Operations Management Fundamentals

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Part 1

Introduction to Operations Management

Operations Management

- **What is operations?**
  - The part of a business organization that is responsible for producing goods or services
- **How can we define operations management?**
  - The management of systems or processes that create goods and/or provide services

Good or Service?

Goods are physical items that include raw materials, parts, subassemblies, and final products.

- Automobile
- Computer
- Oven
- Shampoo

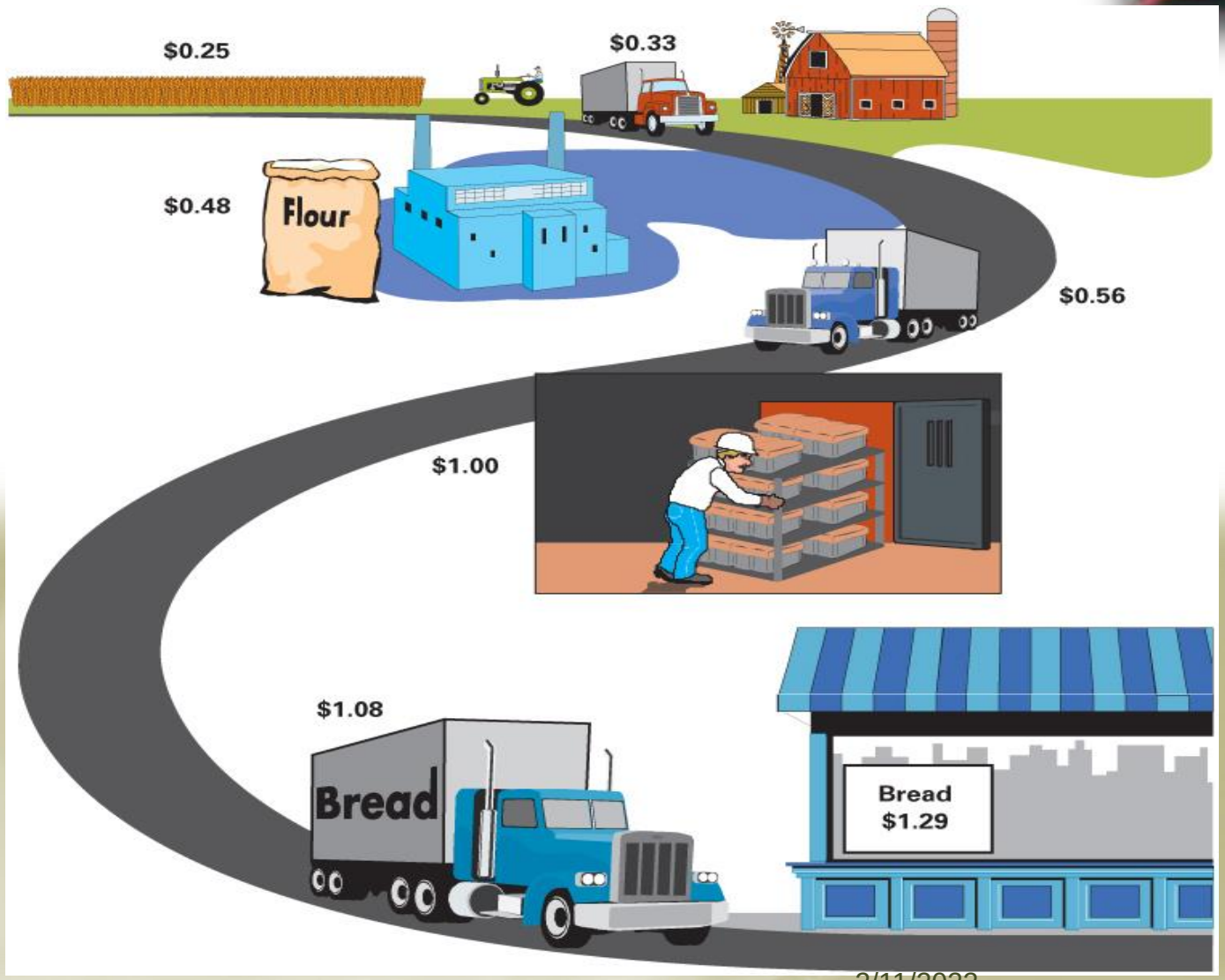
Services are activities that provide some combination of time, location, form or psychological value.

- Air travel
- Education
- Haircut
- Legal counsel

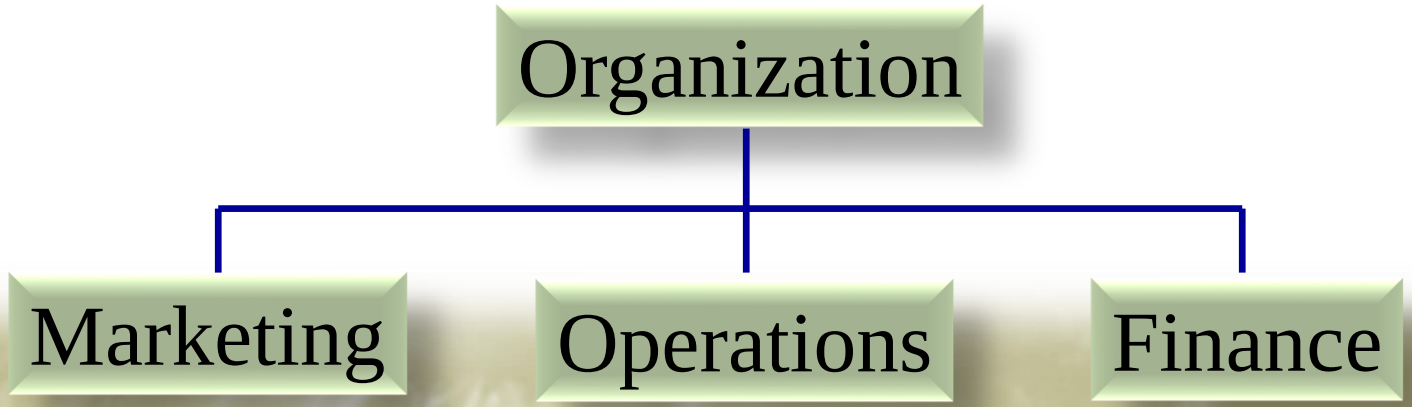
Supply Chain

Supply Chain – a sequence of activities and organizations involved in producing and delivering a good or service

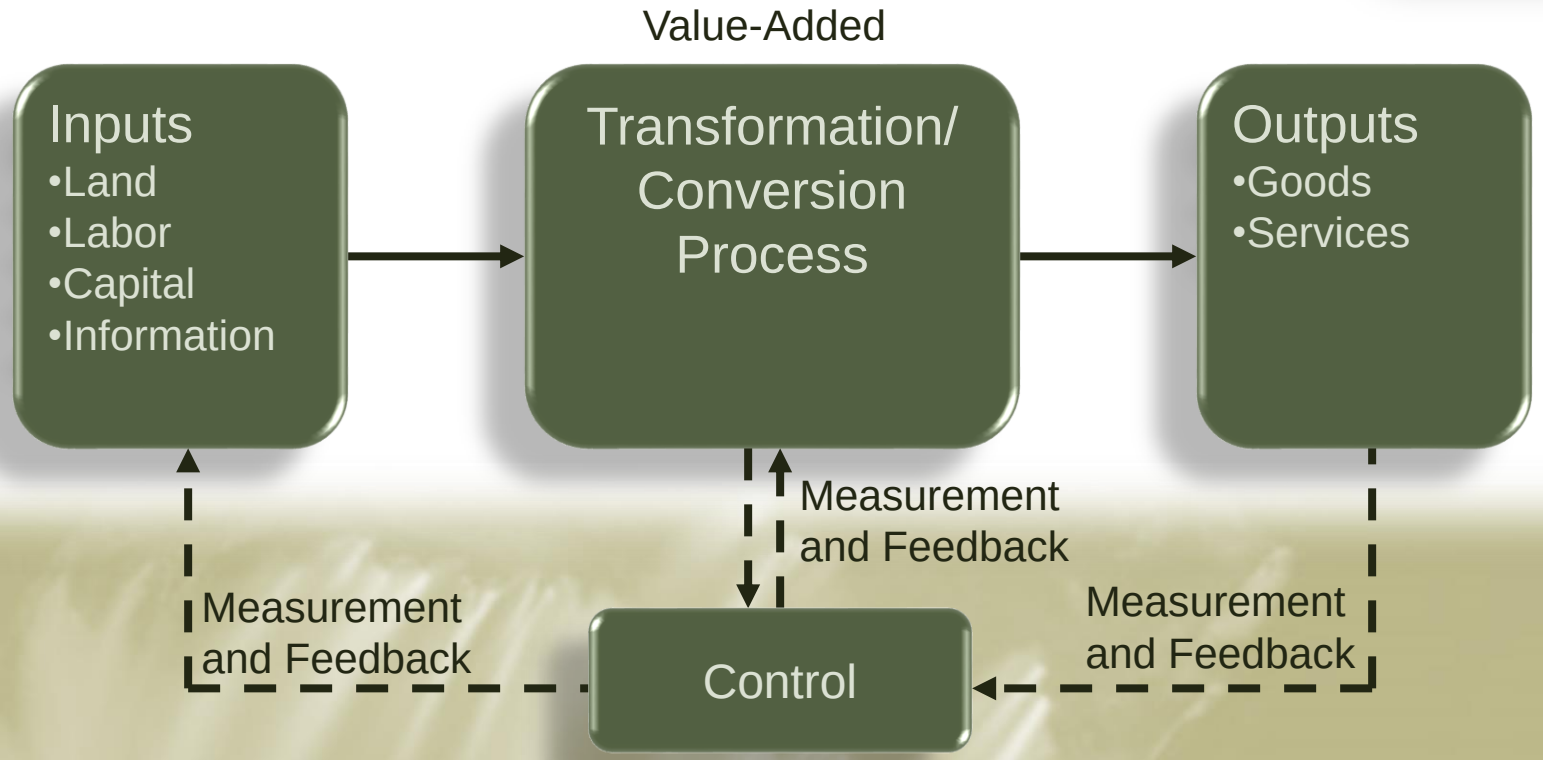
Supply Chain for Bread



Basic Functions of the Business Organization



The Transformation Process



Feedback = measurements taken at various points in the transformation process

Control = The comparison of feedback against previously established standards to determine if corrective action is needed.

Manufacturing vs. Service

1. Degree of customer contact
2. Uniformity of input
3. Labor content of jobs
4. Uniformity of output
5. Measurement of productivity
6. Production and delivery
7. Quality assurance
8. Amount of inventory
9. Evaluation of work
10. Ability to patent design

Process Management

Process - one or more actions that transform inputs into outputs

Three Categories of Business Processes:	
Upper-management processes	These govern the operation of the entire organization.
Operational processes	These are core processes that make up the value stream.
Supporting processes	These support the core processes.

Supply & Demand

Operations & Supply Chains		Sales & Marketing	
Supply	>	Demand	Wasteful Costly
Supply	<	Demand	Opportunity Loss Customer Dissatisfaction
Supply	=	Demand	Ideal

Process Variation

Four Sources of Variation:	
Variety of goods or services being offered	The greater the variety of goods and services offered, the greater the variation in production or service requirements.
Structural variation in demand	These are generally predictable. They are important for capacity planning.
Random variation	Natural variation that is present in all processes. Generally, it cannot be influenced by managers.
Assignable variation	Variation that has identifiable sources. This type of variation can be reduced, or eliminated, by analysis and corrective action.

Variations can be disruptive to operations and supply chain processes. They may result in additional costs, delays and shortages, poor quality, and inefficient work systems.

Scope of Operations Management

The scope of operations management ranges across the organization.

The operations function includes many interrelated activities such as:

- Forecasting
- Capacity planning
- Facilities and layout
- Scheduling
- Managing inventories
- Assuring quality
- Motivating employees
- Deciding where to locate facilities
- And more . . .

Role of the Operations Manager

The Operations Function consists of all activities *directly* related to producing goods or providing services.

A primary function of the operations manager is to guide the system by decision making.

- System Design Decisions
- System Operation Decisions

System Design Decisions

- **System Design**
  - Capacity
  - Facility location
  - Facility layout
  - Product and service planning
  - Acquisition and placement of equipment
- These are typically strategic decisions that
  - usually require long-term commitment of resources
  - determine parameters of system operation

Decision Making

- **Most operations decisions involve many alternatives that can have quite different impacts on costs or profits**
- **Typical operations decisions include:**
  - ***What:*** What resources are needed, and in what amounts?
  - ***When:*** When will each resource be needed? When should the work be scheduled? When should materials and other supplies be ordered?
  - ***Where:*** Where will the work be done?
  - ***How:*** How will he product or service be designed? How will the work be done? How will resources be allocated?
  - ***Who:*** Who will do the work?

Ethical Issues in Operations

- Ethical issues arise in many aspects of operations management:

- Financial statements
- Worker safety
- Product safety
- Quality
- The environment
- The community
- Hiring and firing workers
- Closing facilities
- Workers rights

The Need for Supply Chain Management

- In the past, organizations did little to manage the supply chain beyond their own operations and immediate suppliers which led to numerous problems:
  - Oscillating inventory levels
  - Inventory stockouts
  - Late deliveries
  - Quality problems

Supply Chain Issues

1. The need to improve operations
2. Increasing levels of outsourcing
3. Increasing transportation costs
4. Competitive pressures
5. Increasing globalization
6. Increasing importance of e-business
7. The complexity of supply chains
8. The need to manage inventories

Elements of Supply Chain Management

- **Customers** – what products/services do customers want
- **Forecasting** – predicting timing and volume of customer demand
- **Design** – incorporating customer wants, manufacturability, and time to market
- **Capacity planning** – matching supply and demand
- **Processing** – controlling quality, scheduling work
- **Inventory** – meeting demand requirements while managing costs
- **Purchasing** – evaluating potential suppliers, supporting the needs of operations on purchased goods and services
- **Suppliers** – monitoring supplier quality, on-time delivery, and flexibility; maintaining supplier relations
- **Location** – determining the location of facilities
- **Logistics** – deciding how to best move information and materials

Part 2

Competitiveness, Strategy, and Productivity

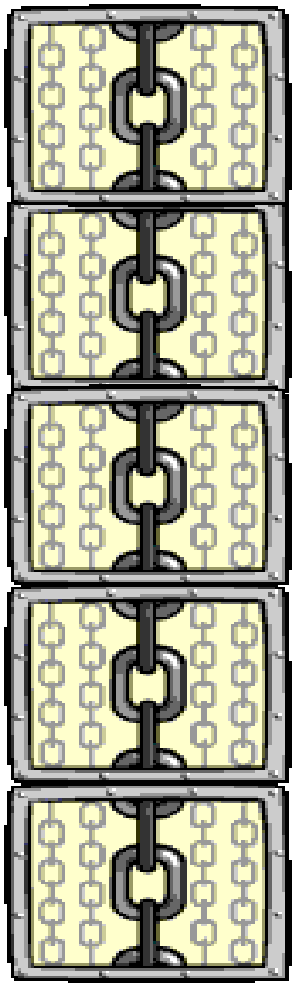
Competitiveness

- **Competitiveness:**
  - How effectively an organization meets the wants and needs of customers relative to others that offer similar goods or services
  - Organizations compete through some combination of their marketing and operations functions
    - What do customers want?
    - How can these customer needs be best satisfied?

Businesses Compete Using Operations

1. Product and service design
2. Cost
3. Location
4. Quality
5. Quick response
6. Flexibility
7. Inventory management
8. Supply chain management
9. Service
10. Managers and workers

Strategic Planning & Management



Mission & Vision

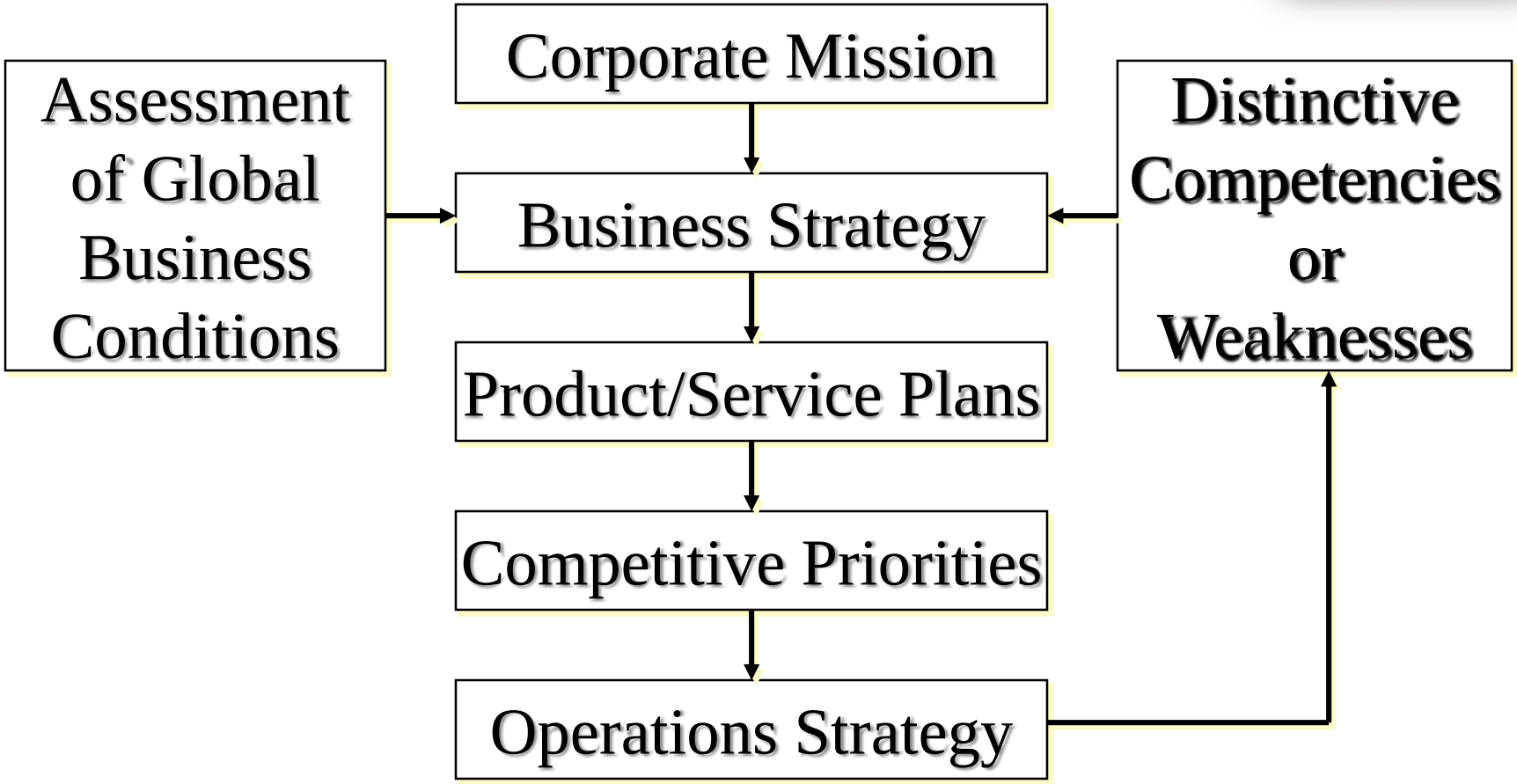
Business Goals and Objectives

Organizational Strategies

Functional Strategies

Strategy formulation (roadmap)

Developing Operations Strategy



Corporate Mission

- **A <u>corporate mission</u> is a set of long-range goals and including statements about:**
  - the kind of business the company wants to be in
  - who its customers are
  - its basic beliefs about business
  - its goals of survival, growth, and profitability

Business Strategy

- **Business strategy is a long-range game plan of an organization and provides a road map of how to achieve the corporate mission.**
- **Inputs to the business strategy are**
  - Assessment of global business conditions - social, economic, political, technological, competitive
  - Distinctive competencies or weaknesses - workers, sales force, R&D, technology, management

SWOT Analysis

- Strengths
- Weaknesses
- Opportunities
- Threats

Core Competencies

- **Core Competencies**

  The special attributes or abilities that give an organization a *competitive edge*

  - To be effective, core competencies and strategies need to be aligned

Strategy Formulation

- Effective strategy formulation requires taking into account**(SWOT analysis)**:
  - Core competencies
  - Environmental scanning
- Successful strategy formulation also requires taking into account:
  - Order qualifiers (minimum requirements for a potential purchase)
  - Order winners (characteristics that win over the customer)

Operations Strategy

- **Operations strategy**
  - The approach, consistent with organization strategy, that is used to guide the operations function.

Decision Area	What the Decisions Affect
Product and service design	Costs, quality, liability, and environmental issues
Capacity	Cost, structure, flexibility
Process selection and layout	Costs, flexibility, skill level needed, capacity
Work design	Quality of work life, employee safety, productivity
Location	Costs, visibility
Quality	Ability to meet or exceed customer expectations
Inventory	Costs, shortages
Maintenance	Costs, equipment reliability, productivity
Scheduling	Flexibility, efficiency
Supply chains	Costs, quality, agility, shortages, vendor relations
Projects	Costs, new products, services, or operating systems

Competitive Edges and Priorities

1. Cost
2. Quality
3. Response time
4. Customer service

Competitive Priorities

- **Low Production Costs**
  - Definition

    Unit cost (labor, material, and overhead) of each product/service
  - Some Ways of Creating
    - Redesign of product/service
    - New technology
    - Increase in production rates
    - Reduction of scrap/waste
    - Reduction of inventory

Competitive Priorities

- **Delivery Performance**
  - Definition
    a) Fast delivery b) On-time delivery
  - Some Ways of Creating
    a) larger finished-goods inventory
    a) faster production rates
    a) quicker shipping methods
    b) more-realistic promises
    b) better control of production of orders
    b) better information systems

Competitive Priorities

- **High-Quality Products/Services**
  - Definition

    Customers' perception of degree of excellence exhibited by products/services
  - Some Ways of Creating

    Improve product/service's
    - Appearance
    - Performance and function
    - Wear, endurance ability
    - After-sales service

Competitive Priorities

- **Customer Service and Flexibility**
  - Definition

    Ability to quickly change production to other products/services. Customer responsiveness.
  - Some Ways of Creating
    - Change in type of processes used
    - Use of advanced technologies
    - Reduction in WIP through lean manufacturing
    - Increase in capacity

Operations Strategy

- **<u>Operations strategy</u> is a long-range game plan for the production of a company's products/services, and provides a road map for the production function in helping to achieve the business strategy.**

Elements of Operations Strategy

- Positioning the production system
- Product/service plans
- Outsourcing plans
- Process and technology plans
- Strategic allocation of resources
- Facility plans: capacity, location, and layout

Positioning the Production System

- **Select the type of <u>product design</u>**
  - Standard
  - Custom
- **Select the type of <u>production processing system</u>**
  - Product focused
  - Process focused
- **Select the type of <u>finished-goods inventory policy</u>**
  - Produce-to-stock
  - Produce-to-order

Product/Service Plans

As a product is designed, all the detailed characteristics of the product are established.

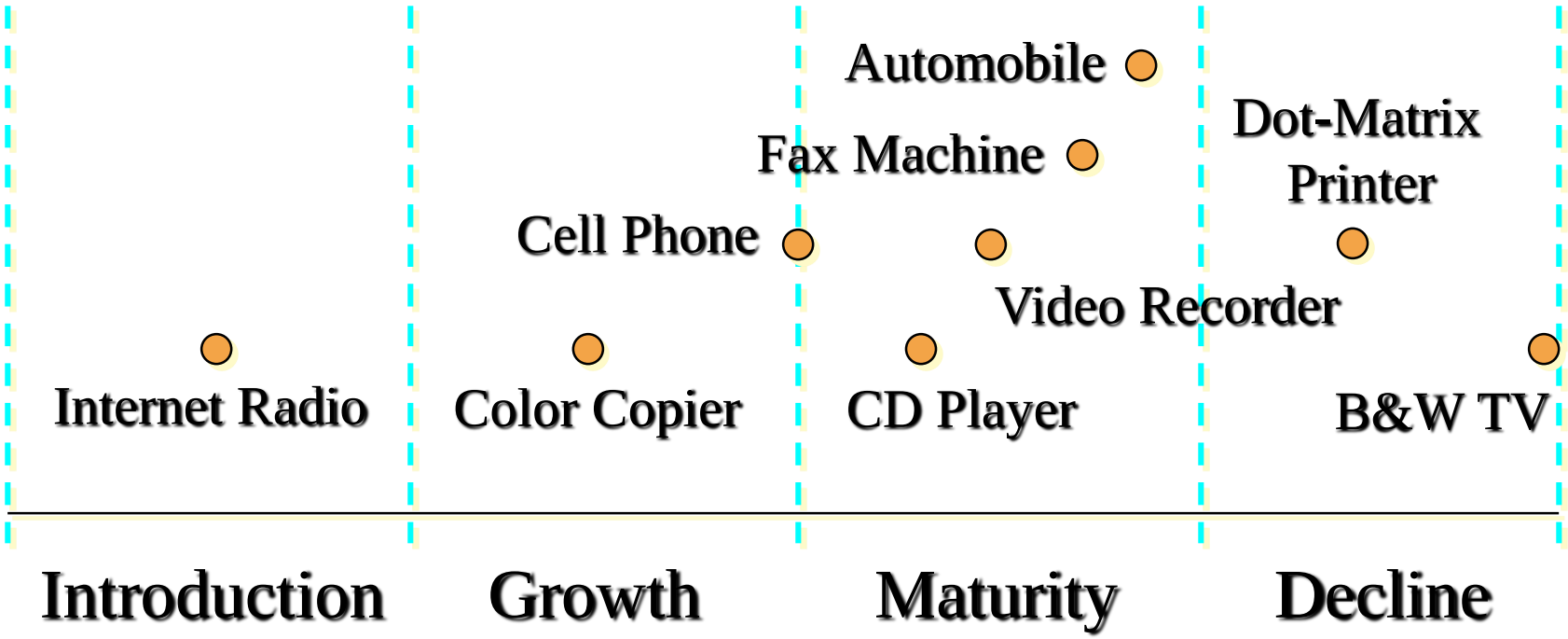
Each product characteristic directly affects how the product can be made.

How the product is made determines the design of the production system.

Stages in a Product's Life Cycle

- **Introduction- Sales begin, production and marketing are developing, profits are negative.**
- **Growth - sales grow dramatically, marketing efforts intensify, capacity is expanded, profits begin.**
- **Maturity - production focuses on high-volume, efficiency, low costs; marketing focuses on competitive sales promotion; profits are at peak.**
- **Decline - declining sales and profit; product might be dropped or replaced.**

Stages of a Product's Life Cycle



Outsourcing Plans

- **Outsourcing refers to hiring out or subcontracting some of the work that a company needs to do.**
- **This strategy is being used more and more as companies strive to operate more efficiently.**
- **Outsourcing has many advantages and disadvantages.**
- **Companies try to determine the best level of out-sourcing to achieve their operations & business goals.**
- **More outsourcing requires a company to have less equipment, fewer employees, and a smaller facility.**

Outsourcing Plans

- **A company might outsource any of the following <u>manufacturing related functions</u>:**
  - Designing the product
  - Purchasing the basic raw materials
  - Processing the subcomponents, subassemblies, major assemblies, and finished product
  - Distributing the product

Outsourcing Plans

- **Many companies even outsource some <u>service functions</u> such as:**
  - Payroll
  - Billing
  - Order processing
  - Developing/maintaining a website
  - Employee recruitment
  - Facility maintenance

Process and Technology Plans

- An essential part of operations strategy is the determination of how products/services will be produced.
- The range of technologies available to produce products/services is great and is continually changing.

Strategic Allocation of Resources

- For most companies, the vast majority of the firm's resources are used in production/operations.
- Some or all of these resources are limited.
- The resources must be allocated to products, services, projects, or profit opportunities in ways that maximize the achievement of the operations objectives.

Facility Plans

- How to provide the long-range capacity to produce the firm's products/services is a critical strategic decision.
- The location of a new facility may need to be decided.
- The internal arrangement (layout) of workers, equipment, and functional areas within a facility affects the ability to provide the desired volume, quality, and cost of products/services.

Characteristics of Services and Manufactured Products

	Services	Products
Output	Intangible	Tangible
Output Inventoried	No	Yes
Customer Contact	Extensive	Little
Lead Time	Short	Long
Intensity	Labor	Capital
Quality	Subjective	Objective

Competitive Priorities for Services

- **The competitive priorities listed earlier for manufacturers apply to service firms as well**
  - Low production costs
  - Fast and on-time delivery
  - High-quality products/services
  - Customer service and flexibility
- **Providing all the priorities simultaneously to customers is seldom possible.**

Forming Operations Strategies

- Support the product plans and competitive priorities defined in the business strategy.
- Adjust to the evolving positioning strategies.
- Link to the marketing strategies.
- Look at alternative operations strategies.

