Ch 19
Flexible Manufacturing Systems

Learning Objectives:

By the end of the lecture the student should be able to:

- Explain what is a Flexible Manufacturing System?
- Outline FMS Components
- Provide FMS Applications and Benefits

Flexible Manufacturing System - Defined

A highly automated GT machine cell, consisting of a group of processing stations (usually CNC machine tools), interconnected by an automated material handling and storage system, and controlled by an integrated computer system

- The FMS relies on the principles of GT
  - No manufacturing system can produce an unlimited range of products
  - An FMS is capable of producing a single part family or a limited range of part families

Flexibility Tests in an Automated Manufacturing System

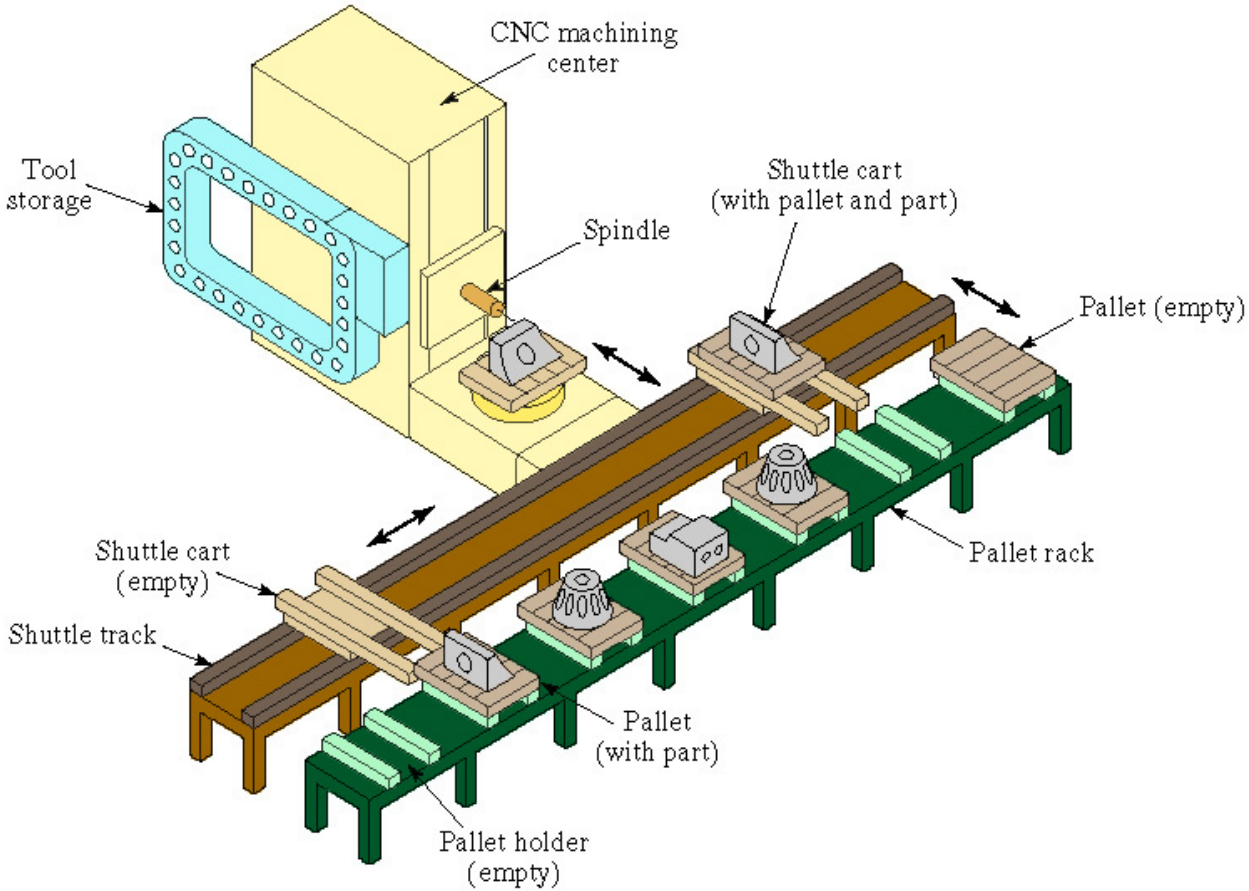
To qualify as being flexible, a manufacturing system should satisfy the following criteria ("yes" answer for each question):

1. Can it process different part styles in a non-batch mode?
2. Can it accept changes in production schedule?
3. Can it respond gracefully to equipment malfunctions and breakdowns?
4. Can it accommodate introduction of new part designs?

