UNIVERSITAS GUNADARMA

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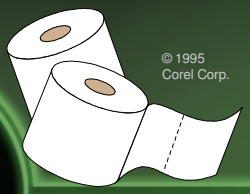
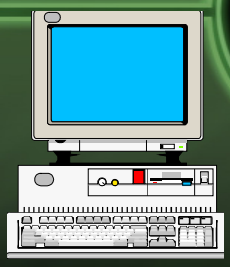
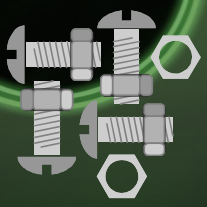
What is Inventory?

- Stock of materials
- Stored capacity
- Examples







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Definitions

- **Inventory-**A physical resource that a firm holds in stock with the intent of selling it or transforming it into a more valuable state.
- **Inventory System**- A set of policies and controls that monitors levels of inventory and determines what levels should be maintained, when stock should be replenished, and how large orders should be

Inventory

- Definisi - A physical resource that a firm holds in stock with the intent of selling it or transforming it into a more valuable state.
- Raw Materials
- Works-in-Process
- Finished Goods
- Maintenance, Repair and Operating (MRO)

Expensive Stuff

- The average carrying cost of inventory across all mfg.. in the U.S. is 30-35% of its value.
- What does that mean?
- Savings from reduced inventory result in increased profit.

Zero Inventory?

- Reducing amounts of **raw materials** and **purchased parts** and **subassemblies** by having suppliers deliver them directly.
- Reducing the amount of **work-in process** by using just-in-time production.
- Reducing the amount of **finished goods** by shipping to markets as soon as possible.

The Functions of Inventory

- To ”decouple” or separate various parts of the production process
- To provide a stock of goods that will provide a “selection” for customers
- To take advantage of quantity discounts
- To hedge against inflation and upward price changes

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Types of Inventory

- Raw material
- Work-in-progress
- Maintenance/repair/operating supply
- Finished goods

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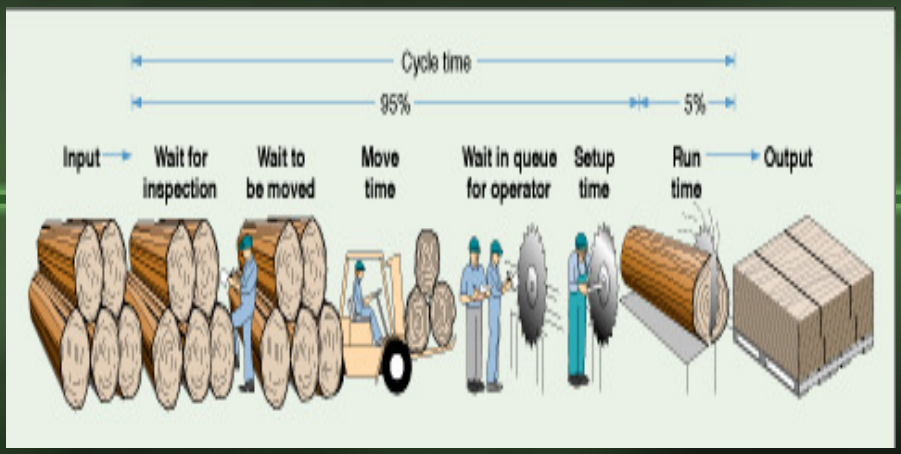
The Material Flow Cycle



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Disadvantages of Inventory

- Higher costs
  - Item cost (if purchased)
  - Ordering (or setup) cost
    - Costs of forms, clerks' wages etc.
  - Holding (or carrying) cost
    - Building lease, insurance, taxes etc.
- Difficult to control
- Hides production problems

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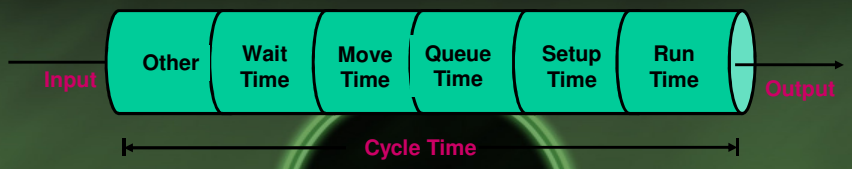
The Material Flow Cycle



1. *Run time*: Job is at machine and being worked on
2. *Setup time*: Job is at the work station, and the work station is being "setup."
3. *Queue time*: Job is where it should be, but is not being processed because other work precedes it.
4. *Move time*: The time a job spends in transit
5. *Wait time*: When one process is finished, but the job is waiting to be moved to the next work area.
6. *Other:* "Just-in-case" inventory or safety stock.