Evolution of Positioning Strategies

- The characteristics of production systems tend to evolve as products move through their product life cycles.
- Operations strategies must include plan for modifying production systems to a changing set of competitive priorities as products mature.
- The capital and production technology required to support these changes must be provided.

Evolution of Positioning Strategies

Life Stage →	Intro.	Early Growth	Late Growth	Maturity
Product	Custom	Slightly Standard	Standard	Highly Standard
Volume	Very Low	Low	High	Very High
Prod mode	Process	Process	Product	Product
Inventory.	To-Order	To-Order	To-Stock	To-Stock
Batch Size	Very Small	Small	Large	Very Large

Linking Operations and Marketing Strategies

- **Operations Strategy**
  - Product-focused
  - Make-to-stock
  - Standardized products
  - High volume
- **Marketing Strategy**
  - Low production cost
  - Fast delivery of products
  - Quality
- **Example: TV sets**

Linking Operations and Marketing Strategies

- **Operations Strategy**
  - Product-focused
  - Make-to-order
  - Standardized products
  - Low volume
- **Marketing Strategy**
  - Low production cost
  - Keeping delivery promises
  - Quality
- **Example: School buses**

Linking Operations and Marketing Strategies

- **Operations Strategy**
  - Process-focused
  - Make-to-stock
  - Custom products
  - High volume
- **Marketing Strategy**
  - Flexibility
  - Quality
  - Fast delivery of products
- **Example: Medical instruments**

Linking Operations and Marketing Strategies

- **Operations Strategy**
  - Process-focused
  - Make-to-order
  - Custom products
  - Low volume
- **Marketing Strategy**
  - Keeping delivery promises
  - Quality
  - Flexibility
- **Example: Large supercomputers**

No Single Best Strategy

- **Start-up and Small Manufacturers**

  Usually prefer positioning strategies with:

  - Custom products
  - Process-focused production
  - Produce-to-order policies

  These systems are more flexible and require less capital.

No Single Best Strategy

- **Start-up and Small Services**

  Successfully compete with large corporations by:

  - Carving out a specialty niche
  - Emphasizing close, personal customer service
  - Developing a loyal customer base

No Single Best Strategy

- **Technology-Intensive Business**
  - Production systems must be capable of producing new products and services in high volume soon after introduction
  - Such companies must have two key strengths:
    - Highly capable technical people
    - Sufficient capital

Wrap-Up: World-Class Practice

- **Put customers first**
- **Get new products/services to market faster**
- **Are high quality producers**
- **Have high labor productivity & low production costs**
- **Carry little excess inventory**
- **. . . more**

Wrap-Up: World-Class Practice

- Think more globally in purchasing and selling
- Quickly adopt and develop new technologies
- Trim organizations to be lean and flexible
- Are less resistant to strategic alliances/joint ventures
- Consider relevant social issues when setting strategies

Productivity

- **Productivity**
  - A measure of the effective use of resources, usually expressed as the ratio of output to input
- **Productivity measures are useful for**
  - Tracking an operating unit's performance over time
  - Judging the performance of an entire industry or country

Factors Affecting Productivity

- Process & Methods
- Product Design
- Capital
- Quality
- Technology
- Management

Productivity Measures

$$\text{Productivity} = \frac{\text{Output}}{\text{Input}}$$

$$\text{Partial Measures} \quad \frac{\text{Output}}{\text{Single Input}}; \quad \frac{\text{Ouput}}{\text{Labor}}; \quad \frac{\text{Output}}{\text{Capital}}$$

$$\text{Multifactor Measures} \quad \frac{\text{Output}}{\text{Multiple Inputs}}; \quad \frac{\text{Ouput}}{\text{Labor} + \text{Machine}}; \quad \frac{\text{Output}}{\text{Labor} + \text{Capital} + \text{Energy}}$$

$$\text{Total Measure} \quad \frac{\text{Goods or services produced}}{\text{All inputs used to produce them}}$$

Improving Productivity (TQM and BPR)

1. Develop productivity measures for all operations
2. Determine critical (bottleneck) operations
3. Develop methods for productivity improvements
4. Establish reasonable goals
5. Make it clear that management supports and encourages productivity improvement
6. Measure and publicize improvements

Don't confuse *productivity* with *efficiency*

Part 3

Inventory Management

Inventory

- ☑ One of the most expensive assets of many companies representing as much as 50% of total invested capital
- ☑ Operations managers must balance inventory investment and customer service

Functions of Inventory

1. To decouple or separate various parts of the production process
2. To decouple the firm from fluctuations in demand and provide a stock of goods that will provide a selection for customers
3. To take advantage of quantity discounts
4. To hedge against inflation

Types of Inventory

- ☑ Raw material
  - ☑ Purchased but not processed
- ☑ Work-in-process
  - ☑ Undergone some change but not completed
  - ☑ A function of cycle time for a product
- ☑ Maintenance/repair/operating (MRO)
  - ☑ Necessary to keep machinery and processes productive
- ☑ Finished goods
  - ☑ Completed product awaiting shipment

The Material Flow Cycle

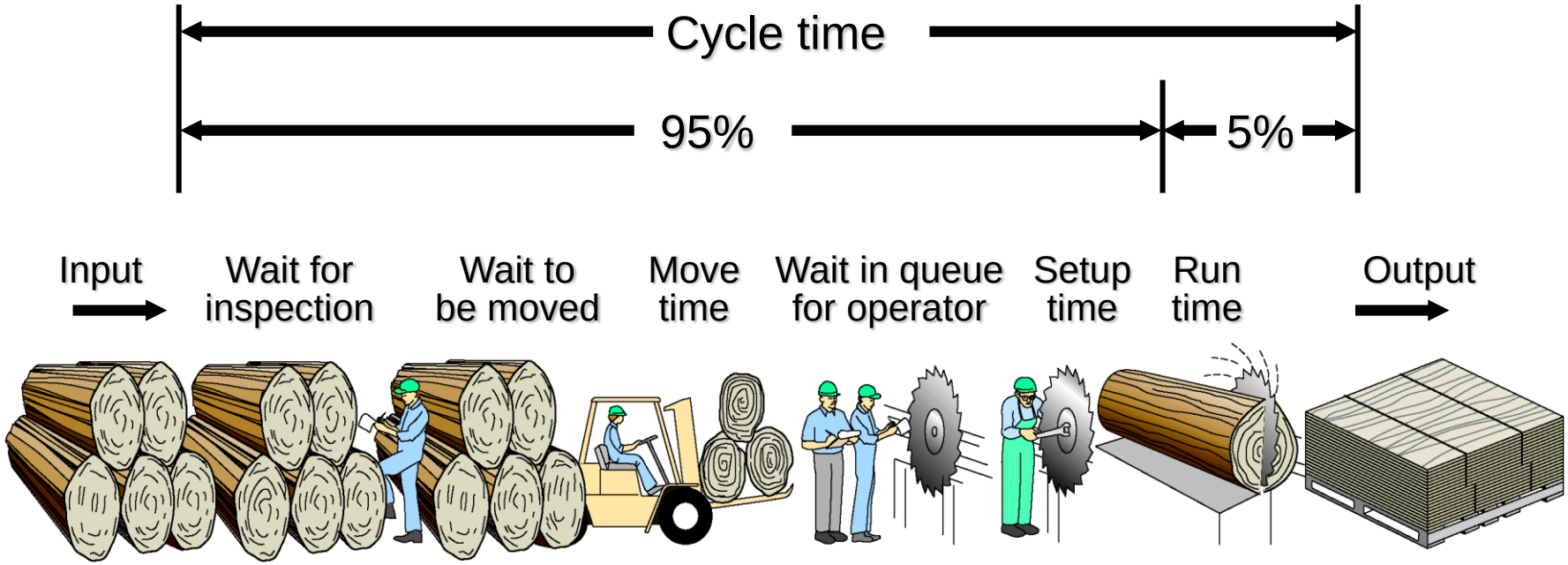


Figure 12.1

Inventory Management

- ☑ How inventory items can be classified
- ☑ How accurate inventory records can be maintained

ABC Analysis

- ☑ Divides inventory into three classes based on annual dollar volume
  - ☑ Class A - high annual dollar volume
  - ☑ Class B - medium annual dollar volume
  - ☑ Class C - low annual dollar volume
- ☑ Used to establish policies that focus on the few critical parts and not the many trivial ones

ABC Analysis

Item Stock Number	Percent of Number of Items Stocked	Annual Volume (units)	x	Unit Cost	=	Annual Dollar Volume	Percent of Annual Dollar Volume		Class
#10286	20%	1,000		$ 90.00		$ 90,000	38.8%	72%	A
#11526		500		154.00		77,000	33.2%		A
#12760		1,550		17.00		26,350	11.3%		B
#10867	30%	350		42.86		15,001	6.4%	23%	B
#10500		1,000		12.50		12,500	5.4%		B

ABC Analysis

- ☑ Other criteria than annual dollar volume may be used
  - ☑ Anticipated engineering changes
  - ☑ Delivery problems
  - ☑ Quality problems
  - ☑ High unit cost

ABC Analysis

- ☑ Policies employed may include
  - ☑ More emphasis on supplier development for A items
  - ☑ Tighter physical inventory control for A items
  - ☑ More care in forecasting A items

Record Accuracy

- ☑ Accurate records are a critical ingredient in production and inventory systems
- ☑ Allows organization to focus on what is needed
- ☑ Necessary to make precise decisions about ordering, scheduling, and shipping
- ☑ Incoming and outgoing record keeping must be accurate
- ☑ Stockrooms should be secure

Cycle Counting

- ☑ Items are counted and records updated on a periodic basis
- ☑ Often used with ABC analysis to determine cycle
- ☑ Has several advantages
  - ☑ Eliminates shutdowns and interruptions
  - ☑ Eliminates annual inventory adjustment
  - ☑ Trained personnel audit inventory accuracy
  - ☑ Allows causes of errors to be identified and corrected
  - ☑ Maintains accurate inventory records

Cycle Counting Example

5,000 items in inventory, 500 A items, 1,750 B items, 2,750 C items

Policy is to count A items every month (20 working days), B items every quarter (60 days), and C items every six months (120 days)

Item Class	*Quantity*	*Cycle Counting Policy*	*Number of Items Counted per Day*
A	**500**	***Each month***	**500/20 = 25/*day***
B	**1,750**	***Each quarter***	**1,750/60 = 29/*day***
C	**2,750**	***Every 6 months***	**2,750/120 = 23/*day***
			77/*day*

Control of Service Inventories

- ☑ Can be a critical component of profitability
- ☑ Losses may come from shrinkage or pilferage
- ☑ Applicable techniques include
  1. Good personnel selection, training, and discipline
  2. Tight control on incoming shipments
  3. Effective control on all goods leaving facility

Independent Versus, Dependent Demand

- ☑ Independent demand - the demand for item is independent of the demand for any other item in inventory
- ☑ Dependent demand - the demand for item is dependent upon the demand for some other item in the inventory

Holding, Ordering, and Setup Costs

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

Holding Costs

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

Inventory Models for Independent Demand

Need to determine when and how much to order

- ☑ Basic economic order quantity
- ☑ Production order quantity
- ☑ Quantity discount model

Basic EOQ Model

Important assumptions

1. Demand is known, constant, and independent
2. Lead time is known and constant
3. Receipt of inventory is instantaneous and complete
4. Quantity discounts are not possible
5. Only variable costs are setup and holding
6. Stockouts can be completely avoided

Inventory Usage Over Time

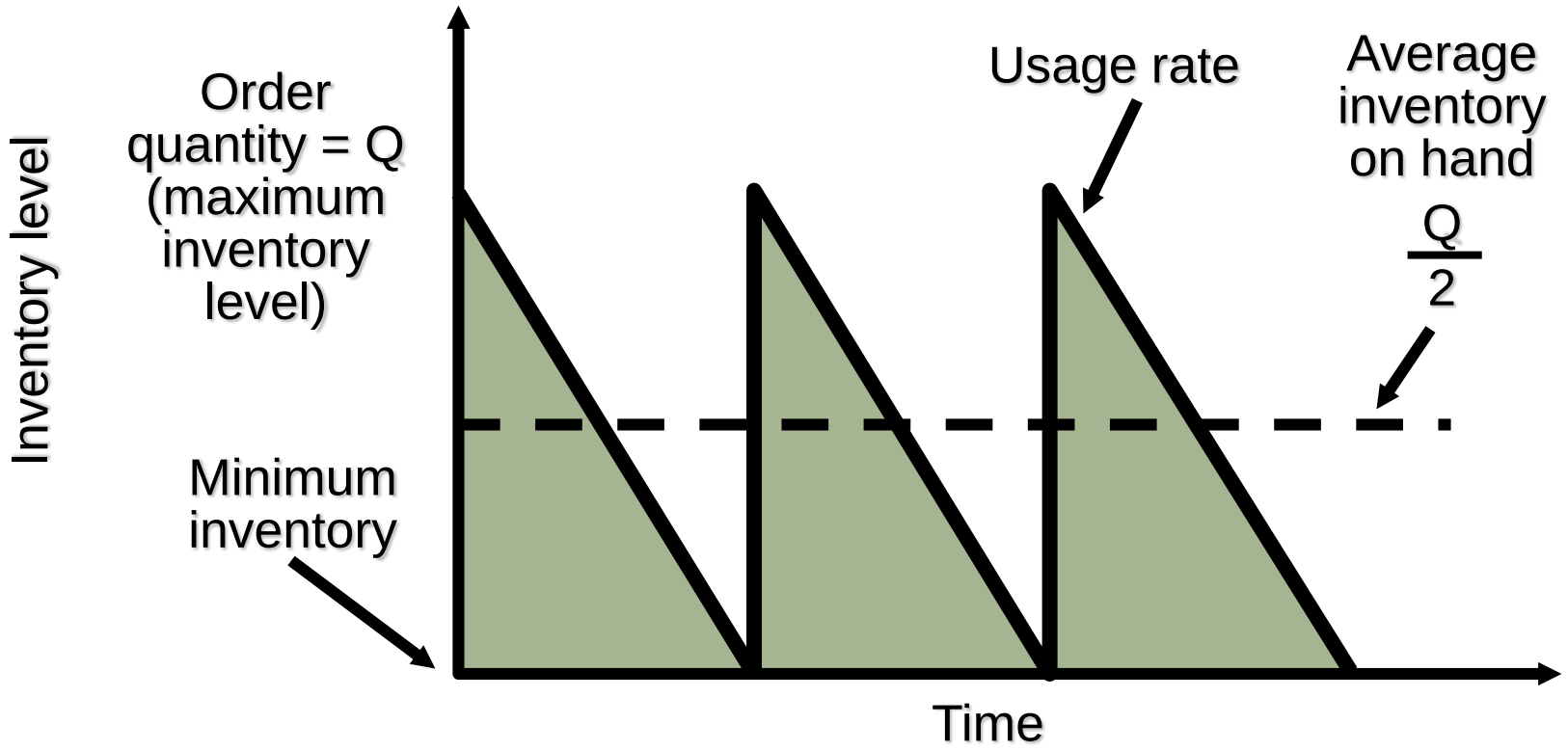


Figure 12.3

Minimizing Costs

Objective is to minimize total costs

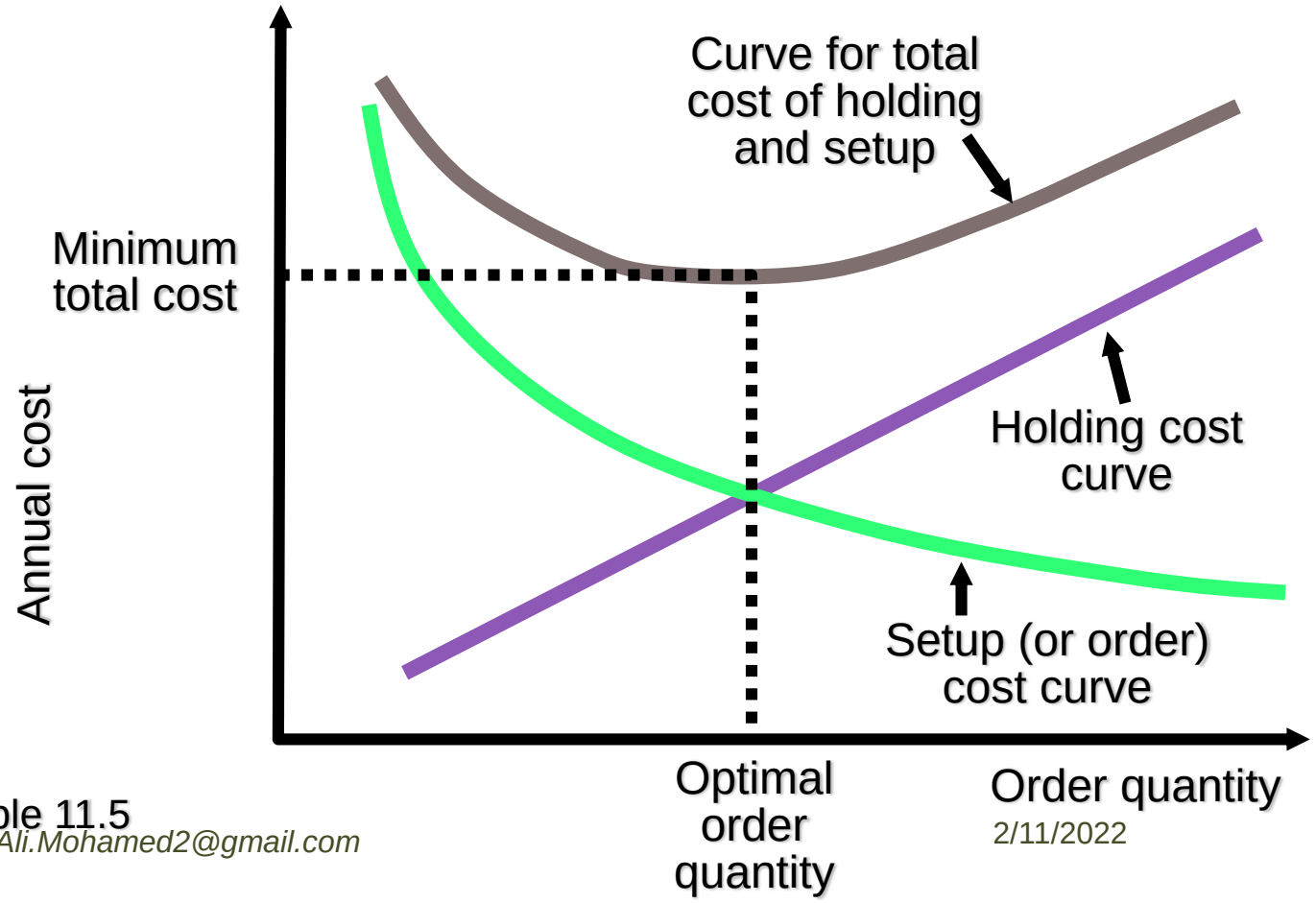


Table 11.5

The EOQ Model

Annual setup cost = $\frac{D}{Q}S$

Q = Number of pieces per order
Q* = Optimal number of pieces per order (EOQ)
D = Annual demand in units for the Inventory item
S = Setup or ordering cost for each order
H = Holding or carrying cost per unit per year

Annual setup cost = (Number of orders placed per year) x (Setup or order cost per order)

$$= \left(\frac{\text{Annual demand}}{\text{Number of units in each order}}\right)\left(\text{Setup or order cost per order}\right)$$

$$= \left(\frac{D}{Q}\right)(S)$$

The EOQ Model

Annual setup cost = $\frac{D}{Q}S$

Annual holding cost = $\frac{Q}{2}H$

Q = Number of pieces per order
Q* = Optimal number of pieces per order (EOQ)
D = Annual demand in units for the Inventory item
S = Setup or ordering cost for each order
H = Holding or carrying cost per unit per year

Annual holding cost = (Average inventory level)
x (Holding cost per unit per year)

$$= \left(\frac{\text{Order quantity}}{2}\right)(\text{Holding cost per unit per year})$$

$$= \left(\frac{Q}{2}\right)(H)$$

The EOQ Model

Annual setup cost = $\frac{D}{Q}S$

Annual holding cost = $\frac{Q}{2}H$

Q = Number of pieces per order
Q* = Optimal number of pieces per order (EOQ)
D = Annual demand in units for the Inventory item
S = Setup or ordering cost for each order
H = Holding or carrying cost per unit per year

Optimal order quantity is found when annual setup cost equals annual holding cost

$$\frac{D}{Q}S = \frac{Q}{2}H$$

Solving for Q*

$$2DS = Q^2H$$

$$Q^2 = 2DS/H$$

$$Q^* = \sqrt{2DS/H}$$

Reorder Points

- ☑ EOQ answers the “how much” question
- ☑ The reorder point (ROP) tells when to order

$$\text{ROP} = \left(\begin{array}{c}\text{Demand}\\ \text{per day}\end{array}\right)\left(\begin{array}{c}\text{Lead time for a}\\ \text{new order in days}\end{array}\right)$$

$$= d \times L$$

$$d = \frac{D}{\text{Number of working days in a year}}$$

Reorder Point Curve

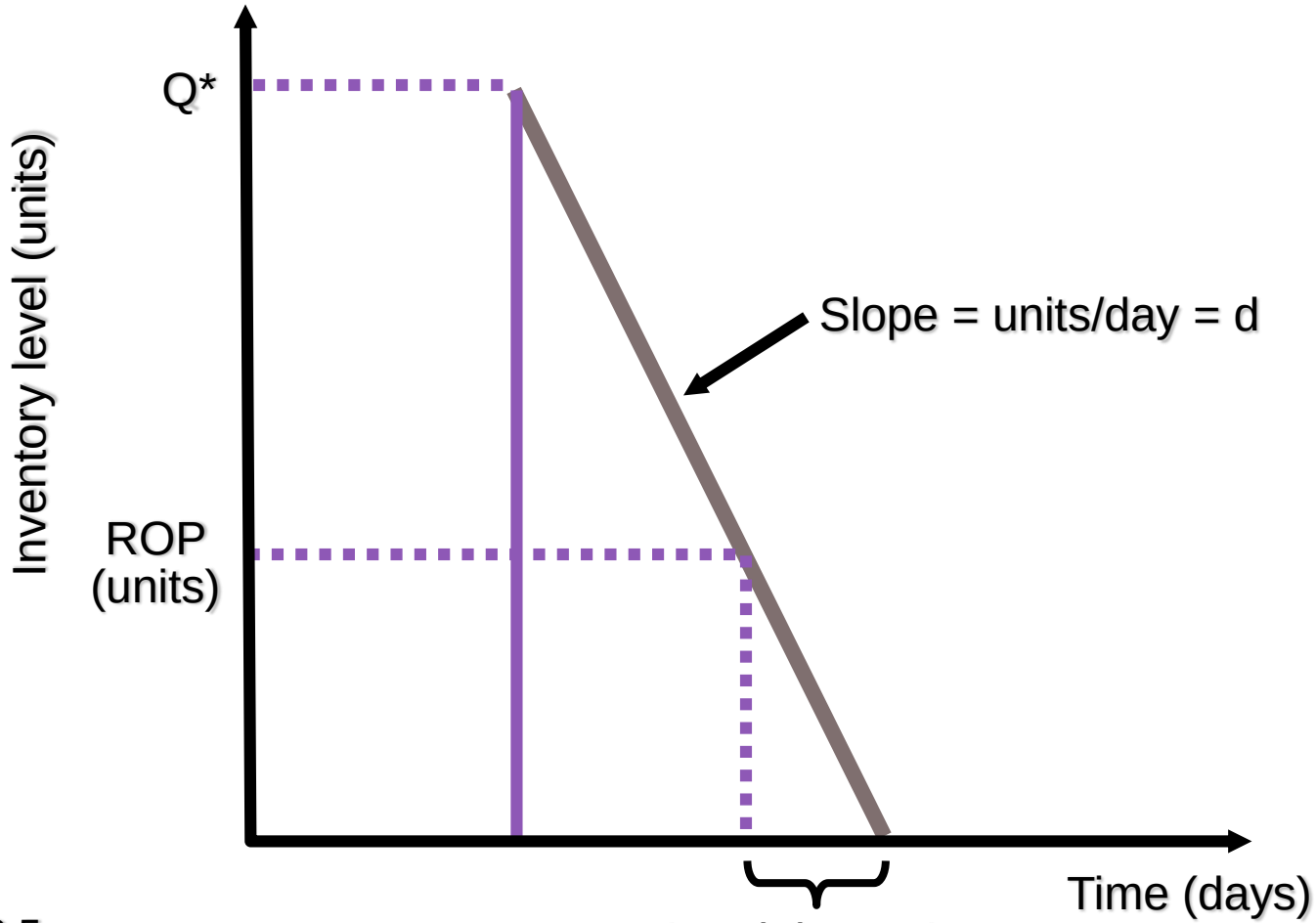


Figure 12.5

Reorder Point Example

Demand = 8,000 DVDs per year
250 working day year
Lead time for orders is 3 working days

$$d = \frac{D}{\text{Number of working days in a year}}$$

= 8,000/250 = 32 units

ROP = d x L

= 32 units per day x 3 days = 96 units

Production Order Quantity Model

- ☑ Used when inventory builds up over a period of time after an order is placed
- ☑ Used when units are produced and sold simultaneously

Production Order Quantity Model

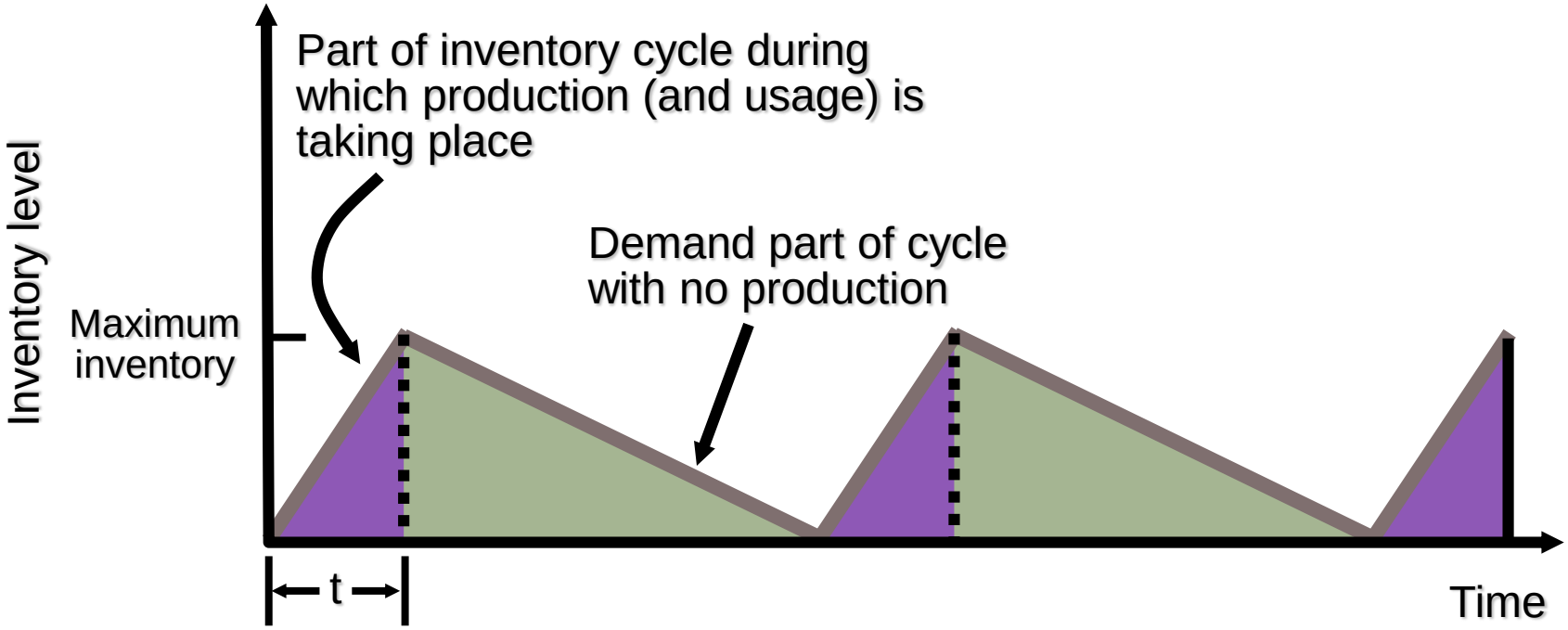


Figure 12.6

Production Order Quantity Model

Q = Number of pieces per order
H = Holding cost per unit per year
t = Length of the production run in days

p = Daily production rate
d = Daily demand/usage rate

$$\left(\begin{array}{c}\text{Annual inventory}\\ \text{holding cost}\end{array}\right) = (\text{Average inventory level}) \times \left(\begin{array}{c}\text{Holding cost}\\ \text{per unit per year}\end{array}\right)$$

$$\left(\begin{array}{c}\text{Annual inventory}\\ \text{level}\end{array}\right) = (\text{Maximum inventory level})/2$$

$$\left(\begin{array}{c}\text{Maximum}\\ \text{inventory level}\end{array}\right) = \left(\begin{array}{c}\text{Total produced during the}\\ \text{production run}\end{array}\right) - \left(\begin{array}{c}\text{Total used during the}\\ \text{production run}\end{array}\right)$$

$$= pt - dt$$

Production Order Quantity Model

Q = Number of pieces per order
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$$\left(\begin{array}{c}\text{Maximum}\\ \text{inventory level}\end{array}\right) = \left(\begin{array}{c}\text{Total produced during the}\\ \text{production run}\end{array}\right) - \left(\begin{array}{c}\text{Total used during the}\\ \text{production run}\end{array}\right)$$

$$= pt - dt$$

However, Q = total produced = pt ; thus t = Q/p

$$\left(\begin{array}{c}\text{Maximum}\\ \text{inventory level}\end{array}\right) = p\left(\frac{Q}{p}\right) - d\left(\frac{Q}{p}\right) = Q\left(1 - \frac{d}{p}\right)$$

$$\text{Holding cost} = \frac{\text{Maximum inventory level}}{2}(H) = \frac{Q}{2}\left[1 - \left(\frac{d}{p}\right)\right]H$$

