

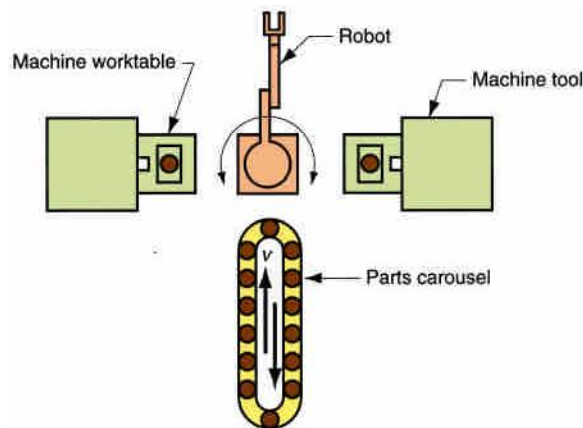
## Unit-4(FMS&AVGs)

### Flexible Manufacturing System

- 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

- Automated manufacturing cell with two machine tools and robot. Is it a flexible cell?



- 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?

**If the automated system does not meet these four tests, it should not be classified as a flexible manufacturing or cell.**

### **Is the Robotic Work Cell Flexible?**

1. Can it machine different part configurations in a mix rather than in batches?
2. Can production schedule and part mix be changed?
3. Can it operate if one machine breaks down?
  - Example: while repairs are being made on the broken machine, can its work be temporarily reassigned to the other machine?
4. As new part designs are developed, can NC part programs be written off-line and then downloaded to the system for execution?

**This fourth capability also requires that the tooling in the CNC machines as well as the end effector of the robot are suited to the new part design.**

### **FMS Components**

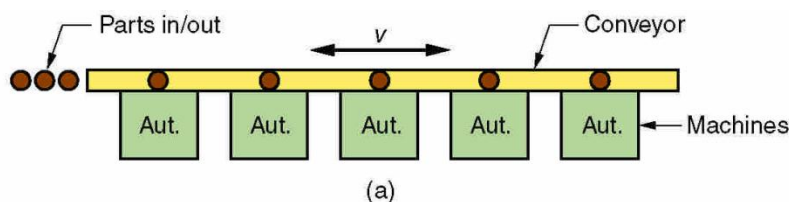
- Hardware components
  - Workstations* - CNC machines in a machining type system
  - Material handling system* - means by which parts are moved between stations
  - Central control computer* - to coordinate the activities of the components so as to achieve a smooth overall operation of the system
- Software and control functions
- Human labor

### **Five Types of FMS Layouts**

1. In-line
2. Loop
3. Ladder
4. Open field
5. Robot-centered cell

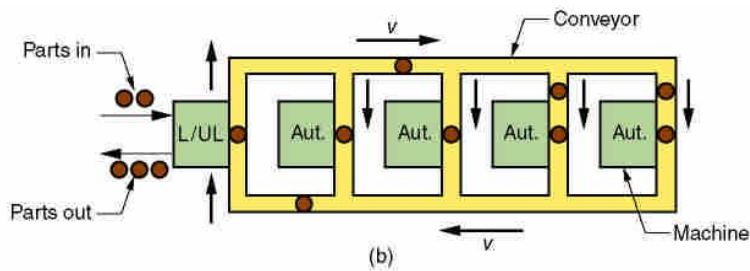
- The basic layout of the FMS is established by the material handling system

Three of the five FMS layout types: (a) in-line



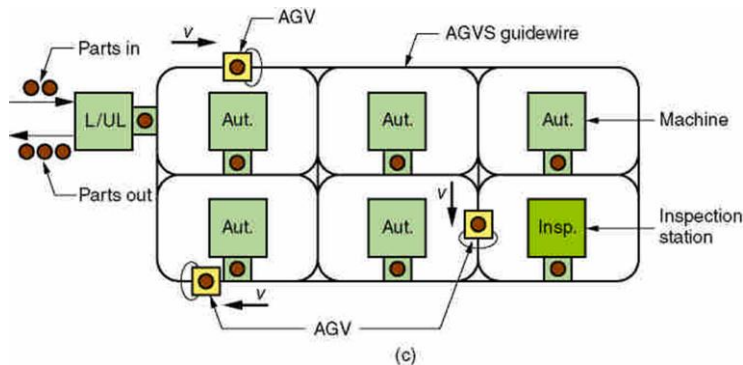
Key: Aut = automated station; L/UL = load/unload station;  
Insp = inspection station; AGV = automated guided vehicle;  
AGVS = automated guided vehicle system

