



# Operations Management I

## Inventory Management (1)

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# Inventory Management

## Introduction

- Inventory – Definition and Classification
- Reasons for Holding Inventory
- ABC classification
- Why Inventory Control – Basic Trade-off
- Inventory Control Systems
- Inventory Models – Classification

Hopp and Spearman, 2008, **Factory Physics**, McGraw Hill. (Chapter 2)

Krajewski and Ritzman, 2005, **Operations Management**, Prentice Hall. (Chapter 15)

# Inventory Management

## ◆ Introduction

### Inventory (재고)

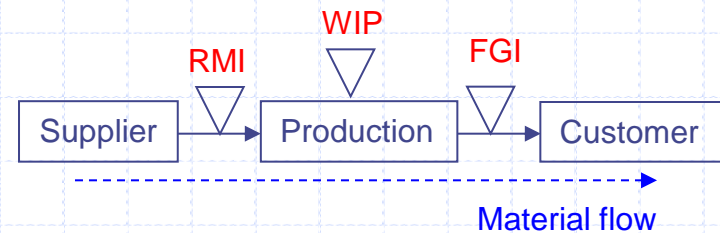
- Definition

An accumulation of a commodity that will be used to satisfy some future demand for that commodity

- Classification

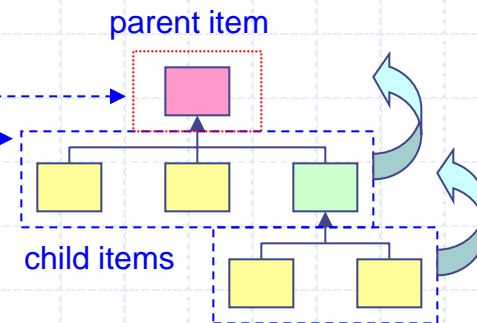
- ✓ Based on material flow

- Raw materials inventory (RMI)
    - Work in process (WIP)
    - Finished goods inventory (FGI)



- ✓ Based on product structure

- Independent demand inventory
    - Dependent demand inventory



	Independent demand	Dependent demand
Demand	Uncertain	Certain (relatively)
Estimation	Forecasting	Compute from independent demand
Methods	Inventory models	MRP

# Inventory Management

## ◆ Introduction

### Reasons for Holding Inventory (1)

- Raw Materials Inventory (RMI)

- ✓ **Batching**

- Quantity discounts from suppliers
  - Limited capacity of the plant's purchasing function
  - Economies of scale in deliveries
- } Incentive to order raw materials in bulk

➡ **Cycle stock** ←----- stock held between ordering cycles

- ✓ **Variability**

- Production gets ahead of schedule.
  - Supplier deliveries get behind schedule.
  - Quality problems cause excessive scrap loss.
- } Shutting down the line for lack of materials

➡ **Safety stock** ←----- stock carried as protection against variability

Protect against supply errors, shortages, and stockouts

# Inventory Management

## ◆ Introduction

### Reasons for Holding Inventory (2)

- Work-in-Process (WIP) ←---- Decouple successive stages in operations

- ✓ Processing

Being worked on by a resource

- ✓ Moving ←---- Material handling

Being transported between resources

- ✓ Queueing

Waits for a resource (person, machine or transport device)

- ✓ Waiting for batch

Waits for other jobs to arrive in order to form a batch  
(serve to fill a bulk manufacturing operation (**process batch**) or a move operation (**transfer batch**))

- ✓ Waiting to match

The case that a product consists of components waiting at an assembly operation for their counter parts to arrive so that an assembly can occur

Storage

# Inventory Management

## ◆ Introduction

### Reasons for Holding Inventory (3)

- Finished goods inventory (FGI)

- ✓ Customer responsiveness

- Variability of customer demand
- Desired level of customer service

} ←----- make-to-stock policy

- ✓ Batch production

If production occurs in prespecified quantities (batches), then output will sometimes not match customer orders and any excess will go into finished goods inventory

- ✓ Forecast errors

Forecasted demand > actual demand

Factory physics (2nd semester) -----> ✓ Production variability

Variability in production quantity can result in overproduction relative to demand

- ✓ Seasonality

# Inventory Management

## ◆ Introduction

ABC Classification ←----- Identifying critical inventory

- Why

A small fraction of the purchased parts represent a large fraction of the purchasing expenditures. ←----- Pareto law

- Method – Inventory classification

- ✓ A parts

5 - 20% of the parts, accounting for 75-80% of total annual expenditures

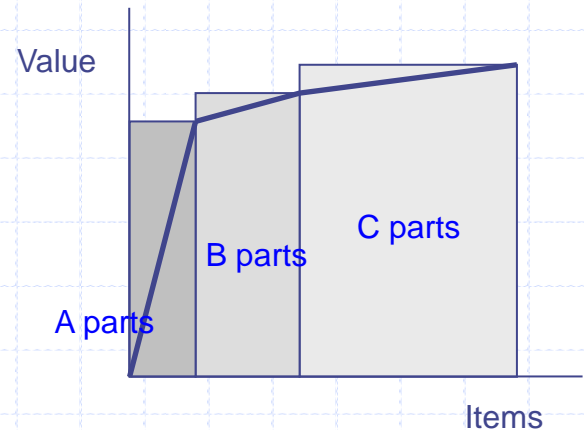
←----- Sophisticate and time-consuming methods for inventory control

- ✓ B parts

Next 10 - 30% of the parts, accounting for 10 - 15% of the total annual expenditures

- ✓ C parts

Bottom 50 - 85% the parts, accounting for only 5 - 10% of the total annual expenditures  
(safety stock ↑ if important in operation)



Inventories of different classes of parts should be treated differently.