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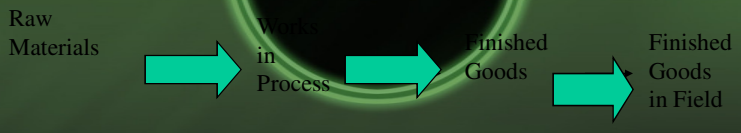
Inventory Positions in the Supply Chain



Reasons for Inventories

- Improve customer service
- Economies of purchasing
- Economies of production
- Transportation savings
- Hedge against future
- Unplanned shocks (labor strikes, natural disasters, surges in demand, etc.)
- To maintain independence of supply chain

Inventory and Value

- Remember this?
  - Quality
  - Speed
  - Flexibility
  - Cost

Nature of Inventory: Adding Value through Inventory

- **Quality** - inventory can be a "buffer" against poor quality; conversely, low inventory levels may force high quality
- **Speed** - *location* of inventory has gigantic effect on speed
- **Flexibility** - location, level of anticipatory inventory both have effects
- **Cost** - direct: purchasing, delivery, manufacturing
  indirect: holding, stockout.
  HR systems may promote this-3 year postings

Nature of Inventory: Functional Roles of Inventory

- Transit
- Buffer
- Seasonal
- Decoupling
- Speculative
- Lot Sizing or Cycle
- Mistakes

Design of Inventory Mgmt. Systems: Macro Issues

- Need for Finished Goods Inventories
  - Need to satisfy internal or external customers?
  - Can someone else in the value chain carry the inventory?
- Ownership of Inventories
- Specific Contents of Inventories
- Locations of Inventories
- Tracking

How to Measure Inventory

- *The Dilemma*: closely monitor and control inventories to keep them as low as possible while providing acceptable customer service.
- **Average Aggregate Inventory Value:** how much of the company's total assets are invested in inventory?
- Ford:6.825 billion
- Sears: 4.039 billion

Inventory Measures

- **Weeks of Supply**
  - Ford: 3.51 weeks
  - Sears: 9.2 weeks
- **Inventory Turnover (Turns)**
  - Ford: 14.8 turns
  - Sears: 5.7 turns
  - GM: 8 turns
  - Toyota: 35 turns

Reasons Against Inventory

- Non-value added costs
- Opportunity cost
- Complacency
- Inventory deteriorates, becomes obsolete, lost, stolen, etc.

Inventory Costs

- Procurement costs
- Carrying costs
- Out-of-stock costs

Procurement Costs

- Order processing
- Shipping
- Handling
- **Purchasing cost:** c(x)= $100 + $5x
- **Mfg. cost:** c(x)=$1,000 + $10x

Carrying Costs

- Capital (opportunity) costs
- Inventory risk costs
- Space costs
- Inventory service costs

Out-of-Stock Costs

- Lost sales cost
- Back-order cost

Independent Demand

- **Independent demand** items are finished products or parts that are shipped as end items to customers.
- Forecasting plays a critical role
- Due to **uncertainty**- extra units must be carried in inventory

Dependent Demand

- **Dependent demand**- items are raw materials, component parts, or subassemblies that are used to produce a finished product.
- MRP systems---next week

Design of Inventory Mgmt. Systems: Micro Issues

- Order Quantity
  - Economic Order Quantity
- Order Timing
  - Reorder Point

Objectives of Inventory Control

- Maximize the level of customer service by avoiding understocking.
- Promote efficiency in production and purchasing by minimizing the cost of providing an adequate level of customer service.

Balance in Inventory Levels

- When should the company replenish its inventory, or when should the company place an order or manufacture a new lot?
- How much should the company order or produce?
- **Next:** Economic Order Quantity

ABC Analysis

- Divides on-hand inventory into 3 classes
  - A class, B class, C class
- Basis is usually annual $ volume
  - $ volume = Annual demand x Unit cost
- Policies based on ABC analysis
  - Develop class A suppliers more
  - Give tighter physical control of A items
  - Forecast A items more carefully