Types of FMS

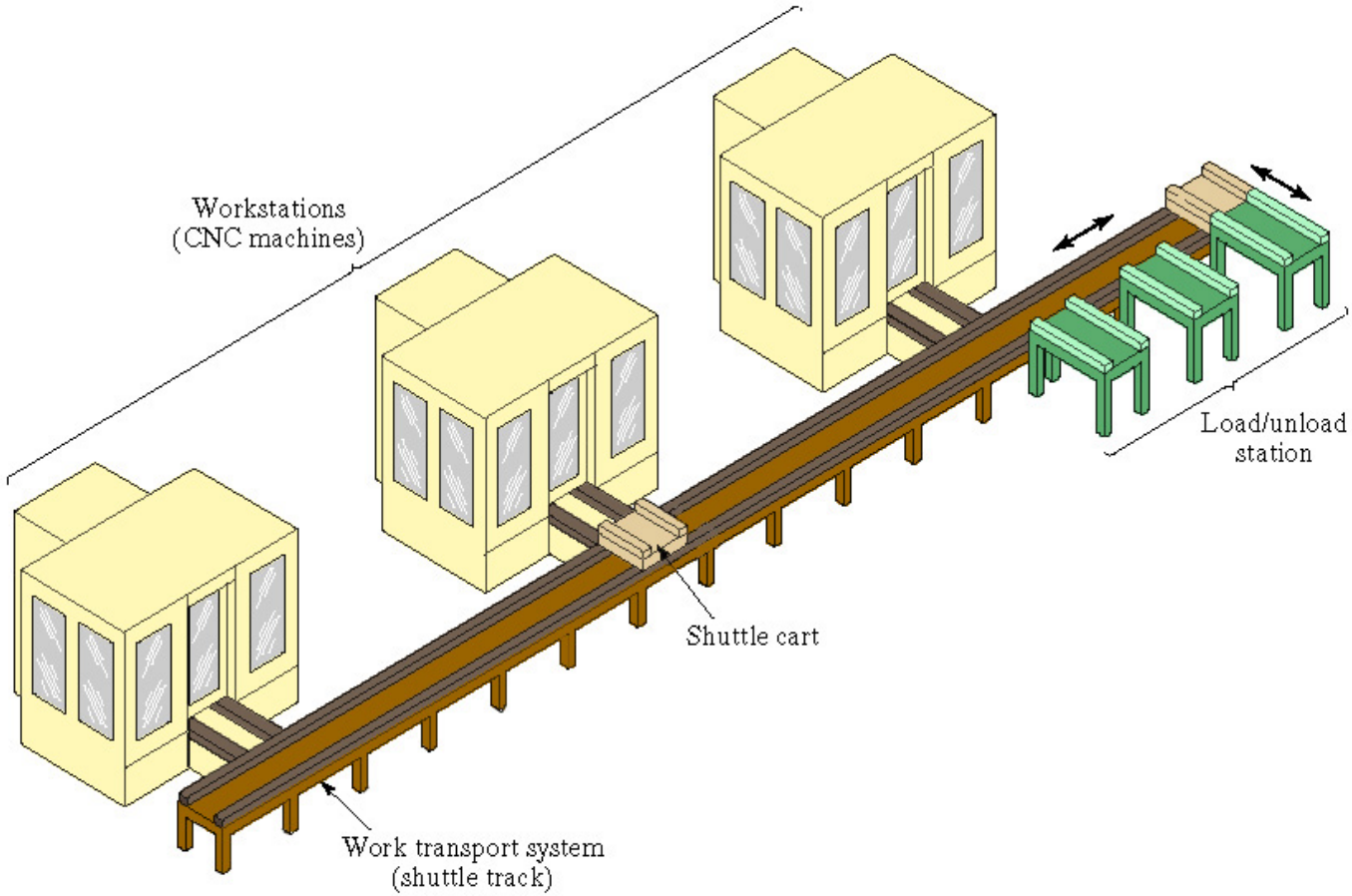
- Kinds of operations
  - Processing vs. assembly
  - Type of processing
    - If machining, rotational vs. non-rotational
- Number of machines (workstations):
  1. Single machine cell (n = 1)
  2. Flexible manufacturing cell (n = 2 or 3)
  3. Flexible manufacturing system (n = 4 or more)