Quantity Discount Models

- ☑ Reduced prices are often available when larger quantities are purchased
- ☑ Trade-off is between reduced product cost and increased holding cost

Total cost = Setup cost + Holding cost + Product cost

$$TC = \frac{D}{Q}S + \frac{QH}{2} + PD$$

Quantity Discount Models

A typical 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

Table 12.2

Quantity Discount Models

Steps in analyzing a quantity discount

1. For each discount, calculate Q*
2. If Q* for a discount doesn't qualify, choose the smallest possible order size to get the discount
3. Compute the total cost for each Q* or adjusted value from Step 2
4. Select the Q* that gives the lowest total cost

Quantity Discount Models

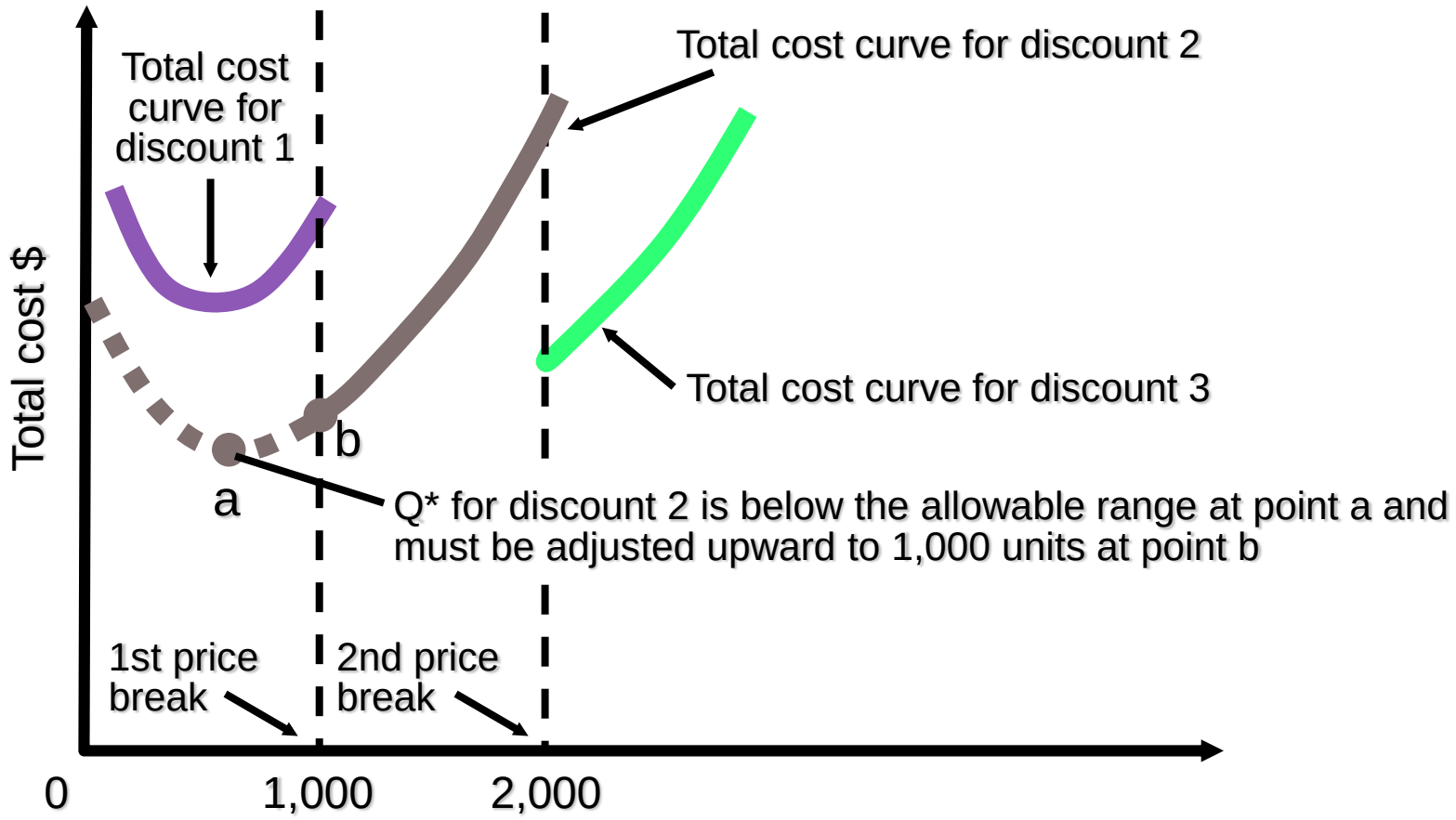


Figure 12.7

Quantity Discount Example

Calculate Q* for every discount

$$Q^* = \sqrt{\frac{2DS}{IP}}$$

$$Q_1^* = \sqrt{\frac{2(5{,}000)(49)}{(.2)(5.00)}} = 700 \text{ cars order}$$

$$Q_2^* = \sqrt{\frac{2(5{,}000)(49)}{(.2)(4.80)}} = 714 \text{ cars order}$$

$$Q_3^* = \sqrt{\frac{2(5{,}000)(49)}{(.2)(4.75)}} = 718 \text{ cars order}$$

Quantity Discount Example

Calculate Q* for every discount

$$Q^* = \sqrt{\frac{2DS}{IP}}$$

$$Q_1^* = \sqrt{\frac{2(5{,}000)(49)}{(.2)(5.00)}} = 700 \text{ cars order}$$

$$Q_2^* = \sqrt{\frac{2(5{,}000)(49)}{(.2)(4.80)}} = 714 \text{ cars order}$$

1,000 — adjusted

$$Q_3^* = \sqrt{\frac{2(5{,}000)(49)}{(.2)(4.75)}} = 718 \text{ cars order}$$

2,000 — adjusted

Quantity Discount Example

Discount Number	Unit Price	Order Quantity	Annual Product Cost	Annual Ordering Cost	Annual Holding Cost	Total
1	$5.00	700	$25,000	$350	$350	$25,700
2	$4.80	1,000	$24,000	$245	$480	$24,725
3	$4.75	2,000	$23.750	$122.50	$950	$24,822.50

Table 12.3

Choose the price and quantity that gives the lowest total cost

Buy 1,000 units at $4.80 per unit

Probabilistic Models and Safety Stock

- ☑ Used when demand is not constant or certain
- ☑ Use safety stock to achieve a desired service level and avoid stockouts

$$ROP = d \times L + ss$$

Annual stockout costs = the sum of the units short x the probability x the stockout cost/unit
x the number of orders per year

Probabilistic Demand

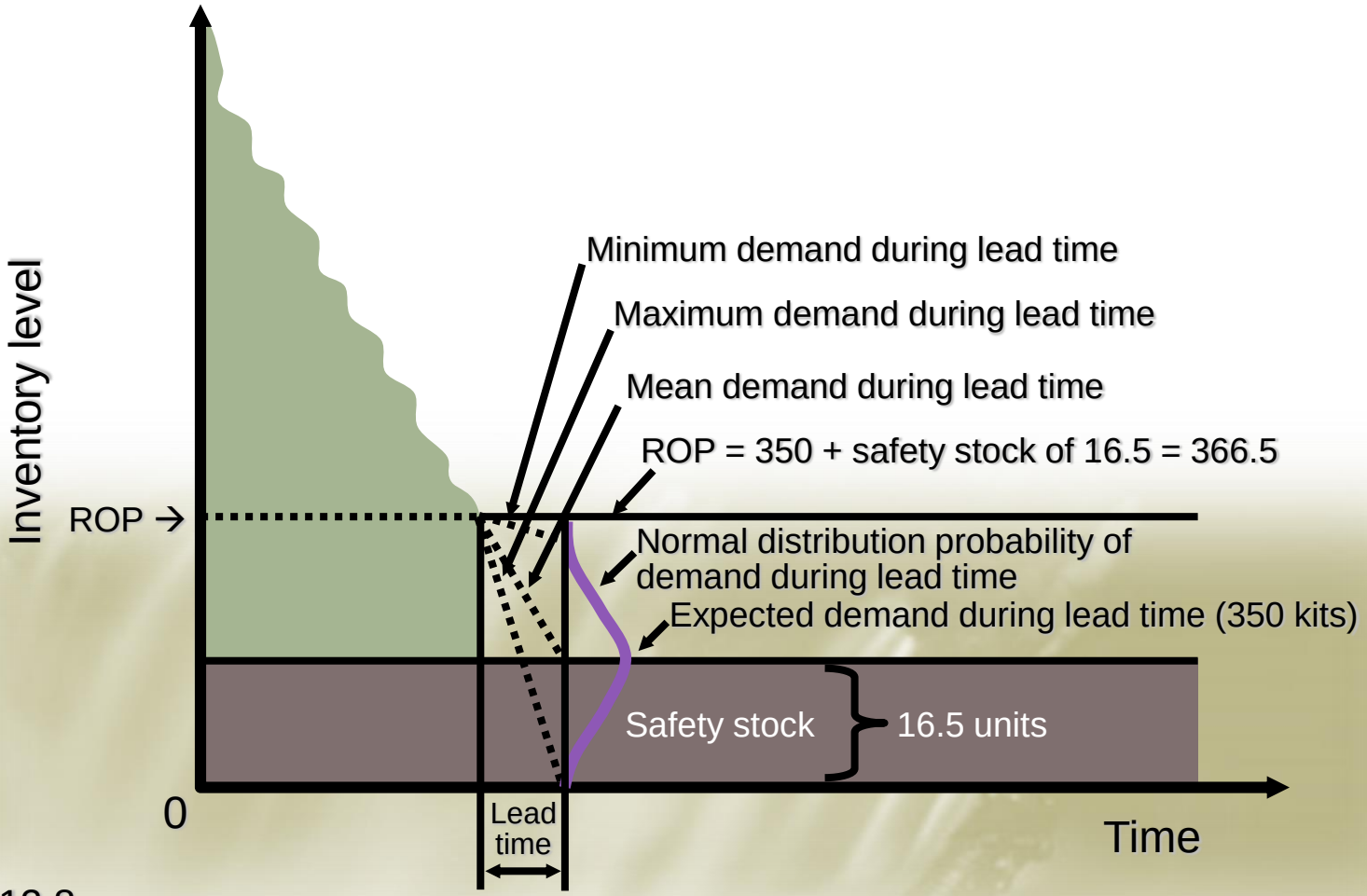
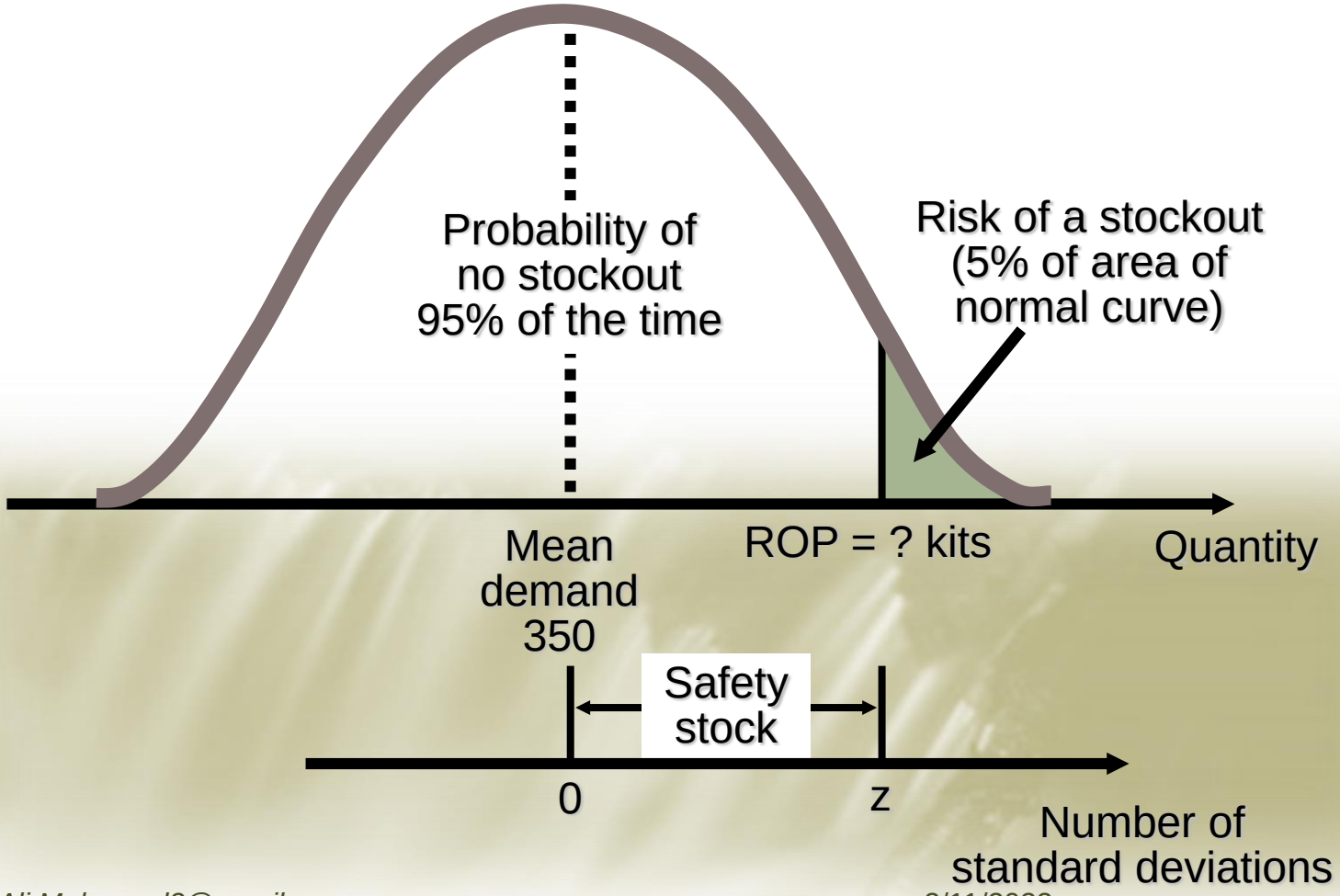


Figure 12.8

Probabilistic Demand



Probabilistic Demand

Use prescribed service levels to set safety stock when the cost of stockouts cannot be determined

$$\text{ROP} = \text{demand during lead time} + Z\sigma_{dlt}$$

where Z = number of standard deviations

σ_{dlt} = standard deviation of demand during lead time

Probabilistic Example

Average demand = μ = 350 kits
Standard deviation of demand during lead time = σ_{dlt} = 10 kits
5% stockout policy (service level = 95%)

Using Appendix I, for an area under the curve of 95%, the Z = 1.65

Safety stock = $Z\sigma_{dlt}$ = 1.65(10) = 16.5 kits

Reorder point = expected demand during lead time + safety stock
= 350 kits + 16.5 kits of safety stock
= 366.5 or 367 kits

Other Probabilistic Models

When data on demand during lead time is not available, there are other models available

1. When demand is variable and lead time is constant
2. When lead time is variable and demand is constant
3. When both demand and lead time are variable

Other Probabilistic Models

Demand is variable and lead time is constant

$$\text{ROP} = (\text{average daily demand} \times \text{lead time in days}) + Z\sigma_{dlt}$$

where σ_d = standard deviation of demand per day

$$\sigma_{dlt} = \sigma_d \sqrt{\text{lead time}}$$

Fixed-Period (P) Systems

- ☑ Orders placed at the end of a fixed period
- ☑ Inventory counted only at end of period
- ☑ Order brings inventory up to target level

- ☑ Only relevant costs are ordering and holding
- ☑ Lead times are known and constant
- ☑ Items are independent from one another

Fixed-Period (P) Systems

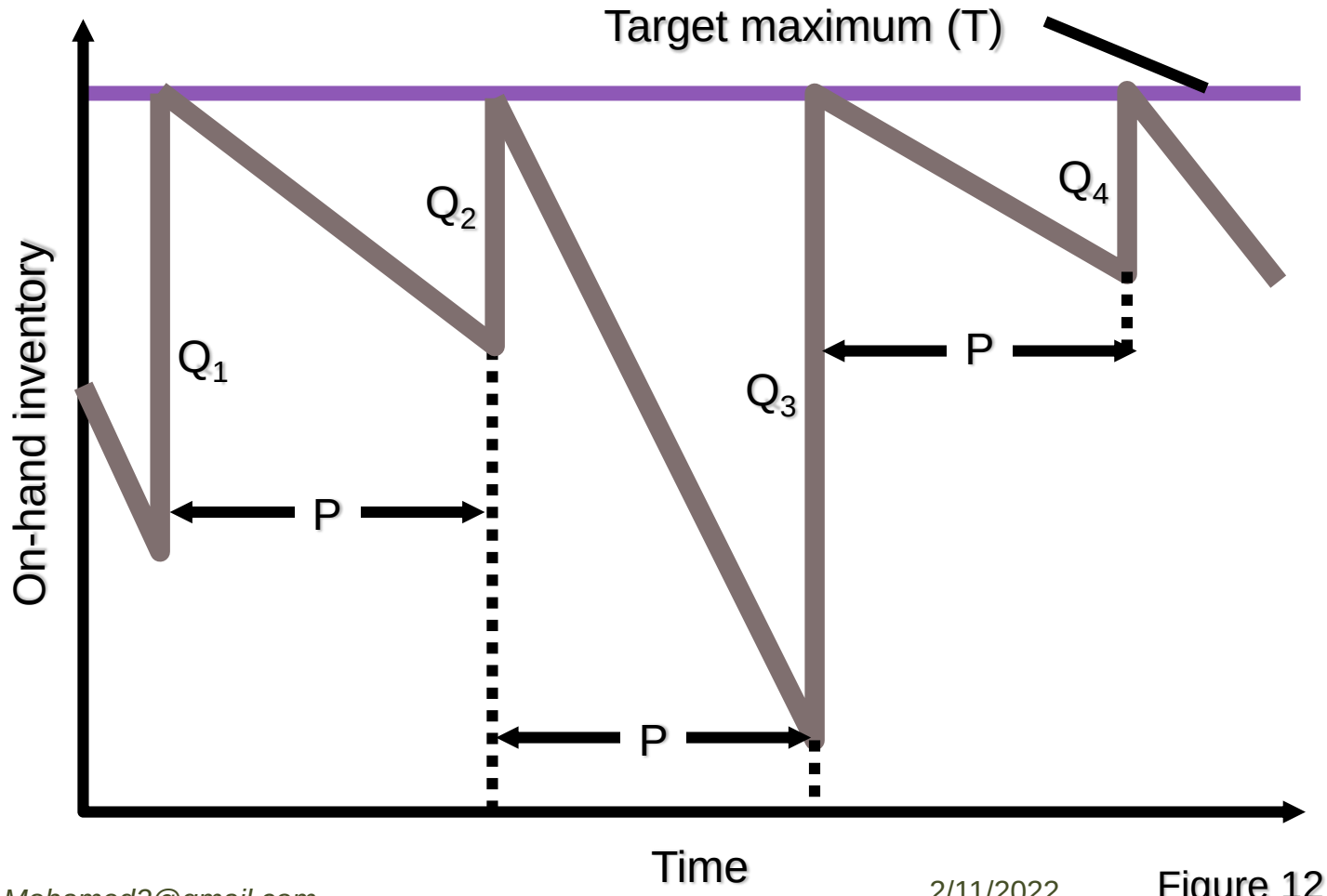


Figure 12.9

Fixed-Period (P) Example

3 jackets are back ordered
It is time to place an order

No jackets are in stock
Target value = 50

Order amount (Q) = Target (T) - On-hand inventory - Earlier orders not yet received + Back orders

Q = 50 - 0 - 0 + 3 = 53 jackets

Fixed-Period Systems

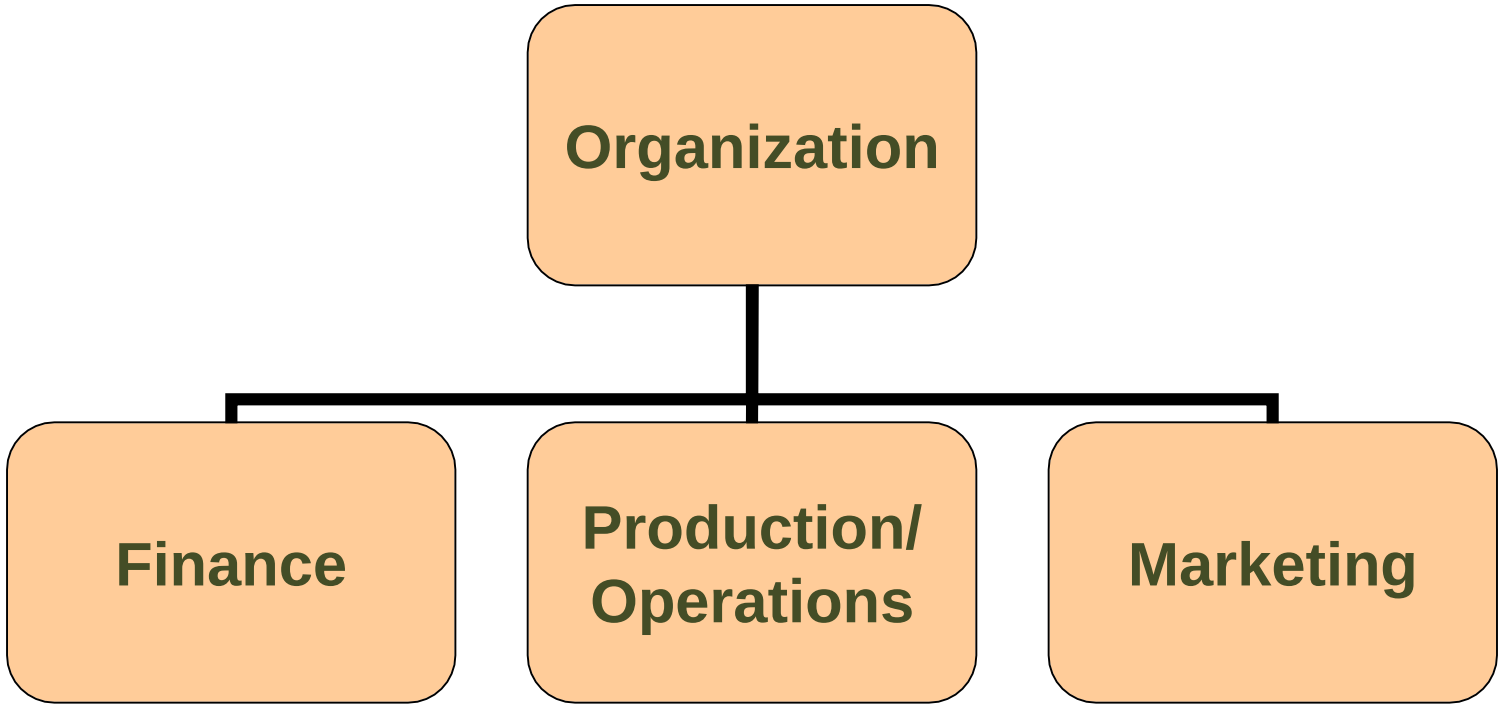
- ☑ Inventory is only counted at each review period
- ☑ May be scheduled at convenient times
- ☑ Appropriate in routine situations
- ☑ May result in stockouts between periods
- ☑ May require increased safety stock

Part 4

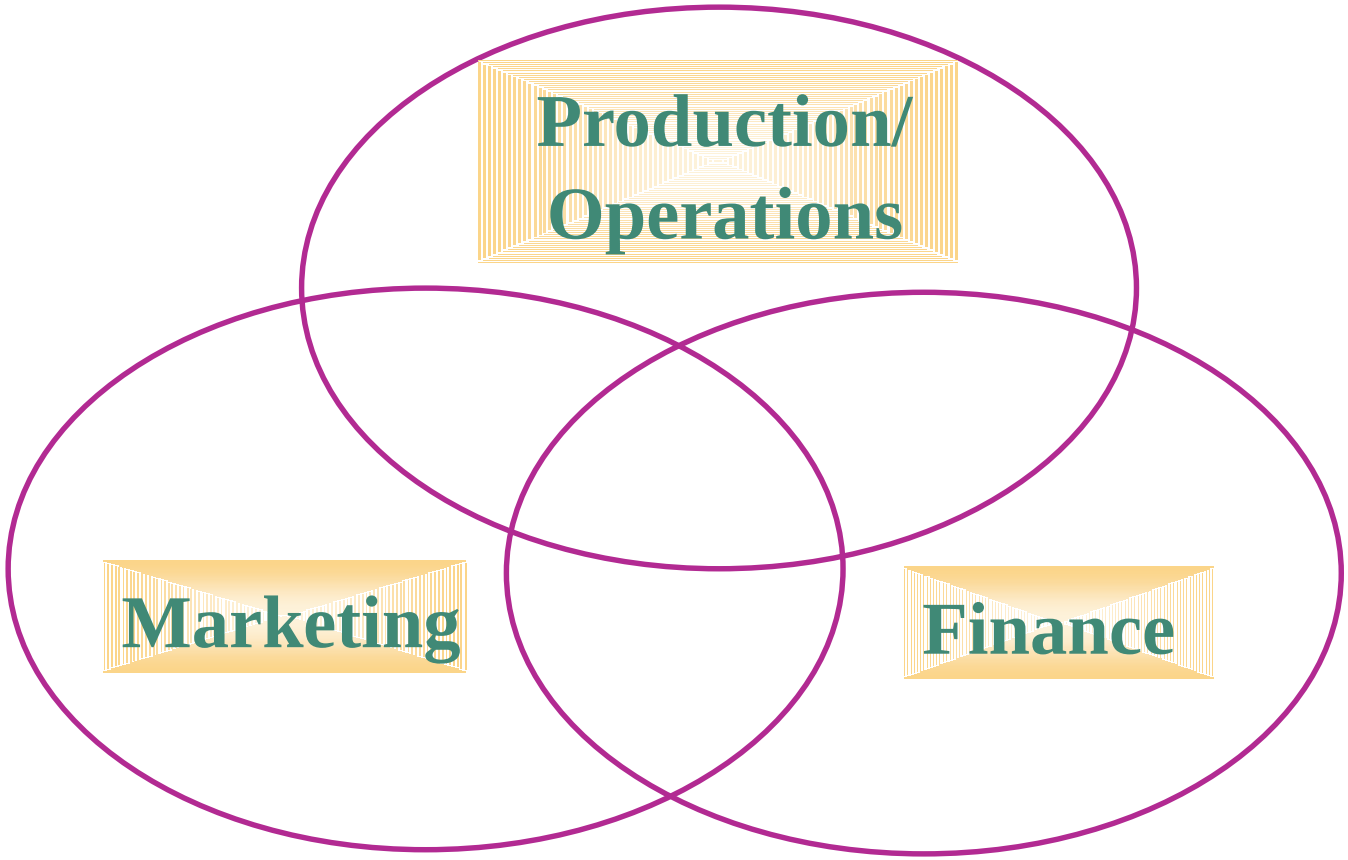
Operations Management & Role of operations Manager

Operations Management

- **Operations function consists of all activities *directly* related to producing goods or providing services.**



Business Operations Overlap

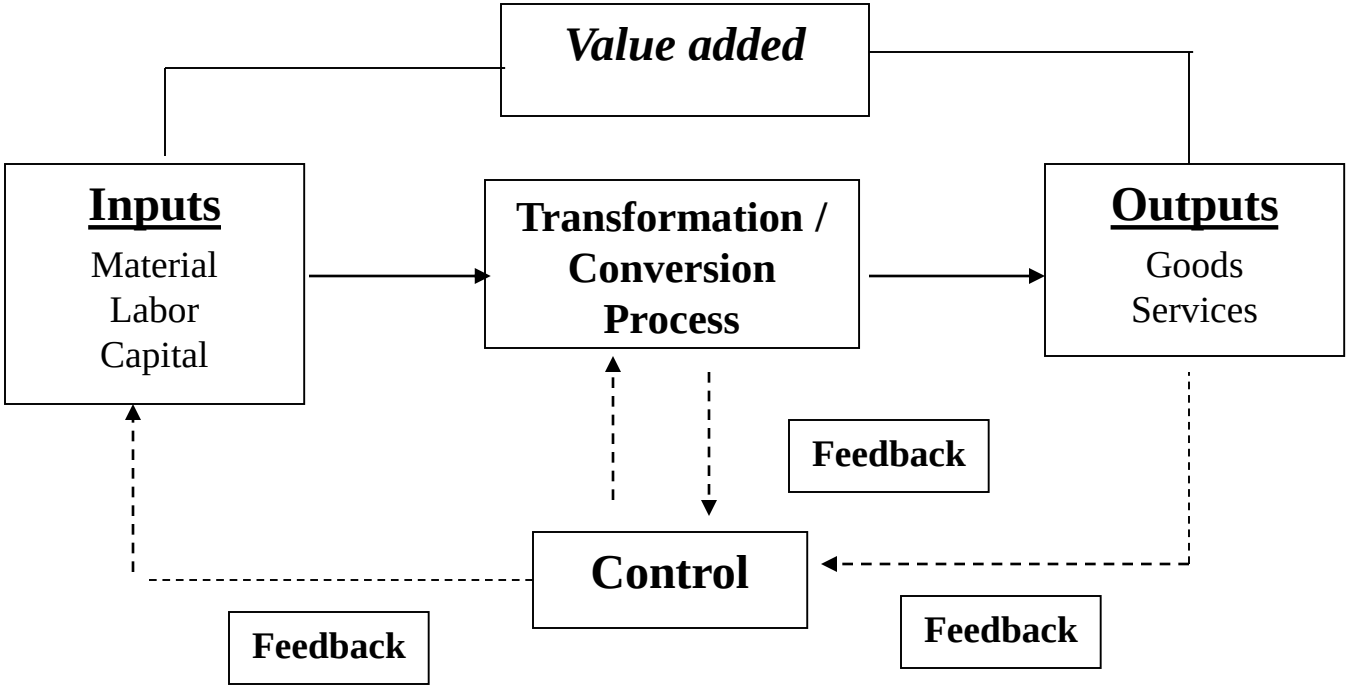


Examples of operations:

Operations	Examples
▪ Goods Production	▪ Farming, Mining, Construction, Manufacturing, Power Generation
▪ Storage / Transportation	▪ Warehousing, Trucking, Mail Service, Moving, Taxis, Buses, Hotels, Airlines
▪ Exchange	▪ Retailing, Wholesaling, Banking, Renting, Leasing, Library, Loans
▪ Entertainment	▪ Films, Radio, Television, Concerts, Recordings
▪ Communication	▪ Newspapers, Radio and Television, Newscasts, Telephone, Satellites

Value added

The difference between the cost of inputs and the value or price of outputs.