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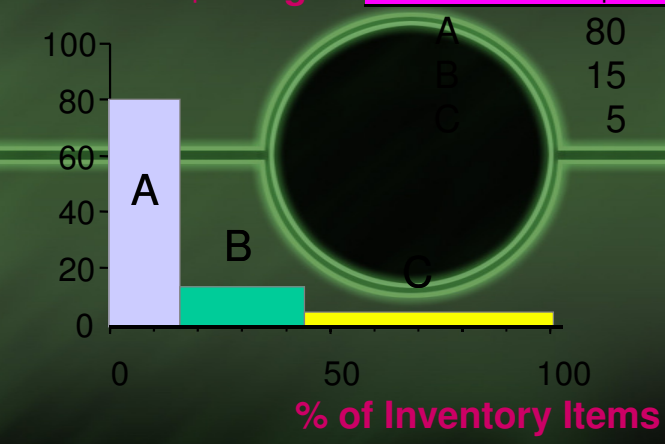
Classifying Items as ABC



Class	% $ Vol	% Items
A	80	15
B	15	30
C	5	55

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Cycle Counting

- Physically counting a sample of total inventory on a regular basis
- Used often with ABC classification
  - A items counted most often (e.g., daily)

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Advantages of Cycle Counting

- Eliminates shutdown and interruption of production necessary for annual physical inventories
- Eliminates annual inventory adjustments
- Provides trained personnel to audit the accuracy of inventory
- Allows the cause of errors to be identified and remedial action to be taken
- Maintains accurate inventory records

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Techniques for Controlling Service Inventory Include:

- Good personnel selection, training, and discipline
- Tight control of incoming shipments
- Effective control of all goods leaving the facility

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Independent versus Dependent Demand

- ***Independent demand*** - demand for item is independent of demand for any other item
- ***Dependent demand*** - demand for item is dependent upon the demand for some other item

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Inventory Costs

- ***Holding costs*** - associated with holding or "carrying" inventory over time
- ***Ordering costs*** - associated with costs of placing order and receiving goods
- ***Setup costs*** - cost to prepare a machine or process for manufacturing an order

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Holding (Carrying) Costs

- Obsolescence
- Insurance
- Extra staffing
- Interest
- Pilferage
- Damage
- Warehousing
- Etc.

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Inventory Holding Costs (Approximate Ranges)

Category	Cost as a % of Inventory Value
Housing costs (building rent, depreciation, operating cost, taxes, insurance)	6% (3 - 10%)
Material handling costs (equipment, lease or depreciation, power, operating cost)	3% (1 - 3.5%)
Labor cost from extra handling	3% (3 - 5%)
Investment costs (borrowing costs, taxes, and insurance on inventory)	11% (6 - 24%)
Pilferage, scrap, and obsolescence	3% (2 - 5%)
Overall carrying cost	26%

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Ordering Costs

- Supplies
- Forms
- Order processing
- Clerical support
- Etc.

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Setup Costs

- Clean-up costs
- Re-tooling costs
- Adjustment costs
- Etc.

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Inventory Models

- Fixed order-quantity models
  - Economic order quantity
  - Production order quantity
  - Quantity discount
- Probabilistic models
- Fixed order-period models

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EOQ Assumptions

- Known and constant **demand**
- Known and constant **lead time**
- **Instantaneous receipt** of material
- **No** quantity **discounts**
- Only order (setup) cost and holding cost
- No **stockouts**

