Chapter 15
The Tools of Finished Goods Inventory Management:
Traditional Methods versus Holistic Methods

Part I: Traditional Methods

APICS Dictionary Inventory Terms

• **Inventory**—Those stocks or items used to support production (raw materials and work-in-process items), supporting activities (maintenance, repair and operating supplies), and customer service (finished goods and spare parts). Demand for inventory may be dependent or independent. Inventory functions are anticipation, hedge, cycle (lot size), fluctuation (safety, buffer, or reserve), transportation (pipeline), and service parts. P. 57.

• **Inventory management**—The branch of business management concerned with planning and controlling inventories. P. 58.

APICS Dictionary Inventory Terms

• **Inventory ordering system**—Inventory models for the replenishment of inventory. Independent demand inventory ordering models include but are not limited to fixed reorder cycle, fixed reorder quantity, optional replenishment, and hybrid models. Dependent inventory ordering models include material requirements planning, kanban, and drum-buffer-rope. P. 58.
**APICS Dictionary Inventory Terms**

- **Independent demand**: The demand for an item that is unrelated to the demand for other items. Demand for finished goods, parts required for destructive testing, and service parts requirements are examples of independent demand. P. 54.

- **Dependent demand**: Demand that is directly related to or derived from the bill of material structure for other items or end products. Such demand are therefore calculated and need not and should not be forecasted… P. 31.

**Is Inventory an Asset or a Liability?**

- On the company balance sheet, inventory is shown as an asset.

- But inventory is considered a liability in most Just-in-Time environments.

- Finished goods inventories exist in several locations—in retail stores, in wholesalers’ and distributors’ warehouses, and in manufacturers’ warehouses. For seventy-five years or more these inventories have been managed by decision rules that consider only one location.

**Why does Finished Goods Inventory Exist?**

- Simply put, finished goods inventory exists to help retailers compete for business among the people who want the product immediately.

- Where finished goods inventory exists, it exists at three levels,
  - the retailer,
  - the wholesaler, and
  - the factory.

- (It also exists in transit, which might be negligible in some cases, but is very significant in others such as automobiles made in Japan and shipped to the United States.)
Finished Goods EC

A To make more money now as well as in the future
B Satisfy customer demand for our product
C Minimize our costs
D Keep inventory on-hand
D' Not keep inventory on-hand

ABC Classification System

- The demand volume and value of items vary in any firm
- Classify inventory into 3 categories, typically on the basis of the dollar value to the firm

<table>
<thead>
<tr>
<th>CLASS</th>
<th>PERCENTAGE OF UNITS</th>
<th>PERCENTAGE OF DOLLARS</th>
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<td>70 - 80</td>
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<tr>
<td>B</td>
<td>30</td>
<td>15</td>
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<tr>
<td>C</td>
<td>50 - 60</td>
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Sample ABC Classification

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<th>Annual Volume</th>
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<td>190</td>
</tr>
<tr>
<td>2</td>
<td>$350</td>
<td>40</td>
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<td>$30</td>
<td>100</td>
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<td>20</td>
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### Sample ABC Classification

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<th>Dollar Volume</th>
<th>Part</th>
<th>Cost</th>
<th>Annual Volume</th>
<th>Dollar Volume</th>
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<td>$320</td>
<td>50</td>
<td>$16,000</td>
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<td>$350</td>
<td>40</td>
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<td>$1,700</td>
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### Sample ABC Classification

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<tr>
<th>Part</th>
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<th>Annual Volume</th>
<th>Dollar Volume</th>
<th>% of total</th>
<th>Quam %</th>
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<tbody>
<tr>
<td>8</td>
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<td>50</td>
<td>$16,000</td>
<td>22.54%</td>
<td>22.54%</td>
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<td>$14,000</td>
<td>19.72%</td>
<td>42.25%</td>
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<tr>
<td>1</td>
<td>$60</td>
<td>190</td>
<td>$11,400</td>
<td>16.06%</td>
<td>58.31%</td>
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<tr>
<td>9</td>
<td>$510</td>
<td>20</td>
<td>$10,200</td>
<td>14.37%</td>
<td>72.68%</td>
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<tr>
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<td>$80</td>
<td>60</td>
<td>$4,800</td>
<td>6.76%</td>
<td>79.44%</td>
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<td>$3,600</td>
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<td>90.00%</td>
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<tr>
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<td>100</td>
<td>$3,000</td>
<td>4.23%</td>
<td>94.23%</td>
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<tr>
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<td>120</td>
<td>$2,400</td>
<td>3.38%</td>
<td>97.61%</td>
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</tbody>
</table>
| 7    | $10  | 170           | $1,700        | 2.39%      | 100.00%

### Two Questions Must be Answered

1. How much inventory should be ordered?
2. When should the order be placed?
Two Basic Approaches

- Fixed-quantity, Variable-period (continuous review systems)
- Variable-quantity, Fixed-period (periodic review system)

How Many to Order (Continuous Review Systems)

- This approach is based on the recognition that there are costs associated with inventory:
  - Ordering (or setup) costs
  - Holding (carrying) costs
  - Item cost

EOQ Cost Model

\[
\text{Annual ordering cost} = \frac{SD}{Q}
\]
\[
\text{Annual carrying cost} = \frac{HQ}{2}
\]
\[
\text{Total cost} = \frac{SD}{Q} + \frac{HQ}{2}
\]
**EOQ Cost Model**

