جلسه دوم: مقدمات و انواع سیستم های تولیدی

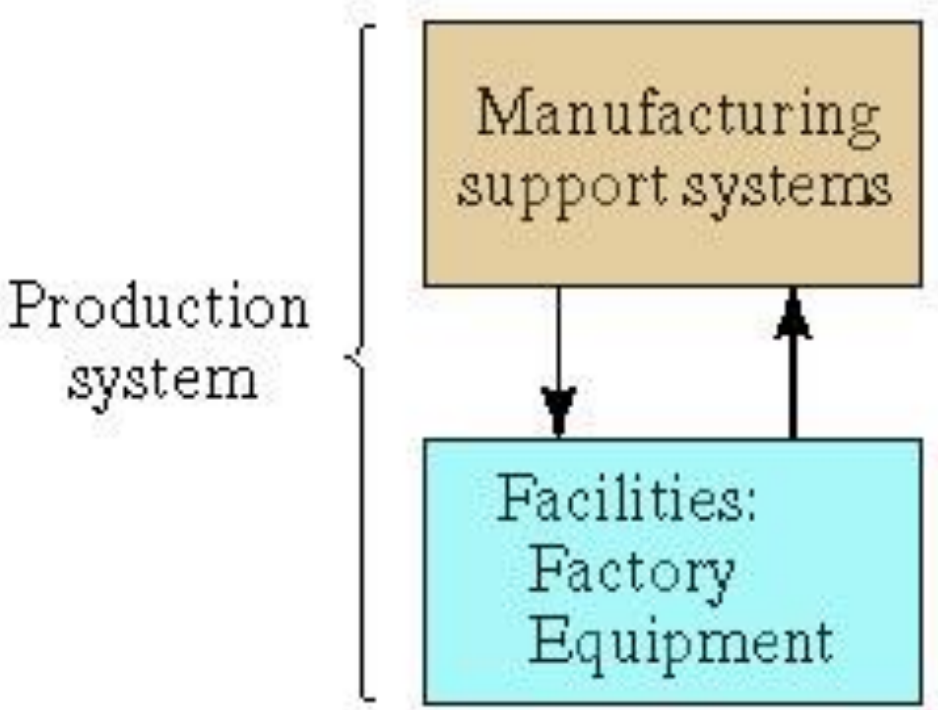
Production System Defined

Production System: A collection of people, equipment, and procedures organized to accomplish the manufacturing operations of a company

Two categories:

- *Facilities* – the factory and equipment in the facility and the way the facility is organized (plant layout)
- *Manufacturing support systems* – the set of procedures used by a company to manage production and to solve technical and logistics problems in ordering materials, moving work through the factory, and ensuring that products meet quality standards

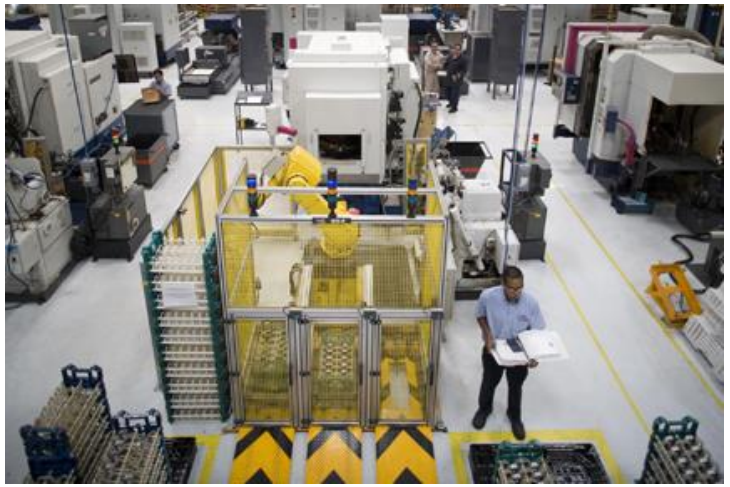
The Production System



Production System Facilities

Facilities include the factory, production machines and tooling, material handling equipment, inspection equipment, and computer systems that control the manufacturing operations

- *Plant layout* – the way the equipment is physically arranged in the factory
- *Manufacturing systems* – logical groupings of equipment and workers in the factory
  - Production line
  - Stand-alone workstation and worker

