

# Computers in Manufacturing Enterprises

*Flexible Manufacturing Systems: Automation, Production Systems and CIM* by M.P. Groover  
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Vandana Srivastava

fppt.com

## Flexible Manufacturing Systems (FMS)

- one of the types of machine cells
- integrates many concepts and technologies into one highly automated production system
- the technologies included are:
  - flexible automation
  - group technology (GT)
  - CNC machine tools: Numerical control (NC) is the automation of machine tools that are operated by precisely programmed commands encoded on a storage medium; in Computer numerical control (CNC), computers play an integral part of the control.
  - automated machine handling between machines
    - Automated guided vehicles (AGV)
    - Conveyors
    - Automated storage and retrieval systems (AS/RS)
  - computer control of machines (DNC) and material handling
- represents one of the highest level of achievement in automated production

## Flexible Manufacturing Systems - Introduction

- **consists of a group of processing stations;**
  - **Interconnected by: automated material handling and storage system**
  - **controlled by: integrated computer system**
  
- **can process different types of parts simultaneously under Numerical Control(NC) program at various workstations**
  
- &
- **mix of part styles and quantities of production can be adjusted based on the demand**



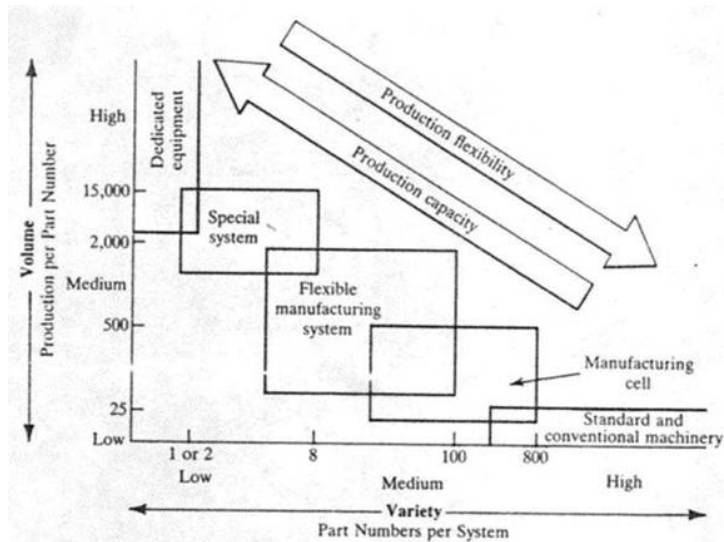
**Flexible Manufacturing**

## Where to Apply FMS Technology ?

- plant presently either:
  - Produces parts in batches or
  - Uses manned GT cells and management wants to automate the cells
  
- It must be possible to group a portion of the parts
  - made in the plant into part families
  - part similarities allow them to be processed on the FMS workstations
  
- Parts and products are in the mid-volume, mid-variety production range
  
- advantage of FMS over transfer line is flexibility to run a variety of product specifications; transfer lines produce one or limited number of product types

