 500 units when inventory stocks drop to a level of 220 units left on hand.

If management does not wish to assume the worst-case situation by using the maximum expected usage per week, then a slightly more complex calculation of the safety stock is necessary as shown in Exhibit 13-11 and based on the data that follow. Assume management makes the following estimates for a yearly period:

- Carrying cost per year, $1 per unit
- Stock-out cost per unit, $0.60
- Average usage per week, 50
- Orders placed per year, 12

<table>
<thead>
<tr>
<th>Demand</th>
<th>Probabilities</th>
</tr>
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<tbody>
<tr>
<td>80</td>
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<tr>
<td>120</td>
<td>0.06</td>
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<tr>
<td>140</td>
<td>0.20</td>
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<tr>
<td>150</td>
<td>0.38</td>
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<tr>
<td>160</td>
<td>0.20</td>
</tr>
<tr>
<td>180</td>
<td>0.06</td>
</tr>
<tr>
<td>220</td>
<td>0.05</td>
</tr>
<tr>
<td></td>
<td>1.00</td>
</tr>
</tbody>
</table>
Determining the Reorder Point — Variable Usage

Economic order quantity........ 500 units
Lead time ................................ 3 weeks
Average weekly usage ........... 50 units
Maximum weekly usage ........ 73.3 units
Safety stock............................ 70 units

Reorder point = (3 weeks × 50 units per week) + 70 units = 220 units.

These estimates reflect the uncertainty experienced by management when they face the various demand possibilities. The table of demand levels and corresponding probabilities presents how management has described the uncertainty they face. This description will, as we shall see, be incorporated in the safety stock calculation.

The calculation of the optimal safety stock begins by computing the various inventory quantities that the demand probabilities indicate could be satisfied by the safety stock. These quantities are the demand quantities in excess of the expected demand during the lead time period. Calculation a in Exhibit 13-11 illustrates the amounts. Each unit of safety stock inventory will be on hand for the year (the typical time period used), so the carrying costs per unit of inventory per year is used to determine the first cost element, the total carrying cost and the safety stock per year.
<table>
<thead>
<tr>
<th>Safety Stock Level in Units</th>
<th>Total Carrying Cost per Year</th>
<th>(b) Stock-Out in Units</th>
<th>(c) Stock-Out Cost per Order Time</th>
<th>(d) Number of Times Orders Placed</th>
<th>(e) Probability of Stock-Out</th>
<th>(d) Expected Stock-Out Cost per Year</th>
<th>(e) Total Cost per Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>-0-</td>
<td>0</td>
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<td>$6.00</td>
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<td>20</td>
<td>12.00</td>
<td>12</td>
<td>0.06</td>
<td>8.64</td>
<td>40.24</td>
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<td>30</td>
<td>40</td>
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<td>70</td>
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<td>12</td>
<td>0.00</td>
<td>0.00</td>
<td>70.00</td>
</tr>
</tbody>
</table>

a. Safety stock level is possible demand minus expected demand (e.g., 180 – 150 = 30). Carrying cost of safety stock is units times cost per unit to carry (e.g., 30 × $1 = 30).

b. Stock-out in units is possible demand minus expected demand minus safety stocks (e.g., 220 – 150 – 10 = 60; 180 – 150 – 10 = 20).

c. Stock-out cost per order time is stock-out in unit times stock-out cost per unit (e.g., 30 × $0.60 = $18.00; 40 × 0.60 = $24.00).

d. Expected stock-out cost per year is stock-out cost per time the order is placed, times the number of orders placed per year, times the probability of a stock-out each time (e.g., $6 × 12 × 0.20 = $14.40; $12 × 12 × 0.06 = $8.64). The probability of a stock-out is obtained from the data for various demand levels in excess of the expected amount of 150 plus the safety stock.

e. Total cost per year is the carrying cost of the safety stock plus the expected stock-out cost per year for the appropriate demand levels (e.g., $0.00 + $14.40 + $12.96 + $25.20 = $52.56; $30 + $14.40 = $44.40).

