

Process Selection and Facility Layout

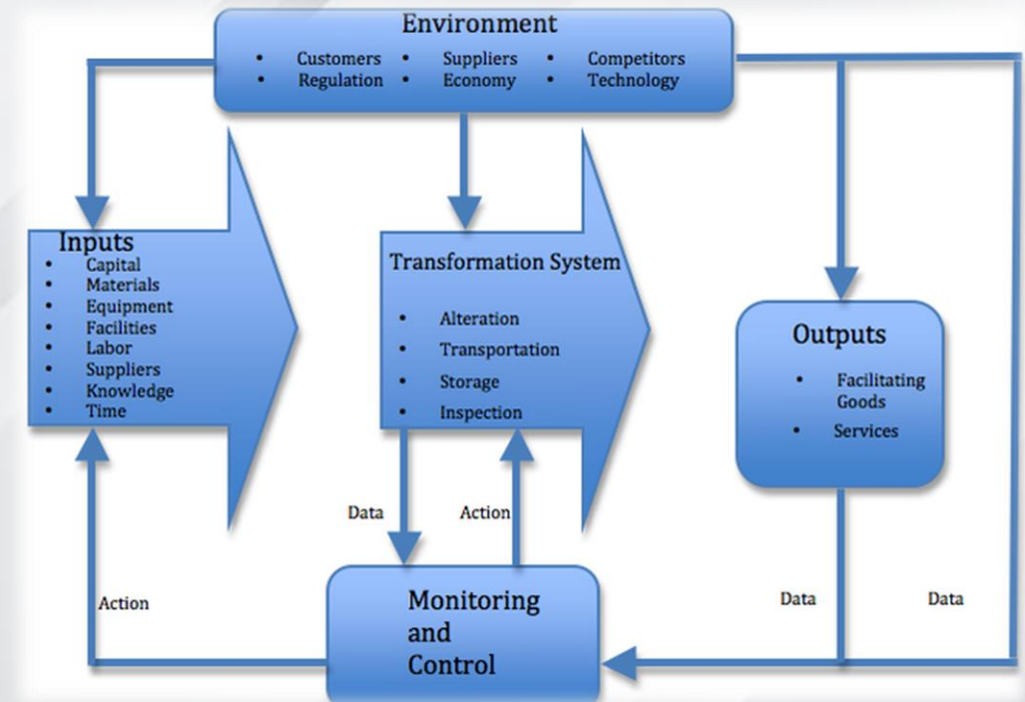
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Lecture 6