<http://homes.ieu.edu.tr/~aornek/ISE314-Ch19.pdf>

## Where to Apply FMS Technology ?

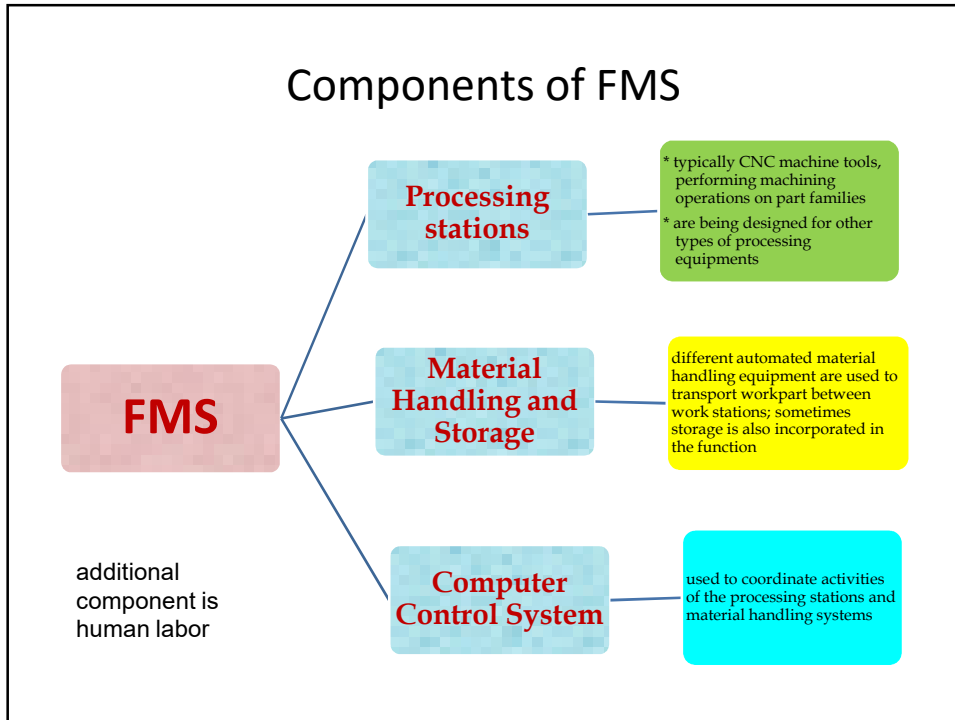


## Flexibility Tests in an Automated Manufacturing System

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

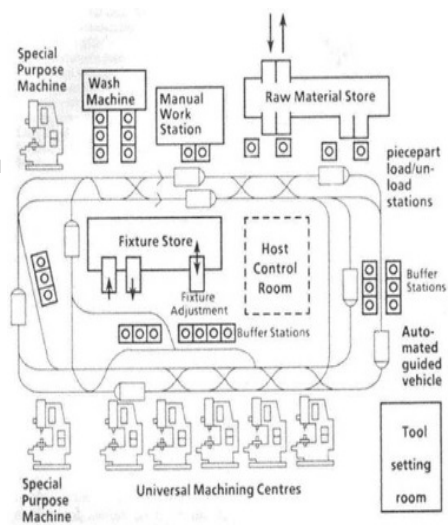
- Can it process different part styles in a non-batch mode?
- Can it accept changes in production schedule?
- Can it respond gracefully to equipment malfunctions and breakdowns?
- Can it accommodate introduction of new part designs?

<http://homes.ieu.edu.tr/~aornek/ISE314-Ch19.pdf>



### The Hattersley Newman Hender F.M.S - Example

- ❑ manufactures high and low pressure bodies and caps for water, gas and oil valves
- ❑ components require a total of 2750 parts for their manufacture
- ❑ fixtures that are not used live in F.M.S. are stored in fixture store; store is served by a stacker crane and motor roller conveyors.
- ❑ system contains two processing centres – a wash machine and two manual workstations
- ❑ loading and unloading is performed at stations with the instructions received on a computer interfaced with the host
- ❑ transport system consists of a controller and 8 Automated Guided Vehicles (A.G.V.).

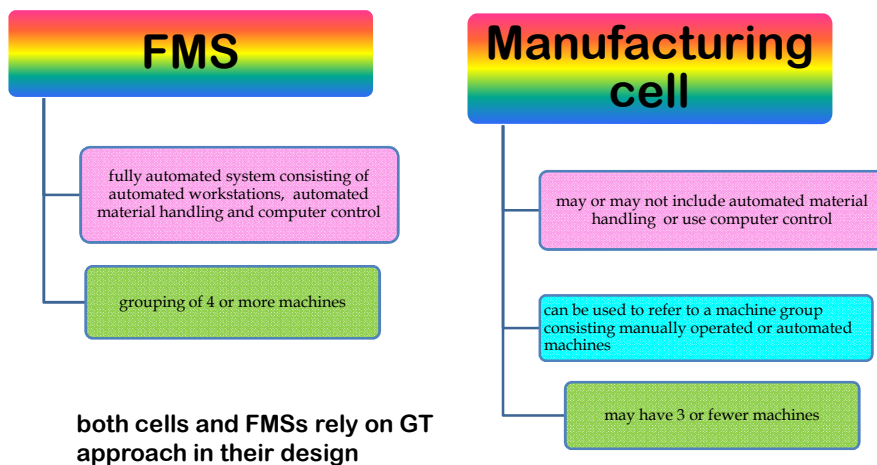


[http://www.aame.in/2008/10/flexible-manufacturing-systems\\_26.html](http://www.aame.in/2008/10/flexible-manufacturing-systems_26.html)

## F.M.S – Working Example

example: [Flexible Manufacturing System](https://www.youtube.com/watch?v=2qc0-yTXBts)  
(<https://www.youtube.com/watch?v=2qc0-yTXBts>)

