Addis Ababa University

Addis Ababa Institute of Technology

School of Mechanical and Industrial Engineering

Manufacturing Engineering Stream

Production and Operation Management
(Meng 6103)

By:

Kassu Jilcha (Asst. Professor)

March 2020

Chapter one:

Introduction to Production and Operations Management (POM)

2. Operations Functions in Organizations

- **Operations Management** is a branch that deals with managing **operations** and processes within the organization.
- Efficacious **management of operations** ensures successful delivery of the project.
- The **operation managers** optimizes the **operations** by making judicious use of resources and capital.
- They manage all the aspects related to the operations that take place in businesses.
- **Operation managers** are not only found in a company but also in manufacturing units.
- They are required to perform various functions as a part of their job responsibilities.
- Some of the **key functions of an Operations Manager includes:**

2. Operations Functions in Organizations

- Finance
- Operation
- Strategy
- Forecast
- Design of the product
- Supply Chain Configuration
- Managing the quality
- Planning

3. Operations Historical development

- For over two centuries operations and production management has been recognized as an important factor in a country's economic growth.
- The traditional view of manufacturing management began in eighteenth century when Adam
- Smith recognized the economic benefits of specialization of labour.
- He recommended breaking of jobs down into subtasks and recognizes workers to specialised tasks in which they would become highly skilled and efficient.
- In the early twentieth century, F.W. Taylor implemented Smith's theories and developed scientific management. From then till 1930, many techniques were developed prevailing the traditional view.
- Brief information about the contributions to manufacturing management is shown in the Table 1.1.

3. Operations Historical development

TABLE 1.1 Historical summary of operations management

Date	*Contribution*	*Contributor*
1776	Specialization of labour in manufacturing	Adam Smith
1799	Interchangeable parts, cost accounting	Eli Whitney and others
1832	Division of labour by skill; assignment of jobs by skill; basics of time study	Charles Babbage
1900	Scientific management time study and work study developed; dividing planning and doing of work	Frederick W. Taylor
1900	Motion of study of jobs	Frank B. Gilbreth
1901	Scheduling techniques for employees, machines jobs in manufacturing	Henry L. Gantt
1915	Economic lot sizes for inventory control	F.W. Harris
1927	Human relations; the Hawthorne studies	Elton Mayo
1931	Statistical inference applied to product quality: quality control charts	W.A. Shewart
1935	Statistical sampling applied to quality control: inspection sampling plans	H.F. Dodge & H.G. Roming
1940	Operations research applications in World War II	P.M. Blacker and others.
1946	Digital computer	John Mauchlly and J.P. Eckert
1947	Linear programming	G.B. Dantzig, Williams & others
1950	Mathematical programming, on-linear and stochastic processes	A. Charnes, W.W. Cooper & others
1951	Commercial digital computer: large-scale computations available.	Sperry Univac
1960	Organizational behaviour: continued study of people at work	L. Cummings, L. Porter
1970	Integrating operations into overall strategy and policy, Computer applications to manufacturing, Scheduling and control, Material requirement planning (MRP)	W. Skinner J. Orlicky and G. Wright
1980	Quality and productivity applications from Japan: robotics, CAD-CAM	W.E. Deming and J. Juran.

5. Information and Non-manufacturing systems

- **Manufacturing businesses** have costs associated with manufacturing and nonmanufacturing business functions.
- These costs are directly apportioned to the direct versus indirect costs associated with producing a product.
- There are three major categories of **manufacturing costs** consisting of direct labor, direct material, and manufacturing overhead.
- **Nonmanufacturing**, also known as "period" costs, consists of selling and administrative expenses.
- Identifying, separating and apportioning cost data provides management and outside decision makers (investors) valuable information on the company's profitability and cost control systems.

