PRESENTATION TOPIC:
Manufacturing Systems

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(1) Manufacturing System

Collection of operating elements working together, whose function is to add value to a starting raw material, part, or set of parts by performing one or more processing and/or assembly steps on it.

Operating elements = production machines and tools, material handling equipment, computer systems, and human resources to run the system.

There is a synergy obtained by combining operating elements to form a system. By working together, system is more productive than if single elements worked alone.
Production System

People, equipment, and procedures organized for the combination of materials and processes that constitute the firm’s manufacturing operations.

Production systems include (1) facilities and (2) manufacturing support procedures.

A larger entity than a manufacturing system.
Examples of Manufacturing Systems:

One worker tending one machine, which operates on semi-automatic cycle

A fully automated assembly machine, periodically attended by a human worker

One worker tending multiple machines, each of which operates on semi-automatic cycle

A group of workers performing assembly operations on a production line

A group of automated machines working on automatic cycles in a coordinated manner
Manufacturing System Components

- Production machines plus tools, fixtures, and other related hardware
- Material handling subsystem
- Computer systems to coordinate and/or control the above components
- Human resources

The types of processing and/or assembly operations, and the way in which the equipment is configured with the other components, determines the type of manufacturing system.
Production Machines (Workstations):

In virtually all modern manufacturing systems, the actual processing or assembly work is accomplished by machines or with the aid of tools. The machines can be classified as:

1. Manually operated machines -

2. Semi-automated machine -

3. Fully automated machine -
Manually operated machines are controlled or supervised by a human worker. The machine provides the power for the operation and the worker provides the control. The entire work cycle is operator controlled.
A semi-automated machine performs a portion of the work cycle under some form of program control, and a worker tends to the machine for the remainder of the cycle. Typical worker tasks include loading and unloading parts.
(3) Fully-Automated Machine

Machine operates for extended periods (longer than one work cycle) without worker attention (periodic tending may be needed). Worker is not required to be present during each cycle.
Material Handling Subsystem

In a system with multiple workstations, a means of moving work units from one station to the next is generally required.

MH System provides Transport + Storage

Two general categories of routing between stations:
- **(a) Fixed routing** – same sequence of operations
- **(b) Variable routing** – different sequence for different work units
(a) Fixed Routing and (b) Variable Routing
(2) Computer Control System

Typical Computer System Functions Include:

- Communicate instructions to workers
- Download part programs to computer-controlled machines
- Material handling system control
- Schedule production
- Failure diagnosis
- Safety Monitoring
- Quality Control
- Operations management.
Human Resources

Direct Labor:
Loading/unloading workparts
Changing tools, tool maintenance, etc.

Indirect Labor:
Maintenance and repair of equipment
Computer programming
Computer operation
CNC parts programming

Distinction between direct and indirect labor not always precise in automated systems.
Classification / Manufacturing Systems

Factors and Parameters:

Types of operations performed

Number of workstations and system layout

Level of automation

Part or product variety.
Types of Operations Performed

*Processing operations vs assembly operations*

In machining systems, *Rotational* parts vs *Nonrotational* (also called *prismatic*) parts.
Number of Workstations

Convenient measure of system size.
As number of stations is increased, amount of work accomplished increases.
There must be a synergistic benefit obtained from multiple stations working in a coordinated manner rather than independently.
More stations mean system is more complex, and thus more difficult to manage.
Layout of stations is an important factor in determining most appropriate MH system.
Let $n =$ number of workstations.
(3) Classification Scheme with Number of Workstations and Layout

**Type I - Single station.** Simplest case - one workstation \( (n = 1) \), usually includes a production machine manually operated, semi-automated, or fully automated.

**Type II - Multiple stations with variable routing.** Two or more stations \( (n > 1) \) organized to accommodate processing or assembly of different part or product styles.

**Type III - Multiple stations with fixed routing.** Two or more workstations \( (n > 1) \) organized as a production line.
Level of Automation

Three categories of workstation (machine) automation:

**Manually operated** – powered machine supervised by human worker (Example: conventional machine tool).

**Semi-automated** – machine performs a portion of work cycle under program control, human worker performs rest of cycle.