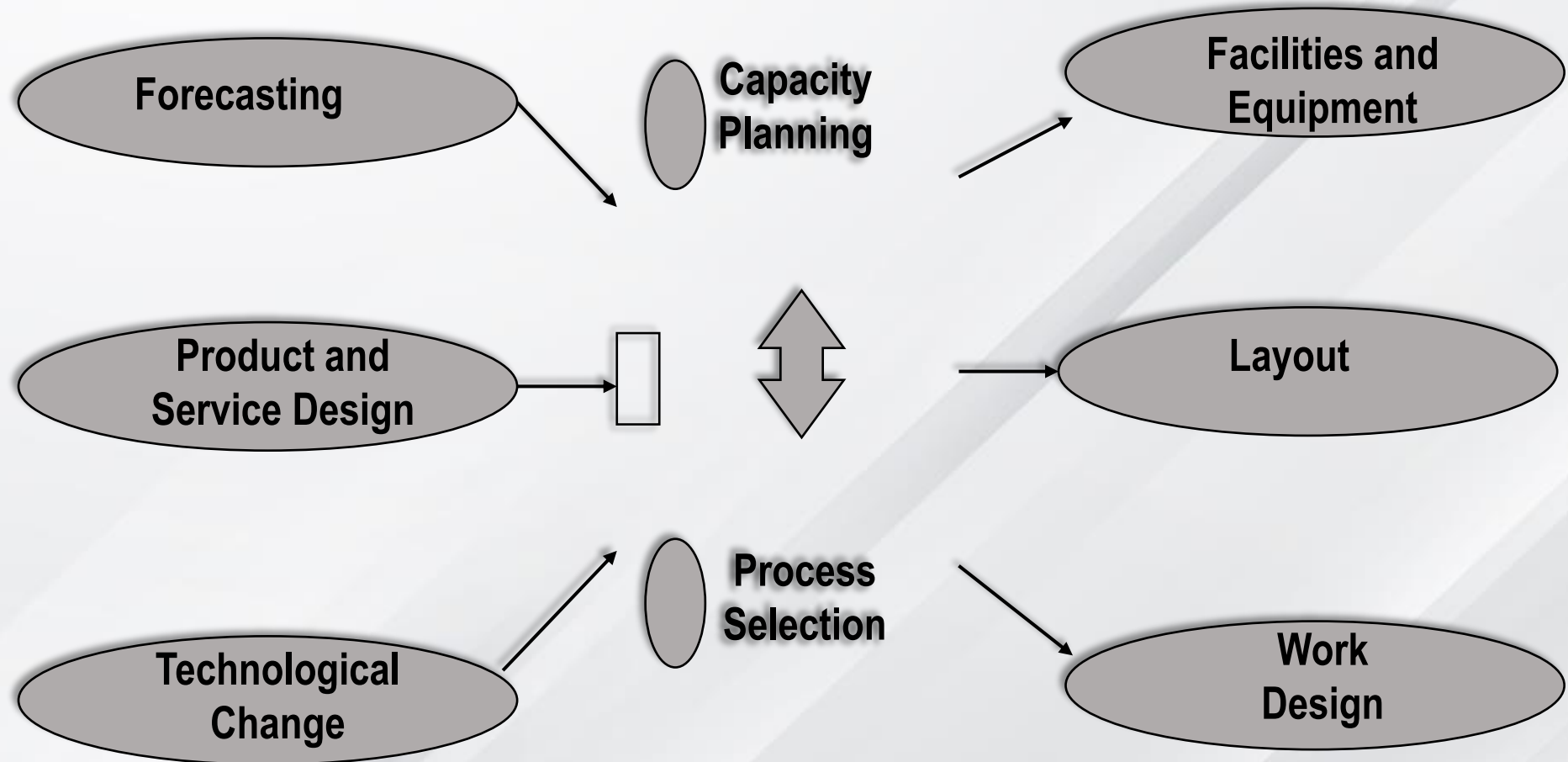


Process Selection

- Process selection
 - Refers to deciding on the way production of goods or services will be organized
 - It has major implications for
 - Capacity planning
 - Layout of facilities
 - Equipment
 - Design of work systems



Process Selection and System Design



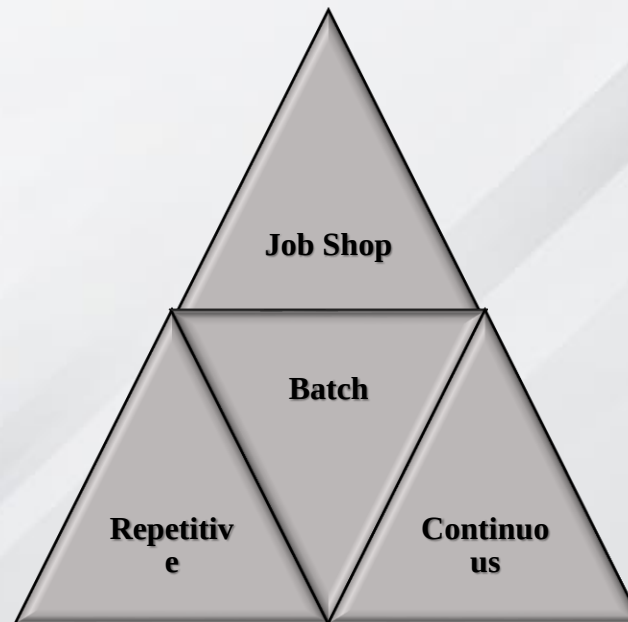
Process Strategy

- Key aspects of process strategy:
 - **Capital intensity**
 - The mix of equipment and labor that will be used by the organization
 - **Process flexibility**
 - The degree to which the system can be adjusted to changes in requirements due to such factors as
 - Product processing and service design changes
 - Volume changes
 - Changes in technology

Process Selection (cont.)