5. Information and Non-manufacturing systems

- **Direct Material Manufacturing Costs**
- Direct material costs are those costs directly associated with manufacturing a product. For instance, a publishing company considers ink and paper as direct material costs.
- However, an auto parts manufacturer considers steel and plastic as direct material costs and the ink and paper used to design the parts plans are considered **nonmanufacturing costs**.
- **Direct Labor Manufacturing Costs**
- Manufacturing companies have **labor costs** associated with direct manufacturing and nonmanufacturing labor costs.
- Direct labor manufacturing costs is determined by calculating the cost of employees directly responsible for producing the product. For example, a clothing manufacturer considers employees that dye the cloth, cut the cloth and sew the cloth into a garment as **direct labor costs**. However, designers and sales personnel are considered **nonmanufacturing labor costs**.

5. Information and Non-manufacturing systems

Direct Manufacturing Overhead Costs

- Manufacturing overhead are costs that are not part of labor or material cost and can be either a fixed or variable cost. For instance, **fixed overhead costs** consist of property taxes, insurance premiums, depreciation and nonmanufacturing employee salaries. Whereas, **variable direct manufacturing** overhead costs include indirect labor, indirect material and utilities.
- Though most of these costs are self-evident, **indirect material costs** are unique because these costs are not essential to the physical production of the product.

Nonmanufacturing Costs

- **Nonmanufacturing costs** are necessary to carry on general business operations but are not part of the physical manufacturing process.
- **Nonmanufacturing costs** consist of selling expenses, including marketing and commission expenses and sales salaries and administration expenses, such as office salaries, depreciation and supplies.
- The purpose of addressing these costs differently is based on the fact that they are accounted for differently when structuring the income statement and balance sheet.

6. Operations management

- **What is Operations?**
  - a function or system that "**transforms**" inputs into outputs of greater value
- **What is a Transformation Process?**
  - a series of activities along a ***value chain*** extending from supplier to customer
- In the past when the field was related primarily to manufacturing, operation management was called production management. But
  - Operation managers have important responsibilities in service industry as well as in Manufacturing companies.
  - In manufacturing, inputs of raw material, energy, labor and capital are transformed into finished goods. In service operations, these same types of inputs are transformed in to service output.
- Later the name was expanded to production and operation or more simply operation management to indicate the service industry as well

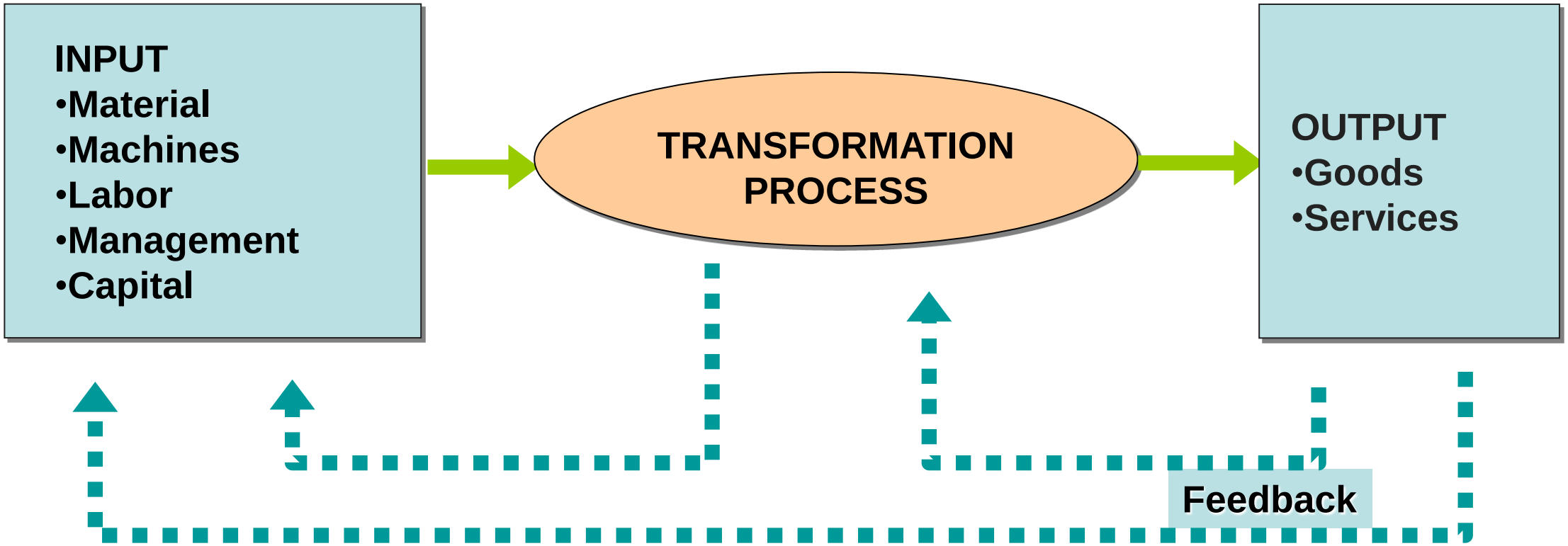
Definitions of OM:

- The term "**operations management**" evolved from factory-oriented terms like "manufacturing management" and "production operations," but its present meaning has been broadened to embrace service industries; and nonprofit activities as well
- process whereby resources, flowing within a defined system, are combined and transformed in a controlled manner to add value in accordance with policies communicated by management

Definitions of OM:

- the management of systems or processes that create goods and/or provide services
- version of *inputs* into *outputs*, using physical resources, so as to provide the desired utility/utilities of form, place, possession or state or a combination there of to the customer while meeting the other organizational objectives of effectiveness, efficiency and adaptability.

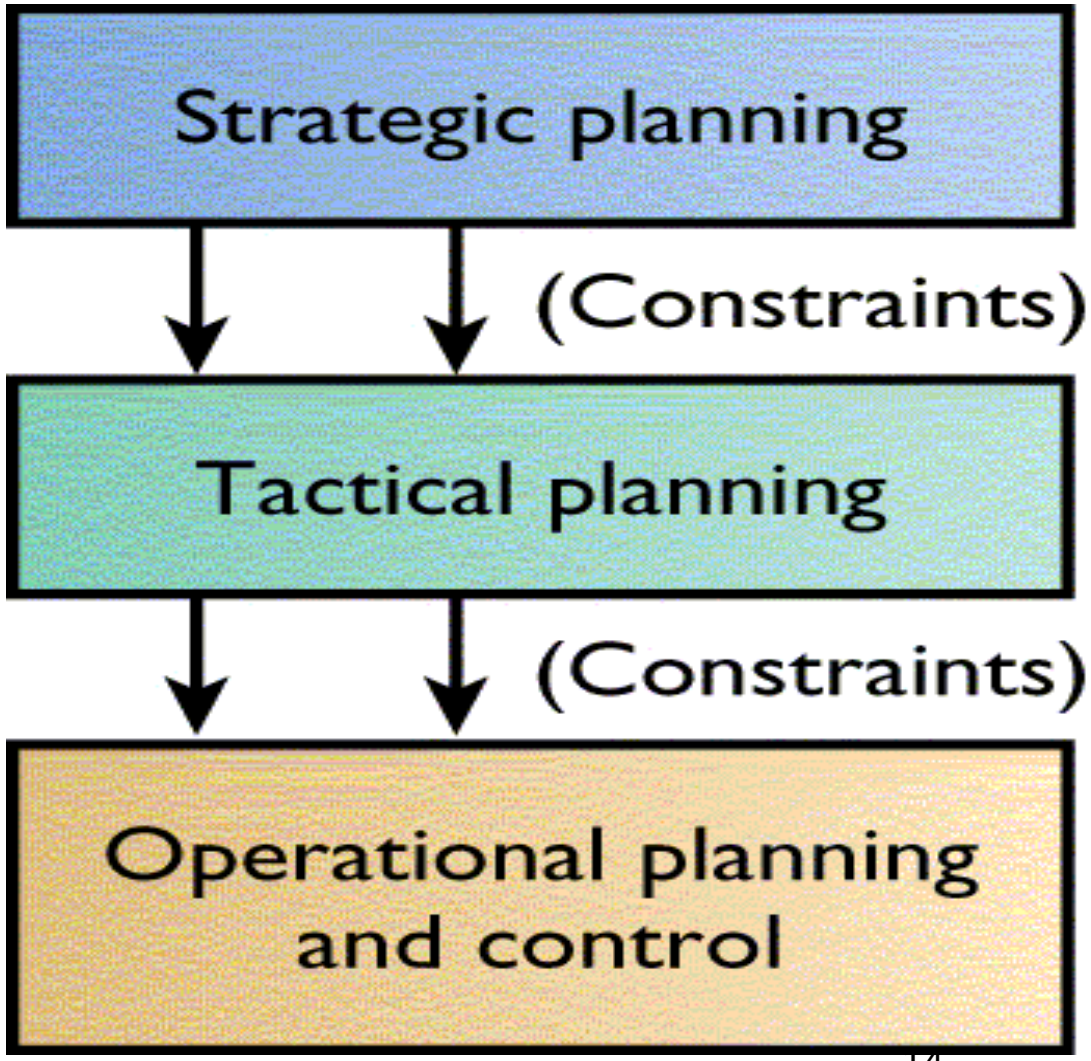
Transformation Process



Operation strategy

Top-down Approach to OM Strategy

- Operations Strategy Decisions
  - –Strategic (long-range)
    - Needs of customers (capacity planning)
  - –Tactical (medium-range)
    - Efficient scheduling of resources
  - –Operational planning and control (short-range)
    - Immediate tasks and activities