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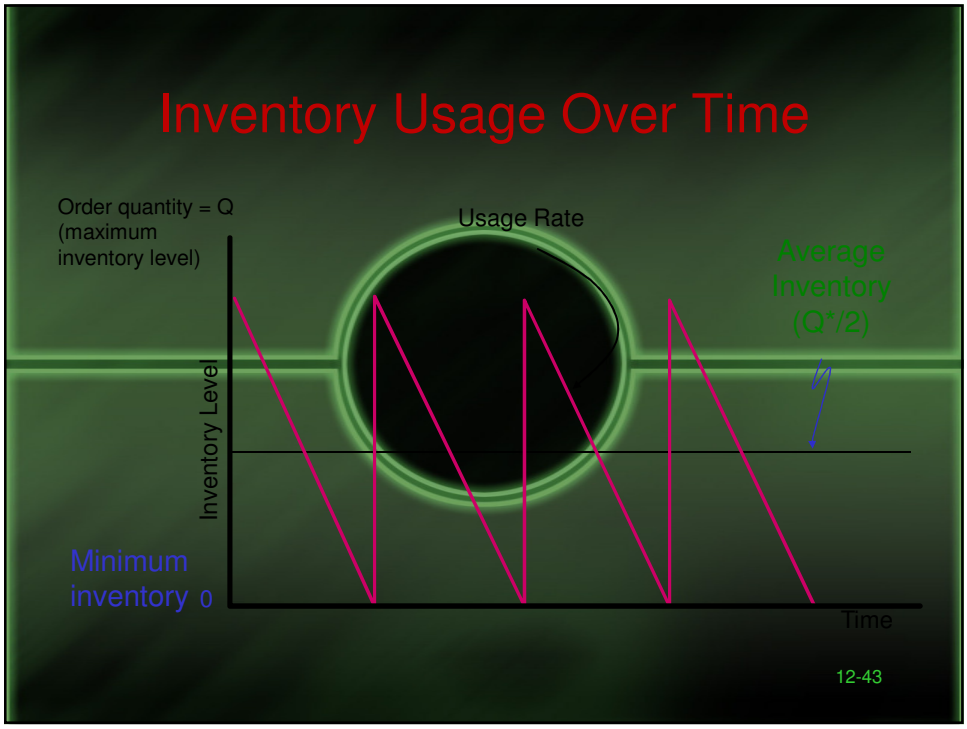
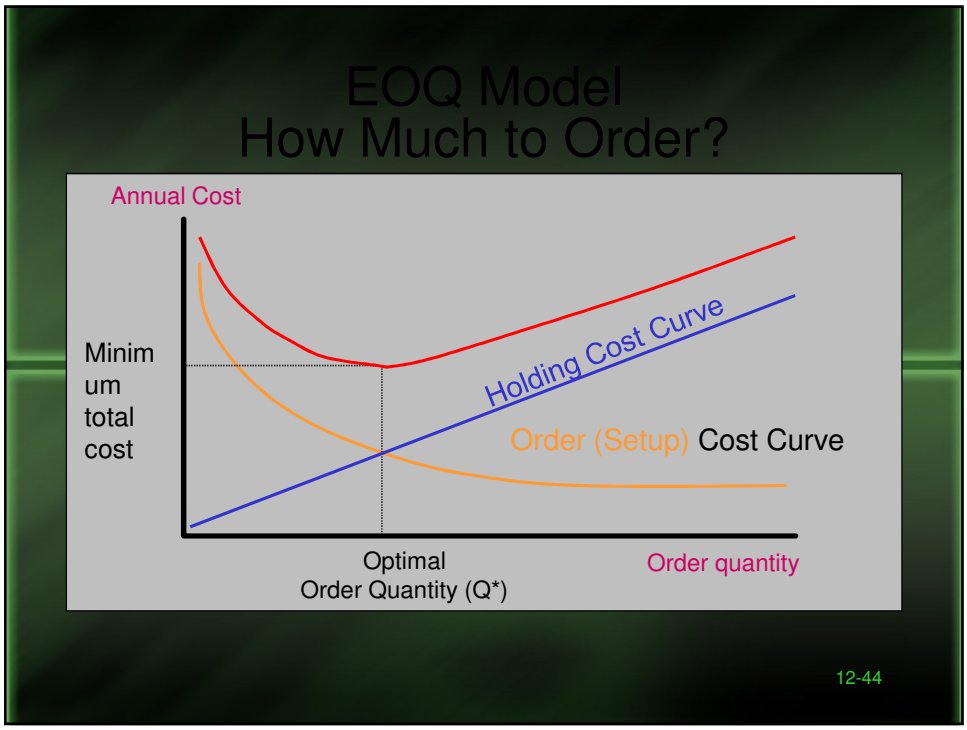

Inventory Usage Over Time
Order quantity = Q (maximum inventory level)
Usage Rate
Average Inventory (Q*/2)
Inventory Level
Minimum inventory 0
Time
12-43


EOQ Model
How Much to Order?
Annual Cost
Minimum total cost
Holding Cost Curve
Order (Setup) Cost Curve
Optimal Order Quantity (Q*)
Order quantity
12-44

Why Holding Costs Increase

- More units must be stored if more are ordered

Purchase Order	
Description	Qty.
Microwave	1

Order quantity

Purchase Order	
Description	Qty.
Microwave	1000

Order quantity

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Why Order Costs Decrease

Cost is spread over more units

Example: You need 1000 microwave ovens

1 Order (Postage $ 0.33) 1000 Orders (Postage $330)

Purchase Order	
Description	Qty.
Microwave	1000

Order quantity

Purchase Order	
Description	Qty.
Microwave	1

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Deriving an EOQ

1. Develop an expression for setup or ordering costs
2. Develop an expression for holding cost
3. Set setup cost equal to holding cost
4. Solve the resulting equation for the best order quantity