Two key questions in process selection:

1. How much variety will the process need to be able to handle?
2. How much volume will the process need to be able to handle?



Types of Processing

	Job Shop	Batch	Repetitive/ Assembly	Continuous
Description	Customized goods or services	Semi-standardized goods or services	Standardized goods or services	Highly standardized Goods or services
Advantages	Able to handle a wide variety of work	Flexibility; easy to add or change products or services	Low unit cost, high volume, efficient	Very efficient, very high volume
Disadvantages	Slow, high cost per unit, complex planning and scheduling	Moderate cost per unit, moderate scheduling complexity	Low flexibility, high cost of downtime	Very rigid, lack of variety, costly to change, very high cost of downtime

Sustainable Production of Goods and Services

- There is increasing pressure for organizations to operate sustainable production processes
- According to the Lowell Center for Sustainable Production:
 - “Sustainable Production is the creation of goods and services using processes and systems that are: non-polluting; conserving of energy and natural resources; economically efficient; safe and healthful for workers, communities, and consumers; and socially and creatively rewarding for all working people.”

Sustainable Production of Goods and Services (cont.)

- Reduce/recycle waste and ecologically incompatible parts and byproducts
- Eliminate hazardous chemicals/physical agents
- Conserve energy and materials
- Redesign workspace to minimize hazards to the workers and the environment

Process and Information Technology

- Process and information technology can have a major impact on costs, productivity and competitiveness:
 - **Process technology**
 - Methods, procedures, and equipment used to produce goods and provide services
 - **Information technology**
 - The science and use of computers and other electronic equipment to store, process, and send information

The Need to Manage Technology

- Process technology and information technology can have a profound impact on:
 - Costs
 - Productivity
 - Competitiveness



Automation

- **Automation**

- Machinery that has sensing and control devices that enable it to operate automatically
 - Fixed automation
 - Programmable automation
 - Flexible automation



Programmable Automation

Involves the use of high-cost, general-purpose equipment controlled by a computer program that provides both the sequence of operations and specific details about each operation

- **Computer-Aided Manufacturing (CAM)**
 - The use of computers in process control, ranging from robots to automated quality control
- **Numerically Controlled (N/C) Machines**
 - Machines that perform operations by following mathematical processing instructions
- **Robot**
 - A machine consisting of a mechanical arm, a power supply, and a controller

Various types of Robots

- Robots that follow a fixed set of instructions
- Programmable robots
 - Repeat a set of movements after being led through a sequence
 - Follow instructions from a computer
- Collaborative robots, also known as cobots

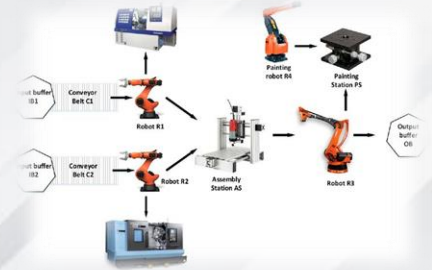


Flexible Automation

Evolved from programmable automation. It uses equipment that is more customized than that of programmable automation. A key difference between the two is that flexible automation requires significantly less changeover time.

- **FMS (Flexible Manufacturing System)**
 - A group of machines designed to handle intermittent processing requirements and produce a variety of similar products
- **CIM (Computer Integrated Manufacturing)**
 - A system for linking a broad range of manufacturing activities through an integrated computer system

Flexible Manufacturing System (FMS)



- A group of machines designed to handle intermittent processing requirements and produce a variety of similar products
 - Have some of the benefits of automation and some of the flexibility of individual, or stand-alone, machines
 - Includes supervisory computer control, automatic material handling, and robots or other automated processing equipment

Computer Integrated Manufacturing (CIM)

- A system for linking a broad range of manufacturing activities through an integrated computer system
 - Activities include
 - Engineering design
 - FMS
 - Purchasing
 - Order processing
 - Production planning and control
- The overall goal of CIM is to link various parts of an organization to achieve rapid response to customer orders and/or product changes, to allow rapid production, and to reduce indirect labor costs
- Internet of Things (IoT) further enhances connectivity of devices through internet