The Importance of Operations Management

- **Synergies must exist with other functional areas of the organization**
- **Operations account for 60-80% of the direct expenses that burden a firm's profit.**

Three Major Phases

Craft manufacturing

- **Craft manufacturing describes the process by which skilled craftspeople produce goods in low volume, with a high degree of variety, to meet the requirements of their individual customers.**

Mass production

- **In many industries, craft manufacturing began to be replaced by mass production in the 19th century. Mass production involves producing goods in high volume with low variety – the opposite of craft manufacturing.**

Mass Production(Innovations 1)

- **Standardization:**
- **An important innovation in operations that made mass production possible was the system of standardised and interchangeable parts known as the 'American system of manufacture', which developed in the United States and spread to the United Kingdom and other countries.**

Mass production(Innovations 2)

Scientific Management:

- **A second innovation was the development by Frederick Taylor (1911) of the system of 'scientific management', which sought to redesign jobs using similar principles to those used in designing machines.**

Mass Production(Innovations 3)

Moving Assembly Line:

- **A third innovation was the development of the moving assembly line by Henry Ford. Instead of workers bringing all the parts and tools to a fixed location where one car was put together at a time, the assembly line brought the cars to the workers.**

Mass Production (in nut shell)

- **A system through which large volumes of standardized products could be assembled by unskilled workers at constantly decreasing costs .**

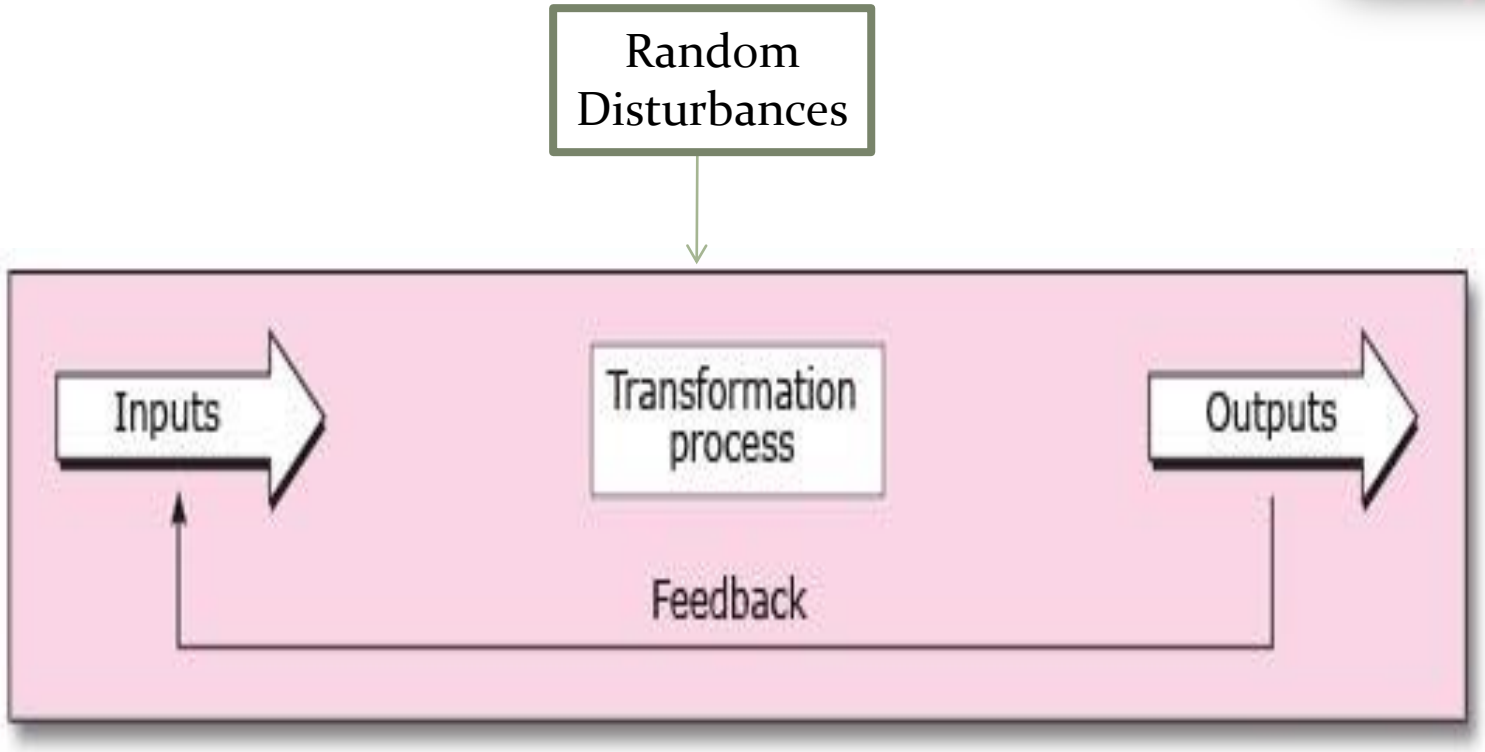
Modern Period(Different Approaches)

- ***Flexible specialization***
- ***Lean production***
- ***Mass customization***
- ***Agile manufacturing***

Modern Period(in a nutshell)

- **These approaches all seek to combine the high volume and low cost associated with mass production with the craft production.**

The transformation model



Input

Some inputs are used up in the process of creating goods or services; others play a part in the creation process but are not used up. To distinguish between these, input resources are usually classified as:

- **Transformed Resources**
- **Transforming Resources**

Input

Three types of resource that may be transformed in operations are:

- **Materials**
- **Information**
- **Customers**

The two types of transforming resource are:

- **staff**
- **facilities**

Output

- **The principal outputs of a doctor's surgery are cured patients; the outputs of a nuclear reprocessing plant include reprocessed fuel and nuclear waste. Many transformation processes produce both goods and services. For example, a restaurant provides a service, but also produces goods such as food and drinks.**
- **Transformation processes may result in some undesirable outputs (such as nuclear waste)**

Transformation Process:-

A transformation process is defined as a user of resources to transform inputs into some desired outputs

Transformations

- **Physical--manufacturing**
- **Locational--transportation**
- **Exchange--retailing**
- **Storage--warehousing**
- **Physiological--health care**
- **Informational--telecommunications**

Transformation Process

One useful way of categorizing different types of transformation is into:

- **manufacture**
- **transport**
- **supply**
- **service**

Feedback

Feedback information is used to control the operations system, by adjusting the inputs and transformation processes that are used to achieve desired outputs.

Random Disturbances

- **It is unplanned or uncontrollable environmental influences.**
- **It causes planned and actual output to differ.**

Examples:-

Weather

Inflation

Equipment breakdown

Government controls

Goods & Services

- **Services** **Intangible tasks that satisfy the needs of consumer and business users.**
- **Goods** **Tangible products that customers can see, hear, smell, taste, or touch.**

Products & Services

- **Purely Manufacturing organizations do not just sell a product but provides services also.**
- **Pure service industries such as banks , hospitals , education and consultancies also often provides a product.**

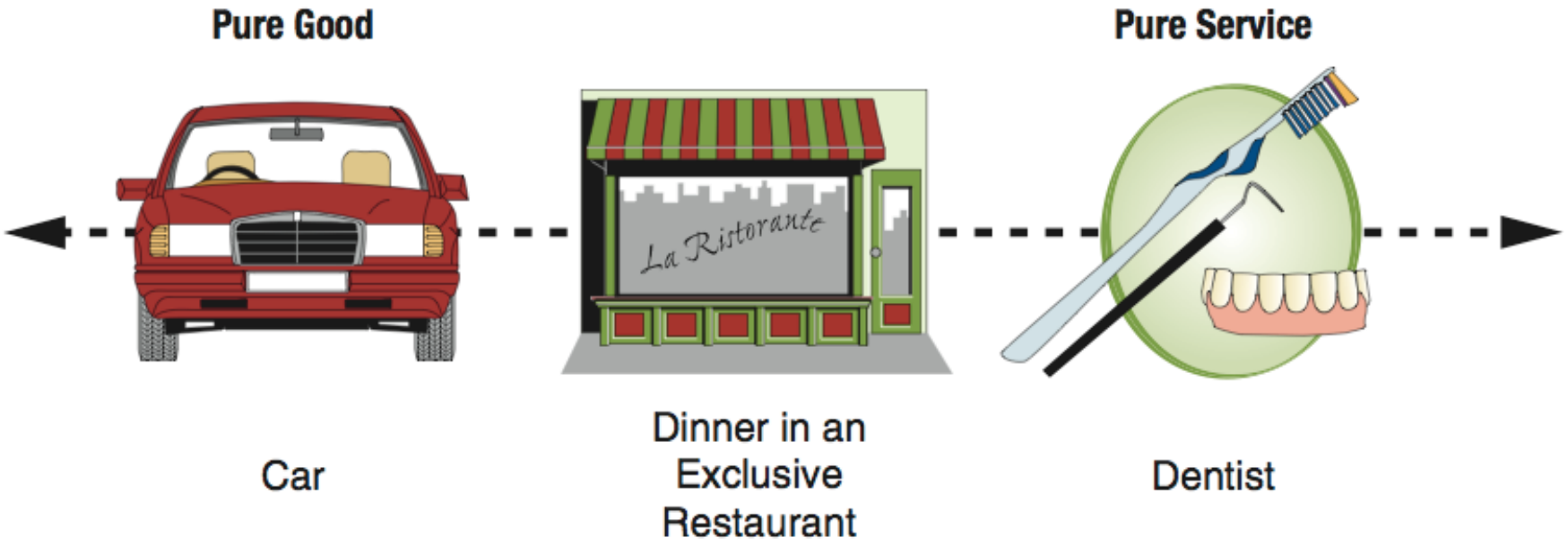
Product & Services

- **In manufacturing we get a tangible or identifiable product, which is obtained as a series of transformation process.**
- **In service industry end product is often intangible. Here it is the customer that has been processed.**
- **In services it is often the process that are bought rather than the product.**
- **Some organizations may be considered as hybrid.**

  Example :Restaurant

  Flying in an aeroplane.

The Goods–Services Continuum



Human resource management

The people employed by an organization either work directly to create a good or service or provide support to those who do. People and the way they are managed are a key resource of all organizations.

Asset management

- **An organization's buildings, facilities, equipment and stock are directly involved in or support the operations function**

Break Even Analysis

Break Even Analysis is the concept that links capacity to cost.It explains the significance of having greater productive capacity to lower cost and maximize profit or contribution.

Breakeven point is that at which the contribution margin is able to cover total fixed cost.

Break Even Analysis

Let:

F-Fixed cost of production

v-variable cost of production per unit.

p-selling price of per unit of the product.

c-contribution of one unit of product towards fixed cost.

S-sales volume required to achieve break even.

Contibution margin c=p-v

BEP S=F/c

Cost management

Most of the costs of producing goods or services are directly related to the costs of acquiring resources, transforming them or delivering them to customers

Decision making

Decisions need to be made in:

- **designing the operations system**
- **managing the operations system**
- **improving the operations system.**

Decision making

The five main kinds of decision in each of these relate to:

- **the processes by which goods and services are produced**
- **the quality of goods or services**
- **the quantity of goods or services (the capacity of operations)**
- **the stock of materials (inventory) needed to produce goods or services**
- **the management of human resources.**

Product Design

- Product design must support product manufacturability (the ease with which a product can be made)
- Product design defines a product's characteristics of;
  - appearance,
  - materials,
  - dimensions,
  - tolerances, and
  - performance standards

Design of Services versus Goods

- **Service design is unique in that the service and entire service concept are being designed**
  - **must define both the service and concept**
  - **Physical elements, aesthetic & psychological benefits**

    e.g. promptness, friendliness, ambiance

The four "C's of Design

- **Creativity**
  - **Requires creation of something that has not existed or not existed in the proposed state.**
- **Complexity**
  - **Requires decisions on many variables & parameters**
- **Choice**
  - **Requires making choices between many possible solutions at all levels, from basic concept to small details.**
- **Compromise**
  - **Requires balancing multiple and sometimes conflicting requirements**.

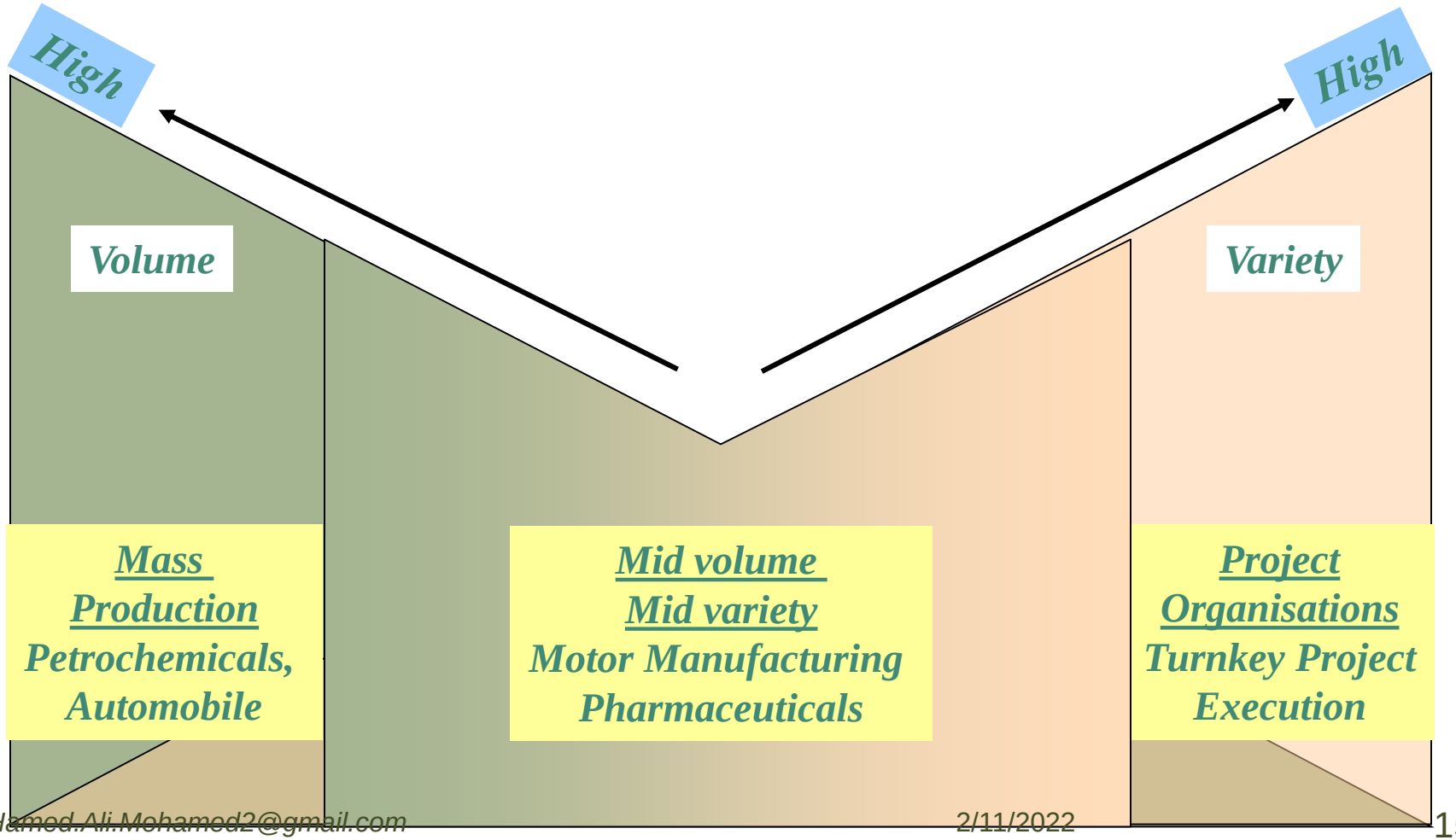
Factors Influencing Process Choices

- ***Volume*: Average quantity of the products produced in a manufacturing system**
  - **Low volume: Turnkey project management firms such as L&T and BHEL**
  - **High volume: Consumer non-durable and FMCG sector firms, Automobile, Chemical Processing**
  - **Mid-volume: Consumer durables, white goods and several industrial products**

- ***Variety*: Number of alternative products and variants of each product that is offered by a manufacturing system**
  - **Variety of product offerings is likely to introduce variety at various processes in the system; alternative production resources, materials, and skill of workers**

- ***Flow*: Flow indicates the nature and intensity of activities involved in conversion of components and material from raw material stage to finished goods stage**

Relationship between volume and variety



Processes & Operations Systems

Available Alternatives

Two broad process classifications include

Intermittent operations – produce a variety of products in lower volumes

Repetitive operations – produce one or a few standardized products in high volume

Process Selection

- **Process selection is based on five considerations**
  - **Type of process; range from intermittent to continuous**
  - **Degree of vertical integration**
  - **Flexibility of resources**
  - **Mix between capital & human resources**
  - **Degree of customer contact**

Process Selection

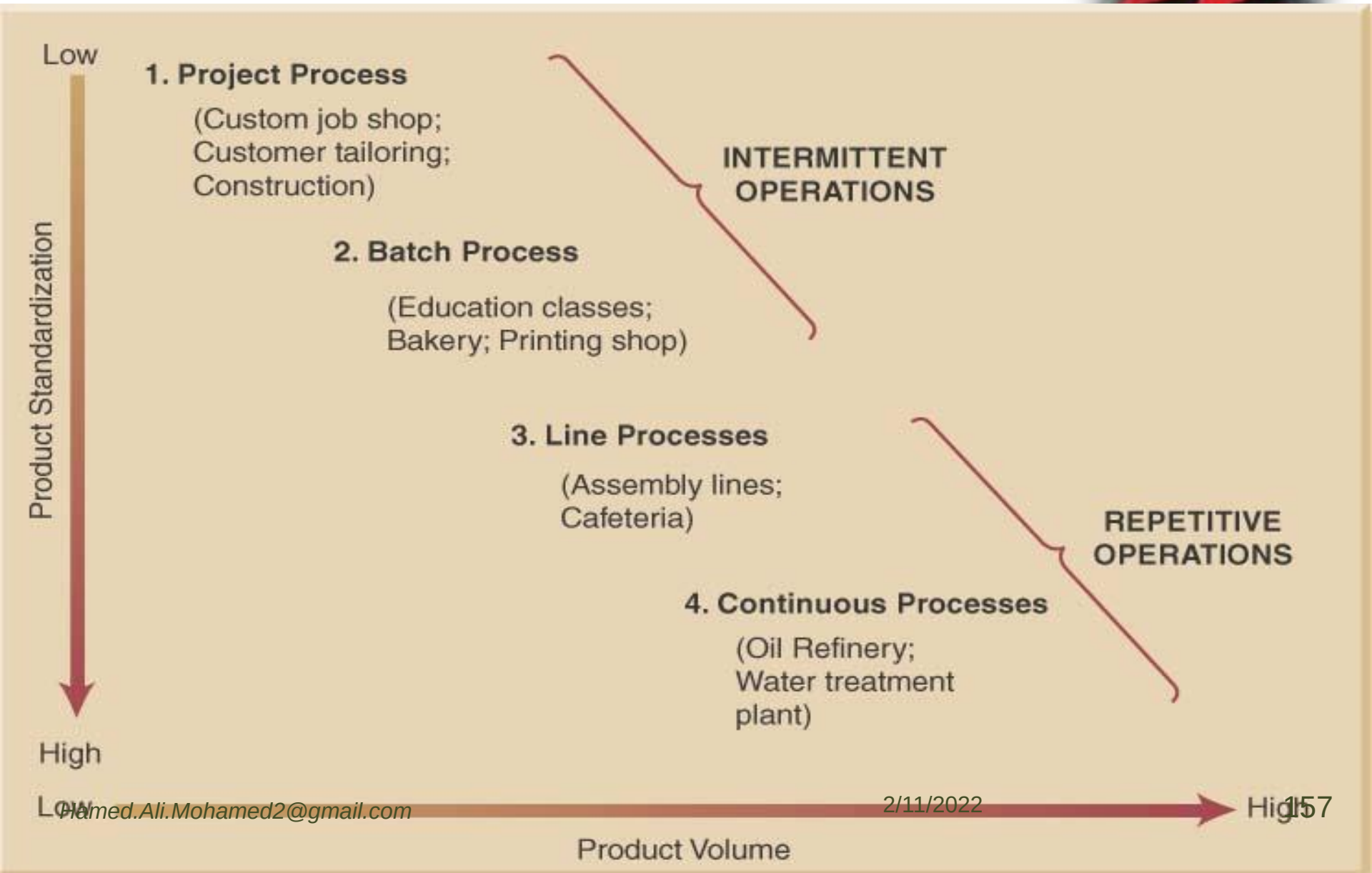
- **Process types can be:**
  - **Project process /Job Shop**– make a one-at-a-time product exactly to customer specifications
  - **Batch process** – small quantities of product in groups or batches based on customer orders or specifications

Process Selection

- **Line process** – large quantities of a standard product

- **Continuous process** – very high volumes of a fully standard product

Underlying Process Relationship Between Volume and Standardization Continuum



Differences between Intermittent and Repetitive Operations

Decision	Intermittent Operation	Repetitive Operation
Product variety	Great	Small
Degree of standardization	Low	High
Organization of resources	Grouped by Function	Line flow
Path of products	Varied, depends on product	Line flow
Factor driving production	Customer orders	Forecast of demand
Critical resource	Labor	Capital
Type of equipment	General purpose	Specialized
Degree of automation	Low	High
Throughput time	Longer	Shorter
Work-in-process inventory	More	Less

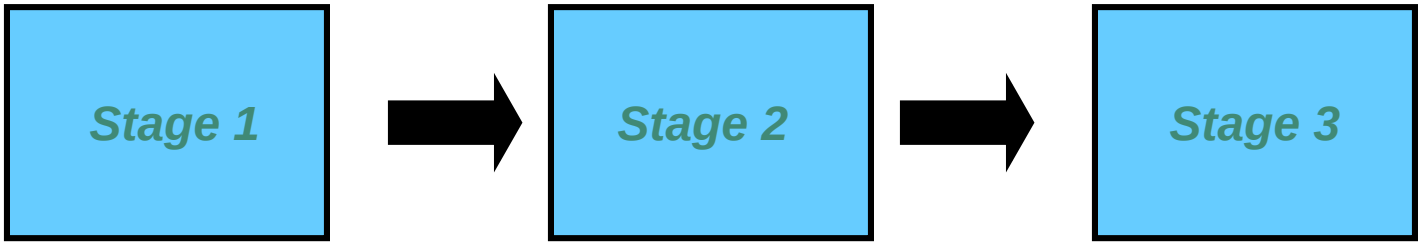
Designing Processes

- **Process design tools include**
  - Process flow analysis
  - Process flowchart (Also used to evaluate and improve processes.)
- **Design considerations include**
  - Make-to-stock strategy
  - Assemble-to-order strategy
  - Make-to-order strategy

Types of Processes

Single-stage Process

Multi-stage Process



Other Process Terminology

Blocking

Occurs when the activities in a stage must stop because there is no place to deposit the item just completed

Starving

If an employee is waiting at a work station and no work is coming to the employee to process.

