

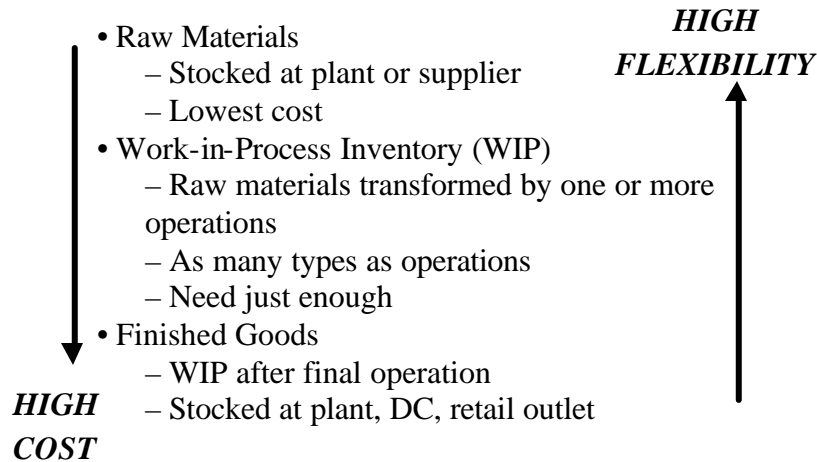
Materials Management

- **Involves Short Time Horizon Decisions:**
 - Supplies
 - Inventories
 - Production Levels
 - Staffing Patterns
 - Schedules
 - Distribution
- } **Logistics or
Supply Chain Management**
- **Tactical not Strategic** ⇒ **Detailed not Aggregate**
 - **Intimate relation between production and inventory control**

Inventory

- **Definition**: stock of materials held to satisfy future demand
- **Why Inventory?**
 - (1) Time – Quickly meet demand
 - (2) Uncertainty
 - Demand
 - Raw Materials availability
 - Production process
 - (3) Economy
 - (4) Decoupling of operations

Inventory — Categories



Inventory Costs

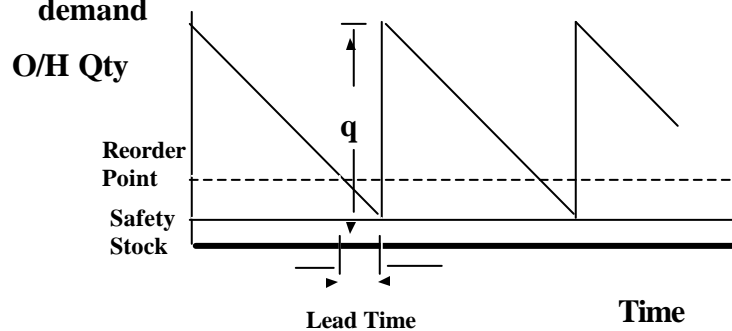
- Amount of inventory to carry depends on its costs
- Holding Costs (denoted h)
 - Based on capital invested in inventory
 - Expressed in dollars or percentage of purchase price per time period (e.g., \$/unit/yr)
- Fixed Order Costs (denoted K)
 - Cost of placing an order
 - Not dependent on order size
 - Equivalent to setup cost in production
- Shortage Costs
 - Hardest to quantify
 - Derived from desired service level
- Cost of purchased items (quantity discounts)

Inventory Theory

- **Scientifically answers the questions:**
 - (1) How many should we order? (Lot Sizing)
 - (2) How often should we order?
- **Lot Size (denoted q) varies inversely with order frequency**
- **Possible to find a policy that is optimal wrt some criteria (usually cost)**
- **Similar analysis used for production batch sizing**

Components of Inventory

- **Cycle Inventory - inventory that varies with lot size**
- **Safety Stock - inventory that protects against uncertainty**
- **Pipeline Inventory - inventory in transit**
- **Anticipation Inventory - inventory to meet varying demand**



Stochastic Models

Basic Economic Order Quantity (EOQ)

- Assumptions

- (1) 8 planning horizon
- (2) Continuous deterministic demand with constant rate
- (3) Zero lead time (Instantaneous replenishment)
- (4) No shortages (no backorders or stockouts)

- Data

D = demand rate (units/period)

K = order cost (\$/order)

C = unit cost (\$/unit)