Facilities Layout

- **Layout**

- The configuration of departments, work centers, and equipment, with particular emphasis on movement of work (customers or materials) through the system
- Facilities layout decisions arise when:
 - Designing new facilities
 - Re-designing existing facilities



The Need for Layout Planning

- Inefficient operations
 - High cost
 - Bottlenecks
- Accidents or safety hazards
- Changes in product or service design
- Introduction of new products or services
- Changes in output volume or product mix
- Changes in methods or equipment
- Changes in environmental or other legal requirements
- Morale problems



Layout Design Objectives

- **Basic objective**

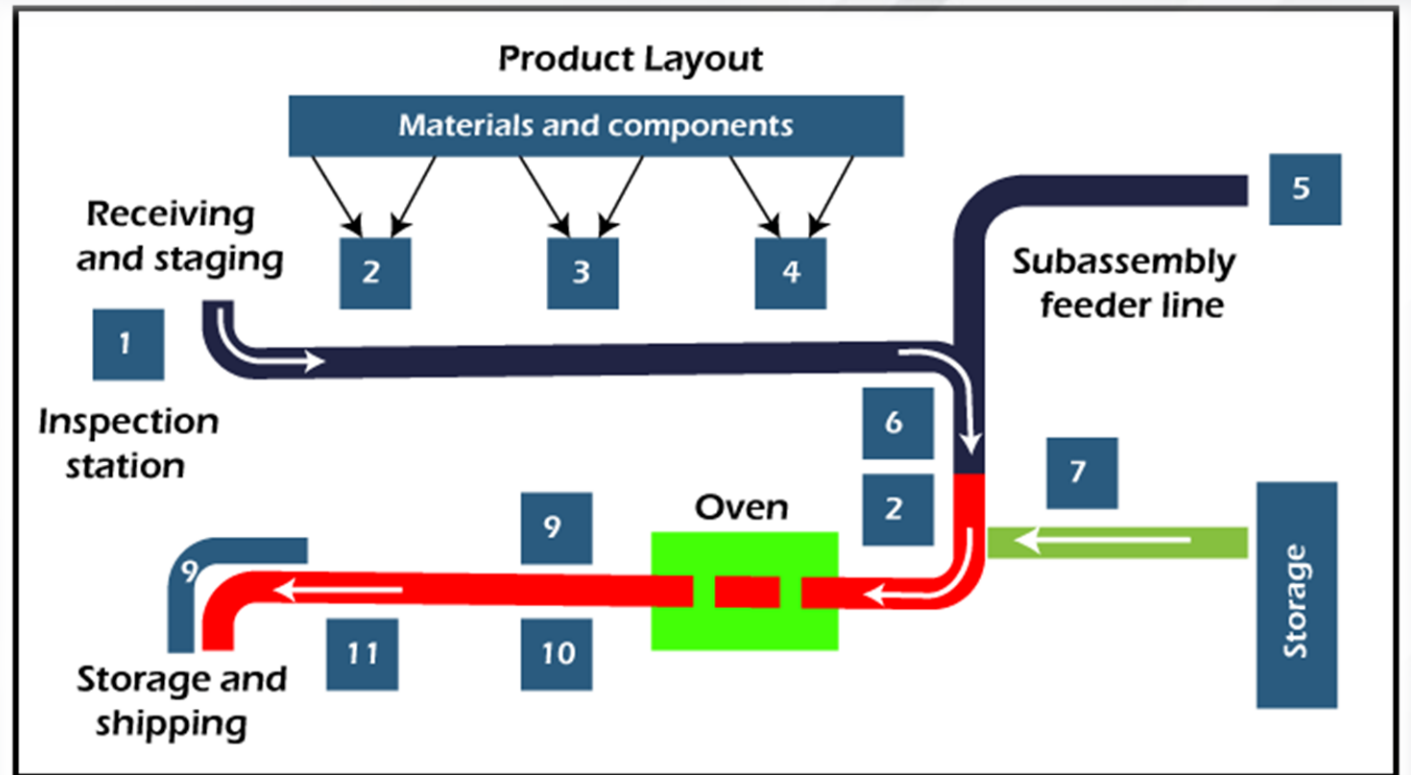
- Facilitate a smooth flow of work, material, and information through the system