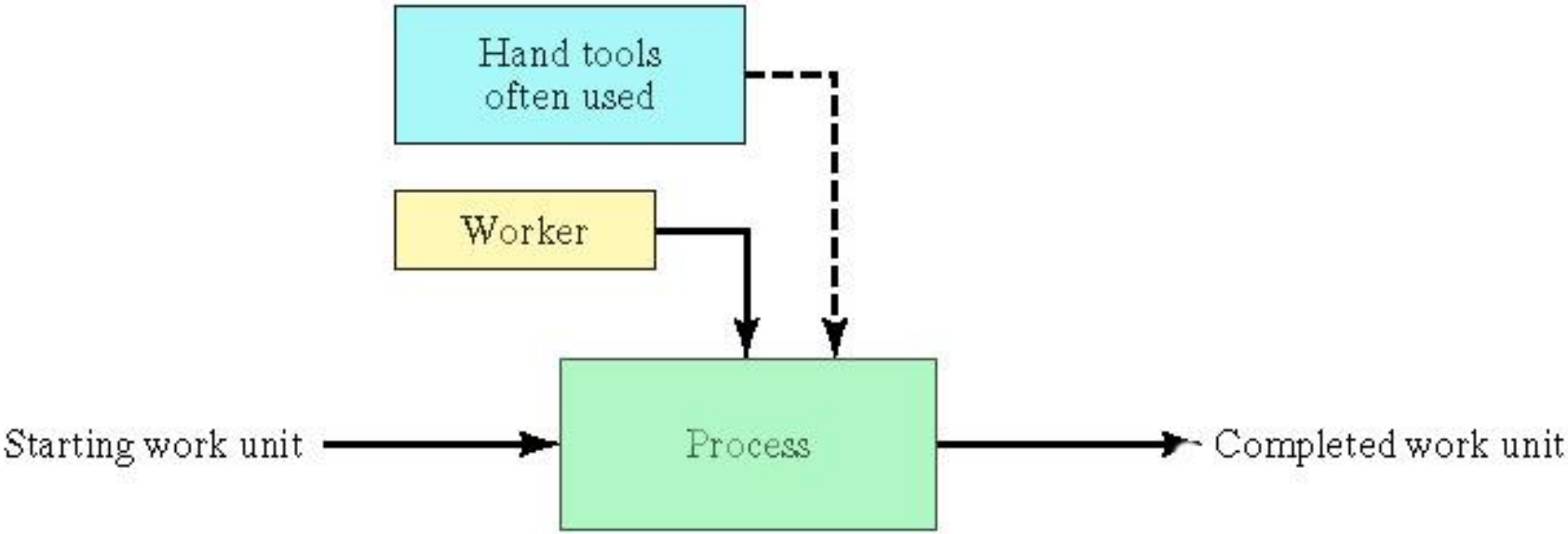


Manufacturing Systems

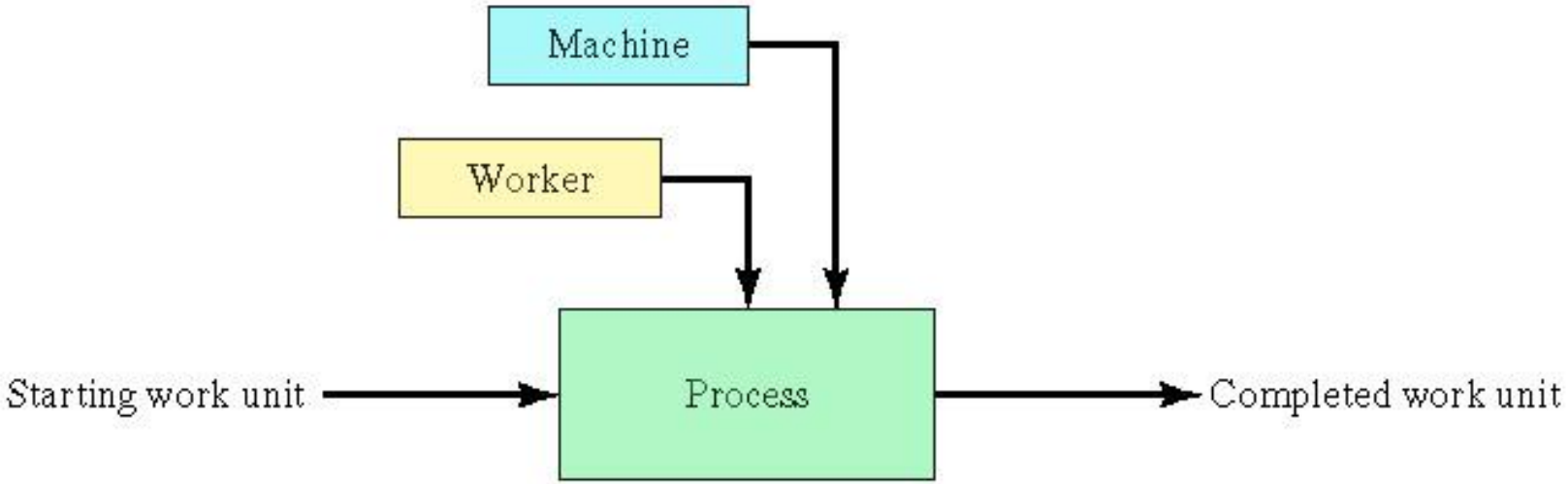
Three categories in terms of the human participation in the processes performed by the manufacturing system:

1. *Manual work systems* - a worker performing one or more tasks without the aid of powered tools, but sometimes using hand tools
2. *Worker-machine systems* - a worker operating powered equipment
3. *Automated systems* - a process performed by a machine without direct participation of a human