**Fully Automated** – machine can operate for extended periods of time with no human attention.

Additional issue is degree to which manufacturing system itself is automated by computer control
Level of Flexibility

Degree to which system is capable of dealing with differences in parts or products produced by the system.

Examples of possible differences that a manufacturing system may have to cope with include:

- Differences in part geometry in a machining operation
- Differences in parts and options that make up an assembled product on a final assembly line
- Differences in electronic components that are placed on a printed circuit board
- Differences in type of plastic in an injection molding machine.
Flexibility in Manufacturing Systems

To be flexible, a manufacturing system must possess the following capabilities:

Identification of the different work units.
Quick changeover of operation instructions (part program).
Quick changeover of physical setup (fixtures, dies, tooling).
Terminology on Model Variations

Single model case – One product or model is produced that is identical from one unit to the next

Batch model case – Different products or models produced in batches
  • Requires changeover between models

Mixed model case – Different products or models produced on same line or equipment with no changeovers between models
Three Cases of Product Variety in Manufacturing Systems

(a) Single-model case, (b) batch model case, and (c) mixed-model case
Enablers for Unattended Operation in Single Model and Match Model Cases

Programmed work cycle
Parts storage subsystem
Automatic transfer of workparts between storage subsystem and production machine
Periodic attention of worker
  - Resupply and removal of workparts, tool changes, minor repairs, maintenance
Built-in safeguards to protect the system itself and the work units processed by the system
Figure 16.2  Single machine cell consisting of one CNC machining center and parts storage unit.
Enablers of Mixed Model Case – Flexible Manufacturing Systems

Identification of different models
  • No problem for human workers
  • For automated system, some means of product identification is required
Quick changeover of operating instructions
  • For automated system, change part program
Quick changeover of physical setup
  • Change tooling and fixtures in very short time
The differences between implementing a manually operated machine cell and installing a flexible manufacturing system are:

The FMS requires a significantly greater capital investment because new equipment is being installed rather than existing equipment being rearranged.

The FMS is technologically more sophisticated for the human resources who must make it work.
Benefits that can be expected from a FMS include:

- Increased machine utilization
- Fewer machines required
- Reduction in factory floor space required
- Greater responsiveness to change.
Benefits:

- Reduced inventory requirements
- Lower manufacturing lead times
- Reduced direct labor requirements and higher labor productivity
- Opportunity for unattended production
(4) What is a FMS?

A *flexible manufacturing system* is a highly automated GT machine cell, consisting of a group of processing workstations, interconnected by an automated material handling and storage system, and controlled by a distributed computer system.

The reason the FMS is called *flexible* is that it is capable of processing a variety of different part styles simultaneously at the various workstations, and the mix of part styles and quantities of production can be adjusted in response to changing demand patterns.
What is a FMS?

The initials FMS are sometimes used to denote the term *flexible machining system*.

The machining process is presently the largest application area for FMS technology.
Figure 16.15 Flexible fabricating system for automated sheet metal processing (based on line drawing provided courtesy of Wiedemann Division, Cross & Trecker Co.)
Flexible Manufacturing System
Basic Components of a FMS:

- Workstations
- Material handling and storage system
- Computer control system
- People are required to manage and operate the system.
Workstations

**Load/Unload Stations** - Physical interface: FMS and factory.

**Machining Stations** - Most common is the **CNC machining center**.

**Other Processing Stations** - Sheetmetal fabrication, forging.

**Assembly** - Industrial robots, component placement machines.

**Other Stations and Equipment** - Inspection stations, cleaning stations, central coolant delivery and chip removal systems.
Material Handling and Storage System

Functions of the Handling System

*Random, independent movement of workparts between stations.*

*Handle a variety of workpart configurations.*

*Temporary storage.*

*Convenient access for loading and unloading workparts.*

*Compatible with computer control.*
FMS Layout Configurations

- In-line layout
- Loop layout
- Ladder layout
- Open field layout
- Robot-centered cell
REFERENCES:

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Thank You!