Single-Machine Manufacturing Cell

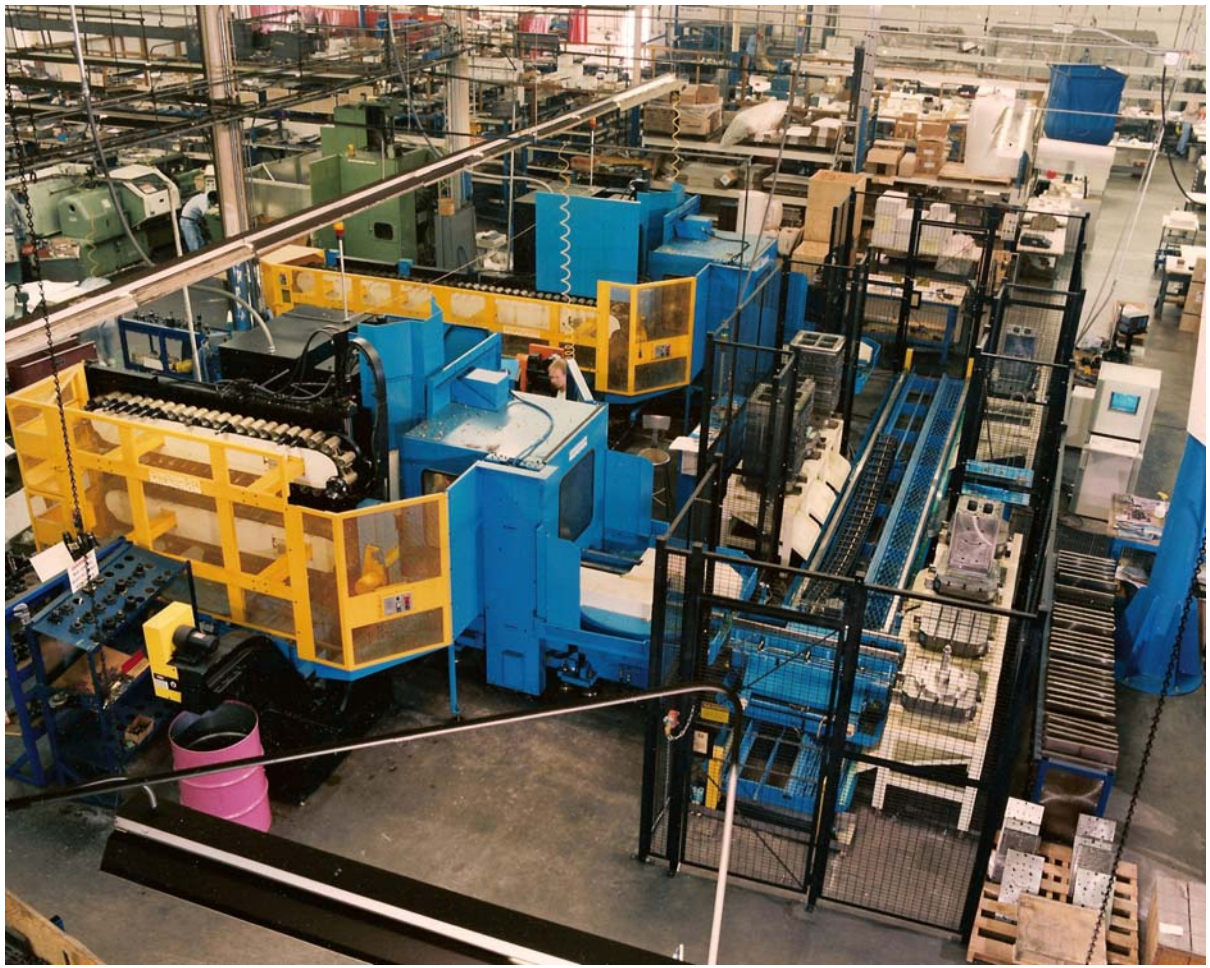


A single-machine CNC machining cell (photo courtesy of Cincinnati Milacron)