- **Supporting objectives**

- Facilitate product or service quality
- Use workers and space efficiently
- Avoid bottlenecks
- Minimize material handling costs
- Eliminate unnecessary movement of workers or material
- Minimize production time or customer service time
- Design for safety

Basic Layout Types

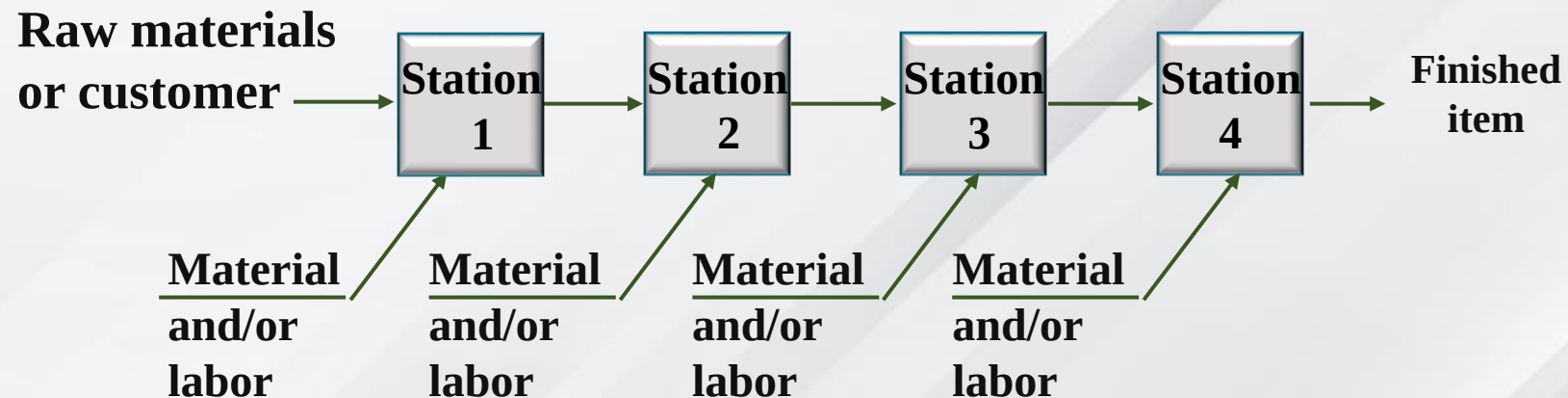
- Product layouts
- Process layouts
- Fixed-position layout
- Combination layouts



Repetitive Processing: Product Layouts

- **Product layout**

- Layout that uses standardized processing operations to achieve smooth, rapid, high-volume flow



Used for Repetitive Processing
Repetitive or Continuous

Process Types



Ingram Publishing

A job shop



Don Tremain/Getty Images

A batch process



Glow Images

A repetitive process



vichie81/123RF

A continuous process

Product Layouts: Advantages

Advantages

- High rate of output
- Low unit cost
- Labor specialization
- Low material handling cost per unit
- High utilization of labor and equipment
- Established routing and scheduling
- Routine accounting, purchasing, and inventory control