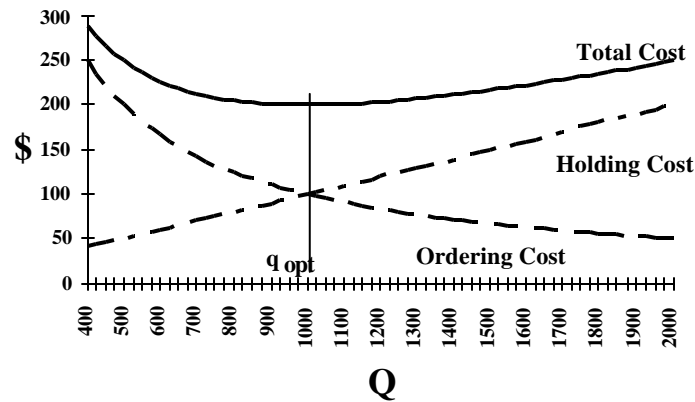
h = holding cost (\$/unit-time period)

(cost of holding I units for T periods is ITh)

p = unit purchase cost (\$/unit)

Stochastic Models

Economic Order Quantity



K = \$10/order

h = \$0.20/unit/year

D = 10,000 units/year

Sensitivity of the EOQ

- **Cycle Inventory vs Demand**
 - Cycle Inventory increases with SqRt of Demand
 - Not sensitive to small changes
- **Lot size vs Setup Cost**
 - Reducing C_o reduces optimal lot size
 - Allows small lots
- **Lot size vs Interest rates**
 - Interest part of holding costs
 - Lot size decreases as holding costs increase
 - Low holding cost allows larger lots
- **Square Root function implies low sensitivity to small errors in estimating K , D , h**

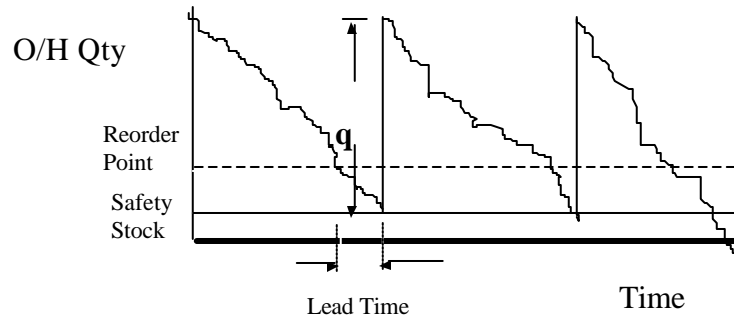
Variability in Demand – Safety Stock

- **Relax assumption that demand is constant and deterministic**
- **Assume we know mean and variance of Lead time demand**
- **Use Continuous Review (Q,R) Inventory system**
- **Definition: Inventory Position – measure of ability to meet future demand**

$$IP = (\text{On Hand}) + (\text{On-Order}) - (\text{Back Orders})$$

- **Policy: When Inventory Position is less than or equal to the Reorder Point, R , order Q units.**

Stochastic Demand Case



Safety Stock and Service Level

- **Safety Stock level depends on:**
 - Variability of lead time demand
 - Desired service level
- **Service level**
 - Overcomes measurement problem of Shortage Cost
 - Tolerated shortage is specified
 - High service level means high safety stock
- **Service level policies**
 - Cycle-Service Level, $\Pr[\text{stockout in a cycle}]$ ★
 - Fill-Rate, % of demand filled off the self
 - Number of stockouts
 - % of days in the period without stockouts

Other Inventory Schemes

- **Periodic Review (P-System)**
 - Check inventory daily, weekly, monthly, etc.
 - Place order each period for $(T - IP)$
where T = target inventory position level

 - A.K.A. "order-up-to" systems, fixed interval systems
- **Optional Replenishment System (Hybrid)**
 - Inventory checked periodically (like P-system)
 - Order up to S if IP is below s
 - Good if both review and ordering costs are high
 - A.K.A s,S system or min-max system

Continuous vs Periodic Review

- **Advantages of Periodic Review**
 - Easier administration
 - Order at convenient times
 - Fixed pickup and delivery times
 - Multiple items can be ordered together
 - Only have to know IP at review time
- **Advantages of Continuous Review**
 - Individualized for each item \rightarrow cheaper
 - Fixed lot sizes are easier
 - Less safety stock is needed