(b) Ladder layout



Key: Aut = automated station; L/UL = load/unload station;  
 Insp = inspection station; AGV = automated guided vehicle;  
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(c) open field



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### Typical Computer Functions in a FMS

- *NC part programming* - development of NC programs for new parts introduced into the system
- *Production control* - product mix, machine scheduling, and other planning functions
- *NC program download* - part program commands must be downloaded to individual stations
- *Machine control* - individual workstations require controls, usually CNC

### More Computer Functions in a FMS

*Workpart control* - monitor status of each workpart in the system, status of pallet fixtures, orders on loading/unloading pallet fixtures

*Tool management* - tool inventory control, tool status relative to expected tool life, tool changing and resharpening, and transport to and from tool grinding

*Transport control* - scheduling and control of work handling system

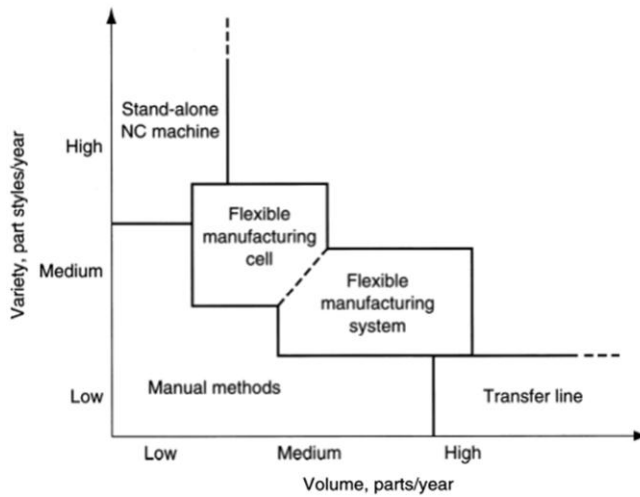
*System management* - compiles management reports on performance (utilization, piece counts, production rates, etc.)

### Duties Performed by Human Labor

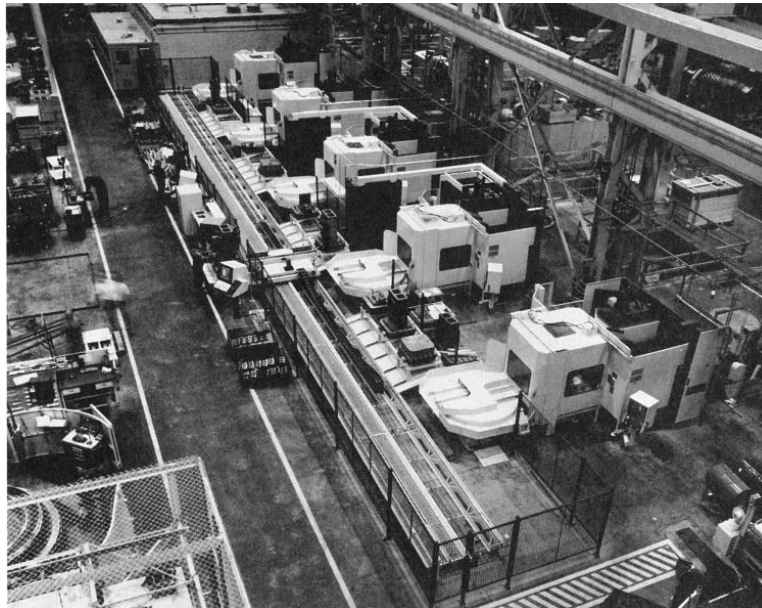
- Loading and unloading parts from the system
- Changing and setting cutting tools
- Maintenance and repair of equipment
- NC part programming
- Programming and operating the computer system
- Overall management of the system

## FMS Applications

- Machining – most common application of FMS technology
- Assembly
- Inspection
- Sheet metal processing (punching, shearing, bending, and forming)
- Forging



## Application characteristics of flexible manufacturing systems and cells relative to other types of production systems



A five station FMS (courtesy of Cincinnati Milacron)

## Typical FMS Benefits

- Higher machine utilization than a conventional machine shop due to better work handling, off-line setups, and improved scheduling
- Reduced work-in-process due to continuous production rather than batch production
- Lower manufacturing lead times
- Greater flexibility in production scheduling