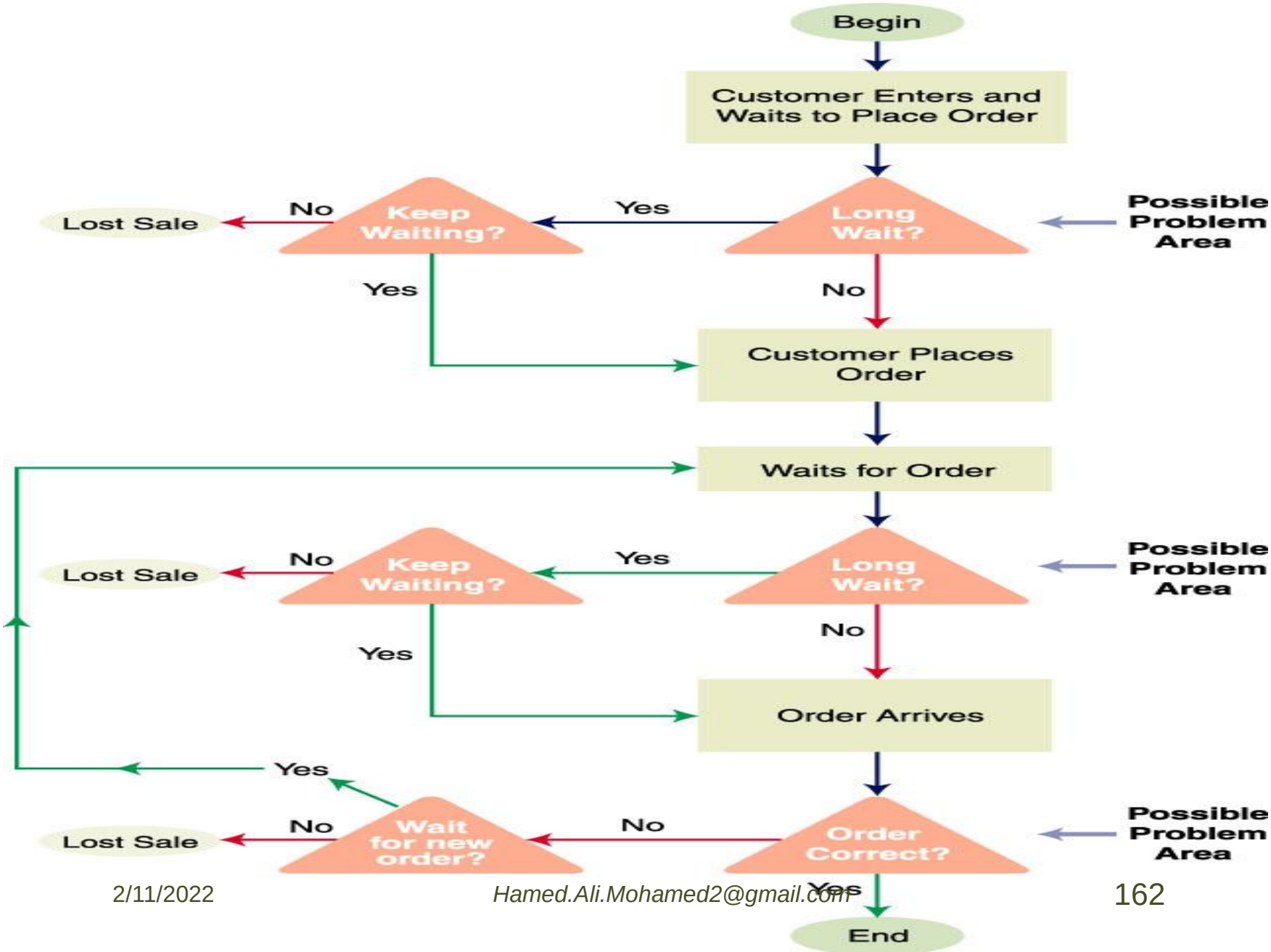
Other Process Terminology

- **Bottleneck**
  - **If an employee works too slow in a multi-stage process, work will begin to pile up in front of that employee. In this is case the employee represents the limited capacity causing the bottleneck.**
- **Pacing**
  - **Refers to the fixed timing of the movement of items through the process**

A buffer refers to a storage area between stages where the output of a stage is placed prior to being used in a downstream stage

- **Make-to-order**
  - **Only activated in response to an actual order**
- **Make-to-stock**
  - **Customer orders are served from target stocking level**

Process Design Tools



Process Performance Metrics

- **Operation time = Setup time + Run time**
- **Throughput time = Average time for a unit to move through the system**
- **Velocity = $\frac{\text{Throughput time}}{\text{Value-added time}}$**
- **Cycle time = Average time between completion of units**
- **Throughput rate = $\frac{1}{\text{Cycle time}}$.**
- **Efficiency = $\frac{\text{Actual output}}{\text{Standard Output}}$**

Process Performance Metrics

Measure	Definition
1. Throughput time	Average amount of time product takes to move through the system.
2. Process velocity $= \frac{\text{Throughput time}}{\text{Value-added time}}$	A measure of wasted time in the system.
3. Productivity $= \frac{\text{Output}}{\text{Input}}$	A measure of how well a company uses its resources.
4. Utilization $= \frac{\text{Time a resource used}}{\text{Time a resource available}}$	The proportion of time a resource is actually used.
5. Efficiency $= \frac{\text{Actual output}}{\text{Standard output}}$	Measures performance relative to a standard.

Part 5

Operations Management & Productivity

Organizing to Produce Goods and Services

- **Essential functions:**
  1. **Marketing** – generates demand
  2. **Production/operations** – creates the product
  3. **Finance/accounting** – tracks how well the organization is doing, pays bills, collects the money
  4. **Human Resources** – provides labor, employs, assigns and gives training.

Options for Increasing Contribution

TABLE 1.1

		MARKETING OPTION	FINANCE /ACCOUNTING OPTION	OM OPTION
	CURRENT	INCREASE SALES REVENUE 50%	REDUCE FINANCE COSTS 50%	REDUCE PRODUCTION COSTS 20%
Sales	$100,000	$150,000	$100,000	$100,000
Cost of goods	–80,000	–120,000	–80,000	–64,000
Gross margin	20,000	30,000	20,000	36,000
Finance costs	–6,000	–6,000	–3,000	–6,000
Subtotal	14,000	24,000	17,000	30,000
Taxes at 25%	–3,500	–6,000	–4,200	–7,500
Contribution	$ 10,500	$ 18,000	$ 12,750	$ 22,500

Ten Strategic Decisions

TABLE 1.2

DECISION	CHAPTER(S)
1. Design of goods and services	5, Supplement 5
2. Managing quality	6, Supplement 6
3. Process and capacity design	7, Supplement 7
4. Location strategy	8
5. Layout strategy	9
6. Human resources and job design	10
7. Supply-chain management	11, Supplement 11
8. Inventory management	12, 14, 16
9. Scheduling	13, 15
10. Maintenance	17

The Strategic Decisions

1. **Design of goods and services**
   - Defines what is required of operations
   - Product design determines quality, sustainability and human resources
2. **Managing quality**
   - Determine the customer's quality expectations
   - Establish policies and procedures to identify and achieve that quality

Table 1.2 (cont.)

The Strategic Decisions

3. Process and capacity design

- How is a good or service produced?
- Commits management to specific technology, quality, resources, and investment.

4. Location strategy

- Nearness to customers, suppliers, and talent.
- Considering costs, infrastructure, logistics, and government.

Table 1.2 (cont.)

The Strategic Decisions

5. **Layout strategy**
   - Integrate capacity needs, personnel levels, technology, and inventory
   - Determine the efficient flow of materials, people, and information.
6. **Human resources and job design**
   - Recruit, motivate, and retain personnel with the required talent and skills.
   - Integral and expensive part of the total system design.

Table 1.2 (cont.)

The Strategic Decisions

7. Supply-chain management

- Integrate supply chain into the firm's strategy.
- Determine what is to be purchased, from whom, and under what conditions.

8. Inventory management

- Inventory ordering and holding decisions.
- Optimize considering customer satisfaction, supplier capability, and production schedules.

Table 1.2 (cont.)

The Strategic Decisions

9. Scheduling

- Determine and implement intermediate- and short-term schedules.
- Utilize personnel and facilities while meeting customer demands.

10. Maintenance

- Consider facility capacity, production demands, and personnel.
- Maintain a reliable and stable process.

Table 1.2 (cont.)

Differences Between Goods and Services

TABLE 1.3

CHARACTERISTICS OF SERVICES	CHARACTERISTICS OF GOODS
Intangible: Ride in an airline seat	Tangible: The seat itself
Produced and consumed simultaneously: Beauty salon produces a haircut that is consumed as it is produced	Product can usually be kept in inventory (beauty care products)
Unique: Your investments and medical care are unique	Similar products produced (iPods)
High customer interaction: Often what the customer is paying for (consulting, education)	Limited customer involvement in production
Inconsistent product definition: Auto Insurance changes with age and type of car	Product standardized (iPhone)
Often knowledge based: Legal, education, and medical services are hard to automate	Standard tangible product tends to make automation feasible
Services dispersed: Service may occur at retail store, local office, house call, or via internet.	Product typically produced at a fixed facility
Quality may be hard to evaluate: Consulting, education, and medical services	Many aspects of quality for tangible products are easy to evaluate (strength of a bolt)
Reselling is unusual: Musical concert or medical care	Product often has some residual value

Productivity Challenge

Productivity is the ratio of outputs (goods and services) divided by the inputs (resources such as labor and capital)

The objective is to improve productivity!

Important Note!
Production is a measure of output only and not a measure of efficiency

The Economic System

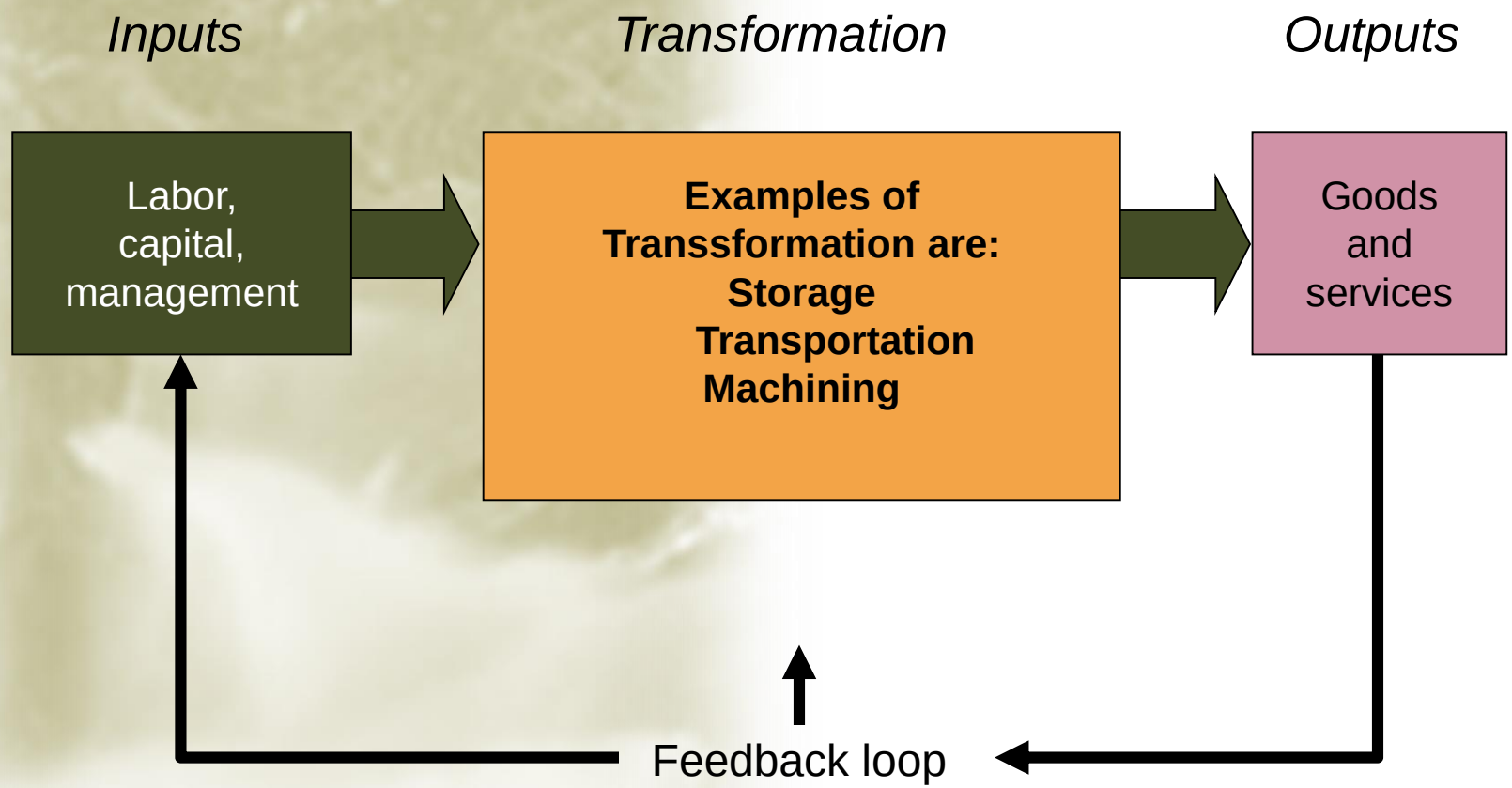


Figure 1.6

Productivity

$$\text{Productivity} = \frac{\text{Units produced}}{\text{Input used}}$$

- Measure of process improvement
- Represents output relative to input
- Only through productivity increases can our standard of living improve

Productivity Calculations

Labor Productivity

$$\text{Productivity} = \frac{\text{Units produced}}{\text{Labor-hours used}}$$

$$= \frac{1{,}000}{250} = 4 \text{ units/labor-hour}$$

One resource input ⇨ single-factor productivity

Multi-Factor Productivity

$$\text{Productivity} = \frac{\text{Output}}{\text{Labor + Material + Energy + Capital + Miscellaneous}}$$

- Also known as total factor productivity
- Output and inputs are often expressed in dollars

Multiple resource inputs ⇨ multi-factor productivity

Productivity Variables

1. **Labor** - contributes about 10% of the annual increase
2. **Capital** - contributes about 38% of the annual increase
3. **Management** - contributes about 52% of the annual increase

Part 6

Service Operations Management

Product and Service Design Examples

Product Design

- **Plumbing**
- **MP3-player**
- **Pool Pump**
- **Hot Tub / Spa**

Service Design:

- **Gas stations**
- **Retail checkout / cashiers**

Product and Service Design

- **Major factors in design strategy**
  - Cost
  - Quality
  - Time-to-market
  - Customer satisfaction
  - Competitive advantage

Product and service design – or redesign – should be closely tied to an organization's strategy

Product or Service Design Activities

1. Translate customer wants and needs into product and service requirements
2. Refine existing products and services
3. Develop new products and services
4. Formulate quality goals
5. Formulate cost targets
6. Construct and test prototypes
7. Document specifications

Reasons for Product or Service Design

- **Economic**
- **Social and demographic**
- **Political, liability, or legal**
- **Competitive**
- **Cost or availability**
- **Technological**

Objectives of Product and Service Design

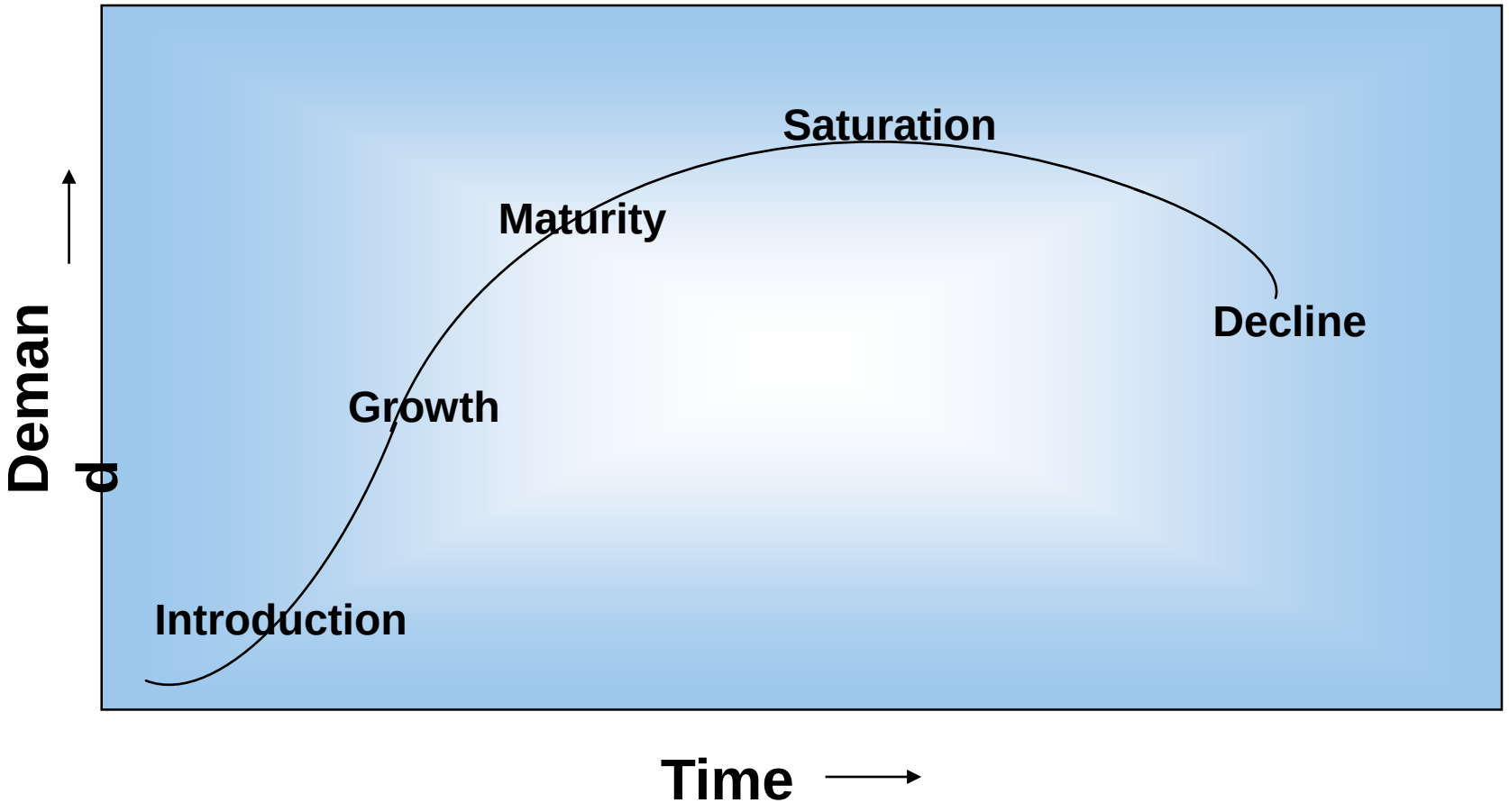
- **Main focus**
  - Customer satisfaction
  - Understand what the customer wants
- **Secondary focus**
  - Function of product/service
  - Cost/profit
  - Quality
  - Appearance
  - Ease of production/assembly
  - Ease of maintenance/service

Other Issues in Product and Service Design

- Product/service life cycles
- How much standardization
- Mass customization
- Product/service reliability
- Robust design
- Degree of newness
- Cultural differences

Life Cycles of Products or Services

Figure 4.1



Advantages of Standardization

- **Fewer parts to deal with in inventory & manufacturing**
- **Design costs are generally lower**
- **Reduced training costs and time**
- **More routine purchasing, handling, and inspection procedures**
- **Quality is more consistent**

Advantages of Standardization (Cont'd)

- Orders fillable from inventory
- Opportunities for long production runs and automation
- Need for fewer parts justifies increased expenditures on perfecting designs and improving quality control procedures.

See "paring parts to pump profits" article

Disadvantages of Standardization

- **Designs may be frozen with too many imperfections remaining.**
- **High cost of design changes increases resistance to improvements.**
- **Decreased variety results in less consumer appeal.**

Mass Customization

- **Mass customization:**
  - A strategy of producing standardized goods or services, but incorporating some degree degree of customization
  - Delayed differentiation
  - Modular design

Delayed Differentiation

- **Delayed differentiation is a postponement tactic**
  - Producing but not quite completing a product or service until customer preferences or specifications are known

Modular Design

Modular design **is a form of standardization in which component parts are subdivided into modules that are easily replaced or interchanged. It allows:**

- easier diagnosis and remedy of failures
- easier repair and replacement
- simplification of manufacturing and assembly

Reliability

- ***Reliability***: **The ability of a product, part, or system to perform its intended function under a prescribed set of conditions**
- ***Failure***: **Situation in which a product, part, or system does not perform as intended**
- ***Normal operating conditions***: **The set of conditions under which an item's reliability is specified**

Improving Reliability

- Component design
- Production/assembly techniques
- Testing
- Redundancy/backup
- Preventive maintenance procedures
- User education
- System design

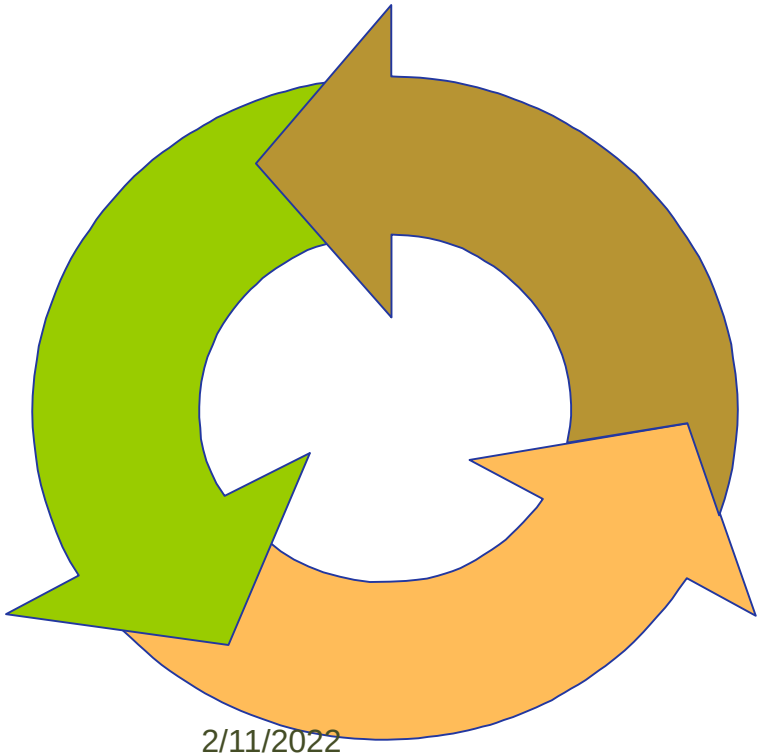
Product design

- Design for manufacturing (DFM)
- Design for assembly (DFA)
- Design for recycling (DFR)
- Remanufacturing
- Design for disassembly (DFD)
- Robust design

Robust Design: Design that results in products or services that can function over a broad range of conditions

Manufacturability

- **Manufacturability is the ease of fabrication and/or assembly which is important for:**
  - Cost
  - Productivity
  - Quality



Designing for Manufacturing

Beyond the overall objective to achieve customer satisfaction while making a reasonable profit is:

Design for Manufacturing(DFM)

The designers' consideration of the organization's manufacturing capabilities when designing a product.

The more general term *design for operations* encompasses services as well as manufacturing

Concurrent Engineering

Concurrent engineering **is the bringing together of engineering design and manufacturing personnel early in the design phase.**

Computer-Aided Design

- ***Computer-Aided Design (CAD)* is product design using computer graphics.**
  - increases productivity of designers, 3 to 10 times
  - creates a database for manufacturing information on product specifications
  - provides possibility of engineering and cost analysis on proposed designs

Recycling

- **Recycling: recovering materials for future use**
- **Recycling reasons**
  - Cost savings
  - Environment concerns
  - Environment regulations

Remanufacturing

- ***Remanufacturing*: Refurbishing used products by replacing worn-out or defective components.**
  - Remanufactured products can be sold for 50% of the cost of a new producer
  - Remanufacturing can use unskilled labor
  - Some governments require manufacturers to take back used products
- ***Design for Disassembly (DFD)*: Designing products so that they can be easily taken apart.**

Service Design

- **Service is an act**
- **Service delivery system**
  - Facilities
  - Processes
  - Skills
- **Many services are bundled with products**

Service Design

- **Service**
  - Something that is done to or for a customer
- **Service delivery system**
  - The facilities, processes, and skills needed to provide a service
- **Product bundle**
  - The combination of goods and services provided to a customer
- **Service package**
  - The physical resources needed to perform the service

Differences Between Product and Service Design

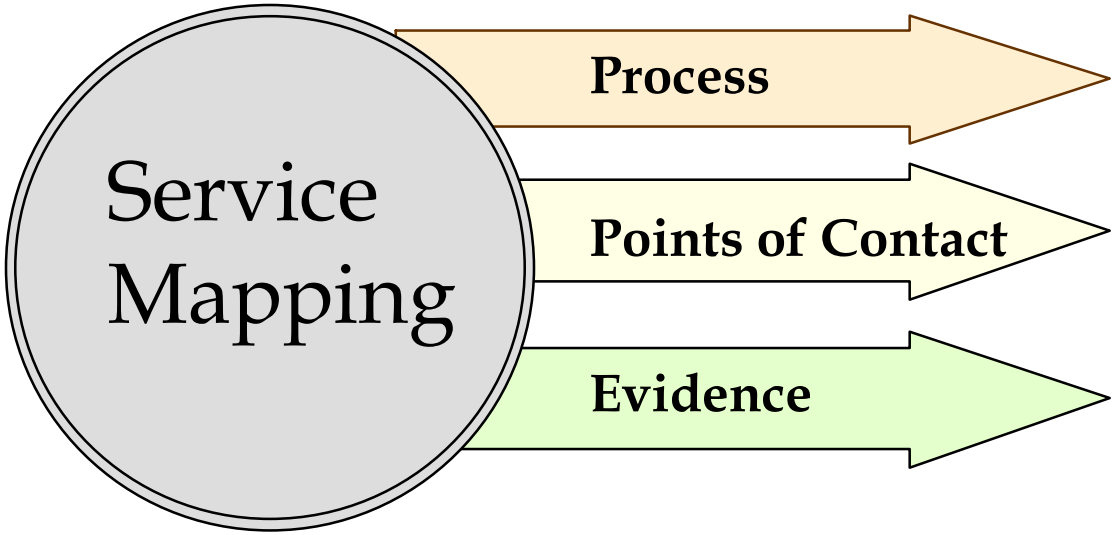
- **Tangible – intangible**
- **Services created and delivered at the same time**
- **Services cannot be inventoried**
- **Services highly visible to customers**
- **Services have low barrier to entry**
- **Location important to service**
- **Range of service systems**
- **Demand variability**

Service Blueprinting

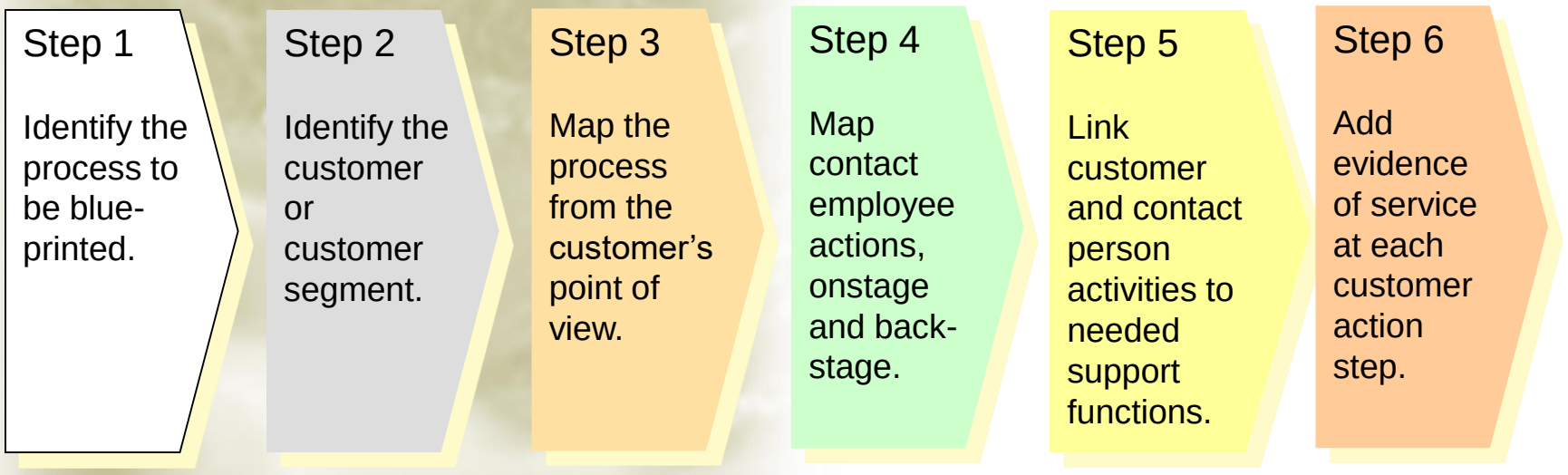
- **Service blueprinting**
  - A method used in service design to describe and analyze a proposed service
- **A useful tool for conceptualizing a service delivery system**

Service Mapping/Blueprinting

- **A tool for simultaneously depicting the service process, the points of customer contact, and the evidence of service from the customer's point of view.**



Building a Service Blueprint



Part 7

Acquisition and Sourcing

Objectives

- To explore the benefits, problems and a process for outsourcing
- To determine the need to subcontract supplies
- "Make-or-Buy decisions compare the cost of producing a component or providing the service internally with the cost of purchasing the component or service from an external supplier"

Outsourcing

- **Outsourcing:-**
- **“Outsourcing is a strategic decision to give a task or activity to an independent contractor who determines how best to do the task or activity”.**

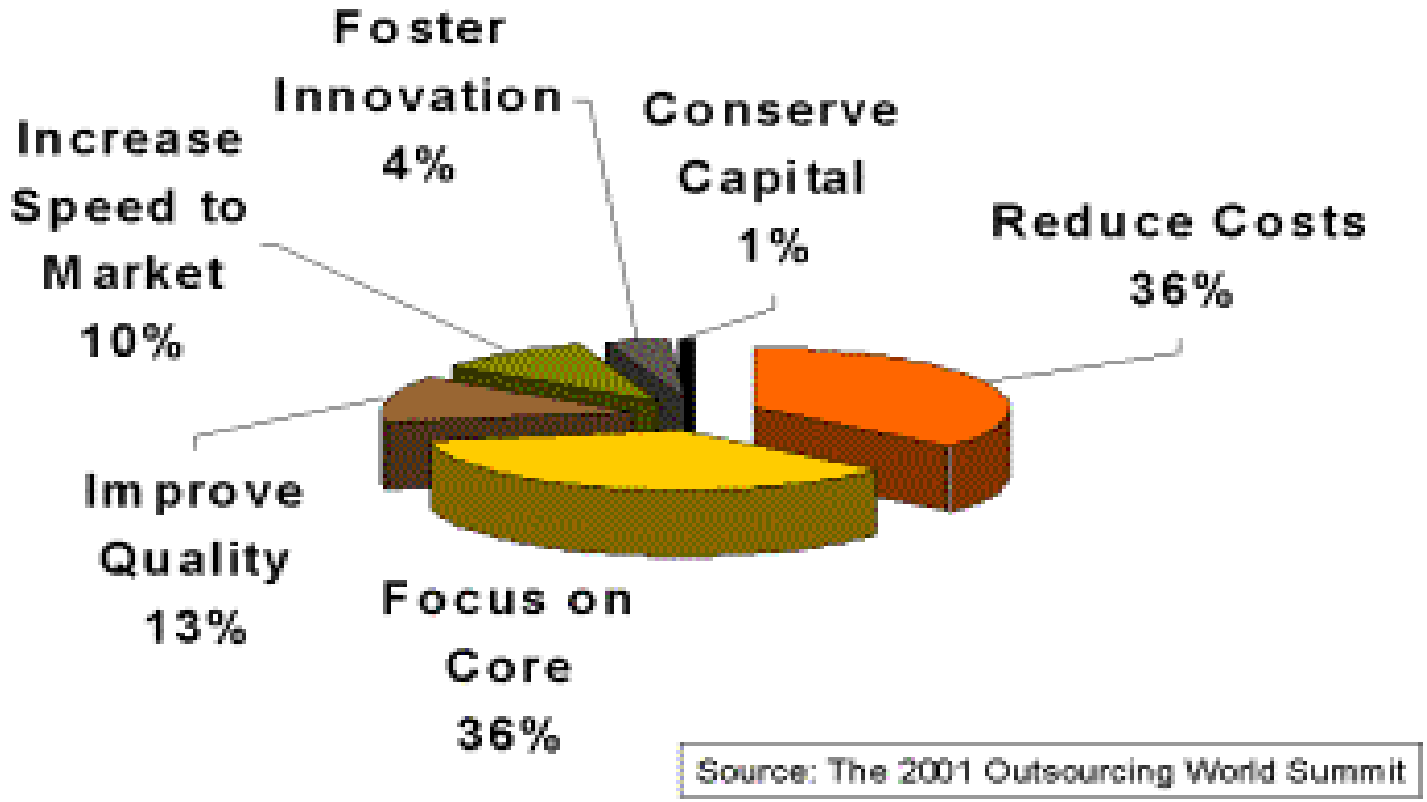
- **(it is a) management strategy by which an organisation outsources major non-core functions to specialised, efficient service providers”**

What is Outsourcing?