# Inventory Management

## ◆ Introduction

### Why Inventory Control

- Basic Trade-off

Balancing the conflicting costs and pressures that argue for both low and high inventories and determining the appropriate inventory levels

- ✓ Pressures for low inventories

- Interest or opportunity cost
- Storage and handling costs
- Taxes, insurance and shrinkage

High inventory holding cost  
(20~40% of product value)

$$h = i \cdot C + w$$

- ✓ Pressures for high inventories

- Customer service
- Ordering and setup costs
- Stockout cost
- Labor and equipment utilization
- Transportation cost
- Payments to suppliers (quantity discount)

- Production: setup cost
- Purchasing: ordering cost

### Inventory control

Problem of determining an appropriate level of inventory  
(when and how much)

- Ordering time
- Ordering quantity
- Monitoring

Shrinkage

- Pilferage
- Obsolescence
- Deterioration

- Backorders
- Lost sales



# Inventory Management

	Continuous Review	Periodic Review
When	Variable	Constant (T)
How much	Constant (Q)	Variable
Safety stock	Low	High
Management	Difficult (A class)	Easy (C class)

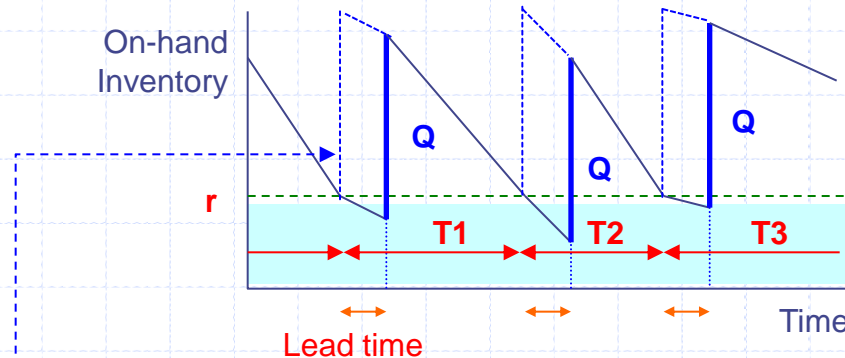
## ◆ Introduction

### Inventory Control Systems (1)

- Continuous Review System (Q system)

Tracks the remaining inventory of an item each time a withdrawal is made to determine whether it is time to order

← Reorder point (ROP) system  
Fixed order quantity system



Inventory position  
= net inventory + replenishment orders  
= (on-hand inventory – backorders) + replenishment orders

### ✓ Method

Order the fixed quantity (Q) if the inventory level reaches the reorder point (r)

### ✓ Decision variables: Q and r

### ✓ Characteristics

- Constant ordering quantity
- Variable ordering cycle

# Inventory Management

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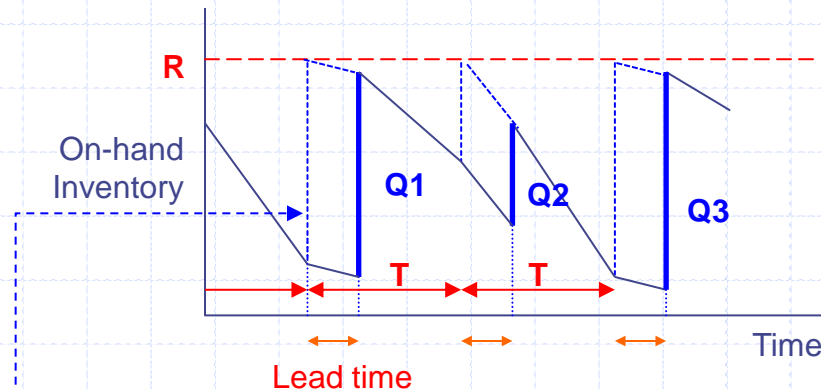
## ◆ Introduction

### Inventory Control Systems (2)

- Periodic Review (P) System

Tracks the remaining inventory of an item periodically

← Periodic reorder system  
Fixed order interval system



Inventory position  
 = net inventory + replenishment orders  
 = (on-hand inventory – backorders) + replenishment orders

### ✓ Method

- Order with the fixed interval  $T$
- Ordering quantity is the difference between the target inventory level  $R$  and the inventory level at the ordering time

### ✓ Decision variables: $R$ and $T$

### ✓ Characteristics

- Constant ordering cycle
- Variable ordering quantity

# Inventory Management

## ◆ Introduction

### Inventory Models

- Classification

Four basic cases (according to demand parameter)

Deterministic models	×	Static models
Stochastic models		Dynamic models

← ✓ Focus of this class    ←----- Extensions (graduate courses)

➤ Deterministic and static

- Economic Order Quantity (EOQ)
- Extensions

➤ Deterministic and dynamic

- Dynamic lot sizing (Wagner-Whitin model)

➤ Stochastic and static

- Single period: newsboy model,
- Multi-period: base-stock model, (Q, r) model