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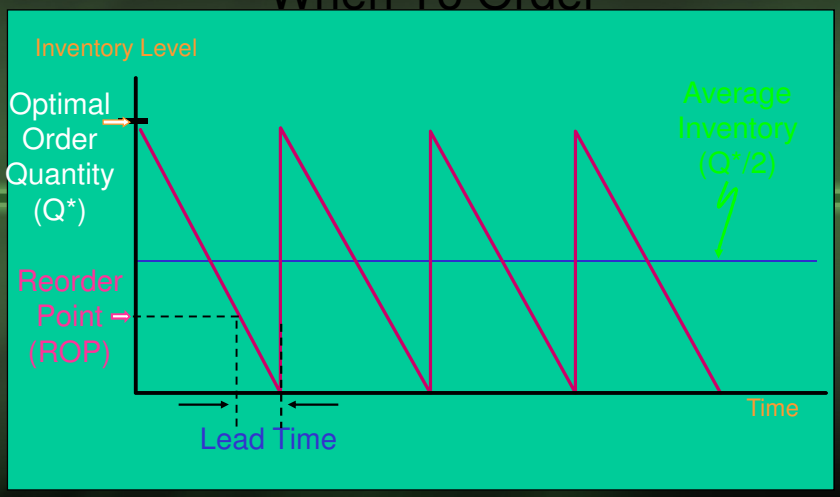
EOQ Model When To Order



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EOQ Model Equations

Optimal Order Quantity $= Q^* = \sqrt{\frac{2 \times D \times S}{H}}$

Expected Number of Orders $= N = \frac{D}{Q^*}$

Expected Time Between Orders $= T = \frac{\text{Working Days / Year}}{N}$

$d = \frac{D}{\text{Working Days / Year}}$

$ROP = d \times L$

D = Demand per year

S = Setup (order) cost per order

H = Holding (carrying) cost

d = Demand per day

L = Lead time in days

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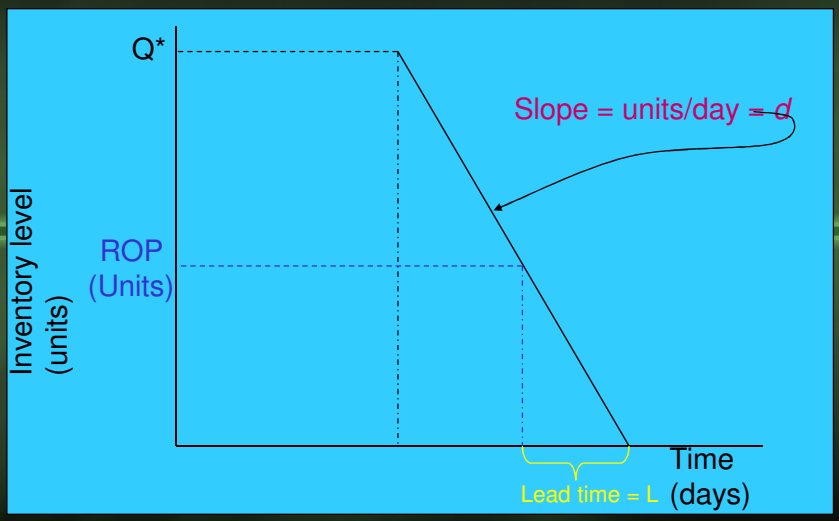
The Reorder Point (ROP) Curve



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Production Order Quantity Model

- Answers how much to order and when to order
- Allows partial receipt of material
  - Other EOQ assumptions apply
- Suited for production environment
  - Material produced, used immediately
  - Provides production lot size
- Lower holding cost than EOQ model

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Reasons for Variability in Production

Most variability is caused by waste or by poor management. Specific causes include:

- employees, machines, and suppliers produce units that do not conform to standards, are late or are not the proper quantity
- inaccurate engineering drawings or specifications
- production personnel try to produce before drawings or specifications are complete
- customer demands are unknown

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Quantity Discount Model

- Answers how much to order & when to order
- Allows quantity discounts
  - Reduced price when item is purchased in larger quantities
  - Other EOQ assumptions apply
- Trade-off is between lower price & increased holding cost

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Quantity Discount Schedule

Discount Number	Discount Quantity	Discount (%)	Discount Price (P)
1	0 to 999	No discount	$5.00
2	1,000 to 1,999	4	$4.80
3	2,000 and over	5	$4.75