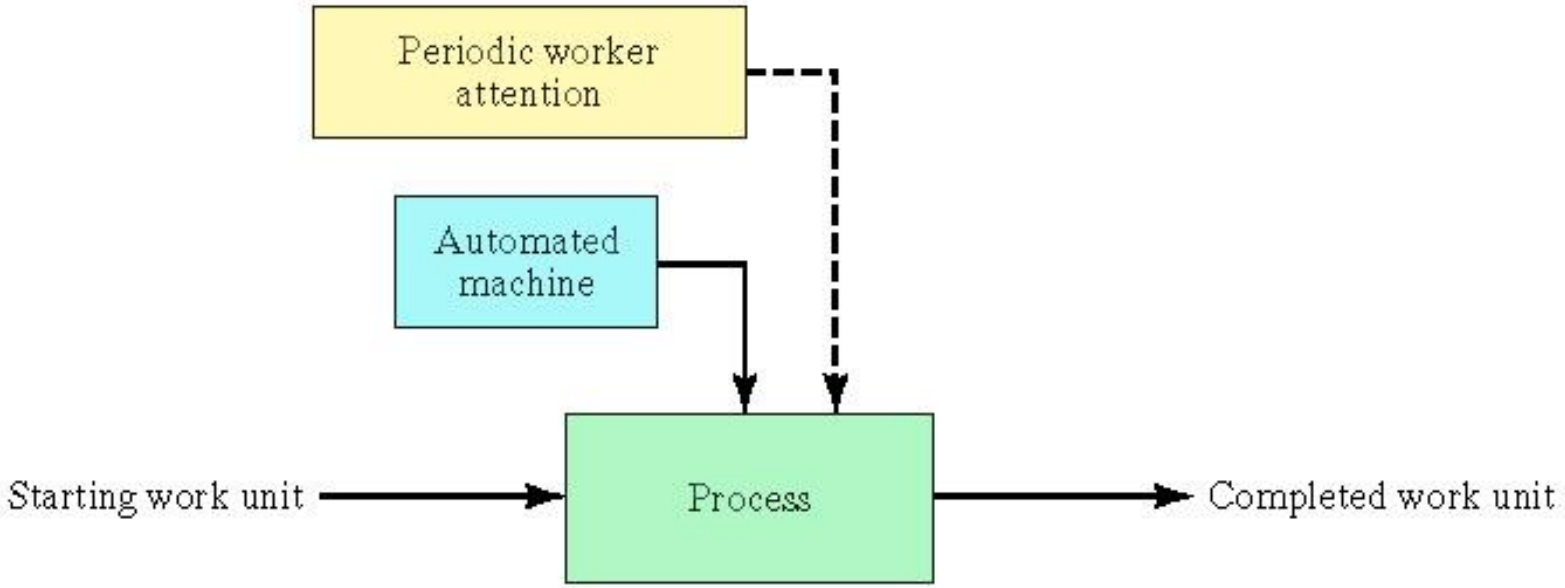
Manual Work System



Worker-Machine System



Automated System



Production Quantity

Number of units of a given part or product produced annually by the plant

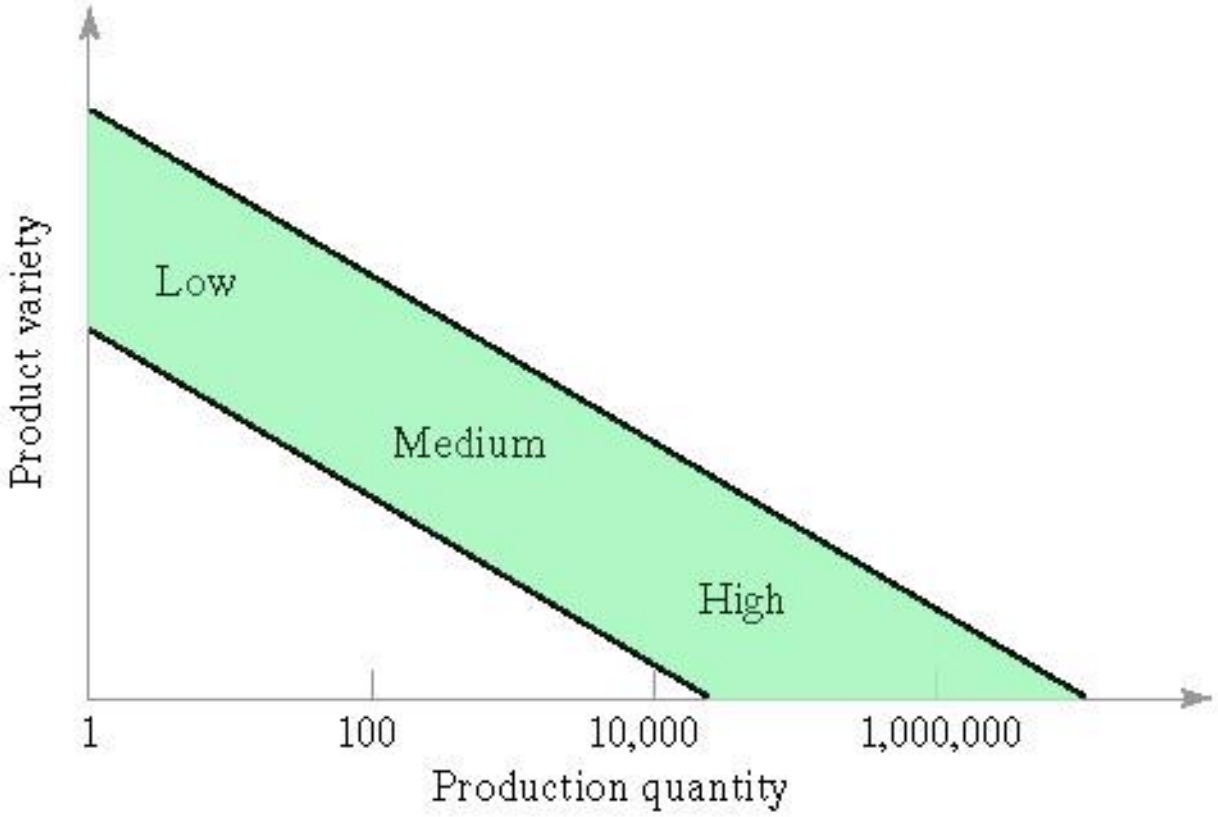
- Three quantity ranges:
  1. Low production – 1 to 100 units
  2. Medium production – 100 to 10,000 units
  3. High production – 10,000 to millions of units

Product Variety

Refers to the number of different product or part designs or types produced in the plant

- Inverse relationship between production quantity and product variety in factory operations
- Product variety is more complicated than a number
  - Hard product variety – products differ greatly
    - Few common components in an assembly
  - Soft product variety – small differences between products
    - Many common components in an assembly