Flexible Manufacturing Cell

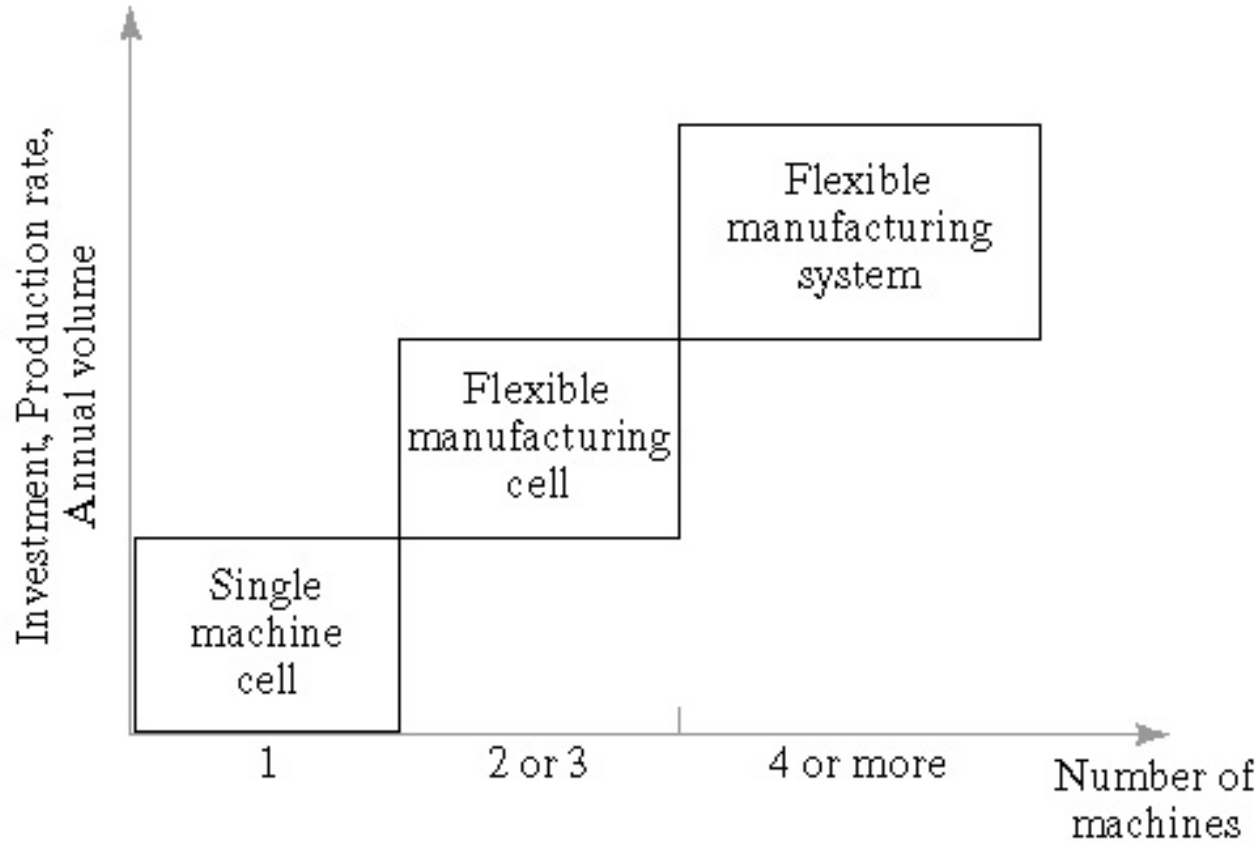


A two-machine flexible manufacturing cell for machining (photo courtesy of Cincinnati Milacron)



A five-machine flexible manufacturing system for machining (photo courtesy of Cincinnati Milacron)

Features of the Three Categories



FMS Computer Functions

1. Workstation control
   - Individual stations require controls, usually computerized
2. Distribution of control instructions to workstations
   - Central intelligence required to coordinate processing at individual stations
3. Production control
   - Product mix, machine scheduling, and other planning functions

FMS Computer Functions

4. Traffic control
   - Management of the primary handling system to move parts between workstations
5. Shuttle control
   - Coordination of secondary handling system with primary handling system
6. Workpiece monitoring
   - Monitoring the status of each part in the system

FMS Computer Functions

7. Tool control
   - Tool location
     - Keeping track of each tool in the system
   - Tool life monitoring
     - Monitoring usage of each cutting tool and determining when to replace worn tools
8. Performance monitoring and reporting
   - Availability, utilization, production piece counts, etc.
9. Diagnostics
   - Diagnose malfunction causes and recommend repairs

Duties Performed by Human Labor

- Loading and unloading parts from the system
- Changing and setting cutting tools
- Maintenance and repair of equipment
- NC part programming
- Programming and operating the computer system
- Overall management of the system

FMS Benefits

- Increased machine utilization
  - Reasons:
    - 24 hour operation likely to justify investment
    - Automatic tool changing
    - Automatic pallet changing at stations
    - Queues of parts at stations to maximize utilization
    - Dynamic scheduling of production to account for changes in demand
- Fewer machines required
- Reduction in factory floor space required

FMS Benefits

- Greater responsiveness to change
- Reduced inventory requirements
  - Different parts produced continuously rather than in batches
- Lower manufacturing lead times
- Reduced labor requirements
- Higher productivity
- Opportunity for unattended production
  - Machines run overnight ("lights out operation")