Operations/Production Strategy

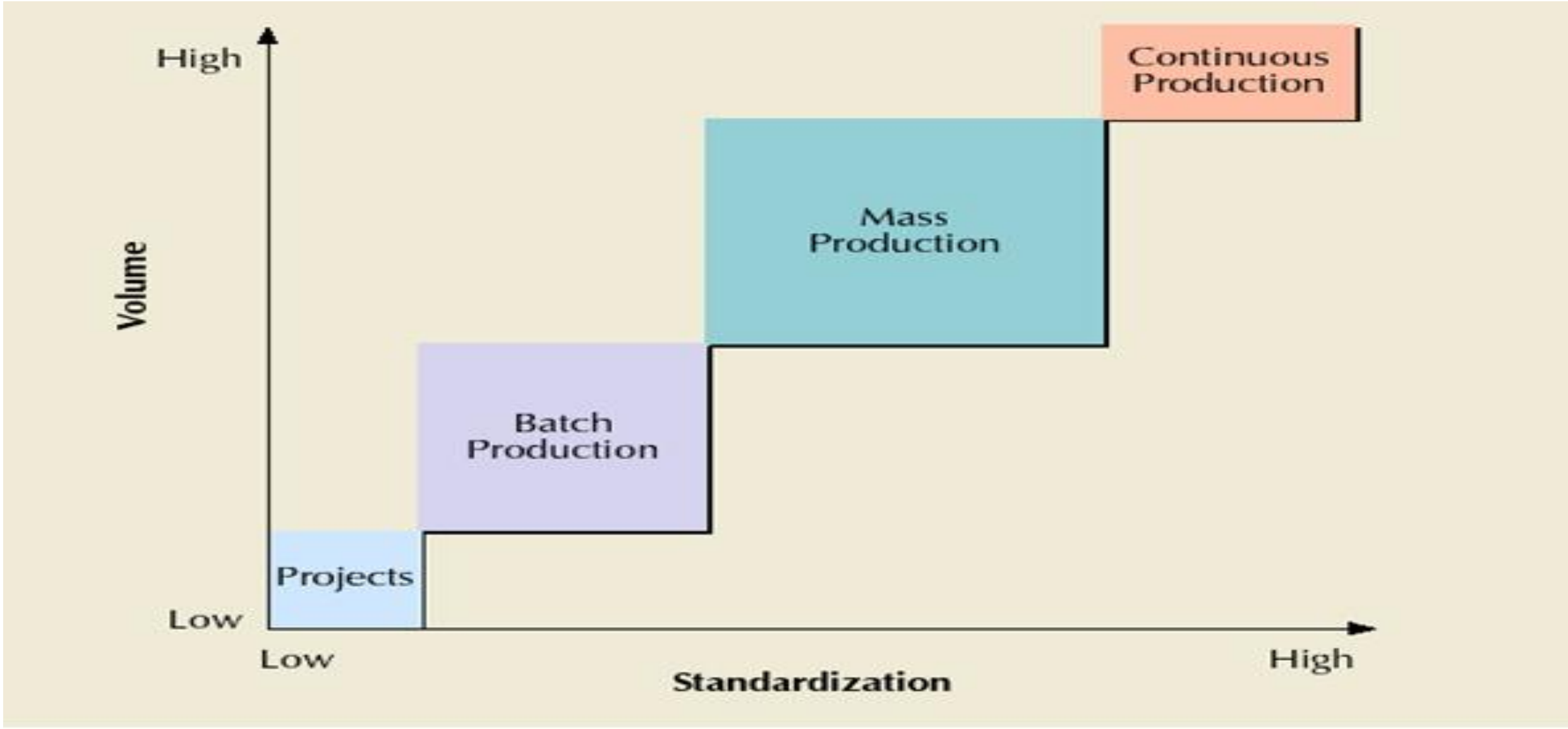
Products and Services

- **Make-to-Order**
  - products and services are made to customer specifications after an order has been received
- **Make-to-Stock**
  - products and services are made in anticipation of demand
- **Assemble-to-Order**
  - products and services add options according to customer specifications

Processes and technology: Types of production system

- **Project**
  - one-at-a-time production of a product to customer order
- **Batch Production**
  - systems process many different jobs at the same time in groups (or batches)
- **Mass Production**
  - large volumes of a standard product for a mass market
- **Continuous Production**
  - used for very high volume commodity products

Product-Process Matrix



Decisions area in OM

- OM managers have the responsibilities in the following four major decision areas:

1. **Quality:-**it must ensure that quality is designed and built into the product in all stages of operation.
2. **Inventory:-** determine what to order, how much to order, and when to order
3. **Capacity:-** right amount of capacity at the right place at the right time .short capacity sometimes be argued by subcontracting, extra shifting or overtime
4. **Process:-** the decision include the type of equipment and technology, process flow, layout of the facility, job design, etc.…

OM's Contributions to Society

- **Higher Standard of Living**
  - Ability to increase productivity
  - Lower cost of goods and services
- **Better Quality Goods and Services**
  - Competition increases quality
- **Concern for the Environment**