Product Variety vs. Production Quantity

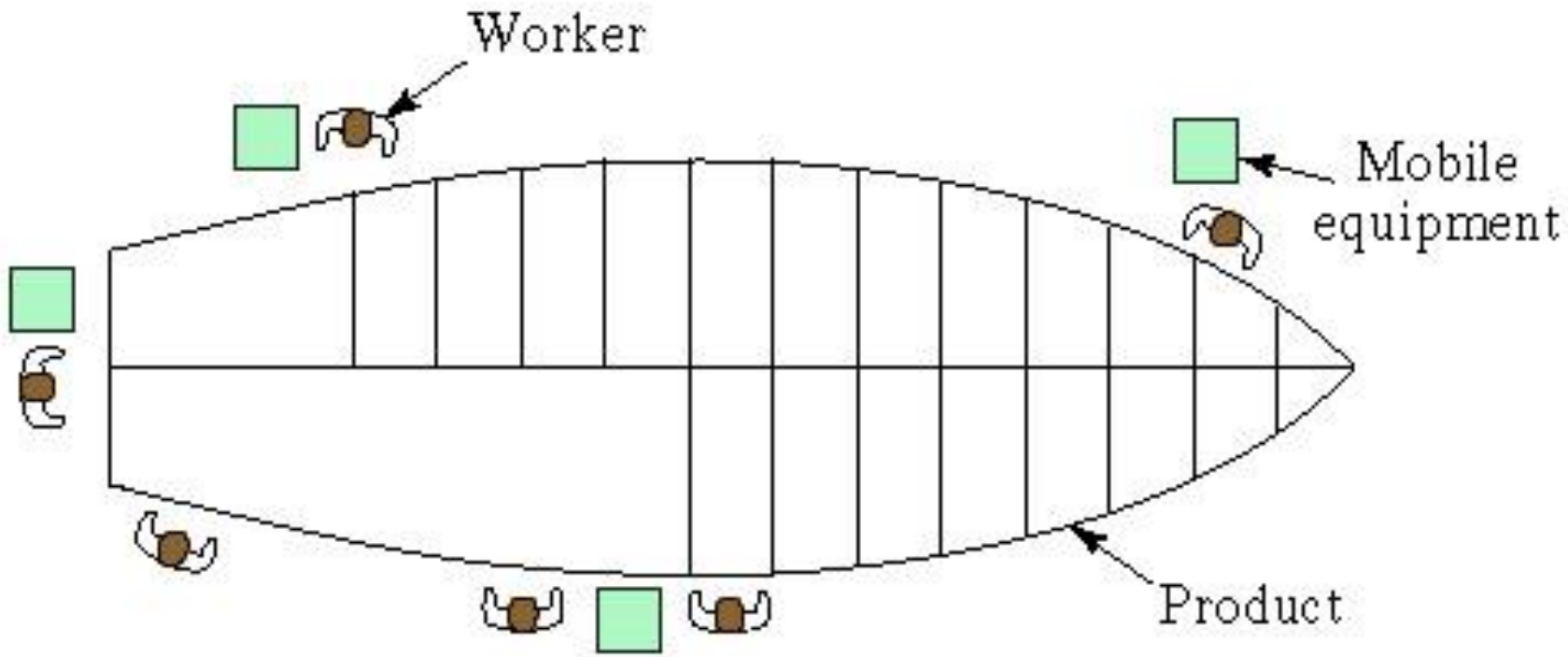


Low Production Quantity

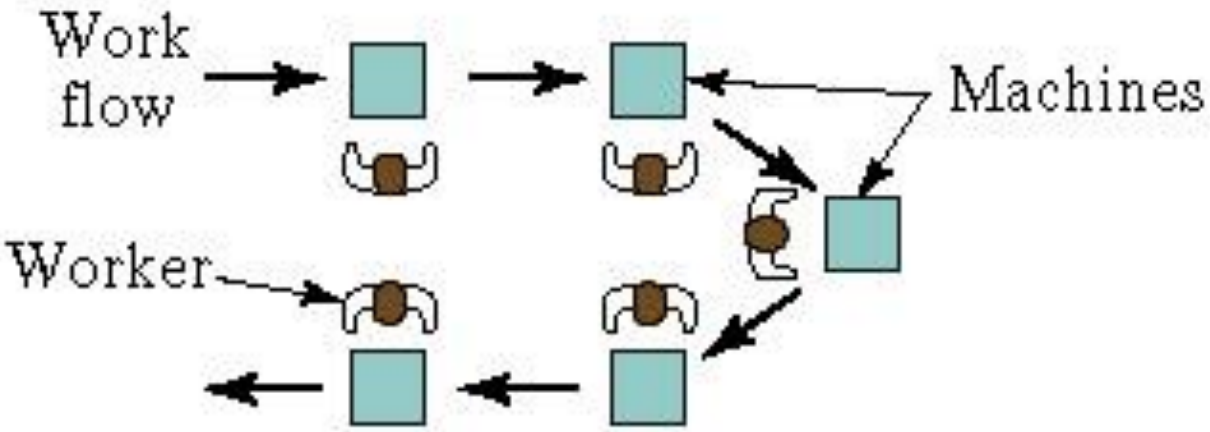
Job shop – makes low quantities of specialized and customized products

- Also includes production of components for these products
- Products are typically complex (e.g., specialized machinery, prototypes, space capsules)
- Equipment is general purpose
- Plant layouts:
  - Fixed position
  - Process layout