Product Layouts: Disadvantages

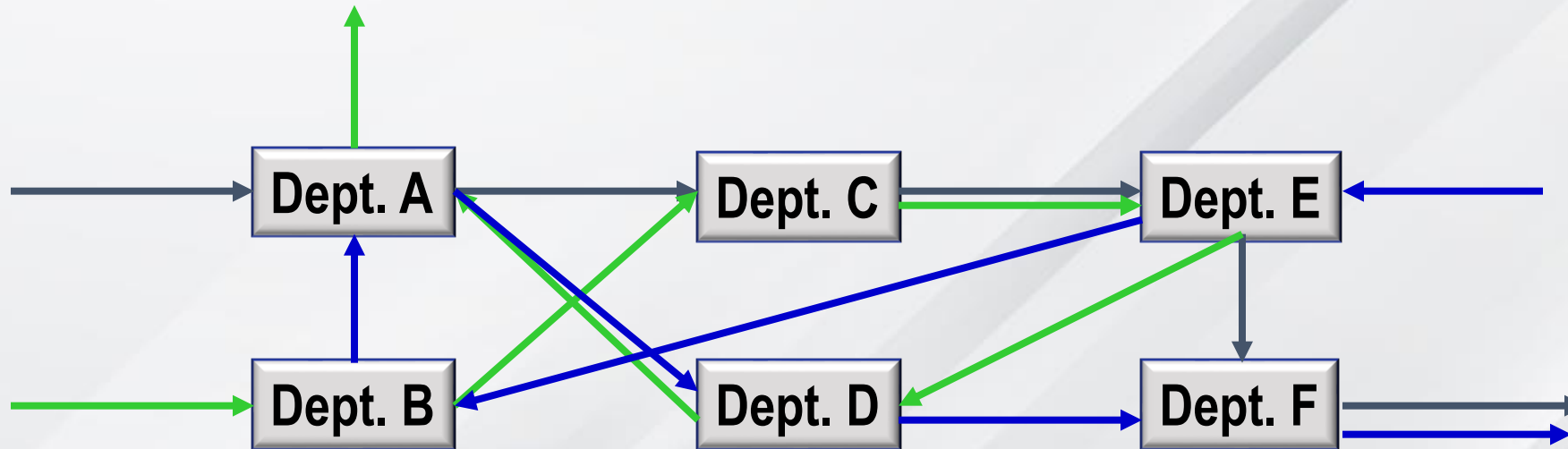
Disadvantages

- Creates dull, repetitive jobs
- Poorly skilled workers may not maintain equipment or quality of output
- Fairly inflexible to changes in volume or product or process design
- Highly susceptible to shutdowns
- Preventive maintenance, capacity for quick repair, and spare-parts inventories are necessary expenses
- Individual incentive plans are impractical
- Right-sized equipment tends to be larger than equipment used in untraditional process layouts



Non-repetitive Processing: Process Layouts

- **Process layouts**
 - Layouts that can handle varied processing requirements



**Used for Intermittent processing
Job Shop or Batch**

Process Layouts: Advantages (cont.)

Advantages

- Can handle a variety of processing requirements
- Not particularly vulnerable to equipment failures
- General-purpose equipment is often less costly and easier to maintain
- It is possible to use individual incentive systems

Process Layouts: Disadvantages (cont.)

- In-process inventories can be high
- Routing and scheduling pose continual challenges
- Equipment utilization rates are low
- Material handling is slow and inefficient
- Reduced spans of supervision
- Special attention necessary for each product or customer
- Accounting, inventory control, and purchasing are more involved

Fixed Position Layouts

- **Fixed position layout**
 - Layout in which the product or project remains stationary, and workers, materials, and equipment are moved as needed
 - Large construction projects
 - Shipbuilding/aircraft manufacturing
 - Space mission

Combination Layouts

- Some operational environments use a combination of the three basic layout types:
 - Hospitals
 - Supermarket
 - Shipyards
- Some organizations are moving away from process layouts to capture the benefits of product layouts
 - Cellular manufacturing
 - Flexible manufacturing systems

Cellular Layouts

- Cellular production
 - Layout in which workstations are grouped into a cell that can process items that have similar processing requirements
 - Groupings are determined by the operations needed to perform the work for a set of similar items, *part families*, that require similar processing
 - The cells become, in effect, miniature versions of product layouts
 - Enables companies to produce a variety of products with very little waste