The second set of calculations computes the stock-out costs caused because demand exceeds the safety stock quantity. Column b in Exhibit 13-11 reflects the excess demand possibilities above the safety stock and the average demand during the lead time, in other words, the stock-out quantity. The stock-out in units is multiplied by the stock-out cost per unit of 60 cents to give the stock-out cost for each time an order is placed. Knowledge of the average inventory usage per year and the order size is used to determine the number of times orders are placed in a year. To determine the stock-out total costs, the stock-out cost per order is multiplied by the number of orders per year by the probability of each possible demand level to yield column d. The sum of the total carrying cost for the safety stock and the expected stock-out costs give the cost for each safety stock level. The lowest expected total costs provide the optimal level of safety stock. Notice that Exhibit 13-11 suggests 10 is the optimal level, with a total cost of carrying the safety stock of $40.24. The conservative maximum safety stock level of 70 suggested earlier had an annual cost of $70 in this illustration.
Perishable Products

Inventory problems for perishable products or services such as hotel rooms pose an interesting and somewhat different inventory problem. Basically, if too much or many are ordered, the cost of the inventory is similar to a carrying cost, while ordering too few has the cost of contribution foregone from the lost sale. A firm cannot sell what it does not have, while it loses what it purchased but did not sell.

Assume the following:

- Purchase cost $3 per unit.
- Selling price $5 per unit.

Remember:

- You cannot sell what you do not have.
- What you buy but cannot sell is lost.

EXHIBIT 13-12

<table>
<thead>
<tr>
<th>Inventory</th>
<th>0.10</th>
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<th>0.05</th>
<th>0.40</th>
<th>0.30</th>
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<td>$2</td>
<td>$3</td>
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<td>-0</td>
<td>5</td>
<td>10</td>
<td>3.25*</td>
</tr>
</tbody>
</table>

Note: Four units is the optimum level of inventory because it has the greatest profit, $4.75.

*Profit × probability; for example, \[0.10(-10) + 0.15(-5) + 0.05(0) + 0.40(5) + 0.30(10)\] = $325.

Carefully review the calculations in Exhibit 13-12 to see how the information can be combined to select the optimum inventory level.

For perishable products, each unsold unit of inventory generally is lost; at best, it may receive a rebate from the inventory supplier. Comparison of the total revenue based on demand quantities time selling prices, with the purchase cost of the inventory adjusted for any rebates or returns, determines the cell profit or loss for each combination of demand and inventory shown in Exhibit 13-12. Because the demand levels are uncertain, each possible net income before income taxes for the particular inventory level is multiplied by the probability of the demand level to yield the expected profits. The maximum expected profit is considered to be the indicator of the optimum inventory level.

9.1 Cost concepts for decision-making

Learning objective

- Identify sunk costs, and explain why they are not relevant in decision-making based on a general rule for distinguishing between relevant and irrelevant costs. (Level 1)

**LEVEL 1**

Decision-making is a complex activity involving many different factors. In this module, you consider short-run decisions. The term "short run" implies that the time of payoff is short enough that the decision maker can safely ignore the time value of money.

**Relevant costs** are the key to decision analysis. Sunk costs and non-differential costs can, and usually should, be ignored because they are irrelevant to decision-making.

Future costs that do not differ between alternative situations are not relevant. You must distinguish between analyzing only differential effects and analyzing the new situation as a whole. Most of the illustrations in the textbook correctly suggest a focus on differentials. However, you may find that it is useful (and easier) to completely analyze the old and new situations, rather than the differentials. Study Exhibit 12-1. A good check is provided when the difference, as well as the old and new situations, can be analyzed independently.
9.2 Adding and dropping product lines

Learning objective

- Prepare an analysis showing whether a product line or other organizational segment should be dropped or retained. (Level 1)

LEVEL 1

According to economic theory, a product line should be dropped if the differential (marginal) revenue does not cover the differential (marginal) costs. Note how this basic tenet of microeconomics is applied in practice. There is a need to analyze qualitative factors as well as the quantitative difference in income.

In the text on page 570, notice the complexity introduced by the idea of avoidable fixed costs where contribution lost is compared to fixed costs avoided. If the loss is greater than the savings and ignoring qualitative factors, the company will be economically hurt by dropping the product line. Exhibit 12-3 presents both the total and differential approaches. "Beware of allocated fixed costs" is a good warning. Arbitrary cost allocations may create problems in decision-making for users of accounting information.