Fixed-Position Layout



Process Layout



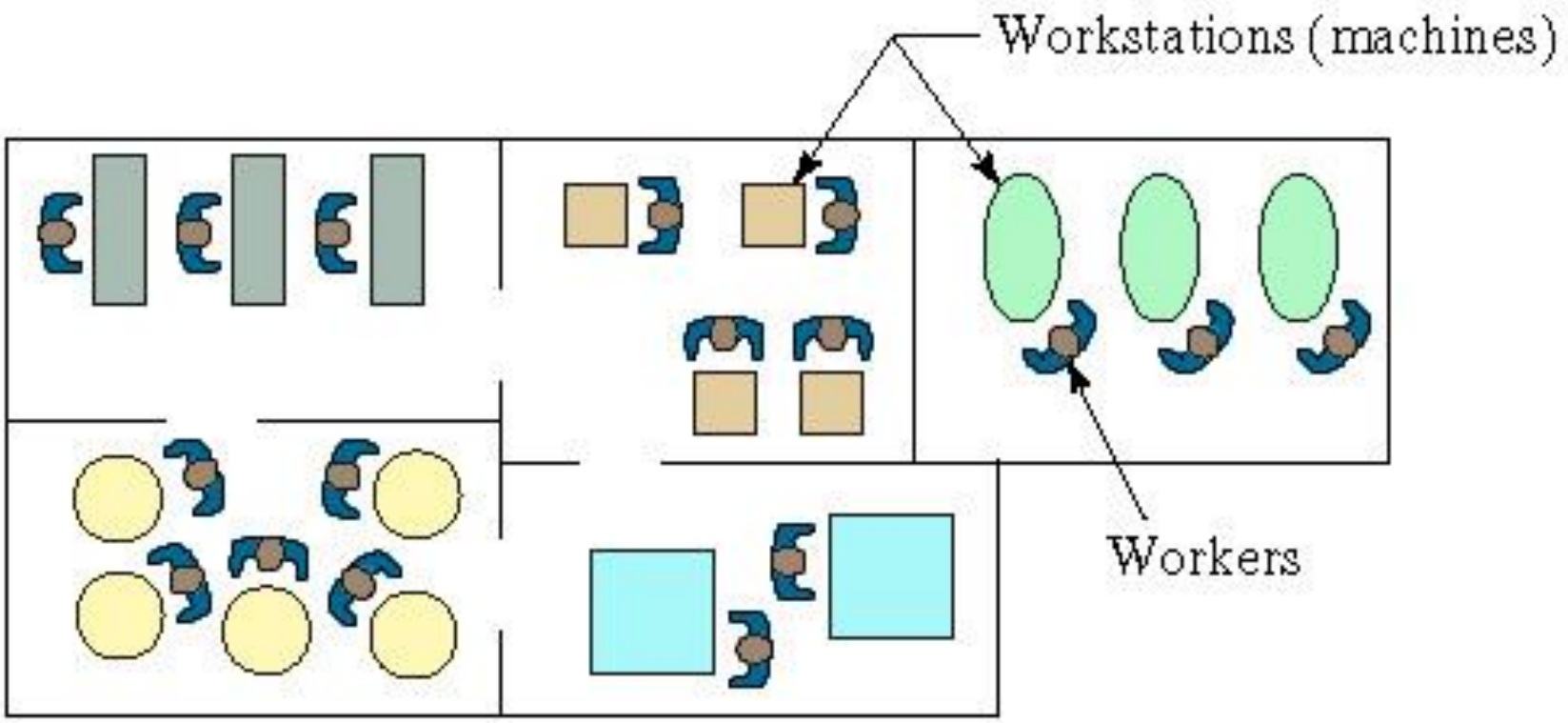
Job shop Production example

Medium Production Quantities

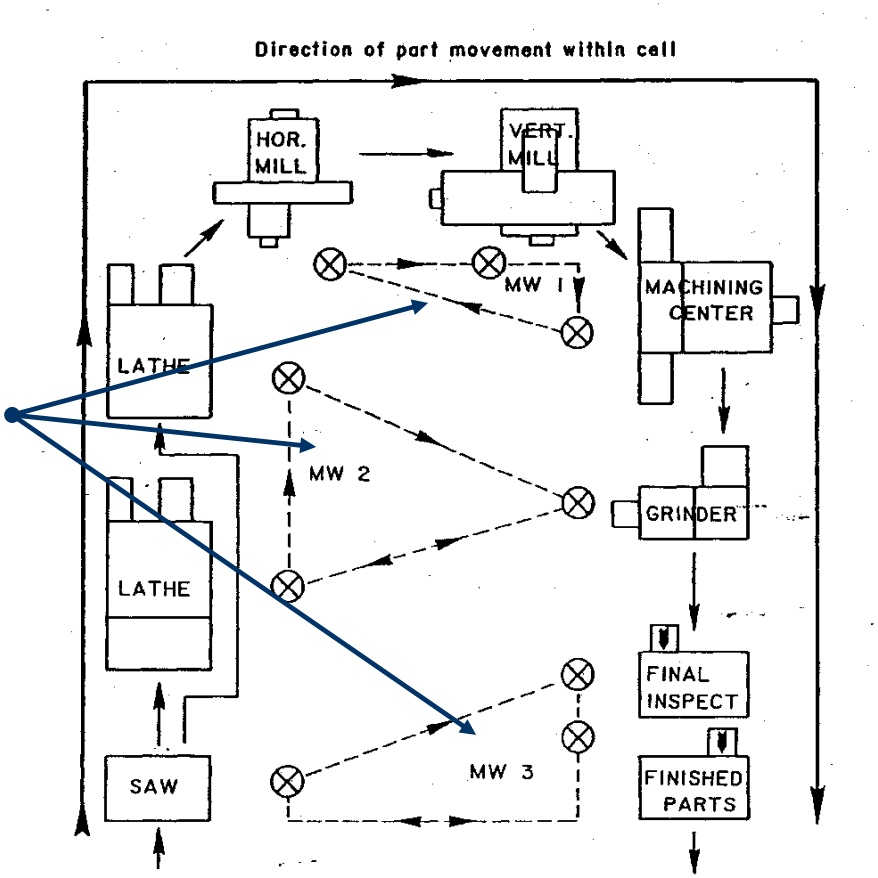
1. Batch production – A batch of a given product is produced, and then the facility is changed over to produce another product
   - Changeover takes time – setup time
   - Typical layout – process layout
   - Hard product variety
2. Cellular manufacturing – A mixture of products is made without significant changeover time between products
   - Typical layout – cellular layout
   - Soft product variety

Batch Production example

Cellular Layout



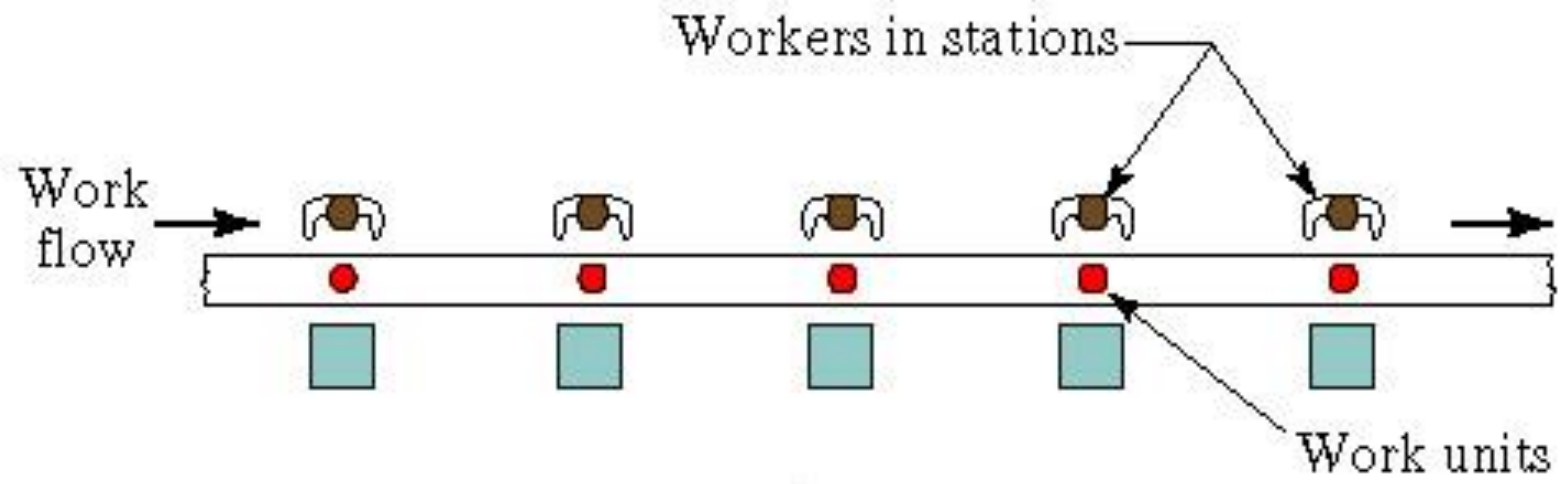
Notice MW or ‘multi-functional’ workers – this team is responsible for all production within their cell