- **Outsourcing -**
  - "the strategic use of outside resources to perform activities traditionally handled by internal staff and resources" Dave Griffiths

- **Why Outsource?**
  - Provide services that are scalable, secure, and efficient, while improving overall service and reducing costs

Why do Companies Outsource?



Reasons for Outsourcing

- **Traditional role - reaction to problem**
  - Reduction and control of costs
  - Avoid large capital investment costs
  - Insufficient resources available
- **Modern role – business strategy**
  - Allows company to focus on their core competencies
  - Keeping up with cutting-edge technology
  - Creating value for the organization and its customers
  - Building partnerships

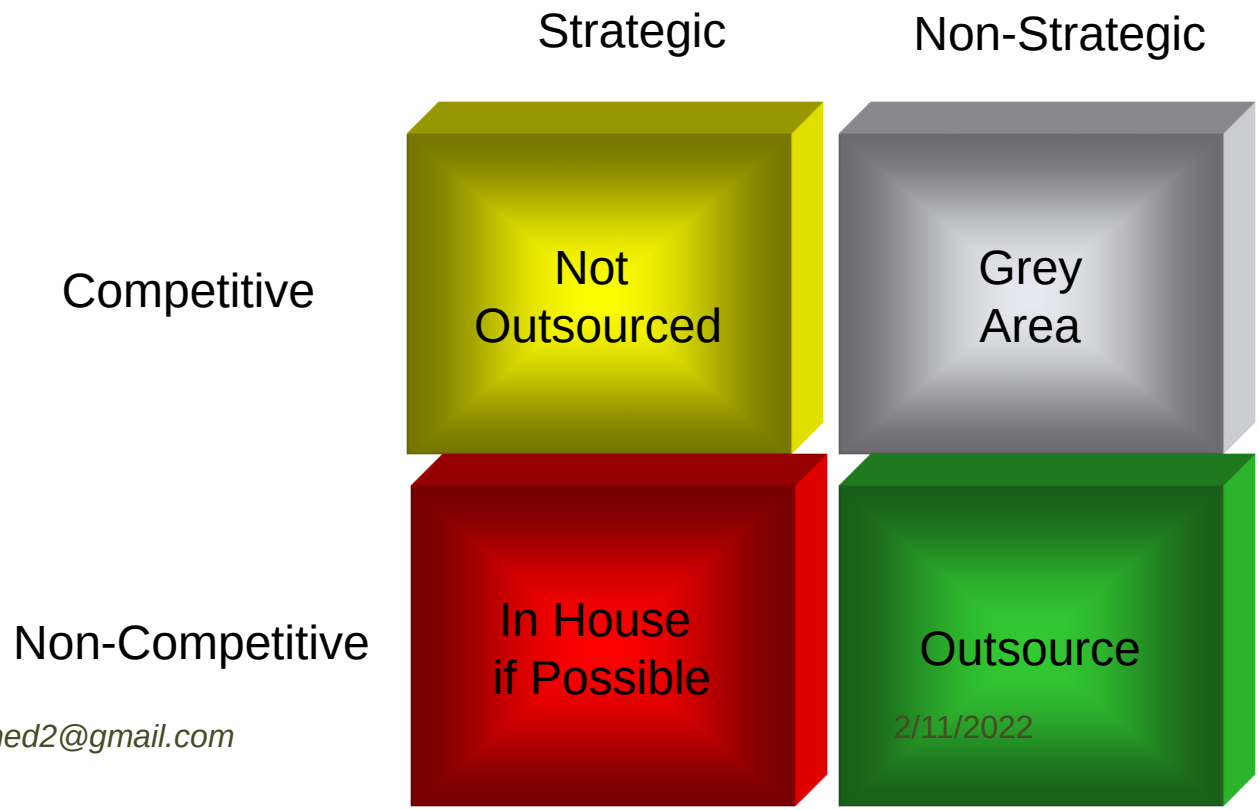
What Can be Outsourced?

- system integration
- data network
- mainframe data center
- voice network, internet/intranet
- maintenance/repair
- applications development
- e-commerce
- end-user support system

Efficient Managerialism

When to Outsource

PricewaterhouseCoopers Model



How to Implement Outsourcing

- **Program initiation**
  - Opinions and ideas shared to form draft contract
- **Program implementation**
  - Transferring staff
  - Service Level Agreement (SLA)
  - Establish communications between partners
  - Actual transfer of the service
  - Establish management procedures
- **Contract agreement**
- **Contract fulfillment**

Problems With Outsourcing

- **Loss of Control**
- **Increased cash outflow**
- **Confidentiality and security**
- **Selection of supplier**
- **Too dependent on service provider**
- **Loss of staff or moral problems**
- **Time consuming**
- **Provider may not understand business environment**
- **Provider slow to react to changes in strategy**

Problems With Outsourcing

Subcontracting

Outsourcing is a strategic long term decision, Subcontracting is a tactical, short term approach.

- ***"Outsourcing is nothing but delegating a particular business activity/function to another individual/entity. Sub-contracting is sharing a part of the business activity with another. "***

Tactical Make-Buy Decisions

- Some common reasons for make-buy decisions at this level follow:-
- Delivery failure or poor service by existing source
- To allow the client organization to focus on its core business
- To access skills and technologies
- To provide flexibility
- Pressure to reduce costs

Operational Make-Buy Decisions

- a simple and probably logical rule of thumb when considering whether to make-or-buy is to carryout a comparison of cost of making ourselves with buying in.

Outsourcing vs Insourcing

- **Out - Sourcing is when a company "A" makes an agreement with a company "B" about giving them some part of the work to do.**
  For example BMW outsourced with with "Boss Sound System" in a way that BOSS does all the music for the BMW cars.

Why Outsourcing?

- **Resource intensive activities – high labour/ capital costs.**
- **Subject to specialist areas**
- **Subject to dynamic market conditions for which it is costly to recruit & retain staff**
- **Subject to rapid changes in technology with high investment**

Examples of outsourced services

- Car park management
- Cleaning
- Catering
- Building maintenance
- Security
- Transport management
- Waste disposal
- Library
- Medical/ Welfare
- Pest control
- Ground maintenance
- Computers & information technology

Types of Outsourcing

- **Bo*dy shop outsourcing* – a means of meeting short term requirement, shortage of in house skills to meet temporary demand.**
- ***Project management outsourcing* – for all parts of a particular project, new IT project, training requirement**
- ***Total outsourcing* – supplier given full responsibility for selected function, catering, security**

Some benefits of Outsourcing

- Gain access to world class capabilities
- Improve organisational focus
- Make capital funds available
- Free management time
- Reduce staff costs
- Increased flexibility
- Cost certainty
- Improved service levels
- Reduced capital requirement
- Reduced risk

Some problems with outsourcing

- Long term commitment
- Communication with suppliers
- Dependence on suppliers
- Additional training
- Reduction in flexibility
- Coordinating different suppliers
- Quality of service
- High staff turnover
- Poor project management
- Lack of control over larger suppliers

Measuring outsourcing performance

- Typically consider measuring:-
- Response time
- Performance reports
- Satisfactory performance statement
- Penalties for non performance

Procurement Planning Tools and Techniques

- **Make-or-buy analysis: determining whether a particular product or service should be made or performed inside the organization or purchased from someone else. Often involves financial analysis**
- **Experts, both internal and external, can provide valuable inputs in procurement decisions**

Make-or Buy Example

- **Assume you can lease an item you need for a project for $150/day. To purchase the item, the investment cost is $1,000, and the daily cost would be another $50/day.**
- **How long will it take for the lease cost to be the same as the purchase cost?**
- **If you need the item for 12 days, should you lease it or purchase it?**

Make-or Buy Solution

- **Set up an equation so the "make" is equal to the "buy"**
- **In this example, use the following equation. Let d be the number of days to use the item.**

  $150d = $1,000 + $50d
- **Solve for d as follows:**
  - Subtract $50d from the right side of the equation to get

    $100d = $1,000
  - Divide both sides of the equation by $100

    d = 10 days
- **The lease cost is the same as the purchase cost at 10 days**
- **If you need the item for 12 days, it would be more economical to purchase it**

Types of Contracts

- **Fixed-price : involve a fixed total price for a well-defined product or service to be provided**
- **Cost-reimbursable: involve payment to the seller for direct and indirect costs**
- **Time and material contracts: Mixture of both fixed-price and cost-reimbursable, often used by consultants**
- **Unit price contracts: require the buyer to pay the seller a predetermined amount per unit of service**

Statement of Work (SOW)

- **A statement of work is a description of the work required for the procurement(is the acquisition of goods or services)**
- **Many contracts, or mutually binding agreements, include SOWs**
- **A good SOW gives bidders a better understanding of the buyer's expectations**

Figure 12-3. Statement of Work (SOW) Template

I.	**Scope of Work:** Describe the work to be done to detail. Specify the hardware and software involved and the exact nature of the work.
II.	**Location of Work:** Describe where the work must be performed. Specify the location of hardware and software and where the people must perform the work
III.	**Period of Performance:** Specify when the work is expected to start and end, working hours, number of hours that can be billed per week, where the work must be performed, and related schedule information.
IV.	**Deliverables Schedule:** List specific deliverables, describe them in detail, and specify when they are due.
V.	**Applicable Standards:** Specify any company or industry-specific standards that are relevant to performing the work.
VI.	**Acceptance Criteria:** Describe how the buyer organization will determine if the work is acceptable.
VII.	**Special Requirements:** Specify any special requirements such as hardware or software certifications, minimum degree or experience level of personnel, travel requirements, and so on.

Solicitation Planning

- **Solicitation planning involves preparing <u>several documents:</u>**
  - **Request for Proposals(RFP)**: used to solicit (obtain)proposals from prospective sellers
  - **Requests for Quotation(RFQ)**: is a document that an organization submits to one or more potential suppliers eliciting quotations for a product or service. used to solicit quotations for well-defined procurements

Figure 12-4. Outline for a Request for Proposal (RFP)

I. Purpose of RFP

II. Organization's Background

III. Basic Requirements

IV. Hardware and Software Environment

V. Description of RFP Process

VI. Statement of Work and Schedule Information

VII. Possible Appendices

- A. Current System Overview
- B. System Requirements
- C. Volume and Size Data
- D. Required Contents of Vendor's Response to RFP
- E. Sample Contract

Source Selection

- **Source selection involves**
  - evaluating bidders' proposals
  - choosing the best one
  - negotiating the contract
  - **awarding the contract**
- **It is helpful to prepare formal evaluation procedures for selecting vendors**
- **Buyers often create a "short list"**

Contract Close-out

- **Contract close-out includes**
  - **product verification** to determine if all work was completed correctly and satisfactorily
  - administrative activities to update records to reflect final results
  - archiving information for future use
- **Procurement audits identify lessons learned in the procurement process**

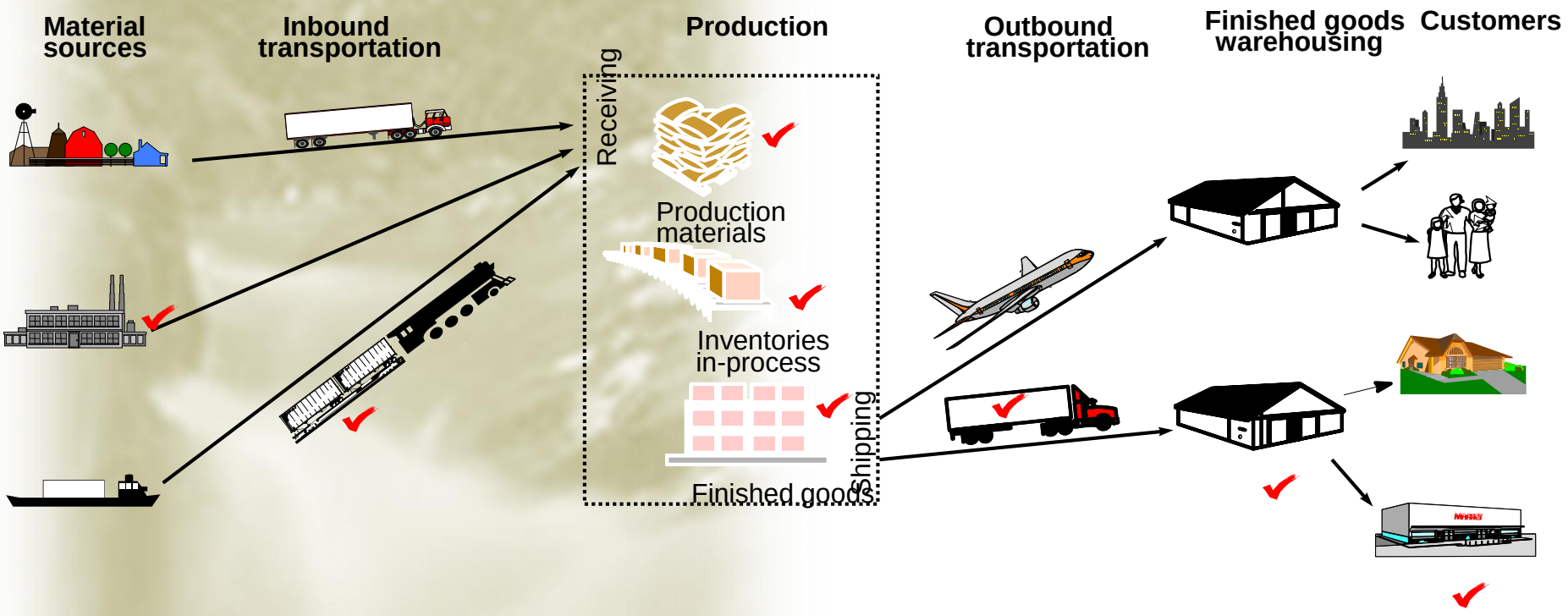
Part 8

Inventory and Procurement

What are Inventories?

- Finished product held for sale
- Goods in warehouses
- Work in process
- Goods in transit
- Staff hired to meet service needs
- Any owned or financially controlled raw material, work in process, and/or finished good or service held in anticipation of a sale but not yet sold

What are Inventories?



✔ Inventory locations

Reasons for Inventories

- **Improve customer service**
  - Provides immediacy in product availability
- **Encourage production, purchase, and transportation economies**
  - Allows for long production runs
  - Takes advantage of price-quantity discounts
  - Allows for transport economies from larger shipment sizes
- **Act as a hedge against price changes**
  - Allows purchasing to take place under most favorable price terms
- **Protect against uncertainties in demand and lead times**
  - Provides a measure of safety to keep operations running when demand levels and lead times cannot be known for sure
- **Act as a hedge against contingencies**
  - Buffers against such events as strikes, fires, and disruptions in supply

Reasons Against Inventories

- They consume capital resources that might be put to better use elsewhere in the firm
- They too often mask quality problems that would more immediately be solved without their presence
- They divert management's attention away from careful planning and control of the supply and distribution channels by promoting an insular attitude about channel management

Types of Inventories

- **Pipeline**
  - Inventories in transit
- **Speculative**
  - Goods purchased in anticipation of price increases
- **Regular/Cyclical/Seasonal**
  - Inventories held to meet normal operating needs
- **Safety**
  - Extra stocks held in anticipation of demand and lead time uncertainties
- **Obsolete/Dead Stock**
  - Inventories that are of little or no value due to being out of date, spoiled, damaged, etc.

Nature of Demand

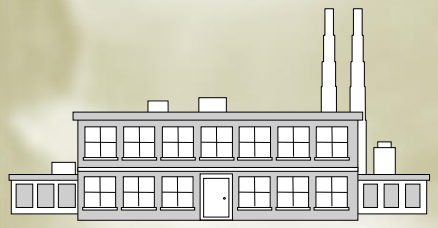
- **Perpetual demand**
  - Continues well into the foreseeable future
- **Seasonal demand**
  - Varies with regular peaks and valleys throughout the year
- **Lumpy demand**
  - Highly variable ($3\sigma \geq$ Mean)
- **Regular demand**
  - Not highly variable ($3\sigma <$ Mean)
- **Terminating demand**
  - Demand goes to 0 in foreseeable future
- **Derived demand**
  - Demand is determined from the demand of another item of which it is a part

Accurately forecasting demand is singly the most important factor in good inventory management

Pull vs. Push Inventory Philosophies

PUSH - Allocate supply to each warehouse based on the forecast for each warehouse

PULL - Replenish inventory with order sizes based on specific needs of each warehouse

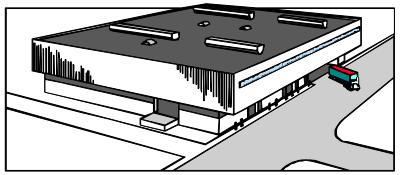


Plant

A_1

A_2

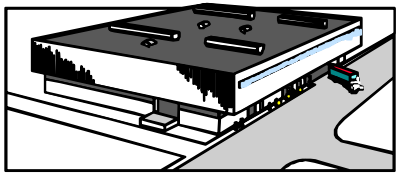
A_3



Warehouse #1

Q_1

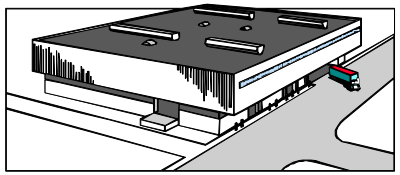
Demand forecast



Warehouse #2

Q_2

Demand forecast



Warehouse #3

Q_3

Demand forecast

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

Inventory Management Philosophies

- **Pull**
  - Draws inventory into the stocking location
  - Each stocking location is considered independent
  - Maximizes local control of inventories
- **Push**
  - Allocates production to stocking locations based on overall demand
  - Encourages economies of scale in production
- **Just-in-time**
  - Attempts to synchronize stock flows so as to just meet demand as it occurs
  - Minimizes the need for inventory
- **Supply-Driven**
  - Supply quantities and timing are unknown
  - All supply must be accepted and processed
  - Inventories are controlled through demand
- **Aggregate Control - Classification of items**
  - Groups items according to their sales level based on the 80-20 principle
  - Allows different control policies for 3 or more broad product groups

Costs Relevant to Inventory Management

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

Procurement costs

- **Price of the goods**
- **Cost of preparing the order**
- **Cost of order transmission**
- **Cost of production setup if appropriate**
- **Cost of materials handling or processing at the receiving dock**

Carrying Costs

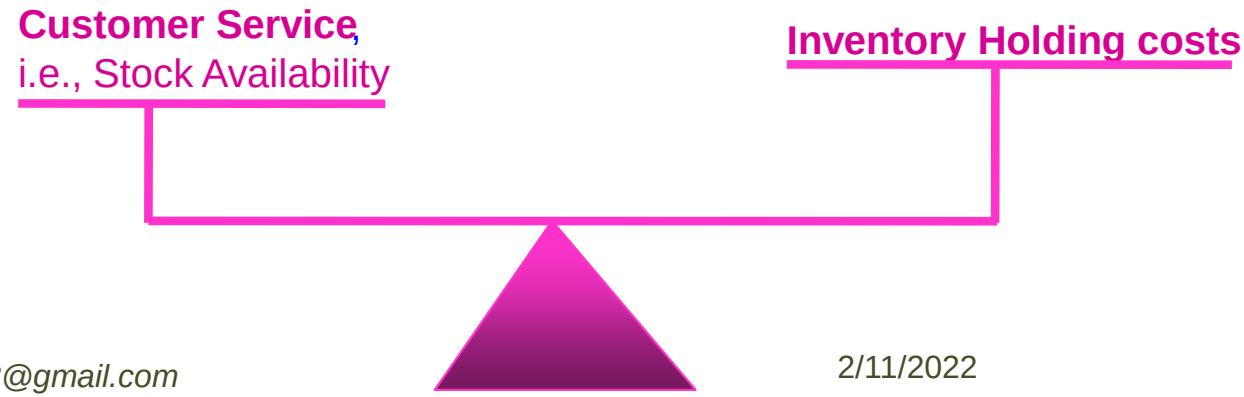
- **Cost for holding the inventory over time**
- **The primary cost is the cost of money tied up in inventory, but also includes obsolescence, insurance, personal property taxes, and storage costs**
- **Typically, costs range from the cost of short term capital to about 40%/year. The average is about 25%/year of the item value in inventory.**

Out-of-stock costs

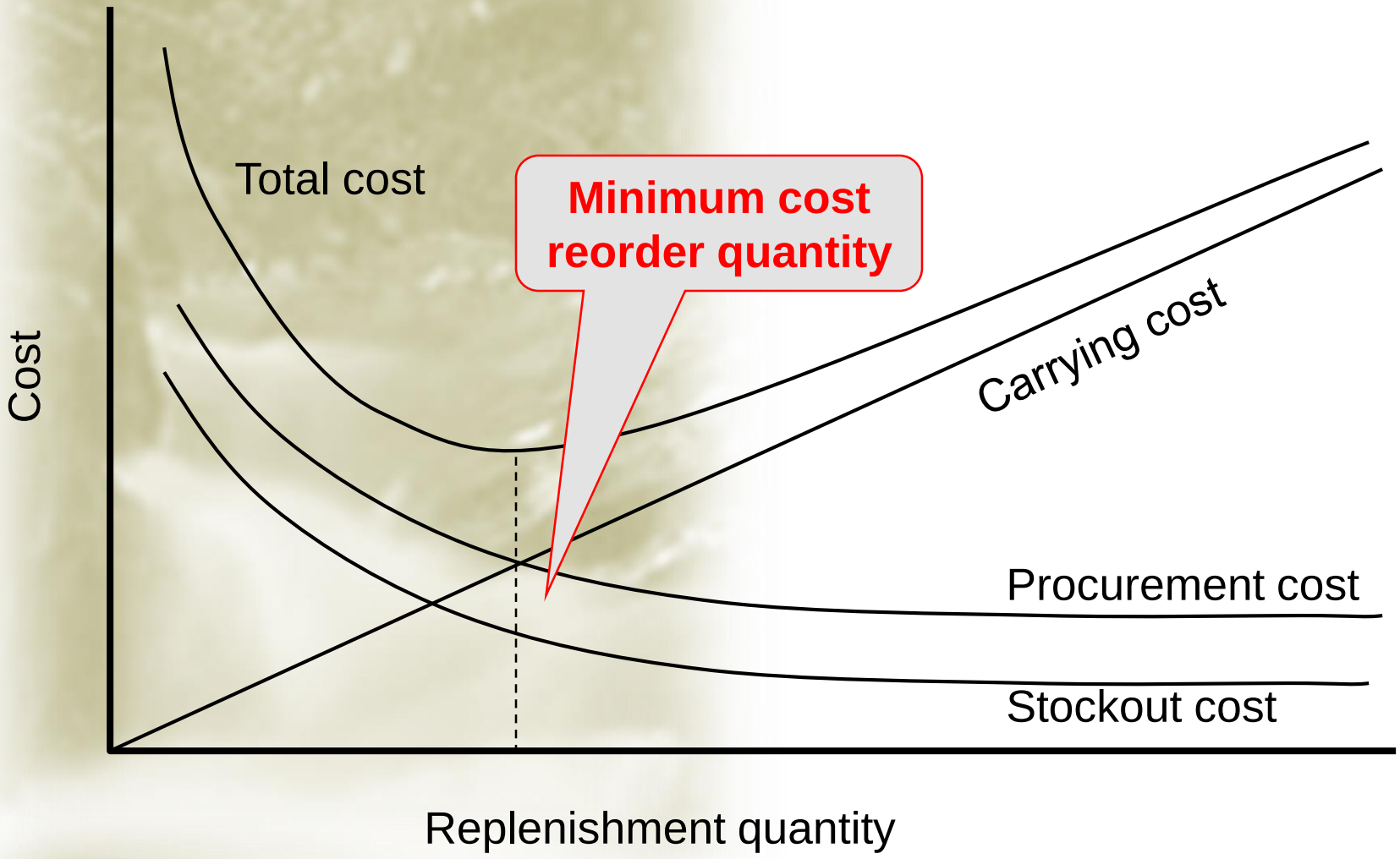
- **Lost sales cost**
  - Profit immediately foregone
  - Future profits foregone through loss of goodwill
- **Backorder cost**
  - Costs of extra order handling
  - Additional transportation and handling costs
  - Possibly additional setup costs

Inventory Management Objectives

- **Good inventory management is a careful balancing act between stock availability and the cost of holding inventory.**
- **Service objectives**
  - Setting stocking levels so that there is only a specified probability of running out of stock
- **Cost objectives**
  - Balancing conflicting costs to find the most economical replenishment quantities and timing



