M O D U L E

II

Independent Demand Inventory Systems

Learning Objectives

After completing this module, you will be able to

- Describe the four major types of manufacturing environments
- Define the three types of manufacturing processes
- Describe the major independent demand systems

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INVENTORY INFORMATION SYSTEMS

In this module we will look at independent demand inventory information systems. Dependent demands models will be discussed in Module VI.

Before going any further, consider the following:

- The choice of the appropriate model and formula must be consistent with the overall business plan and objectives, and with the strategies for research and development (R&D), marketing, finance and manufacturing. The inventory system should be included in the manufacturing strategy, which primarily supports the marketing strategy and secondarily the R&D and finance strategies.

- The manufacturing environment that the inventory system will support must be taken into account. These manufacturing environments include build-to-stock, build-to-order, engineer-to-order, and assemble-to-order, and are discussed in this module.

- Nonmanufacturing environments (retailers, wholesalers, banks, hospitals, etc.) must also consider how inventory levels impact their business.

- The inventory information system has to fit the volume variety matrix discussed later in this module.

INDEPENDENT DEMAND MODELS

Independent demand models are methods to manage items whose demand is influenced by customer demand or demand from outside of the company control.

Independent demand systems are used to determine levels of finished goods inventory. This method is used by retail, wholesale and manufacturing companies. Even banks use this system to determine the level of paper stock to be carried to support the manufacture of checks and other legal documents. Hospitals must inventory medical supplies, bed linens, instruments, etc.; shelf lives in these situations have a major impact on inventory levels.

The *independent demand inventory system* has five different models or formulas.

#1. Fixed Reorder CYCLE Inventory Model

#2. Fixed Reorder QUANTITY Inventory Model

#3. Optional Replenishment System

#4. Joint Replenishment System

#5. Forecasting (discussed in Module III)

Following is a discussion of each type of independent demand system.

#1. Fixed Reorder CYCLE Inventory Model

This independent demand model places a "fixed order quantity" on a predetermined time schedule (daily, weekly, etc.).

The actual order quantity will vary from order to order based on how many units have shipped. A maximum inventory level is established based on experience, budget or targeted inventory levels.

The order quantity will be the difference between what was used during the period and the maximum (targeted) inventory. For example, if 500 units are on hand and the maximum targeted inventory is 1500 units, the order quantity would be 1000 to replace the items shipped during the period.

#2. Fixed Reorder QUANTITY Inventory Model

A variation to the Fixed Reorder CYCLE Inventory Model is the Fixed Reorder QUANTITY Model. In this model a fixed quantity is established, usually using the economic order quantity (EOQ) formula described in Module III. This module uses a fixed quantity rather than the fixed time period described in the Fixed Reorder CYCLE method.

The fixed order quantity is placed every time the inventory reaches a predetermined order point. This order point is set at a level whereby there is sufficient inventory to cover the demand from the time material is ordered from the supplier until it is received in the warehouse.

ROP = Reorder Point

DLT = Forecast Demand Through the Lead Time

SS = afety Stock*

DMLT **=** Demand During Manufacturing Lead Time

$$\mathbf{ROP=DLT+SS}$$

A variation to this formula is called the "double reorder point formula." This formula is used in determining order quantities in combined manufacturing and distribution environments.

The formula for double reorder point is shown below:

$$\textbf{Order point 1 } (\mathbf{OP_1})\mathbf{=DLT+SS}$$

$$\textbf{Order point 2 } (\mathbf{OP_2})\mathbf{=OP_1+DMLT}$$

*The amount of safety stock carried for an inventory item in a periodic review system depends on the amount of variation in demand (aka forecast error) and the desired level of on-time shipments. (Safety stock calculation is covered in Module III.)

Reorder Point with Safety Stock

The traditional "saw-tooth diagram" in Figure 2.1 graphically shows the reorder point formula.