## Classification of FMS



## Classification of FMS

- based on part geometry
  - prismatic: cubelike and require milling and related machining operations
  - round: cylindrical and disk-shaped and require turning and related machining operations
  
- based on part variety
  - *Dedicated FMS*
    - designed to produce a limited variety of part styles
    - complete universe of parts to be made on the system is known in advance
    - part family likely based on product commonality rather than geometric similarity
  - *Random-order FMS*
    - appropriate for large part families
    - new part designs and engineering changes will be introduced
    - production schedule is subject to daily changes
  
- Random-order FMS:
  - must be more flexible than the dedicated FMS and require more sophisticated computer control system

<http://homes.ieu.edu.tr/~aornek/ISE314-Ch19.pdf>

## Flexible Manufacturing cell

### [example of FM cell](#)

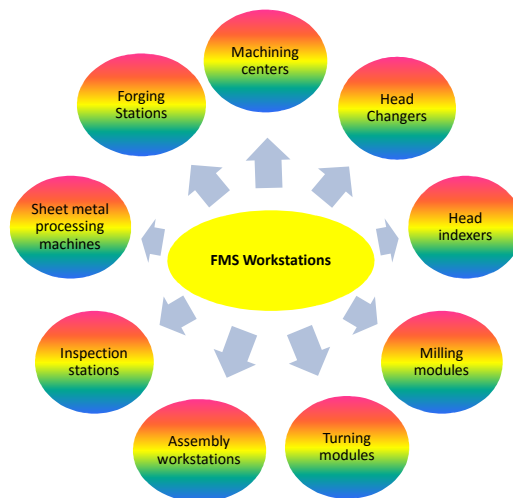
(<https://www.youtube.com/watch?v=hNGzFJqUnjE>)

## Flexible Manufacturing System

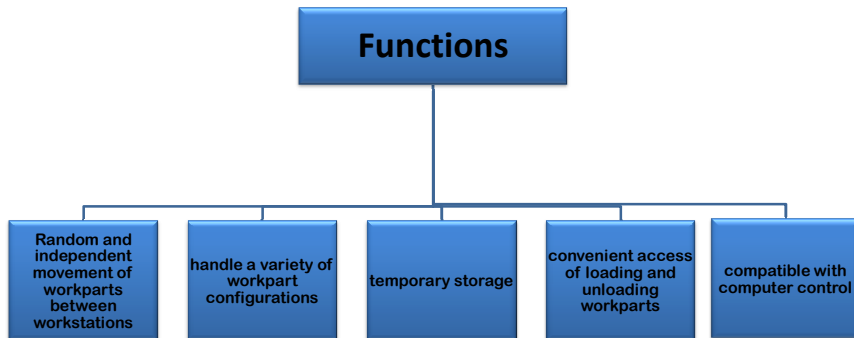
<https://www.youtube.com/watch?v=wkddDUkKxsg>

## FMS Workstations

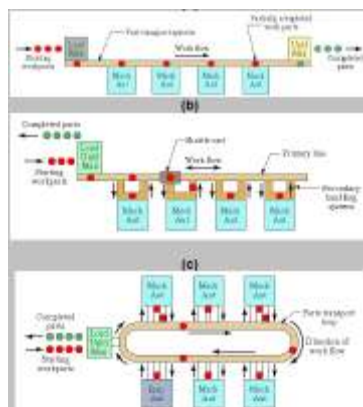
- depends on the type of work being accomplished