Typical Inventory Conflicting Cost Patterns

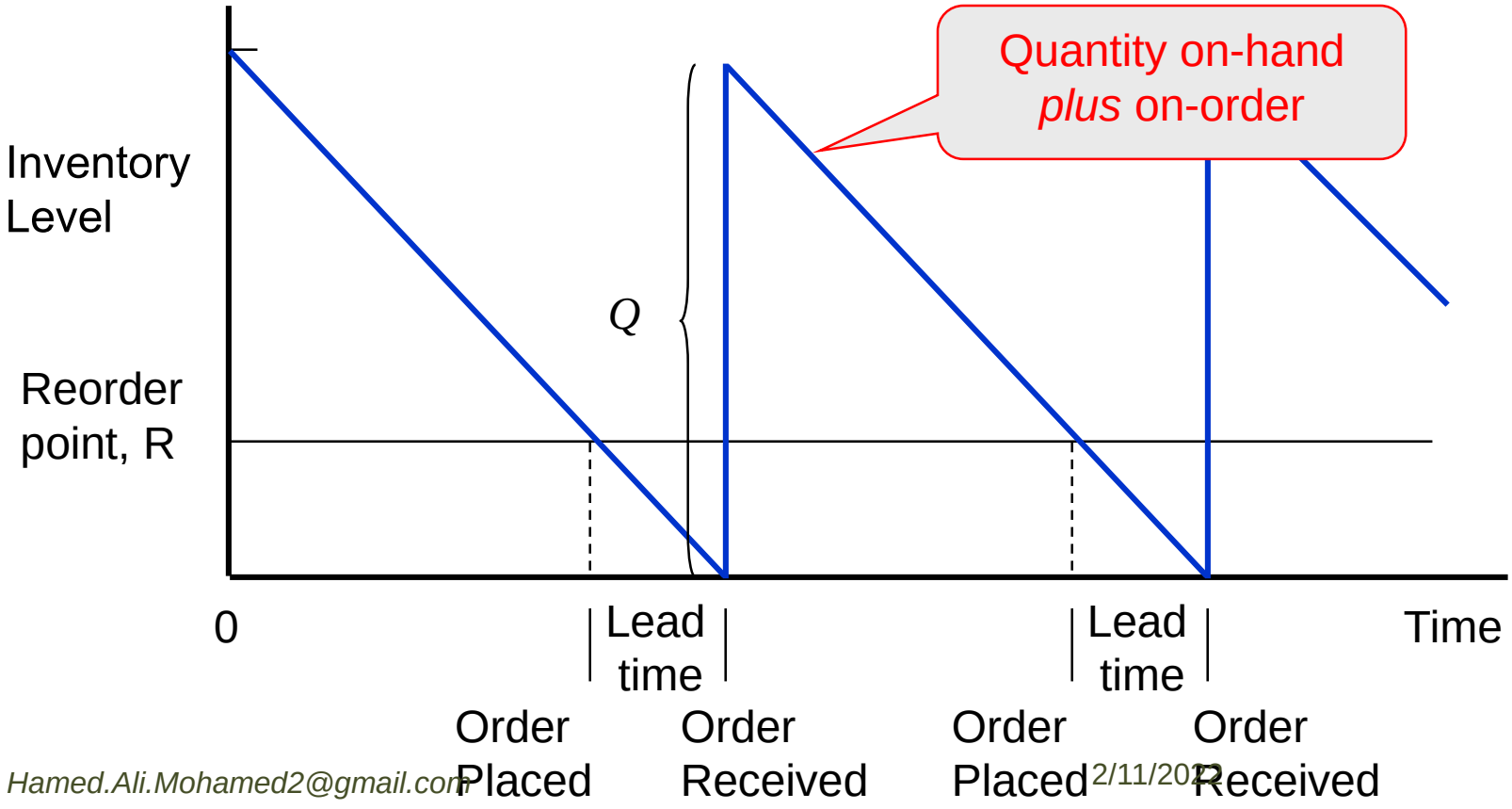


Pull - Single Order Purchasing

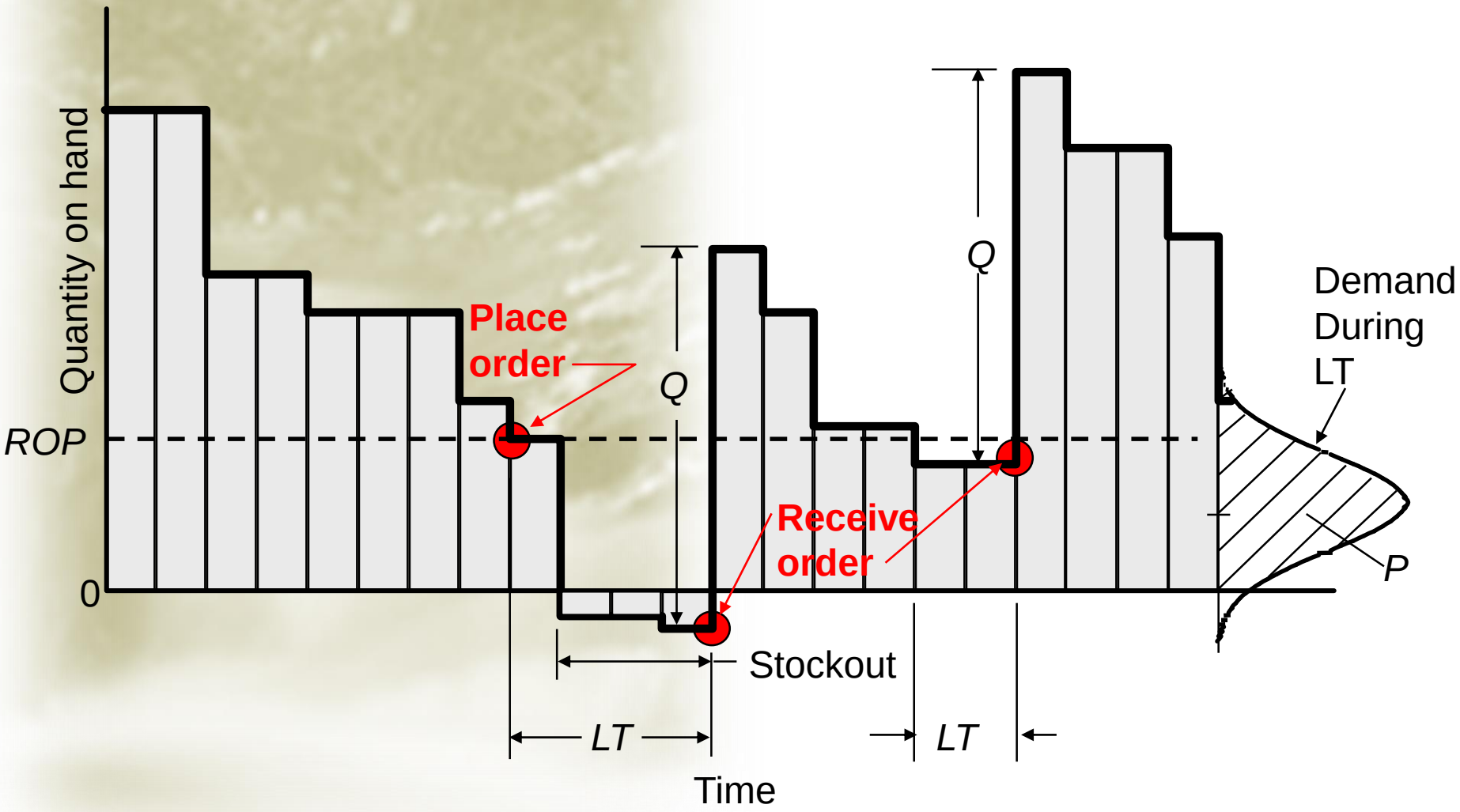
- **Make a one-time purchase of an item. How much to order?**
- ***Procedure:*** **Balance incremental profit against incremental loss.**
- **Estimated these expected values …**

Simple Two-Bin Pull Method

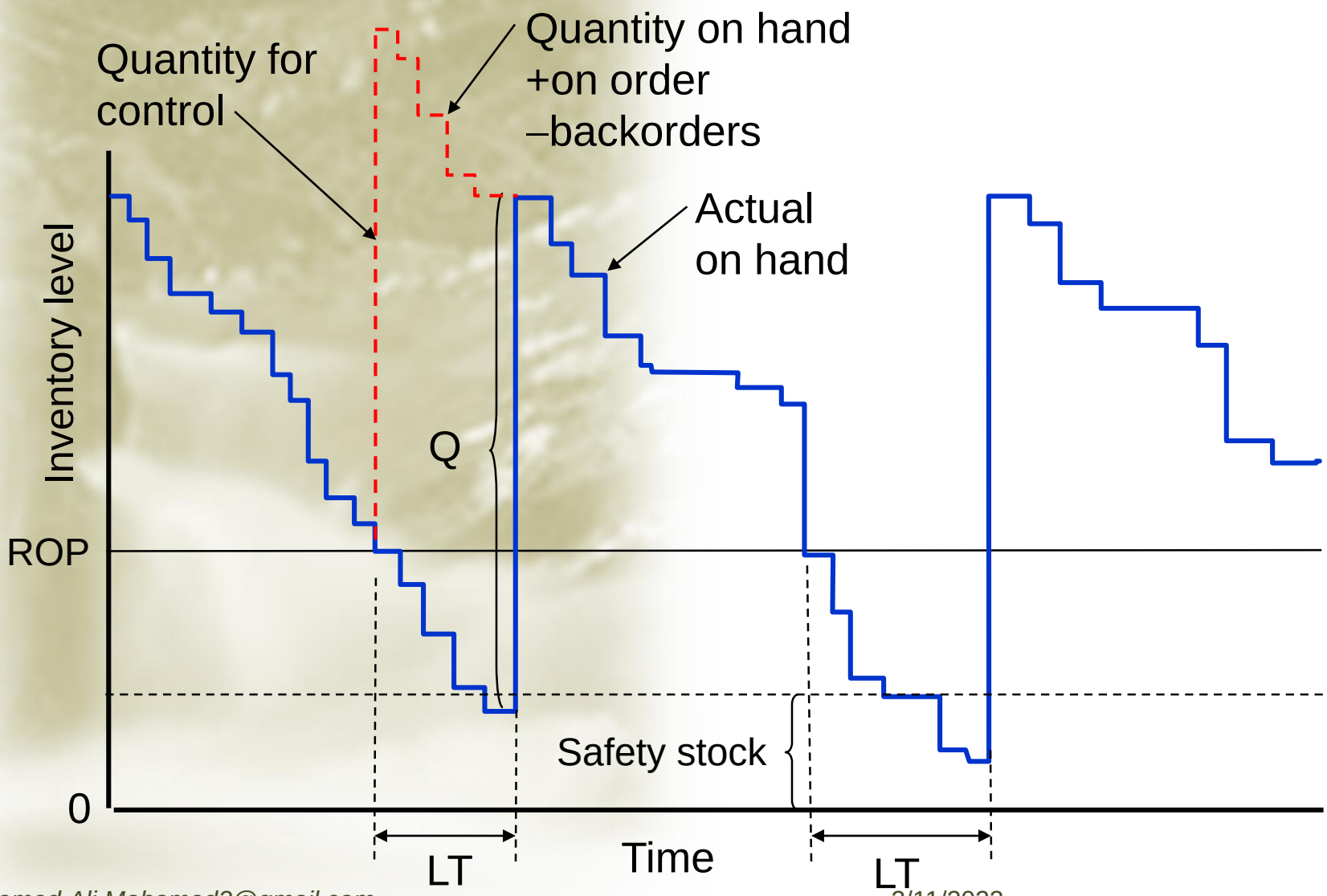
- **Develop a simple control system by finding the replenishment quantity (Q) and the reorder point (ROP).**
- **Applicability: no uncertainty in demand or lead time: manage regular (cycle) stock only**



Reorder Point Control for a Single Item



Reorder Point Control for a Single Item (2)

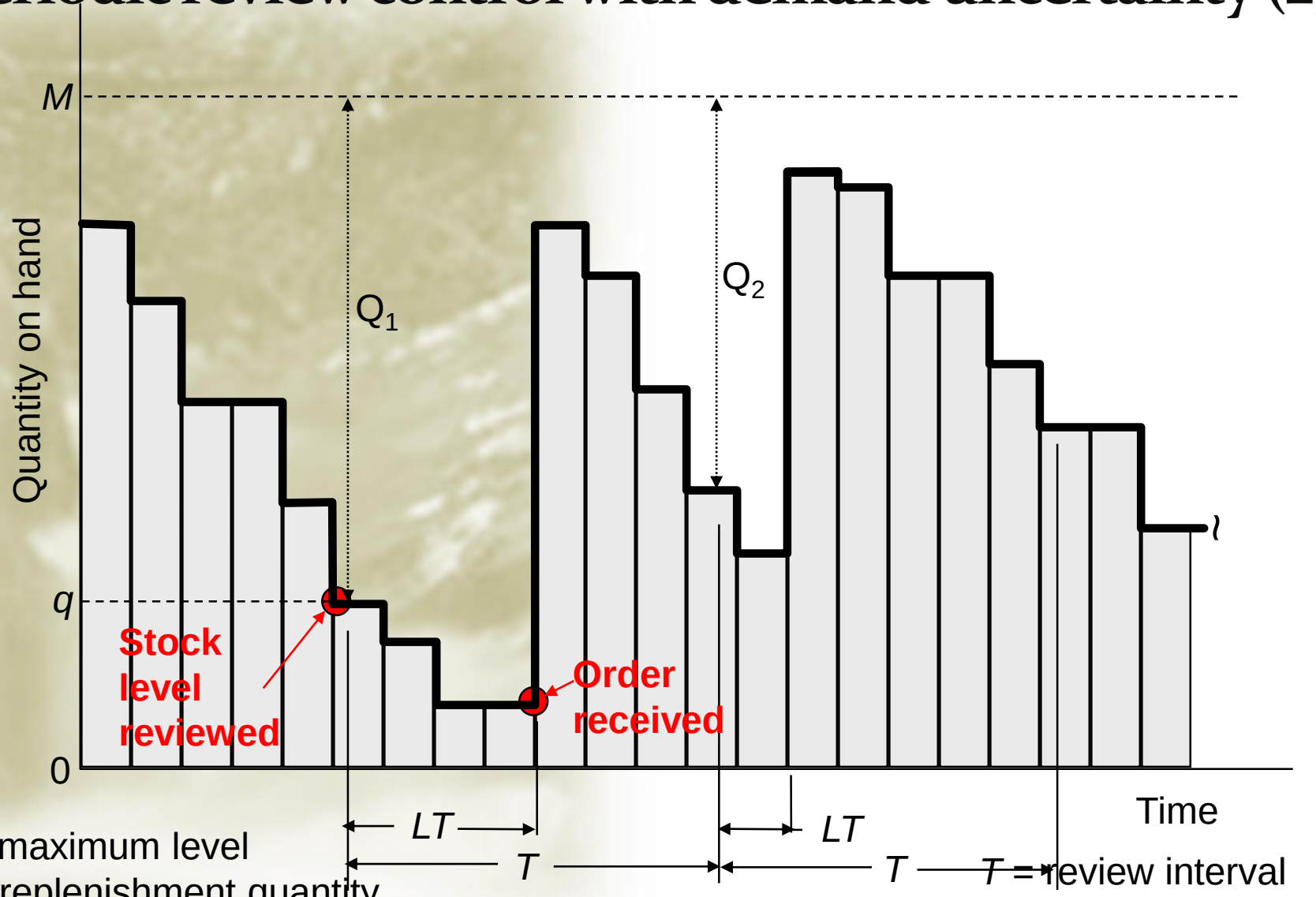


Pull Methods

- ***Non-instantaneous re-supply -*** **At times, production or supply continues while demand is depleting inventories.**
- ***Reorder point control with demand and lead time uncertainties***
  - The combined effect of these two uncertainties is particularly hard to estimate accurately.
  - It is the standard deviation of the demand-during-lead-time distribution that is the problem, especially if the level of demand and the length of the lead time are related to each other.
  - Ideally, we would simply observe the actual demand occurring over each lead time period.
  - If the demand and lead time are independent of each other and each are represented by separate distributions, we may estimate the standard deviation (s') from

$$s' = \sqrt{LT(s_d^2) + d^2(s_{LT}^2)}$$

Periodic review control with demand uncertainty (2)



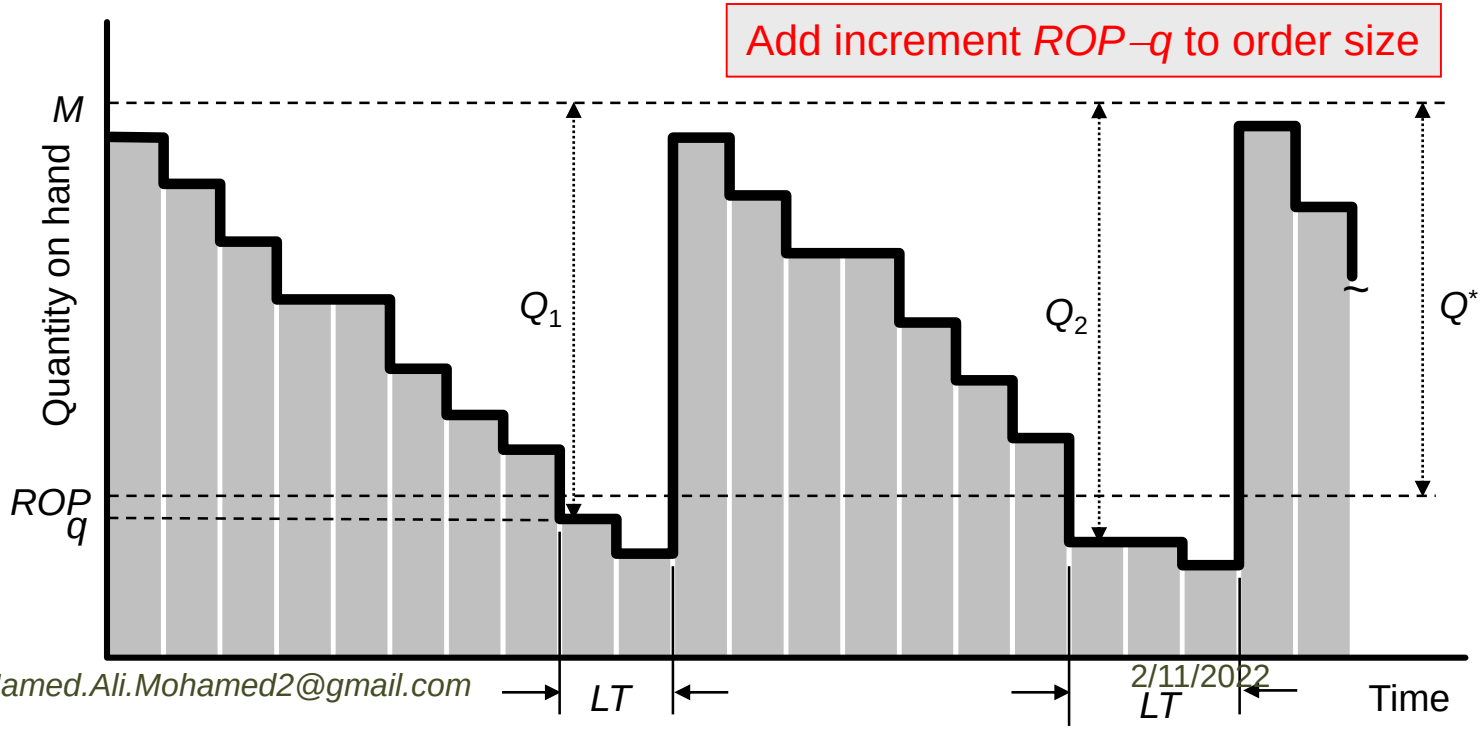
M = maximum level
M - *q* = replenishment quantity
LT = lead time
T = review interval
q = quantity on hand
Q_i = order quantity

Joint ordering

- **Perpetual inventory control for most firms is the problem of managing items jointly rather than singly.**
- **This occurs since more than one item is typically purchased from the same vendor.**
- **The approach to joint ordering is to find a common order review interval (*T*) and then to set separate target levels (*MAX*) based on specific item costs and service levels.**
- **A common review time may be specified, or it may be computed based on appropriate economics.**

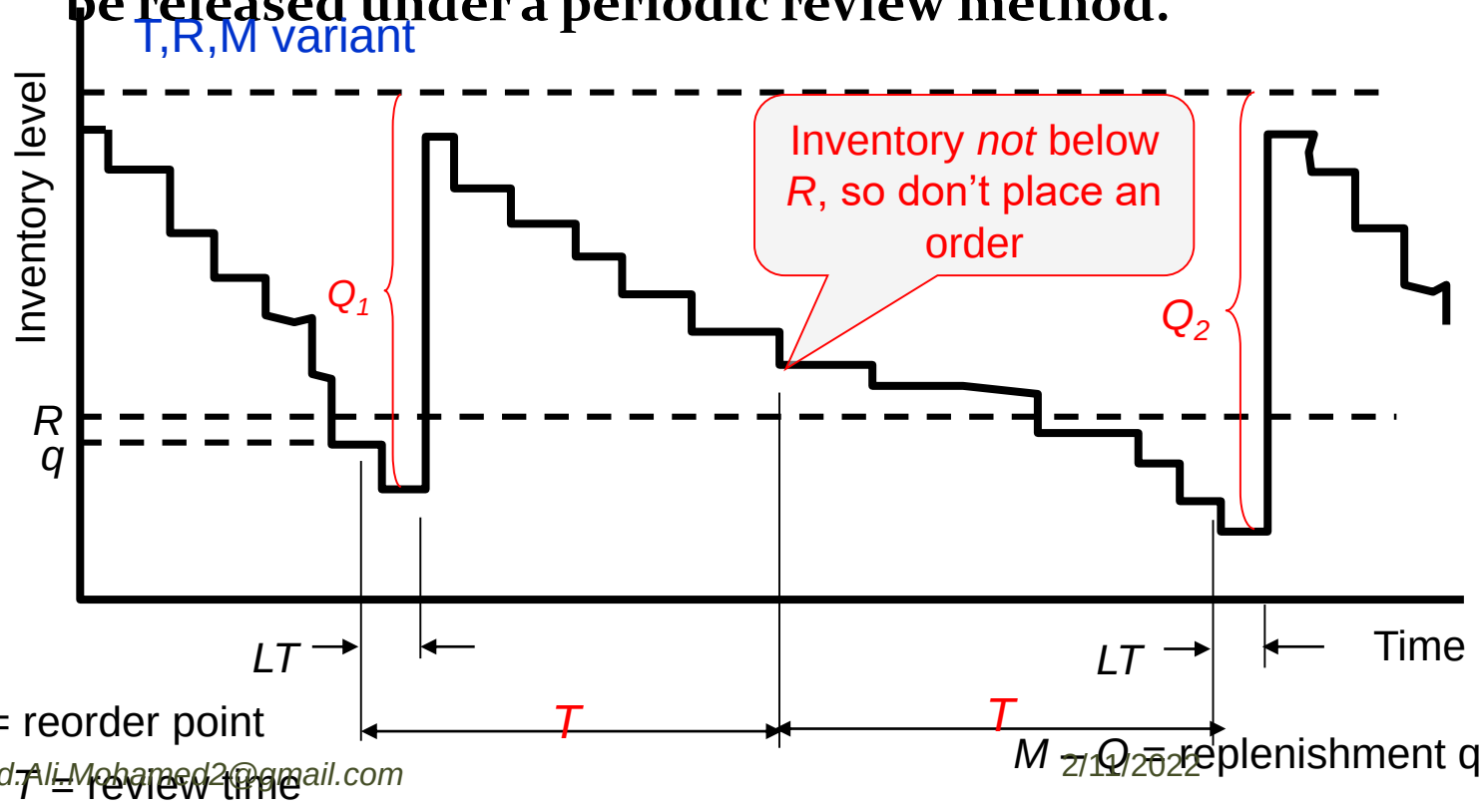
The Min-Max variant

- basically a reorder point system, but the order quantity is incremented by the amount of the difference between the reorder point quantity and the quantity on hand + quantity on order – backorders.
- takes into account that demand does not decrement inventory levels evenly. Therefore, inventory levels may fall below the reorder point at the time that it is reached.



The T, R, M variant

- a combination of the min-max and the periodic review systems.
- stock levels are reviewed periodically, but control the release of the replenishment order by whether the reorder point is reached.
- useful where demand is low, such that small quantities might be released under a periodic review method.

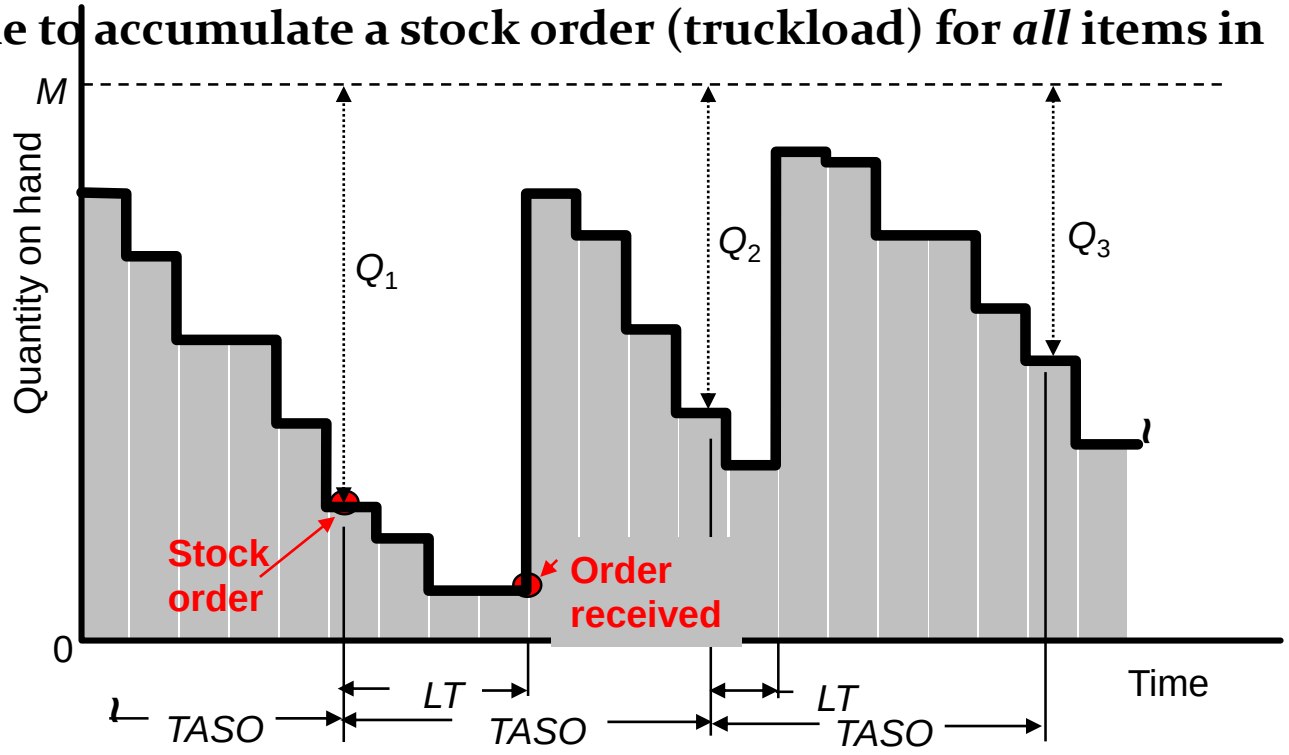


Stock to demand - a periodic review method

- **This is an important periodic review method, not so much because of its accuracy but because of its popularity in practice.**
- **The method is synchronized with the period of the forecast. The target quantity (*MAX*) is developed as follows.**
  - Set the period of the forecast, say 4 weeks
  - Add time for lead time, say 1 week
  - Add an increment of time for safety stock, say 1 week

Multiple item, multiple-location control

- **The theory that has been discussed previously is useful when designing inventory control systems for the practical problem of controlling many items at many locations.**
- **Consider how a specialty chemical company designed such a practical system.**
- ***TASO* is the time to accumulate a stock order (truckload) for *all* items in warehouse.**