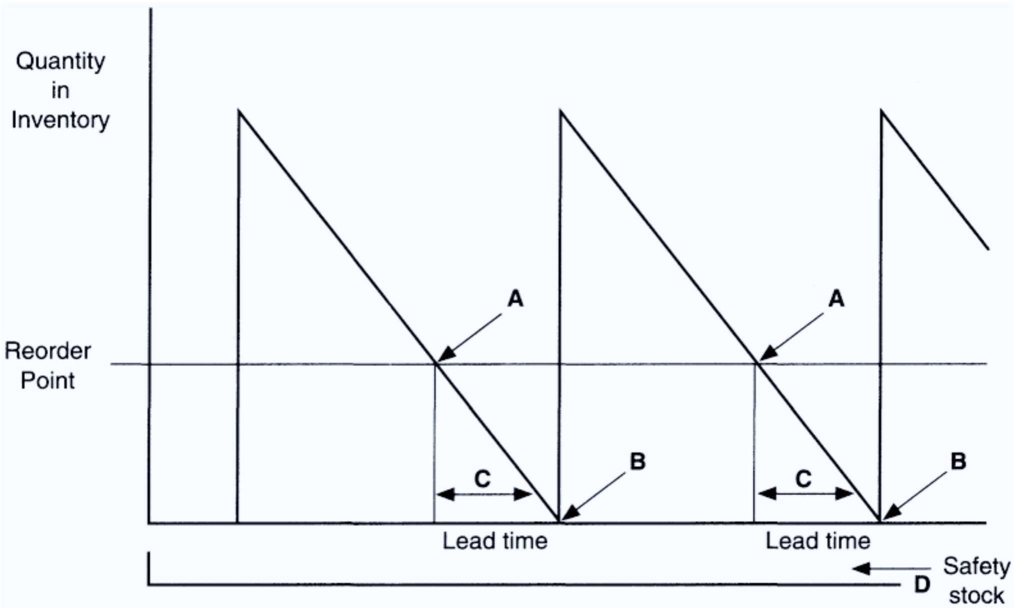


Figure 2.1: A Reorder Point with Safety Stock

A = Reorder Point—The point at which an order must be placed so it can be received before the inventory level gets to zero

B = Point at which a new order is received and the on-hand balance is increased by the order quantity

C = Lead time before the order is received

D = Safety stock carried to buffer against shortages and stockouts

In this system, inventory levels are reviewed periodically and all orders are placed at one time, often for all items in stock, to replenish the inventories up to some target level. This approach is applicable especially in retail businesses where goods are often ordered from a common source and where it is not feasible to keep perpetual inventory records. However, modern point-of-sale devices make possible perpetual inventory records for retailers in many situations today.

EXERCISE 1: Calculations

Using the following information about a regional warehouse that uses a double order point system, calculate the order points and reorder points. *See page 111 in the back of the book for the answers.*

Average weekly demand	2,000 units
Safety stock	200 units
Manufacturing lead time	3 weeks
Replenishment lead time	2.0 weeks

#3. Optional Replenishment System

This is a type of order point replenishment system where the minimum is the order point and the maximum is the level the inventory is not to exceed. The order quantity is variable and is calculated by subtracting the on-hand inventory from the maximum inventory, as the result falls below the minimum quantity. The min-max system is used commonly for low dollar volume items ("C" parts). It prevents ordering items in very small quantities. It is also useful when periods of low demand are anticipated or where it is desirable to use up current quantities of stock before replenishing, such as for items subject to spoilage or deterioration. The main advantage of this system is its simplicity.

#4. Joint Replenishment System

A joint order in purchasing is an order in which several items are combined to obtain volume or transportation discounts. Joint replenishment happens when items kept in the same inventory are ordered from one supplier. In production situations, it may be the case that multiple items are produced from a single work center or from a single major setup operation at a work station, with only minor setups needed for different items within a group. Some of the benefits achieved from joint replenishment in these situations are listed on the following page.

- *For purchased items:*
  - Transportation economies
  - Reduced order costs
  - Discounts based on order value
  - Accounting efficiencies achieved through reduction in paperwork
- *For manufactured items:*
  - Minor, rather than major, setups
  - Reduced setup time and cost
  - Reduced paperwork
  - More effective scheduling

Visual Review Systems

The visual review system (VRS) is completed by walking up and down aisles of inventory and visually scanning and, if necessary, counting on-hand inventory to determine reorder quantities.

A common VRS is the two-bin system. This method uses two storage locations with stock of the same item. When one location, or bin, becomes empty, a replenishment order is placed to refill it while material is being used from the second bin. This method is used frequently for low-value items that are stocked on the manufacturing floor.

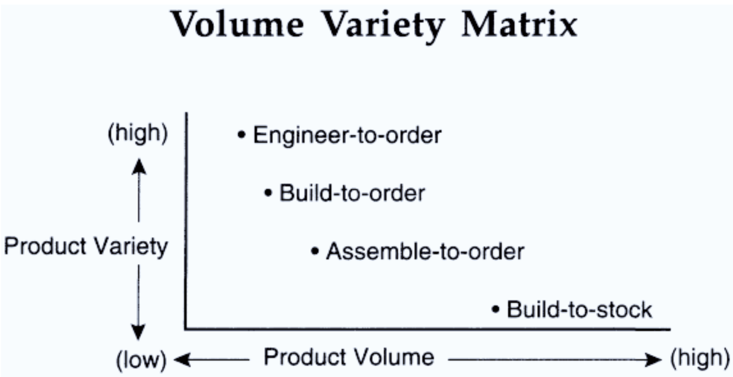
Time-Phased Order Point (TPOP)