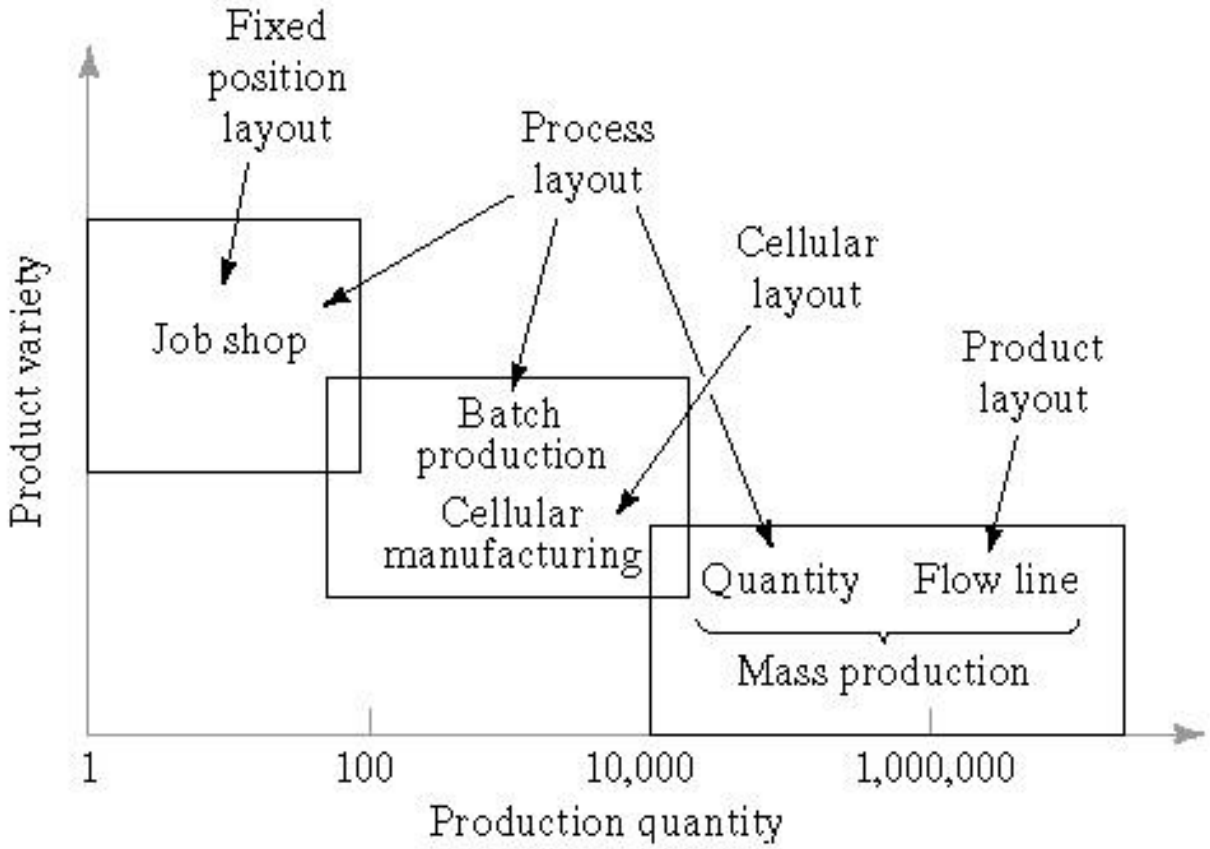
High Production

1. Quantity production – Equipment is dedicated to the manufacture of one product
   - Standard machines tooled for high production (e.g., stamping presses, molding machines)
   - Typical layout – process layout
2. Flow line production – Multiple workstations arranged in sequence
   - Product requires multiple processing or assembly steps
   - Product layout is most common

Product Layout



Relationships between Plant Layout and Type of Production Facility

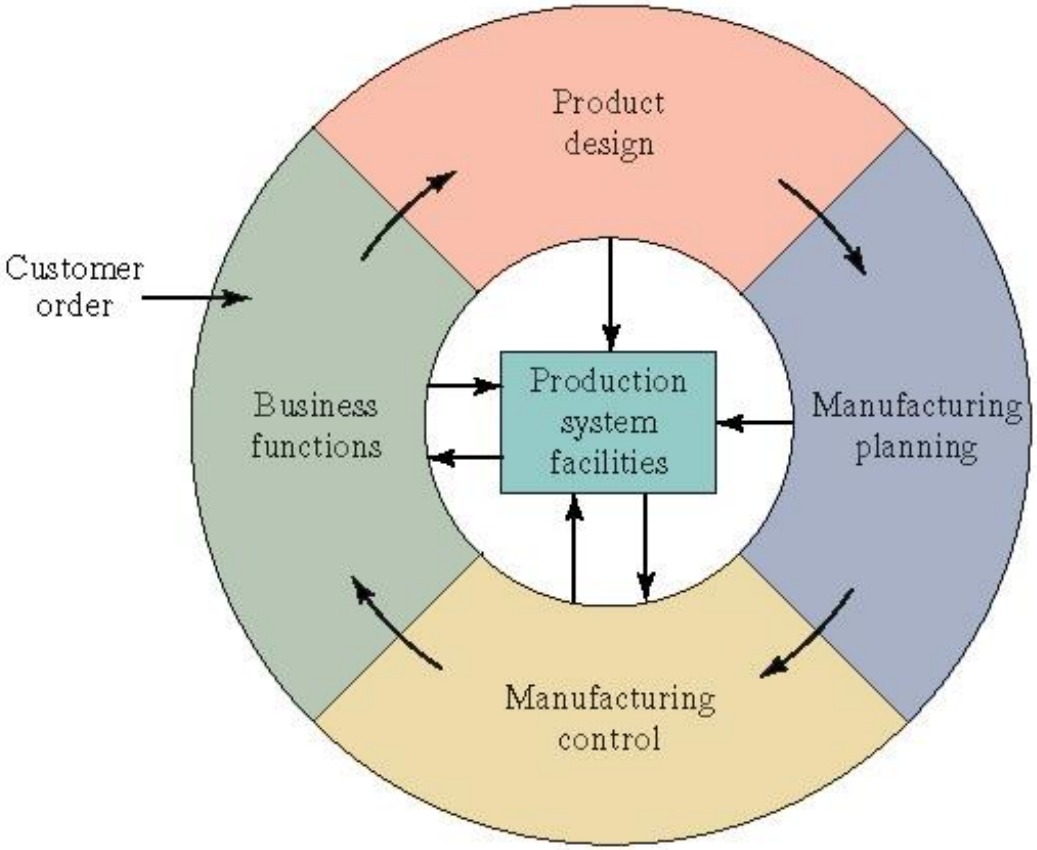


Manufacturing Support Systems

Involves a cycle of information-processing activities that consists of four functions:

1. Business functions - sales and marketing, order entry, cost accounting, customer billing
2. Product design - research and development, design engineering, prototype shop
3. Manufacturing planning - process planning, production planning, Material requirements planning (MRP), capacity planning
4. Manufacturing control - shop floor control, inventory control, quality control