Group Technology

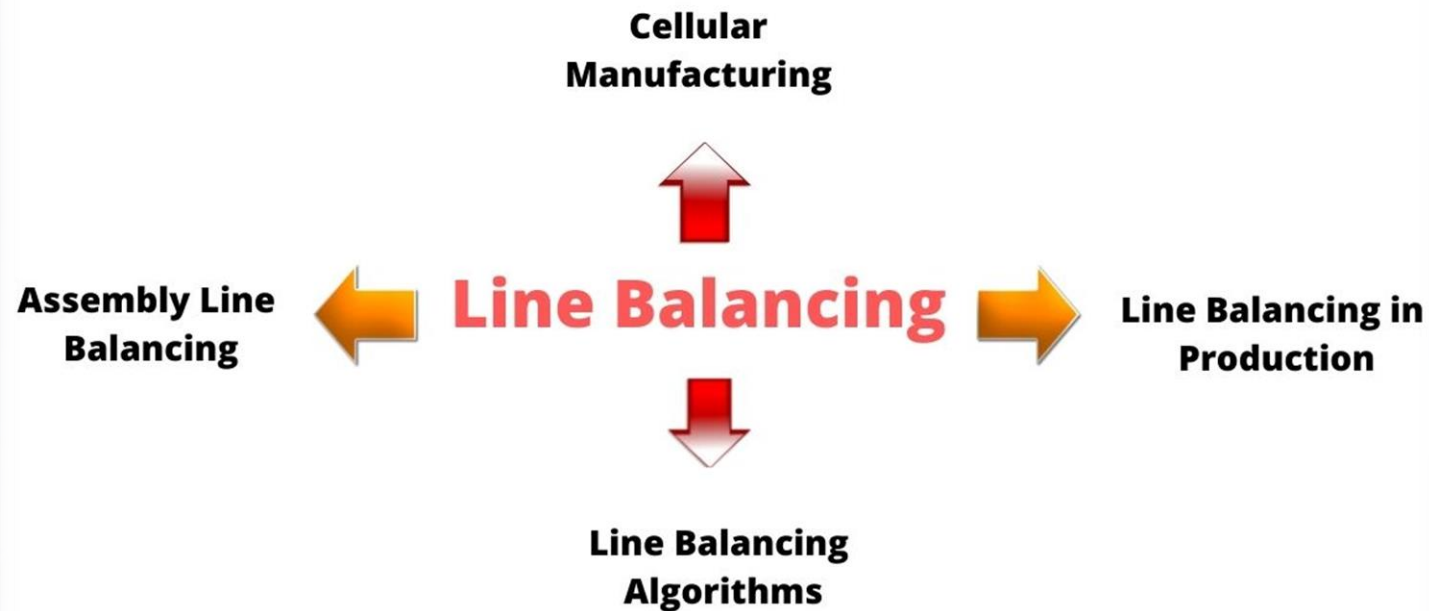
- The grouping into part families of items with similar design or manufacturing characteristics
 - Design characteristics:
 - Size
 - Shape
 - Function
 - Manufacturing or processing characteristics
 - Type of operations required
 - Sequence of operations required
- Requires a systematic analysis of parts to identify the part families

Service Layouts

- Service layouts can be categorized as: product, process, or fixed position
- Service layout requirements are somewhat different due to such factors as:
 - Degree of customer contact
 - Degree of customization
- Common service layouts:
 - Warehouse and storage layouts – minimize item movement
 - Retail layouts – influence customers into buying more
 - Office layouts – increase employee interactions

Designing Product Layouts: Line Balancing

- The goal of a product layout is to arrange workers or machines in the sequence that operations need to be performed



Line Balancing

The process of assigning tasks to workstations in such a way that the workstations have approximately equal time requirements

- Goal:
 - Obtain task grouping that represents approximately equal time requirements, since this minimizes idle time along the line and results in a high utilization of equipment and labor
- Why is line balancing important?
 1. It allows us to use labor and equipment more efficiently
 2. To avoid fairness issues that arise when one workstation must work harder than another

Cycle Time

- **Cycle time**

- The maximum time allowed at each workstation to complete its set of tasks on a unit
- Cycle time also establishes the output rate of a line