Segment margins (Exhibit 12-4) avoid arbitrary allocations and thus help present the merits of a product line. However, if space or capacity is a constraint, it may be possible to find a line of products that will generate more segment margin than the present line. This is considered a qualitative factor and the idea leads to linear programming analysis, which has a quantitative solution. A second qualitative factor is the interaction of one product line with another (the "magnet"). This is why loss leaders are used in marketing.
9.3 The make-or-buy decision

Learning objective

- Explain make-or-buy decisions, and prepare a make-or-buy analysis. (Level 1)

LEVEL 1

Vertical integration, a major strategy consideration in running a business, entails a make-or-buy decision. Notice the qualitative factors that the analysis ignores but the decision maker cannot. If the long run (time value of money) is introduced, some of these qualitative factors are captured. Decision analysis attempts to narrow the focus to a few variables that can be quantified, and the process is unlikely to capture all the relevant aspects of the decision situation. Consequently, the decision maker must take care in drawing conclusions from such an analysis.

Exhibit 12-5 shows a list of common differential costs if alternative uses for the space are ignored, as mentioned with the product analysis. The analysis concentrates on the differential costs of making or buying. The result is calculated by taking the difference.

Opportunity costs are used to consider the effect of an alternative use of the space. Opportunity cost, as used here, refers to the differential gain (segment margin) foregone by not using the space for the alternative purpose. This lost contribution to income is a differential cost of producing units because it is an extra cost of using the space.
9.4 Computer illustration 9.4-1: Relevant costs

Learning objective

● Construct a worksheet to analyze the relevant costs of a decision to retain or close a store. (Level 1)

LEVEL 1

This computer illustration demonstrates a typical decision analysis used by managers.

Material provided

● A partially completed worksheet M9P1
● A solution worksheet M9P1S

Required

Solve Requirement 1 of Problem 12-22 (pages 605-607) using the following procedure.

Procedure

1. Open the file MA1M9P1.
2. Study the layout of the worksheet. Rows 6 to 31 have been used as a data table.
3. To save time, column C has been entered for you in the downtown store closure analysis table. Complete columns D and E of the analysis, using the additional information given in the problem, (a) to (g).
4. Save your worksheet.
5. You should obtain a net loss increase of $9,800 if the downtown store is closed. If you do not obtain this result, print a copy of your worksheet and compare your results with the solution sheet M9P1S.
9.5 Special orders

Learning objective

- Prepare an analysis showing whether a special order should be accepted. (Level 1)

LEVEL 1

Since a special order is a one-time order that is not expected to become a part of the company's normal business, the special order is not likely to affect the existing fixed costs for the business. Therefore, the existing fixed costs should be ignored. The only new costs will be the variable costs and any fixed costs relating to the new order. These costs should be compared to the projected revenues to determine whether the special order should be accepted.
9.6 Utilization of a constrained resource

Learning objective

- Determine the most profitable utilization of scarce resources. (Level 2)

LEVEL 2

Analysis of the utilization of scarce resources can be simple or complex. In this course, a simple form of analysis is used. The analysis given in the Mountain Goat Cycles example uses contribution per unit of constraint (machine-hour) multiplied by the total constraint capacity to rank the benefits of that alternative. This analysis is extended to other constraining factors such as advertising or floor space, and is a fundamental tenet of running a business.
9.7 Joint product costs and the contribution approach

Learning objective

- Prepare an analysis showing whether joint products should be sold at the split-off point or processed further. (Level 1)

LEVEL 1

Study the definitions of **joint product cost** and **split-off point** (Exhibit 13-6). Allocation of the costs for costing purposes is done on the basis of the relative sales value at the split-off point or the end product point if no split-off value is available. The allocation is not done for decision purposes.

Whether to sell or process further is the decision problem. In terms of the textbook example, whether to buy or not to buy the "pig" is a separate question based on the total revenue from the "pig" versus its total cost of acquisition and processing. To process further, the incremental (differential) revenue from further processing less the incremental processing costs must be positive. The differential revenue is the ultimate sales price less the sales price at the split-off point. Exhibit 13-7 illustrates the analysis.

Consider the following problem. The common (joint) cost of wool was allocated on the basis of the relative sales value of the different "grades" that can be produced from the wool. A building is allocated to various products on the basis of the physical production passing through it; the case is similar for a machine or for service departments. Why? Certainly, the cost of the wool would not be allocated on the basis of the weight of various grades, yet many other common costs are so allocated (that is, on the basis of physical inputs or outputs rather than the relative value of inputs or outputs).

The reason for this common difference in practice is far from obvious. Plantwide as opposed to departmental overhead allocation is one attempt to get a relative value concept of cost allocation. For example, costing different meals would also allocate the total cost of a cafeteria based on relative value to producing departments in a company because departments would be charged differently for different types of meals.