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Probabilistic Models

- Answer how much & when to order
- Allow demand to vary
  - Follows normal distribution
  - Other EOQ assumptions apply
- Consider service level & safety stock
  - Service level = *1 - Probability of stockout*
  - Higher service level means more safety stock
    - More safety stock means higher ROP

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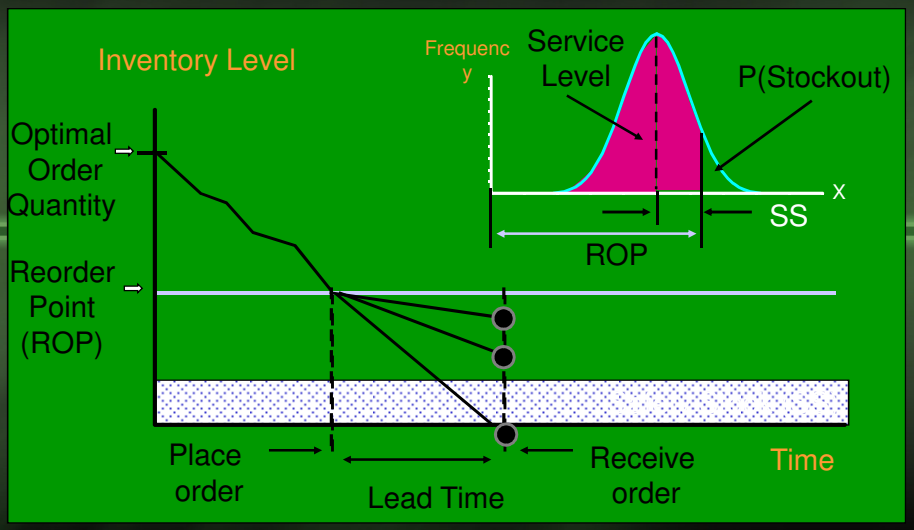
Probabilistic Models When to Order?



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Fixed Period Model

- Answers how much to order
- Orders placed at fixed intervals
  - Inventory brought up to target amount
  - Amount ordered varies
- No continuous inventory count
  - Possibility of stockout between intervals
- Useful when vendors visit routinely
  - Example: P&G representative calls every 2 weeks

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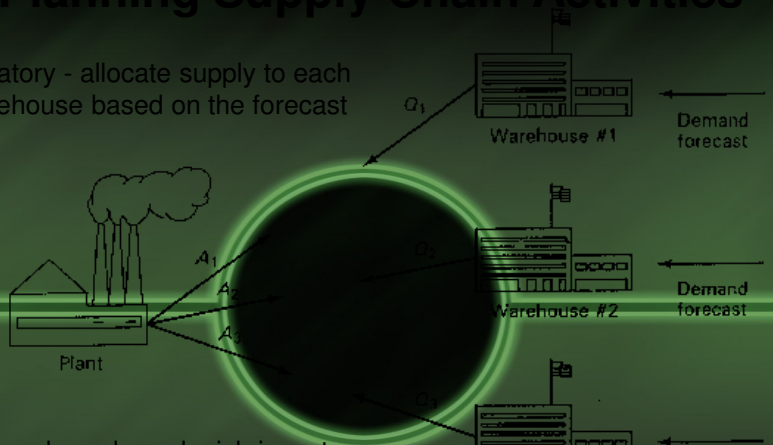
Planning Supply Chain Activities

Anticipatory - allocate supply to each warehouse based on the forecast



Response-based - replenish inventory with order sizes based on specific needs of each warehouse

A = Allocation quantity to each warehouse
Q = Requested replenishment quantity by each warehouse

Anticipatory Inventory Control

- determine requirements by forecasting demand for the next production run or purchase
- establish current on-hand quantities
- add appropriate safety stock based on desired stock availability levels and uncertainty demand levels
- determine how much new production or purchase needed (total needed - on-hand)

Response-Based System

- replenishment, production, or purchases of stock are made only when it has been signaled that there is a need for product downstream
- requires shorter order cycle time, often more frequent, lower volume orders
- determine stock requirements to meet only most immediate planning period (usually about 3 weeks)

Service Level Achieved

•Item fill rate (IFR): the probability of filling an order for 1 item from current stock

$$1 - \frac{\text{expected number of units out of stock/year}}{\text{total annual demand}}$$

•Weighted Average Fill Rate (WAFR): multiply IFR for each stock item on an order weighted by the ordering frequency for the item