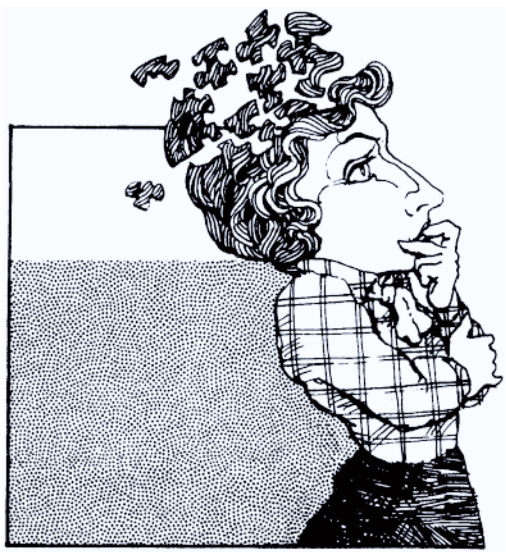
Time-phased order point is a technique that has been borrowed from Material Requirements Planning (MRP) logic as a means to determine when replenishment orders must be placed to ensure a continuous supply of goods. The logic of TPOP is illustrated in Module V.

ENVIRONMENTS AND THEIR EFFECTS ON INVENTORY MANAGEMENT

Business environments often determine the type of inventory control systems needed in various industries. Following is a brief overview of the major types of business environments and their impact on each type of inventory management consideration.

The Volume Variety Matrix below illustrates that when product variety increases, the product volume decreases. The chart on the following page expands on this.



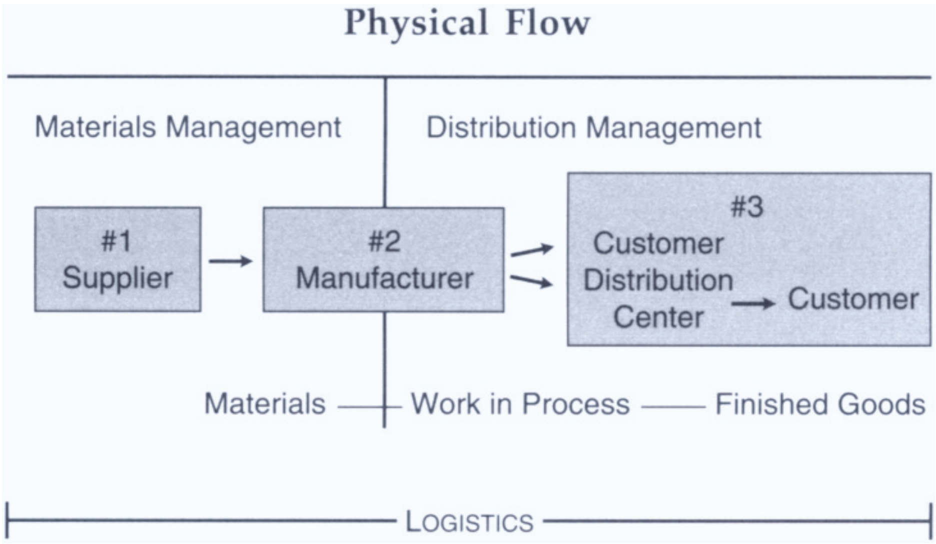


Review of Business Environments

Type of Business Environment	Description	Impact on Inventory
Engineer-to-order	• Requires unique one-of-a-kind engineering design • Unique bill of materials and part # • Work does not begin until customer specifications are complete • Very long lead time • One-of-a-kind products • Huge profit margin per unit	• No finished goods and little or no raw material until the customer specifications are complete
Build-to-order	• More products than engineer-to-order; however, volumes are very low • Customer lead times are long, but not as long as engineer-to-order • High profit margin per unit	• No finished goods • Raw material and work-in-process inventories • Safety stock carried for long lead time items
Assemble-to-order	• Fewer products than build-to-order, but volumes are higher • Build to forecasted options • Assemble option to customer specification • Use of planning bills • Medium profit margin per item	• Little if any finished goods • Inventory based on option forecast • Raw material held, especially for long lead time items
Build-to-stock	• Very low product variety, high product volume • Build to forecasted demand of independent items • Buffer for forecast error must be calculated • Low profit margin per item	• Inventory carried at the finished goods level • Emphasis on instant availability
Wholesale	• Buy from manufacturers and sell to retailers • Must vie for shelf and floor space • May do some repackaging • Provides services of bulk storing and quick delivery	• Primarily carry finished goods
Retail	• Emphasis on service and merchandising products provided by manufacturer • Provide space to display wide variety of products available to customer instantly	• Carry only finished goods
Others: Banks, insurance	• Provide service relating to checks and other legal documents	• Combination of preprinted form and assemble-to-order (checks) • Raw material (paper) held by printer
Hospital	• Service requires medical supplies, linens, etc.	• Linens and other medical supplies

ORDER CYCLES AND LEAD TIMES

The figure below shows how three major information systems tie in with the actual physical flow of goods.