  - Recycling and concern for air and water quality
- **Improved Working Conditions**
  - Better job design and employee participation

10. Operations Strategy and Competitiveness

- A process for getting from where the company is today to where company would like to be in the future.
- A process for getting from “here” to “there.”

Strategic Planning Steps

1. Preparing a mission statement
2. Creating a vision
3. Setting goals
4. Formulating strategies
5. Designing tactics
6. Evaluating process and taking corrective action
7. Measuring results or outcomes

Strategic Planning Steps

- Mission
  - What is our business? (Who we are?)
  - Focus is on “today” (Here!)
- Vision
  - What we hope to be.
  - Focus is on “future” (There!)

Strategic Planning Steps

- Goals
  - What we must do to achieve vision.
  - Should be measurable.
- Strategies
  - In broad terms, what must we do to achieve goal?
  - Does not say how.

Strategic Planning Steps

- Depends on opportunities and threats
  - Conduct environmental scan
- Also depends on companies strengths (core competencies) and weakness

- Conducting an environmental scan and identifying companies strengths and weakness is a SWOT analysis.

SWOT

Internal	S = Strengths	W= Weakness
External	O = Opportunities	T = Threats

Strategic Planning Steps

- Tactics
  - What must we do to make strategies work?
- Evaluation and corrective action
  - Are tactic working?
  - Are they moving you closer to achieving goal?
  - If not, take corrective action by changing tactics.
- Outcome
  - Outcome of strategic planning process
  - Tells us if strategic planning process was successful.
    - Was goal was achieved?
  - If not, repeat.