Information Processing Cycle in Manufacturing Support Systems



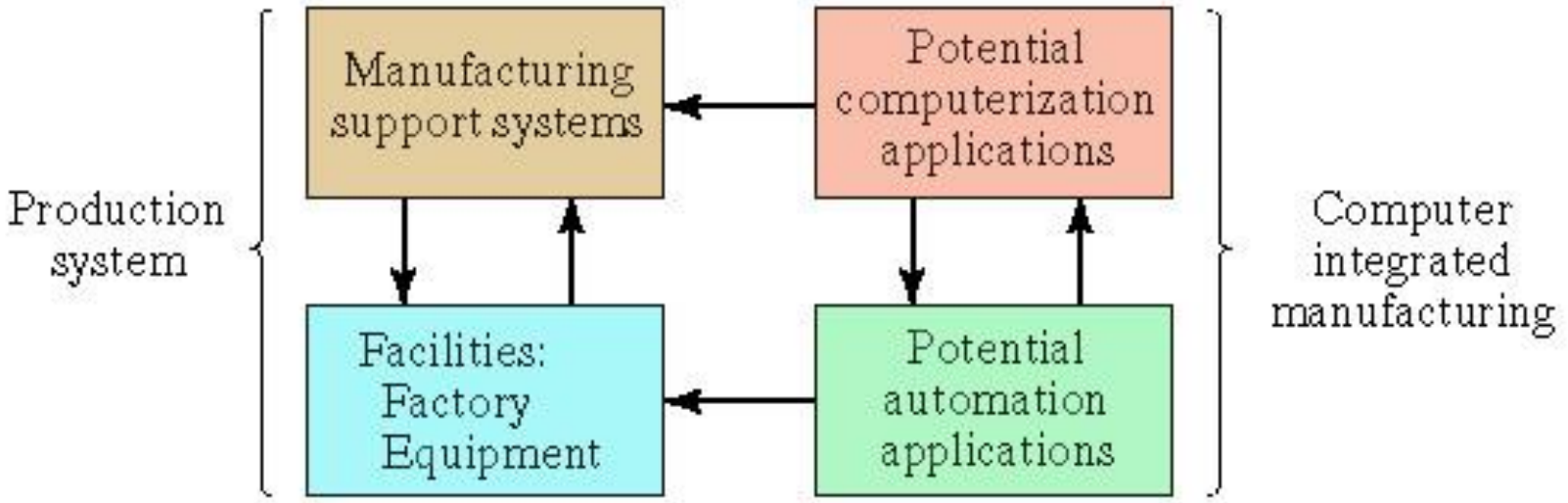
Automation in Production Systems

Two categories of automation in the production system:

1. Automation of manufacturing systems in the factory
2. Computerization of the manufacturing support systems

- The two categories overlap because manufacturing support systems are connected to the factory manufacturing systems
  - Computer-Integrated Manufacturing (CIM)

Computer Integrated Manufacturing



Opportunities of automation and computerization in a production system

Automated Manufacturing Systems

Examples:

- Automated machine tools
- Transfer lines
- Automated assembly systems
- Industrial robots that perform processing or assembly operations
- Automated material handling and storage systems to integrate manufacturing operations
- Automatic inspection systems for quality control

Automated Manufacturing Systems

Three basic types:

1. Fixed automation
2. Programmable automation
3. Flexible automation

Fixed Automation

A manufacturing system in which the sequence of processing (or assembly) operations is fixed by the equipment configuration

Typical features:

- Suited to high production quantities
- High initial investment for custom-engineered equipment
- High production rates
- Relatively inflexible in accommodating product variety

Programmable Automation

A manufacturing system designed with the capability to change the sequence of operations to accommodate different product configurations

Typical features:

- High investment in general purpose equipment
- Lower production rates than fixed automation
- Flexibility to deal with variations and changes in product configuration
- Most suitable for batch production
- Physical setup and part program must be changed between jobs (batches)

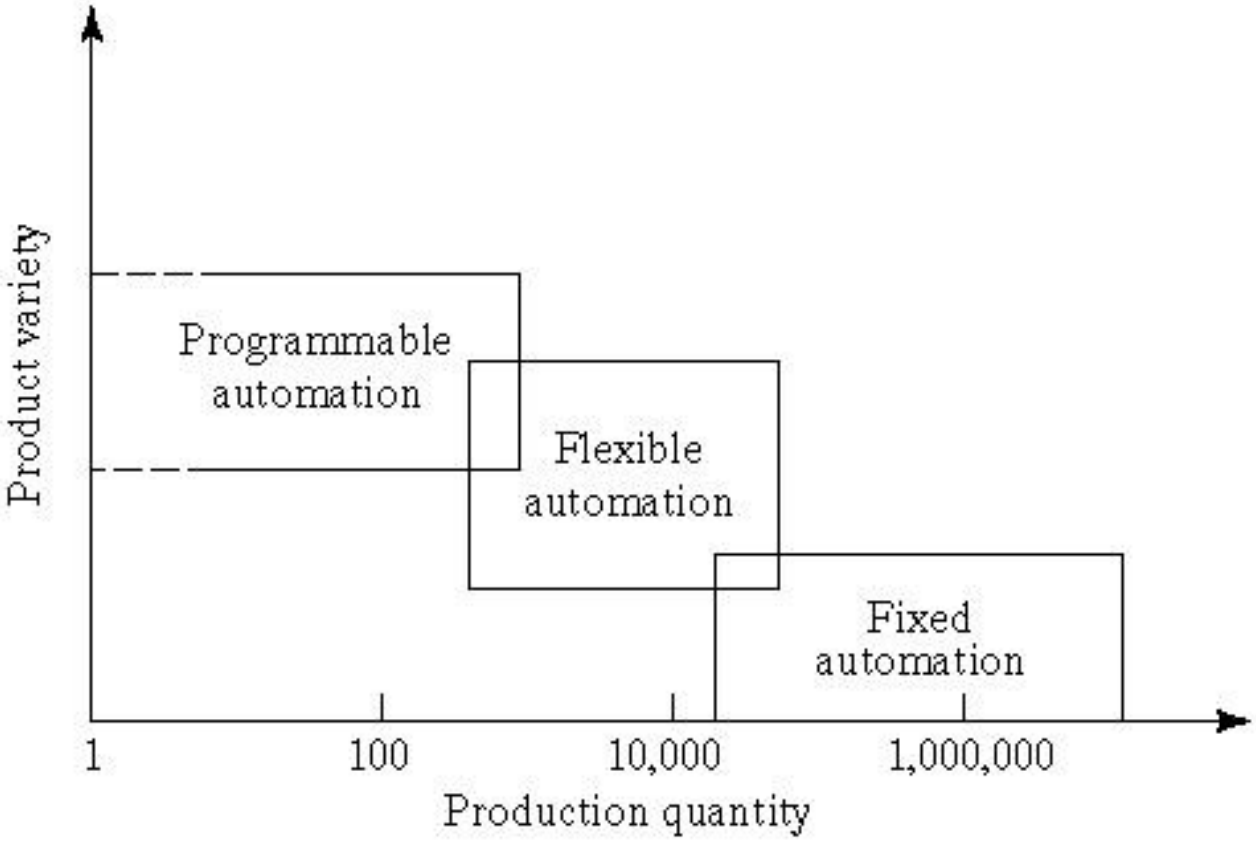
Flexible Automation

An extension of programmable automation in which the system is capable of changing over from one job to the next with no lost time between jobs