The three major information systems are customer order processing (customer orders), manufacturing order processing (work orders) and supplier order processing (purchase orders).

- **Customer Order Processing Time**

  The customer order processing begins with order entry—either directly into the master schedule, or first through an order entry module that checks for order correctness, credit status, etc. and then into the master schedule.

- **Manufactur ing Order Processing Time**

  The customer orders, once entered into the master schedule, create manufacturing orders or purchase orders via the MRP system.

The time from the work order release until the order is complete makes up manufacturing lead time. This lead time varies based on the type of manufacturing. The major components of lead time are

- Queue (the time the inventory is sitting on the shop floor waiting to be worked on)
- Setup (time spent preparing the machine)
- Run time (time the machine is actually running)
- Wait (time spent waiting for the finished item at one machine to be moved to the next
- Move (time spent moving to the next machine)
- Finished goods inventory (time spent waiting to move to the end customer)

► Purchasing Order Processing Time

Purchasing order-processing lead time includes the time to get a purchase requisition, release it to the supplier and receive it into the warehouse or directly to the production floor.

► Reconciling the Physical Flow with the Information Flow

Reconciling the information flow (from MPS through MRP and on to the suppliers) with the physical flow of the parts from suppliers into manufacturing and then on to the customers is one of the major challenges in companies today.

In many cases, products can actually be built faster than orders can be entered and processed through the manufacturing and purchasing information systems. In meeting time-to-market objectives, information systems bottlenecks have taken the place of manufacturing (machine) bottlenecks.

This situation worsens when changes take place, especially customer changes. Marketing people, financial people and particularly executives have little appreciation for the time the entire process takes. It takes time to analyze and make corrections or changes, not just to the customer order, but all the way through manufacturing and the affected suppliers.

Additional time must be spent "coercing" the suppliers and "armtwisting" the operations people to make the changes.

This situation causes a large number of part shortages and late deliveries, both from suppliers and to customers. In addition, costs such as premiums and expedited charges are incurred, which seldom get passed on to the customer.

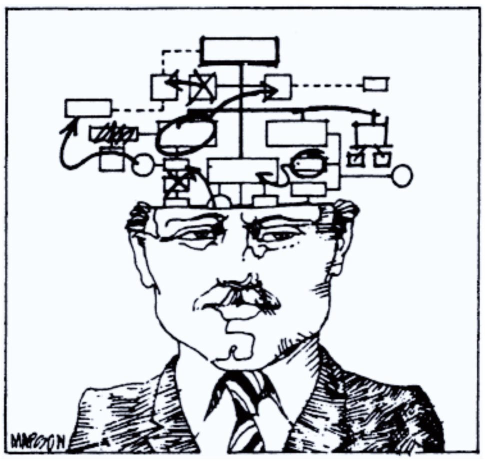
The answer to this problem is twofold.

1. Good account management should point out to the customers the cost of the changes they are asking for.

2. A significant improvement in manufacturing software is needed, which will allow for instantaneous updates of all the information.

Summary

In the meantime, the physical flow and the information flow will continue to be reconciled through physical inventories and/or cycle counting (these concepts are covered in Module IV).



EXERCISE 2: Choose the Correct Answer

Choose the correct answer. *See page 111 in the back of the book for the answers.*

1. All of the following are major types of manufacturing environments EXCEPT:

A. Build-to-order
B. Build-to-stock
C. Assemble-to-order
D. Assemble-to-build

2. Which of the following systems would be best for determining the amount of component parts to be used in a product?

A. Independent demand system
B. MRP system
C. Dependent demand system
D. Both B and C

3. The use of reorder point systems is appropriate when

A. There are many small orders.
B. Lot sizes are fixed/known.
C. Cost of stocking is high.
D. All of the above

4. Which of the following would be best suited to an independent demand system?

A. Build-to-order products
B. Service parts
C. Parts used in end items

5. The formula for calculating reorder point is

A. $\dfrac{\textbf{Cost of sales}}{\textbf{Average inventory}}$

B. DLT+S
C. Safety stock+order quantity
D. None of the above

6. Time-phased order point uses the same logic as

A. MRP
B. Exponential smoothing
C. EOQ
D. Both A and B