Example : Strategic Plan

Mission	We are in business of selling men's dress shoes in SFV
Vision	Expand market area to include So. Ca.
Goal	Capture 30% of So. Ca. market in 1 yr.
Strategies	Expand product line, increase marketing effort
Tactics	Carry women's shoes; carry more shoe lines including athletic shoes and sandals; Advertise in major newspapers.
Evaluation/Corrective action	Are tactics working?
Outcome	Market share 1 year from now

Developing an Operations Strategy

- Operations Strategy is a plan for using the operational capabilities of a company to decide how it will compete.
- Will it compete on
  - **Price,**
  - **Quality,**
  - **Time,**
  - **Flexibility?**
- One, some or all?

Competing on Price?

- Offering product at a lower price relative to competition
- Works if there are many competitors offering same product or service.
- If you of a product with a high degree of customization, does it make sense for you to compete on price?

Competing on Quality?

- Quality of product and service
- Does competing on quality mean that a company can't compete on price because it, if it offers better quality, it will charge a higher price?
- Depends on how quality affects ??? If it increases ????

Competing on Time?

- Time/speed one of most important competition priorities
- Time related issues involve
  - **Rapid delivery:**
    - Focused on shorter time between order placement and delivery
  - **On-time delivery:**
    - Deliver product exactly when needed every time

Competing on Flexibility?

- **Product flexibility:**
  - Easily switch production from one item to another
  - Easily customize product/service to meet specific requirements of a customer
- **Volume flexibility:**
  - Ability to ramp production up and down to match market demands

7. Productivity Measurement

Productivity (P)

$$P = \frac{Outputs}{Inputs}$$

Productivity Measures

- **Partial Measures:**
  - A ratio of **outputs** to only **one input** (e.g.: labor productivity, machine utilization, energy efficiency)
  - output/(single input)
- **Multifactor Measures:**
  - A ratio of **outputs** to **several**, but not all, inputs
  - output/(multiple inputs)
- **Total Productivity Measures:**
  - The ratio of **outputs** to **all inputs**
  - output/($ value of all inputs)

Labor Productivity

Example:

- Assume two workers paint 24 tables in 8 hours:
- **Inputs**: 16 hours of labor (2 workers x 8 hours)
- **Outputs**: 24 painted tables

$$\frac{Outputs}{Inputs} = \frac{24\,tables}{16\,hours} = 1.5\,tables/our$$

Multifactor Productivity

- Convert all inputs & outputs to $ value
- **Example:**
  - 200 units produced sell for $12.00 each
  - Materials cost $6.50 per unit
  - 40 hours of labor were required at $10 an hour
  - **Solution**

$$\frac{200\,units\times\$12/unit}{(200\,units\times\$6.50/unit)+(40\,hours\times\$10/hour)}=\frac{\$2400}{\$1700}=1.41$$

Interpreting Productivity Measures

- Is the productivity measure of 1.41 in the previous example a good or bad?
- It can't tell without a reference point
- Compare to previous measures (*e.g.*: last week) or to another benchmark

Productivity Growth Rate

- Can be used to compare a process' **productivity** at a given time (P_2) to the same process' productivity at an earlier time (P_1)

$$Growth\ Rate=\frac{P_2-P_1}{P_1}$$

Productivity Growth Rate…

Example:

- Last week a company produced 150 units using 200 hours of labor
- This week, the same company produced 180 units using 250 hours of labor

Solution

$$P_1 = \frac{150\,units}{200\,hours} = 0.75\,units/\,hour$$

$$P2 = \frac{180\,units}{250\,hours} = 0.72\,units/\,hour$$

$$Growth\ Rate = \frac{P_2 - P_1}{P_1} = \frac{0.72 - 0.75}{0.75} = -0.04$$

$$or\ a\ negative 4\%\ growth\ rate$$

Measures of Productivity

$$Partial\ Measures = \frac{output}{labour}, or\ \frac{output}{machine}, or \frac{output}{energy}, or \frac{output}{material}, etc$$

$$Multifactors\ Measures = \frac{output}{labour + machine}, or\ \frac{output}{machine + Capital + energy}, or \frac{output}{energy + material + labour}, etc$$

$$Total\ Measures = \frac{Goods\ or\ service\ produced}{\$\ value\ of\ all\ inputs\ used\ to\ produce\ them},$$