The answer to this problem could lie in the financial accounting concept of materiality and the homogeneity of the services provided by the common cost. If all meals had the same relative value, physical separation of the common cost would be adequate. If all meals used the same ingredients, why use a value relationship to separate the cost? If ingredients or labour differ, we allow for it by using a value relationship.

A joint product with a relatively small value and of a secondary importance to the manufacturer is often termed a by-product. Wood chips, sawdust, and certain animal parts are common examples. Because of materiality, costs are not allocated to by-products for costing purposes as they are to joint products. Often, the inventory of by-products is carried in terms of quantities only, and revenue less costs of disposal (the net realizable value of the by-product) may be credited to cost of goods sold or cost of goods manufactured, or even overhead in the period when the by-product is sold.

If the inventory of by-products is valued, net realizable value is used and a credit made in the same way as for sales of regular products. Materiality here permits the rather loose theoretical treatment of by-products. The decisions with respect to by-products concern the issues of whether they should be sold (possibly involving disposal costs or even further processing) or simply dumped as waste. The relevant information is the net realizable value of the by-product plus the cost of waste removal saved by selling the by-product. As long as this amount is greater than zero, the by-product should be sold. As in joint product decisions, the common costs are completely irrelevant to the decision.

To conclude your study of relevant costing, read the material on page 634 related to activity-based costing. Note that activity-based costing does not change the nature of sunk costs just because the costs are traceable to an activity.

Chapter summary

This topic marks the end of the textbook coverage of relevant costing. To ensure you understand this material and the corresponding terminology, read the summary on page 585, and work through the review problems on pages 585-587.
9.8 Economic order quantity (EOQ) and the reorder point

Learning objective

- Compute the optimum inventory level and order size. (Level 1)

LEVEL 1

Inventory management can be complex and, as a result, very costly. Inventory management usually begins with a system that subdivides inventory into categories A, B, and C. Category A represents a small number of items that are very important in terms of value, either of cost or sales. Category B represents a larger number of items that are somewhat less important in total value. Category C represents the least important items in terms of value but largest in terms of number. The A-B-C approach is used to determine where increased efforts are likely to pay off.

Most audit textbooks provide a reasonable exposition of how to control items classed as C and perhaps also those classed as B. This module focuses on class A items (high in value, small in number).

First, note the costs associated with inventories and how they are classified into three groups (Reading 9-1). Unlike costs considered relevant for some of the earlier types of decisions, costs associated with alternatives for the amount of inventory to be carried are not isolated in the usual accounting system. They must be specifically sought out through analysis of the accounting records and from other operating information. As usual, some are opportunity costs.

The decision maker’s alternatives are described in terms of the possible average levels of inventory to be maintained. The choice is expressed indirectly in terms of how much to order at a time or produce in a run. For a given annual demand, this can be readily translated into the required number of orders per year as well as the frequency of an order. More importantly, it determines the average amount of inventory on hand.

Begin the analysis with the following cost formula:

\[ T = P \left(\frac{Q}{E}\right) + C \left(\frac{E}{2}\right) \]

where:

- \( T \) = the total of order costs \( [P(Q/E)] \) plus the carrying cost of the order while the units are in inventory \( [C(E/2)] \) per period (usually a year); \( T \) is a cost for whatever period is represented by \( Q \), so care must be exercised on how \( C \) is specified (that is, it must be for the same period as \( Q \)).
- \( P \) = cost of placing one order (that is, the total ordering costs that are relevant are those directly variable with the number of orders placed, not the number of units ordered).
- \( C \) = a constant periodic carrying cost per unit of inventory (that is, relevant total carrying costs are variable with the number of units ordered).
- \( Q \) = quantity needed in units for period specified.
- \( E \) = order size in units (what you are trying to find).

\( E/2 \) is the average number of units on hand during the period. To illustrate this formula, assume that the order size is 10 units. When the order is first received, there will be 10 units on hand. Just before the next order is received, there will usually be zero units in inventory. Therefore, the average number of units on hand throughout the period is 5, the average of 10 and 0, or \( E/2 \).

The costs for \( P \) and \( C \), which are “fixed” with respect to the activity base (number of orders and number of units ordered respectively), are not relevant to the model.
Exhibit 13-8 (Reading 9-1) shows a tabular version for calculating \( T \) as a function of the various order sizes. This table is useful for practice and adapts well to the use of computer spreadsheets.