- **Annual cost ($)**
- **Total Cost**
- **Slope = 0**
- **Carrying Cost = \( HQ \)**
- **Ordering Cost = \( \frac{SD}{Q} \)**
- **Minimum total cost**
- **Optimal order EOQ**
- **Order Quantity, Q**

**EOQ Formula**

Proving equality of costs at optimal point:

\[
\frac{SD}{Q} = \frac{HQ}{2}
\]

\[
Q^* = \frac{2SD}{H}
\]

\[
EOQ = \sqrt{\frac{2SD}{H}}
\]

**EOQ Assumptions**

- Demand occurs continuously at a constant rate.
- All of an order is received at once.
- Price is independent of quantity.
- Supply lead time is 0.
- Replenishment of one item is independent of replenishment of all other items.
- There are no constraints on cash or space.
**EOQ with Quantity Discounts**

Price per unit decreases as order quantity increases

\[ TC = \frac{SD}{Q} + \frac{HQ}{2} + PD \]

Where:

\( P \) = per unit price of the item

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**When to Place the Order** (Continuous Review Systems)

- The answer to this question is usually answered by the Reorder Point.
- EOQ assumes that lead time is zero, but that is not always the case.
- If we know that it will take 5 days for an order to be delivered after it is placed, then how do we know when to place the order?
- The answer lies in knowing something about the rate of demand.

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**The Inventory Order Cycle**

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The Reorder Point

When to Order

Reorder Point is the level of inventory at which a new order is placed:

\[ R = dL \]

where

\( d \) = demand rate per period

\( L \) = lead time

What Happens if Demand and/or Lead Time are not Constant?

If demand is faster than expected during lead time, we stock out.

If lead time longer than expected, we stock out.

Such occurrences are handled by holding safety stock.
Safety Stock

- The amount of safety stock needed can be determined statistically.
- If the mean and standard deviation of demand and of lead time are known (or can be estimated), then an amount of safety stock can be determined to provide a desired level of service.
- Level of service – a measure (usually expressed as a percentage) of satisfying demand through inventory or by the current production in time to satisfy the customers’ requested delivery dates and quantities. P. 62.

Calculating an Economic Order Quantity and Reorder Point

Assume that annual demand is 200 units, average cost of order preparation is $25, inventory carry cost percentage is 30%, and unit cost is $50.00. What is the economic order quantity?

\[
EOQ = \sqrt{\frac{2SD}{H}} \\
\text{or} \quad EOQ = \sqrt{\frac{2SD}{IC}}
\]

Therefore: 

\[
EOQ = \sqrt{\frac{2(25)(200)}{30(50)}} = 26 \text{ units}
\]

Demand rate (d) = 200 units per year/50 weeks = 4 units per week

Let safety stock = 2 weeks of demand or 8 units.

If order lead time is 1 week, then ROP = 4(1) + 8 = 12 units

Other Calculations

Orders placed per year = Annual demand / order size
= 200 units / 26 units
= approximately 8 orders

Annual order cost = 8 orders X $25 per order
= $200

Average inventory = 1/2 EOQ + SS
= 1/2 (26) + 8 units
= 21 units

Average inventory inv. = 21 units X $50
= $1050

Carrying cost per year = (carrying cost % X cost) (1/2 EOQ + SS)
= (30 X $50) X (26/2 + 8)
= $315

Inventory turns at cost = Sales at cost / Ave. Inventory
= (200 units X $50 each) / $1050
= 9.26 turns
Alternate Continuous Review Systems

- Continuous review systems require an expensive perpetual inventory system.
- Two alternate continuous review systems:
  - Two-Bin system
  - Min-Max system

Min-Max Periodic Review

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Max.</th>
<th>Min.</th>
<th>Safety stock</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead time</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Order interval</td>
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<td></td>
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<tr>
<td>Order Interval</td>
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<td></td>
</tr>
<tr>
<td>Order Interval</td>
<td></td>
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</tr>
</tbody>
</table>

Periodic Review System

- This system is the opposite of a continuous review system having a fixed-interval and variable quantity.
- Inventory is reviewed on a fixed cycle, each time ordering the amount that has been sold since the previous review.
The Inventory Cycle in a Periodic Review System

Time-Phased Order Point (TPOP)

• EOQ assumes a constant rate of demand;
• However, many products exhibit variation in demand due to:
  – Random variation
  – Seasonality
  – Cycles
  – Trends

TPOP Record

<table>
<thead>
<tr>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Forecast</td>
<td>10</td>
<td>10</td>
<td>20</td>
<td>30</td>
<td>50</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>Receipts</td>
<td>20</td>
<td>30</td>
<td>20</td>
<td>0</td>
<td>-30</td>
<td>-80</td>
<td>-130</td>
</tr>
<tr>
<td>On-Hand Planned Release</td>
<td>20</td>
<td>30</td>
<td>20</td>
<td>0</td>
<td>-30</td>
<td>-80</td>
<td>-130</td>
</tr>
</tbody>
</table>

Assuming a safety stock of 0 and an order lead time of 1 month, how many should be ordered and when should the order be released?
### TPOP Record

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<tr>
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<tbody>
<tr>
<td>Forecast</td>
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</table>

Assuming a safety stock of 0 and an order lead time of 1 month, how many should be ordered and when should the order be released?

Release 30 in Sept., 50 in Oct., and 50 in Nov.