Given: Numerical Example in table

	Output	Labor	Machine
Units	500	x	x
Hours	x	26	6
Cost/unit	x	$8	$3
Price/unit	$15	x	x

Partial Measures

$$\text{Labor Productivity} = \frac{\text{Units Produced}}{\text{Labor hrs.}}$$

Explain meaning of 19.3/hr.?

$$\text{Labor Productivity} = \frac{500}{26} = 19.3$$

$$\text{Labor Productivity} = \frac{\text{Dollar Value of Output}}{\text{Labor hrs.}}$$

$$\text{Labor Productivity} = \frac{500 \text{ x } \$15/\text{unit}}{26 \text{ hrs.}} = \frac{\$7{,}500}{26 \text{ hrs.}} = \$288.46/hr$$

Explain meaning $288.46/hr.?

Partial Measures

$$\text{Labor Productivity} = \frac{\text{Units Produced}}{\text{Labor cost}} = \frac{\text{Units Produced}}{(\text{Labor hrs.}) \times (\text{Labor cost/hr.})}$$

$$\text{Labor Productivity} = \frac{50}{26 \times \$8} = 2.4$$

Explain meaning 2.4units/$?

$$\text{Machine Productivity} = \frac{\text{Units Produced}}{\text{Machine hrs.}}$$

$$\text{Machine Productivity} = \frac{500}{6} = 83.3$$

Explain meaning 83.3 units/machine?

Multi-factor

$$\text{MFP} = \frac{\text{Units Produced}}{\text{Machine Cost} + \text{Labor Cost}} = \frac{\text{Units Produced}}{(\text{Machine hrs.}) \times (\text{Machine cost/hr.}) + (\text{Labor hrs.}) \times (\text{Labor cost/hr.})}$$

$$\text{MFP} = \frac{\text{Units Produced}}{(\text{Machine hrs.}) \times (\text{Machine cost/hr.}) + (\text{Labor hrs.}) \times (\text{Labor cost/hr.})}$$

$$= \frac{500}{6 \times \$3 + 26 \times \$8} = 2.21$$

Measuring Productivity

Measure	Outputs	Inputs
Partial	Units or dollars	Units or dollars
Multi-factor	Units or dollars	Dollars
Total	Units or dollars	Dollars

Improving Productivity

- Eliminate bottleneck operations
- Eliminate non-value added steps
- Use improved technology
- Improve quality
  - Less rework
  - More good units produced the first time
  - Productivity should measure number of good units produced the first time

Factors Affecting Industrial Productivity

1. **Technological development:** Technical factors including the degree of mechanization, technical know-how, raw materials, layout and the methods and techniques of work determine the level of technological development in any industry. The principal factors in technological development affecting productivity are:

- ✓The Size of the Plant
- ✓research and development
- ✓Plant and Job layout
- ✓Machine and equipment design
- ✓Production Processes
- ✓Power, raw Materials etc.
- ✓Scientific Management Techniques

Factors Affecting Industrial Productivity…

2. Individual factors*:* Individual factors such as knowledge, skill and attitude also affect the productivity of industry.

3. **Organization factors***:* Organization factors include various steps taken by the organization towards maintaining better industrial relations such as delegation and decentralization of authority, participative management (workers' participation in management), organisational efficiency, proper, personnel policies relating to selection, placement, promotion, wage salary levels, incentives, merit rating, job evaluation, training and provision for two-way communication, supervision, etc.

Factors Affecting Industrial Productivity…

4. Work environment: The importance of proper work environment and physical conditions on the job has been emphasized by industrial psychologists and human engineers.

5. Other factors: There are several other factors that affect productivity. These are:

(a) **Natural factors**:

(b) **Managerial factors**

(c) **government Policy**:

Questions?