The formula for the economic order quantity is obtained by solving the minimization of total order cost \( T \) for various order sizes \( O \). It is of limited usefulness because of the restrictive assumptions, particularly the assumption of no change in purchase cost as quantity changes and the assumption of no stock-out costs being incurred.

If quantity discounts are present, the total order costs should be modified to include the effects of changes in purchase costs. The easiest way to do this is to add purchase costs per period to the formula for \( T \):

\[
T = \text{carrying cost} + \text{order costs} + \text{purchase costs}
\]

A table is needed and is constructed by adding a new row for annual purchasing costs for each order size. Some forms of the table insert the difference in prices (discounts foregone) for each order quantity to give the annual loss for each order level. The smallest order sizes have the greatest cost, which means these orders have to bear the extra cost of lost purchase discounts.

If periodic demand is not known, if usage is not regular throughout the period, if lead times vary, or if multiple deliveries are necessary for each order, then careful tabular analysis of the problem is necessary because the basic analysis tends to ignore these matters.

Management may find it is not worthwhile to avoid stock-out costs totally. It may be prepared to incur some level of these costs because they are outweighed by savings from different order sizes. Stock-out costs are the third category of costs listed on page 1 of Reading 9-1. Many of them represent opportunity costs resulting from unavailable inventory, while some represent real out-of-pocket costs of making up the shortage quickly. Items 3 and 5 are of this latter type, along with an obvious cost not included in the list — the cost of placing the “extra” order in an emergency.

The economic order quantity formula in the textbook could be expanded to include the stock out costs as a variable but the extension is complex and somewhat artificial.

To make decisions about the length of production runs, the simple case uses a tradeoff between the cost of setting up runs for a period \( [P(Q/O)] \) and the cost of carrying the inventory for a period \( [CO/2] \), where \( P \) is now the set-up cost for each run and \( O \) is the size of the production run.

Realistically, a more complex analysis is necessary, which recognizes that during the production cycle, inventory is being both built up and used, and the average level of inventory thus depends on the rate of production.

JIT systems may affect the EOQ calculation in two ways. The cost of placing an order may be less in a JIT system because of more frequent orders. The cost of carrying inventory may be lower because the inventory is always the supplier's most recent stock. Therefore, JIT proponents argue that there is less risk of obsolescence.

The resulting calculation on page 5 of Reading 9-1 shows that the economic order quantity may be lower in a JIT system. This conclusion is logical because JIT means that ordering is constant. You would expect a company that orders frequently to have smaller order sizes compared to a company that orders infrequently.

**LEVEL 2**

The textbook material on safety stock and reorder points (Reading 9-2) deals with the questions of when to order and how much inventory to keep on hand to cover unexpected demands during the waiting time. **Reorder point**, for a single order case, is lead time in days (or weeks) multiplied by average demand per day (or week) in units, plus safety stock.

Safety stock decisions are reasonably complex ones, trading off carrying costs of safety stock with stock-out costs. The calculation on page 2 of the reading assumes a worst-case situation, that is, maximum demand during the lead time so that again no tradeoff with stock-out costs is considered, since stock-outs will be zero.

Carefully review the examples in Reading 9-2, which introduce the effects of probabilities and expected stock-out costs.

**Activity 9.8-1** Economic order quantity (EOQ) demonstration
Work through this activity to reinforce your understanding of the economic order quantity concept.
Module 9 summary

This module addresses decision-making issues.

Whatever decision a manager has to make, management accounting plays a central role in providing only information that is relevant to that decision. Topic 9.1 discusses the criteria of relevant costs.

Topic 9.2 deals with the decision of adding or dropping a product line, a decision that makes use of the tool of segment reporting and examines capacity issue and possible interactions with other existing product lines.

Topic 9.3 focuses on make-or-buy decisions and introduces the use of the concept of opportunity cost of possible capacity freed by a decision to buy from outside.

Extending the decision discussed in Topic 9.2 above, Topic 9.4 explores the decision to retain or to close a store.

The special order or only-one-time order decision is the object of Topic 9.5, a decision that focuses on incremental revenues and incremental costs.

Bottleneck is a common concern to many businesses, and Topic 9.6 examines a decision involving scarce resources that is based on the contribution margin generated per unit of the constrained resource.

Topic 9.7 introduces the notion of joint products and raises the issue of selling them immediately at the split-off point or processing them further.

To conclude, Topic 9.8 is devoted to the decision of timing of and order size of inventory purchases.