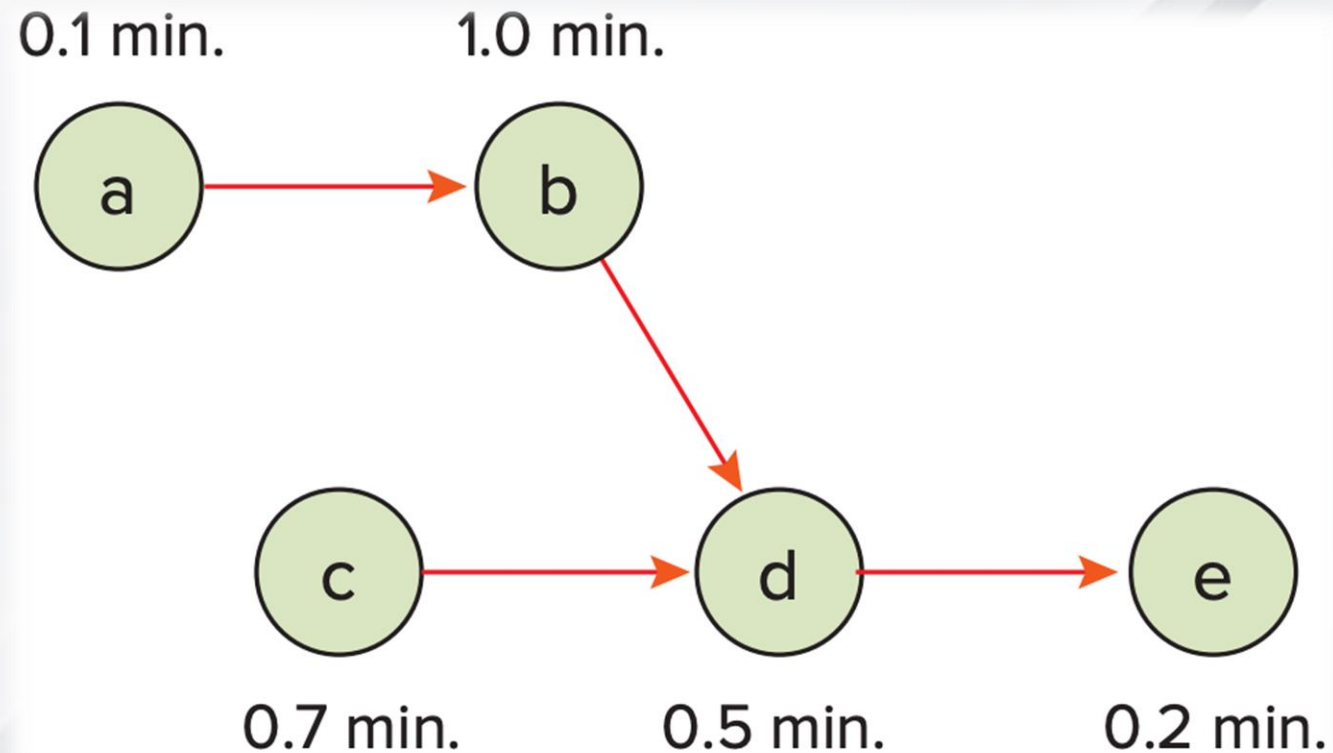
$$\text{Cycle time} = \frac{\text{Operating time per day}}{\text{Desired output rate}}$$

$$\text{Output rate} = \frac{\text{Operating time per day}}{\text{Cycle time}}$$

Precedence Diagram

- **Precedence diagram**

- A diagram that shows elemental tasks and their precedence requirements



Assigning Tasks to Workstations

- Some heuristic (intuitive) rules:
 - Assign tasks in order of *most following tasks*
 - Count the number of tasks that follow
 - Assign tasks in order of *greatest positional weight*
 - Positional weight is the sum of each task's time and the times of all following tasks

Designing Process Layouts

- The main issue in designing process layouts concerns the relative placement of the departments
- Measuring effectiveness
 - A major objective in designing process layouts is to minimize transportation cost, distance, or time

Information Requirements

- In designing process layouts, the following information is required:
 1. A list of departments to be arranged and their dimensions
 2. A projection of future workflows between the pairs of work centers
 3. The distance between locations and the cost per unit of distance to move loads between them
 4. The amount of money to be invested in the layout
 5. A list of any special considerations
 6. The location of key utilities, access and exit points, etc.



Thank You