Typical features:

- High investment for custom-engineered system
- Continuous production of variable mixes of products
- Medium production rates
- Flexibility to deal with soft product variety

Product Variety and Production Quantity for Three Automation Types



Computerized Manufacturing Support Systems

Objectives of automating the manufacturing support systems:

- To reduce the amount of manual and clerical effort in product design, manufacturing planning and control, and the business functions
- Integrates computer-aided design (CAD) and computer-aided manufacturing (CAM) in CAD/CAM
- CIM includes CAD/CAM and the business functions of the firm

Reasons for Automating

1. To increase labor productivity
2. To reduce labor cost
3. To mitigate the effects of labor shortages
4. To reduce or remove routine manual and clerical tasks
5. To improve worker safety
6. To improve product quality
7. To reduce manufacturing lead time
8. To accomplish what cannot be done manually
9. To avoid the high cost of not automating

Manual Labor in Production Systems

Is there a place for manual labor in the modern production system?

- Answer: YES

- Two aspects:
  1. Manual labor in factory operations
  2. Labor in manufacturing support systems

Manual Labor in Factory Operations

The long term trend is toward greater use of automated systems to substitute for manual labor

- When is manual labor justified?
  - Some countries have very low labor rates and automation cannot be justified
  - Task is too technologically difficult to automate
  - Short product life cycle
  - Customized product requires human flexibility
  - To cope with ups and downs in demand
  - To reduce risk of product failure

Labor in Manufacturing Support Systems

- Product designers who bring creativity to the design task
- Manufacturing engineers who
  - Design the production equipment and tooling
  - And plan the production methods and routings
- Equipment maintenance
- Programming and computer operation
- Engineering project work
- Plant management

Automation Principles and Strategies

1. The USA Principle
2. Ten Strategies for Automation and Process Improvement
3. Automation Migration Strategy

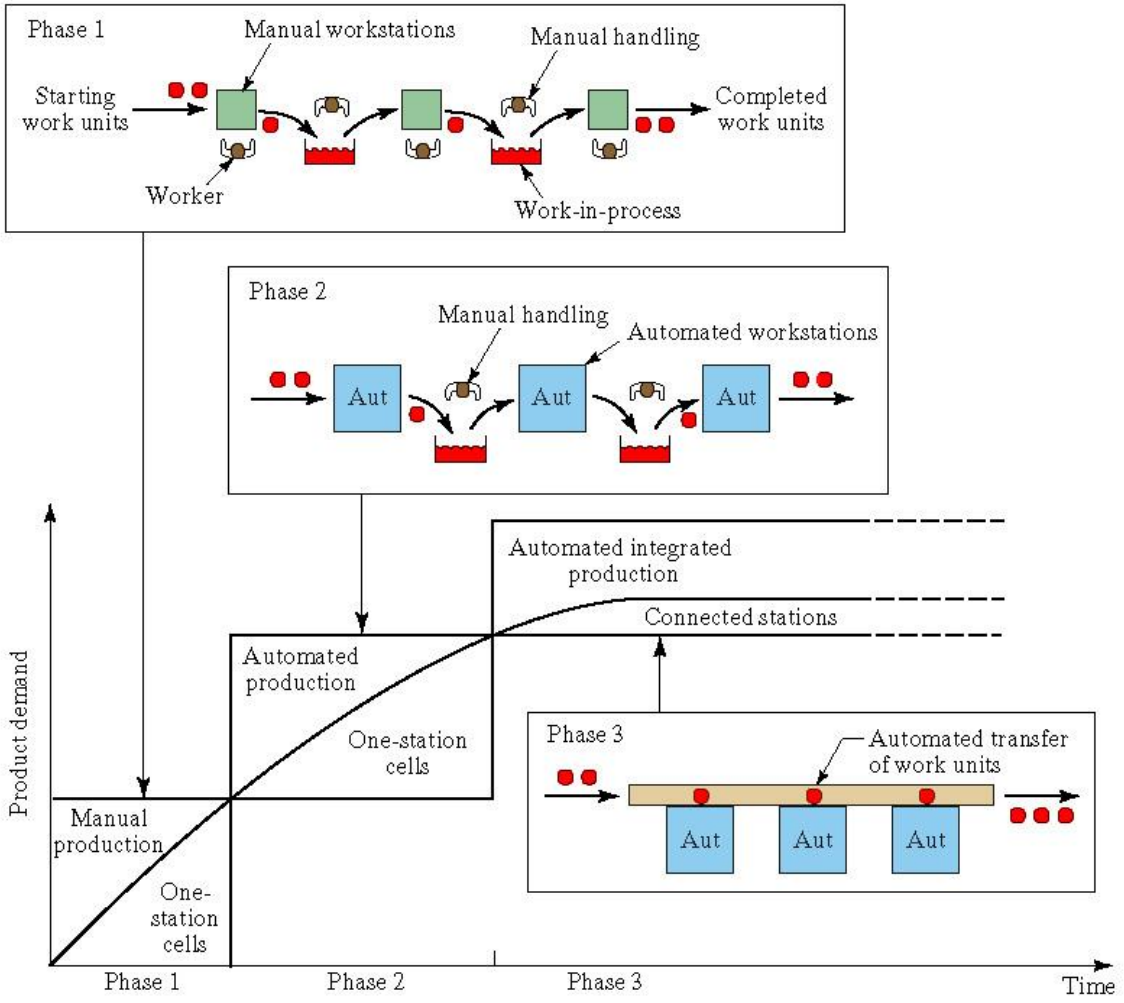
U.S.A Principle

1. Understand the existing process
   - Input/output analysis
   - Value chain analysis
   - Charting techniques and mathematical modeling
2. Simplify the process
   - Reduce unnecessary steps and moves
3. Automate the process
   - Ten strategies for automation and production systems
   - Automation migration strategy

Ten Strategies for Automation and Process Improvement

1. Specialization of operations
2. Combined operations
3. Simultaneous operations
4. Integration of operations
5. Increased flexibility
6. Improved material handling and storage
7. On-line inspection
8. Process control and optimization
9. Plant operations control
10. Computer-integrated manufacturing

Automation Migration Strategy For Introduction of New Products

1. Phase 1 – Manual production
   - Single-station manned cells working independently
   - Advantages: quick to set up, low-cost tooling
2. Phase 2 – Automated production
   - Single-station automated cells operating independently
   - As demand grows and automation can be justified
3. Phase 3 – Automated integrated production
   - Multi-station system with serial operations and automated transfer of work units between stations

Automation Migration Strategy