## Material Handling and Storage System



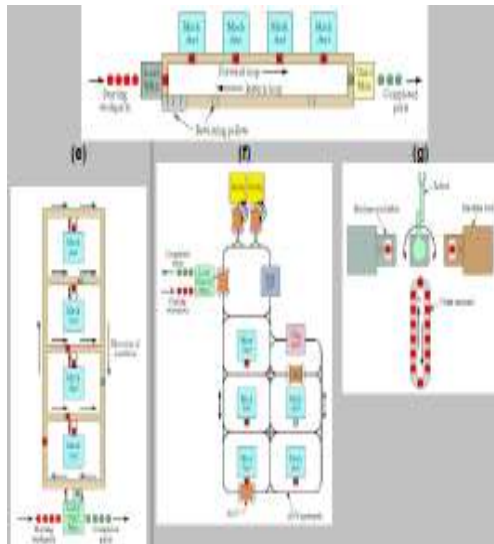
## FMS Layout Configurations



- (a) In-line
- (b) In-line – both direction
- (c) Loop



## FMS Layout Configurations



(d) Rectangular loop

(e) Ladder

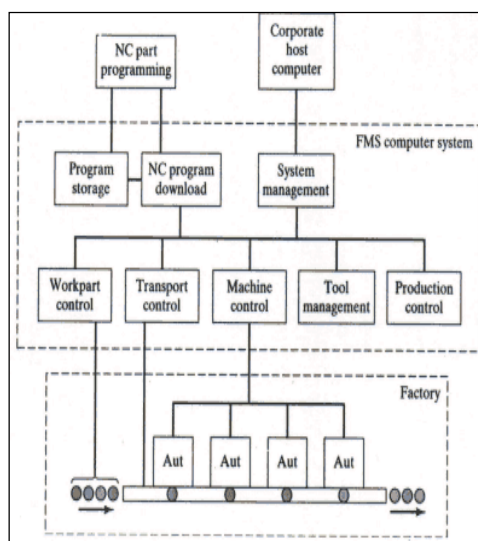
(f) open field

(g) Robot-centred

[www.nuigalway.ie/staff.../unit\\_15\\_flexible\\_manufacturing\\_systems.pdf](http://www.nuigalway.ie/staff.../unit_15_flexible_manufacturing_systems.pdf)

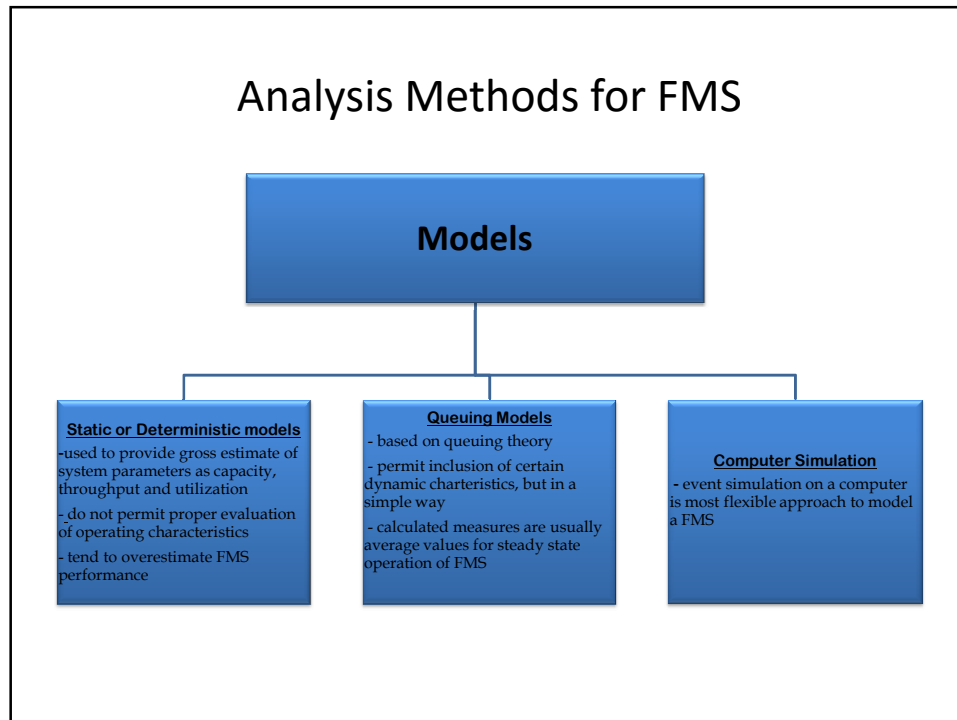
## FMS computer control system

1. Workstation control
2. Supervisory control among workstations (workstation coordination)
3. Production control (part rate and mix)
4. Traffic control (manage part delivery systems)
5. Shuttle control (part handling between machine and primary handling system)
6. Workpiece monitoring (status of various systems)
7. Tool control (location and tool life)
8. Performance monitoring and reporting (report operational data)
9. Diagnostics (identify sources of error, preventive maintenance)



[www.et.byu.edu/~ered/ME482/PPT\\_Lectures/Ch8-FMS.ppt](http://www.et.byu.edu/~ered/ME482/PPT_Lectures/Ch8-FMS.ppt)

## Analysis Methods for FMS



## Advantages of FMS

- to reduce set up and queue times and improve utilization
- Improve efficiency
- improve product routing and reduce WIP
- produce a variety of items with improved quality and more quickly (reduce MLT)