M = maximum level
TASO = time to accumulate stock order

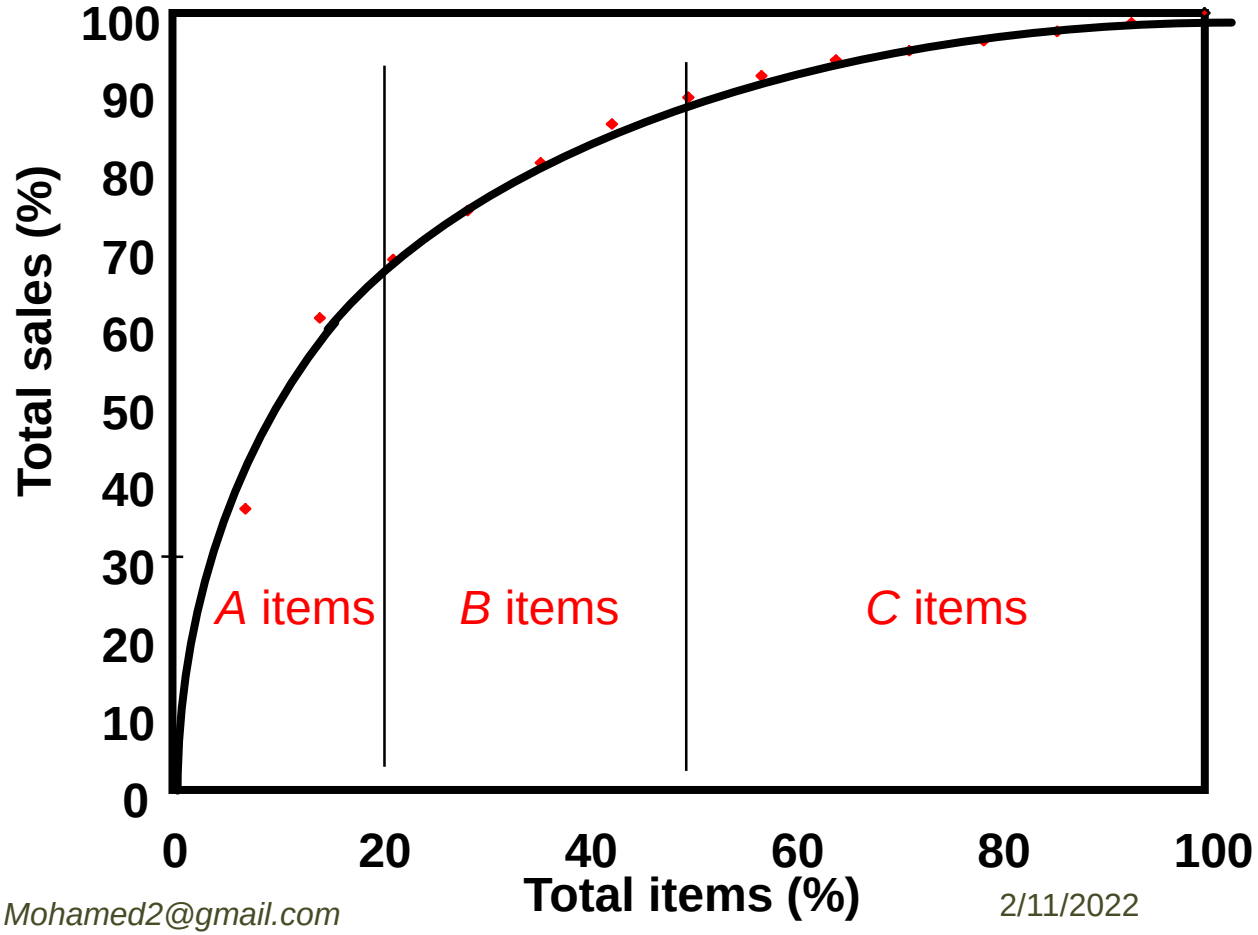
Q_i = order quantity
LT = lead time

Customer Service Level

- **The service level (stock availability) actually achieved by inventory control methods is *not* best represented by the probability (*P*) of a stockout during the lead time.**
- **This actual level is higher that was used to set the inventory level.**
- **The reason is that there are periods of time when the stock level is above the reorder point and there is no risk of being out of stock.**
- **Methods for defining stock availability include:**
  - Probability of filling all item demand
  - Probability of filling an order completely
  - Probability of filling a percent of all item demand
  - Weighted average of items filled on an order (fill rate)

Aggregate Inventory Control

- **Product items can be grouped according to 80-20 curve, each with different stocking policies**



Inventory Consolidation ("Risk Pooling")

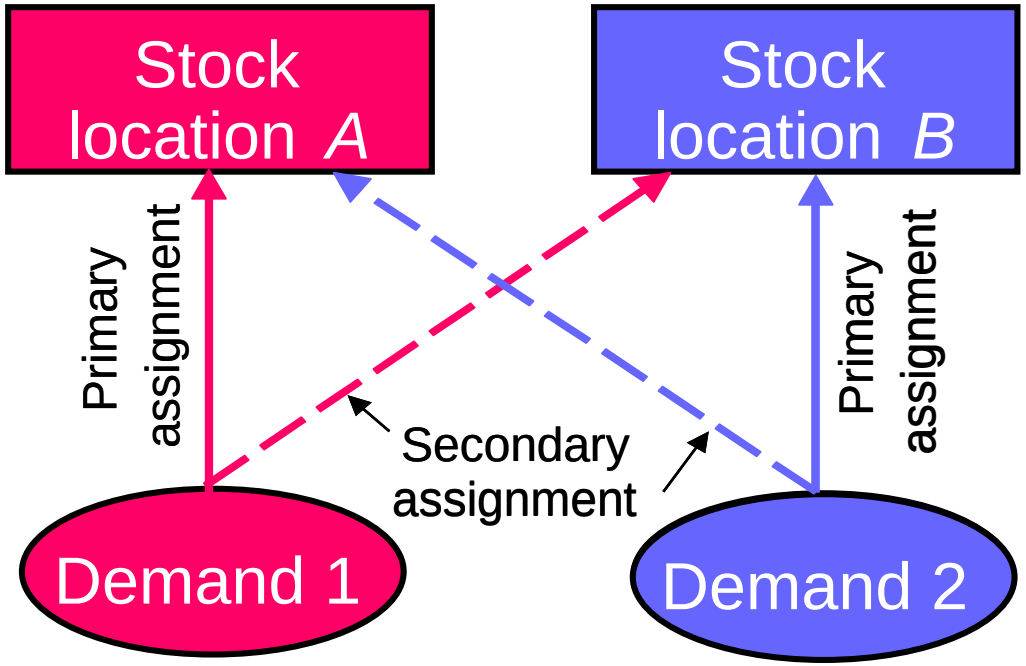
- **There is a *reduction* in the average inventory level of an item as the number of stocking points in the supply channel is *decreased*.**
- **Both regular stock and safety stock decline.**

Virtual Inventories

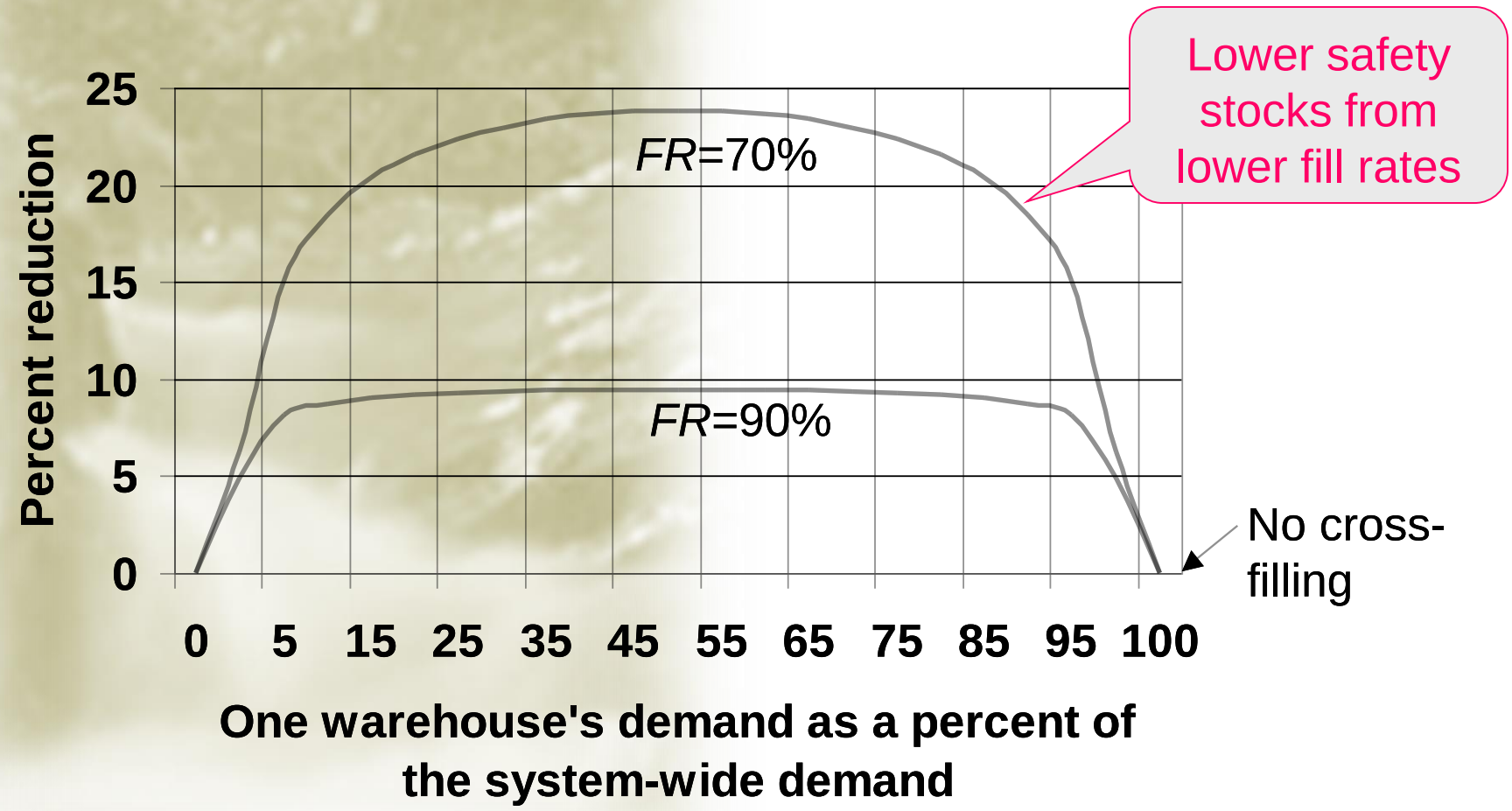
- Stockouts are filled from other stocking locations in the distribution network
- Customers assigned to a primary stocking location
- Backup locations are usually determined by “zoning” rules
- Expectation is that lower system-wide inventories can be achieved while maintaining or improving stock availability levels
- Total distribution costs should be lower to support the cross filling of customer demand

Cross Filling Virtual Inventory

- Suppose that an item is stocked at a fill rate of 80% in 4 stocking locations. If cross filling is used, what is the effective fill rate for the customer?
- Fill rate = [1 – (.20)(.20)(.20)(.20)] x 100 = 99.8%
- Customer service levels can be quite high even if the item fill rate is low!



Safety Stock Reduction due to Cross Filling

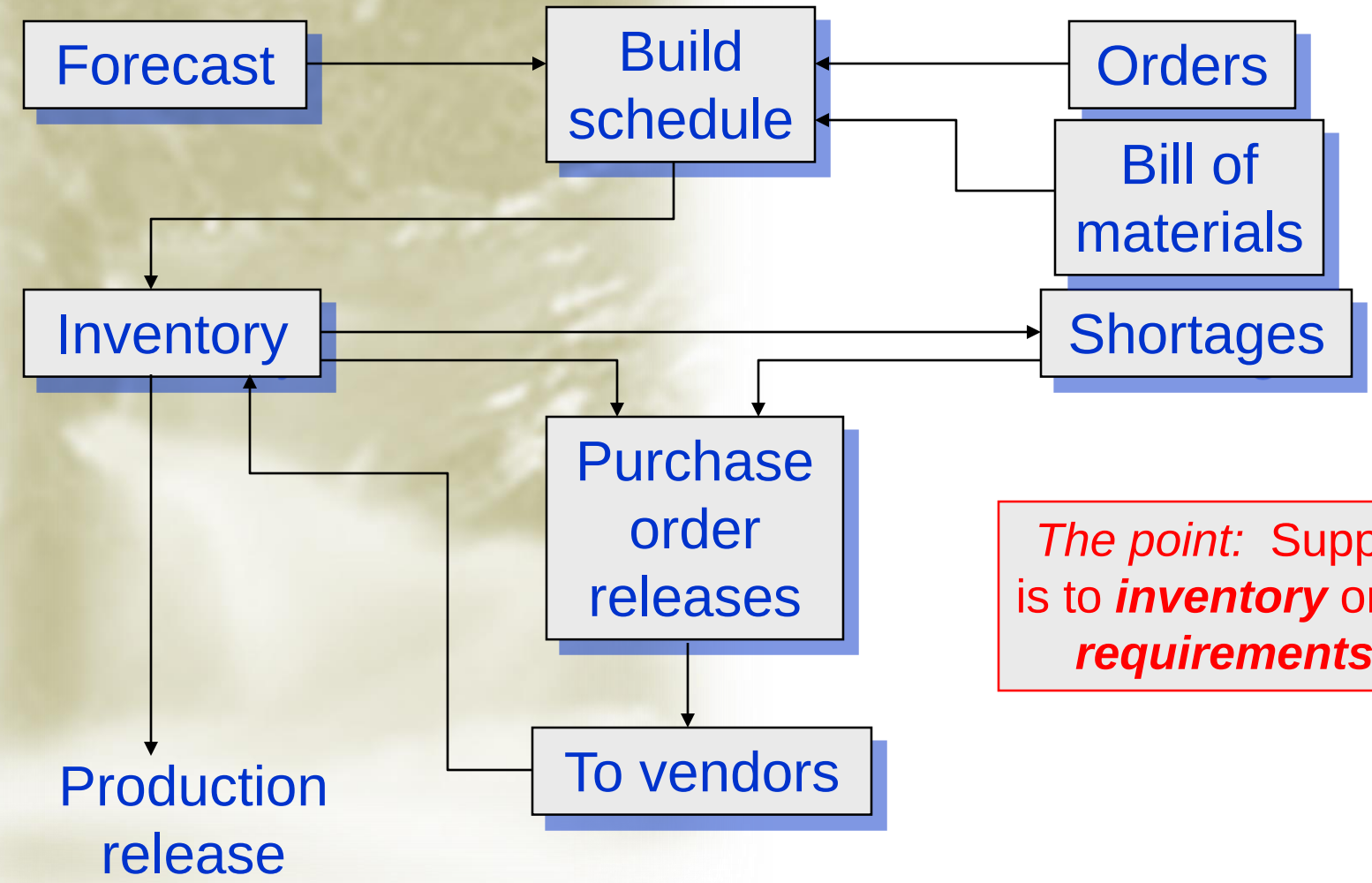


Performance Metrics - Turnover Ratio

$$\text{Turnover ratio} = \frac{\text{Annual sales}}{\text{Average inventory}}$$

$ are at *cost*

A Typical Scheduling Diagram



The point: Supply is to ***inventory*** or to ***requirements***

Just-in-time Philosophy

- ***A philosophy*** **of scheduling where the entire supply channel is synchronized to respond, in as short a time as possible, to the requirements of operations**
- **Close relationship with a few suppliers and transport carriers**
- **Information is shared between buyers and suppliers**
- **Frequent production/purchase and transport of goods in small quantities**
- **Minimum inventory levels**
- **Uncertainties are to be eliminated wherever possible throughout the supply channel**

Requirements planning

- **A formal, mechanical method of scheduling whereby the timing of purchases or supplies is determined by offsetting the requirements in the master production schedule.**
- **Why requirements become lumpy for the materials manager**
- **Setting the master schedule**
  - through derived demand patterns and bill of materials explosion
  - forecasting
  - orders on hand

MRP Scheduling

- **The mechanics of lot-for-lot scheduling given certain requirements and lead times**
  - Purchase orders are matched on a one-for-one basis with requirements.
- **Determining lot sizes**
  - Trading purchase price for inventory carrying cost
  - Vendors can set order minimum quantities to avoid the high cost of handling small orders.
  - This will usually force some inventory into the system.
  - The economically best order quantities can be set by balancing the cost of processing an order with the cost of carrying the inventory associated with ordering more than what is immediately needed.
- **Handling uncertainties in the master schedule**
  - Minimum inventory levels
  - Part-period cost balancing
- **Handling lead time uncertainties**

KANBAN

- **Toyota's method of scheduling using the order point inventory control procedure, but with very low setup costs and very short lead-times**
- **Models are repeated frequently in the master schedule.**
  - A typical master schedule for economies of scale might look like
    AAAAAABBBBBBAAAAAABBBBBB
  - but a KANBAN schedule would approach
    ABABABABABABABABABABAB
- **Lead-times are predictable because they are short and because suppliers are located near the site of operations**
- **Order quantities are small because setup or procurement costs are kept low**
- **Few vendors are used with high expectations of vendors and high level of cooperation with them**
- **Classic reorder point inventory control is used to determine reorder quantities and timing of purchases**

Vendor Managed Inventory

- The supplier usually owns the inventory at the customer's location
- The supplier manages the inventory by any means appropriate and plans shipment sizes and delivery frequency
- The buyer provides point of sale information to the supplier
- The buyer pays for the merchandise at the time of sale
- The buyer dictates the level of stock availability required

What is Purchasing?

- **Primarily a buying activity**
- **A decision area to be integrated with overall materials management and logistics**
- **At times, an area to be used to the firm's strategic advantage**
- **Mission: Securing the products, raw materials, and services needed by production, distribution, and service organizations at the *right time*, the *right price*, the *right place*, the *right quality*, and in the *right quantity*.**
- **Importance**
  - Decisions impact on 40 to 60% of sales dollar
  - Decisions are highly leveraged

What is purchased?

- **Price**
  - Cost of goods
  - Terms of sale
  - Discounts
- **Quality**
  - Meeting specifications
  - Conformance to quality standards
- **Service**
  - On-time and damage-free delivery, order-filling accuracy, product availability
  - Product support

Activities of purchasing

- Selects and qualifies suppliers
- Rates supplier performance
- Negotiates contracts
- Compares price, quality, and service
- Sources goods
- Times purchases
- Sets terms of sale
- Evaluates the value received
- Measures inbound quality if not a responsibility of quality control
- Predicts price, service, and sometimes demand changes
- Specifies form in which goods are to be received

Criteria for selecting suppliers

- **Past or anticipated relations**
  - Honesty
  - Financial viability
  - Reciprocity
- **Measured performance**
  - Price
  - Responsiveness to change or requests
  - On-time delivery
  - Product or service backup
  - Meeting quality goals
- **Weighted average of ratings**
- **Operational compatibility**
  - Informational compatibility
  - Physical compatibility
- **Ethical and moral issues**
  - Minority vendors
  - Lowest price bidding
  - Patriotic purchasing
  - Open bidding but a pre-selected vendor

Single vs Multiple Vendors

Single vendors

- Allows for economies of scale
- Consistent with the just-in-time philosophy
- Builds loyalty and trust
- May be only source for unique product or service

Multiple vendors

- Encourages price competition
- Diffuses risk
- May disturb supplier relations, reduce loyalty, reduce responsiveness, and cause variations in product quality and service

Finding Suppliers

- Personal contacts
- Trade publications
- Web sites, catalogs, and directories
- Advertisements and solicitations

Qualifying suppliers

- Previous experiences and formal rating schemes
- Word of mouth
- Samples of product
- Reputation
- Site visits and demonstrations

Allocation to Suppliers

- **Company policy considering risk, fairness, ethics, etc.**
- **Definitive methods**
- **Is buying based on lowest price a good strategy – consider other costs too…**
- **Allocate using linear programming**
- **Asking "what if" questions can provide insight into good allocation plans**
  - weak supplier - perhaps some price concessions can be negotiated
  - valuable supplier and more capacity should be sought

Timing of Purchases

- **Through just-in-time planning**
  - Material requirements planning for continuous work
  - Gantt charts and CPM/PERT for project work
- **Through inventory management**
  - Push methods
  - Pull methods
- **According to market conditions**
  - Speculative buying
  - Forward buying
  - Hand-to-mouth buying, or buying to current requirements

Speculative buying

- **Buying more than the foreseeable requirements at current prices in the hope of reselling later at higher prices.**
- **Some of the purchased quantities may be used in production and some simply resold.**
- **Generally a financial activity, not a materials management one.**

Hand-to-mouth buying

- **Buying to satisfy immediate needs such as those generated through MRP.**
- **Advantageous when prices are *dropping***
- **May improve cash flow by temporarily reducing expenses of carrying inventory**

Forward buying

- **Buying in quantities exceeding current requirements, but not beyond foreseeable needs.**
- **Takes advantage of favorable prices in an unstable market, or takes advantage of volume transportation rates**
- **Reduces risk of inadequate delivery**
- ***Dollar Averaging***
  - Spend the same amount on each purchase with the idea of buying more when prices are low and less when they are high.
  - This is a good strategy when prices are expected to rise over the long term and there is substantial uncertainty as to the actual price level.
  - Because under-supply may occur, some level of inventory will need to be maintained.

Deal Buying

- **A one-time buying opportunity.**
- **Determining the quantity to purchase requires balancing the benefits of a price discount against extra inventory holding costs.**

Part 9

GOODS, SERVICES, AND OPERATIONS MANAGEMENT

What Do Operations Managers Do?

- Forecasting
- Supply chain management
- Facility layout and design
- Technology selection
- Quality management
- Purchasing
- Resource and capacity management
- Process design
- Job design
- Service encounter design
- Scheduling

OM in the Workplace

Operations Managers have such titles as:

- Chief Operating Officer
- Hotel or Restaurant Manager
- Vice President of Manufacturing
- Customer Service Manager
- Plant Manager
- Field Services Manager
- Supply Chain Manager

Understanding Goods and Services

- *A **good** is a physical product that you can see, touch, or possibly consume.* Examples of goods include: oranges, flowers, televisions, soap, airplanes, fish, furniture, coal, lumber, personal computers, paper, and industrial machines.

- *A **durable good** is a product that typically lasts at least three years*. Vehicles, dishwashers, and furniture are some examples of durable goods.

Understanding Goods and Services

- *A **non-durable good** is perishable and generally lasts for less than three years.* Examples are toothpaste, software, shoes, and fruit.

- *A **service** is any primary or complementary activity that does not directly produce a physical product.*

Differences Between Goods and Services

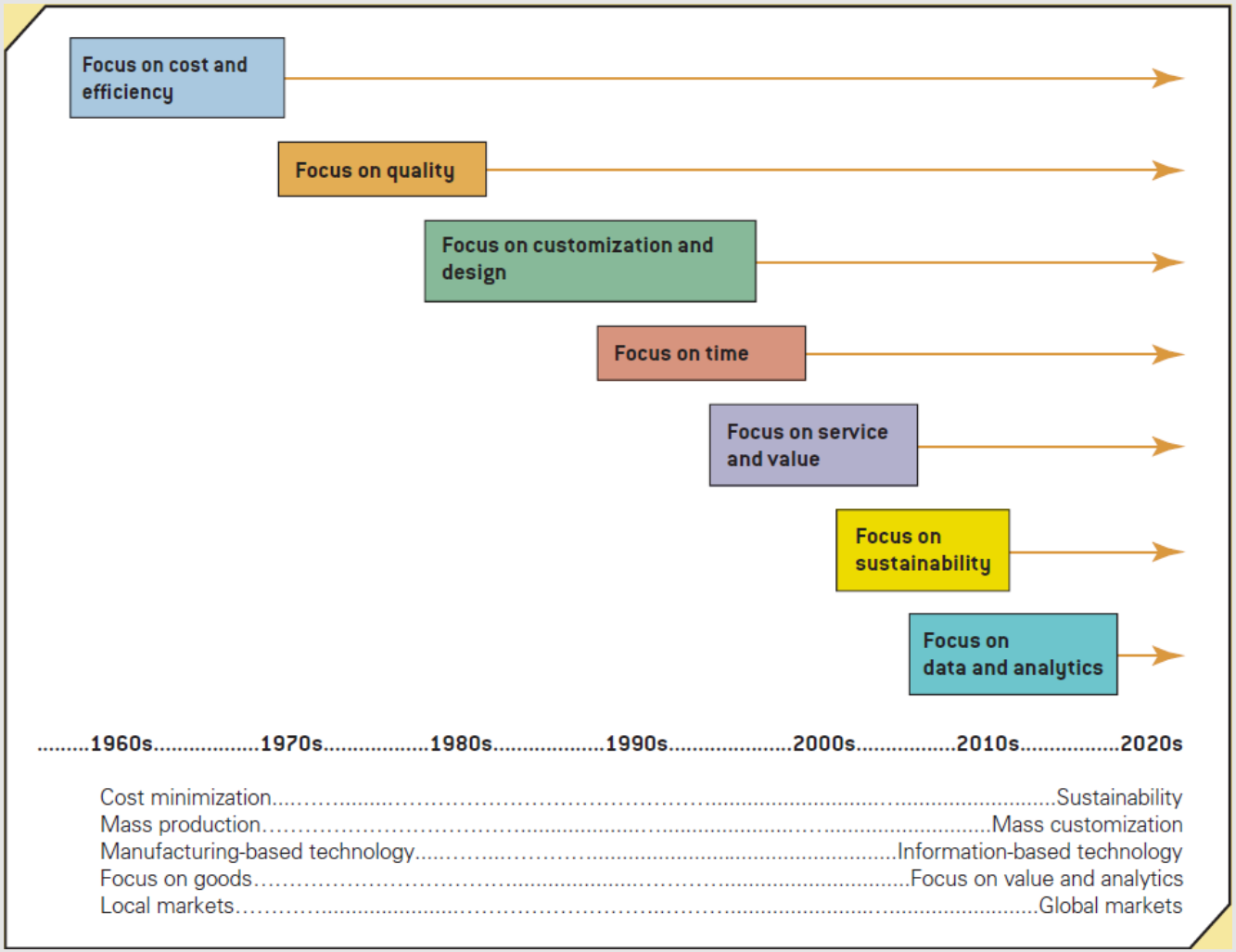
1. Goods are tangible while services are intangible.
2. Customers participate in many service processes, activities, and transactions.
3. The demand for services is more difficult to predict than the demand for goods.
4. Services cannot be stored as physical inventory.
5. Service management skills are paramount to a successful service encounter.
6. Service facilities typically need to be in close proximity to the customer.
7. Patents do not protect services.

Exhibit 1.1

How Goods and Services Affect Operations Management Activities

OM Activity	Goods	Services
Forecasting	Forecasts involve longer-term time horizons. Goods-producing firms can use physical inventory as a buffer to mitigate forecast errors. Forecasts can be aggregated over larger time frames (e.g., months or weeks).	Forecast horizons generally are shorter, and forecasts are more variable and time-dependent. Forecasting must often be done on a daily or hourly basis, or sometimes even more frequently.
Facility Location	Goods-producing facilities can be located close to raw materials, suppliers, labor, or customers/markets.	Service facilities must be located close to customers/markets for convenience and speed of service.
Facility Layout and Design	Factories and warehouses can be designed for efficiency because few, if any, customers are present.	The facility must be designed for good customer interaction and movement through the facility and its processes.
Technology	Goods-producing facilities use various types of automation to produce, package, and ship physical goods.	Service facilities tend to rely more on information-based hardware and software.
Quality	Goods-producing firms can define clear, physical, and measurable quality standards and capture measurements using various physical devices.	Quality measurements must account for customer's perception of service quality and often must be gathered through surveys or personal contact.
Inventory/ Capacity	Goods-producing firms use physical inventory such as raw materials and finished goods as a buffer for fluctuations in demand.	Service capacity such as equipment or employees is the substitute for physical inventory.
Process Design	Because customers have no participation or involvement in goods-producing processes, the processes can be more mechanistic and controllable.	Customers usually participate extensively in service creation and delivery (sometimes called co-production), requiring more flexibility and adaptation to special circumstances.
Job/Service Encounter Design	Goods-producing employees require strong technical and production skills.	Service employees need more behavioral and service management skills.
Scheduling	Scheduling revolves around the movement and location of materials, parts, and subassemblies and when to assign resources (i.e., employees, equipment) to accomplish the work most efficiently.	Scheduling focuses on when to assign employees and equipment (i.e., service capacity) to accomplish the work most efficiently without the benefit of physical inventory.
Supply Chain Management	Goods-producing firms focus mainly on the physical flow of goods often in a global network with the goal of maximizing customer satisfaction and profit, and minimizing delivery time, costs, and environmental impact.	Service-providing firms focus mainly on the flow of people, information, and services often in a global network with the goal of maximizing customer satisfaction and profit, and minimizing delivery time, costs, and environmental impact.

Exhibit 1.4 Six Eras of Operations Management



Sustainability *refers to an organization's ability to strategically address current business needs and successfully develop a long-term strategy that embraces opportunities and manages risk for all products, systems, supply chains, and processes to preserve resources for future generations*.

Sustainability

- ***Environmental sustainability*** *is an organization's commitment to the long-term quality of our environment.*
- ***Social sustainability*** *is an organization's commitment to maintain healthy communities and society that improve the quality of life.*
- ***Economic sustainability*** *is an organization's commitment to address current business needs and economic vitality, and to have the agility and strategic management to prepare successfully for future business, markets, and operating environments.*

Thanks For Attention

&

Hope it will Help You All