Flexible Manufacturing System (FMS)

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What Will Be Covered?

- History of FMS
- Definition
- FMS equipment
- Types of FMS
- FMS Layouts
- Applications of FMS
- FMS different approaches
- Advantages
- Disadvantage
- Development of FMS
- FMS Types Level of Flexibility
- How FMS works
- A real world example
- Summary
At the turn of the century FMS did not exist. There was not a big enough need for efficiency because the markets were national and there was no foreign competition. Manufacturers could tell the consumers what to buy. Henry Ford is quoted as saying people can order any color of car as long as it is black. This was the thinking of many big manufacturers of the time. After the Second World War a new era in manufacturing was to come. The discovery of new materials and production techniques increased quality and productivity. The wars end open foreign markets and new competition. Now the market focused on consumer and not the manufacturer. The first FMS was patent in 1965 by Theo Williamson who made numerically controlled equipment. Examples of numerically controlled equipment are like a CNC lathes or mills which is called varying types of FMS. In the 70ths manufacturers could not stay to date with the ever-growing technological knowledge manufacturers competitors have, so FMS became mainstream in manufacturing.

In the 80ths for the first time manufacturers had to take in consideration efficiency, quality, and flexibility to stay in business.
A Flexible Manufacturing System (FMS) is a production system consisting of a set of identical and/or complementary numerically controlled machine which are connected through an automated transportation system.

Each process in FMS is controlled by a dedicated computer (FMS cell computer).
Primary equipment

Work centers

• Universal machining centers (prismatic FMSs)
• Turning centers (rotational FMSs)
• Grinding machines
• Nibbling machines

Process centers

• Wash machines
• Coordinate measuring machines
• Robotic workstations
• Manual workstations
• Secondary equipment
  Support stations
    • **Pallet/fixture/ load/unload stations**
    • Tool commissioning/setting area
  Support equipment
    • Robots
    • Pallet/fixture
    • Pallet buffer stations
    • Tools storages
    • Raw material storages
    • Transport system (AGVs,RGVs,robots)
    • Transport units
Flexible Manufacturing Cell

- Workstations (CNC machines)
- Shuttle cart
- Load/unload station
- Work transport system (shuttle track)
A single-machine CNC machining cell
A two-machine flexible manufacturing cell for machining
A five-machine flexible manufacturing system for machining
Types of FMS

- Sequential FMS
- Random FMS
- Dedicated FMS
- Engineered FMS
- Modular FMS
FMS Types Level of Flexibility

1. Dedicated FMS
   - Designed to produce a limited variety of part styles
   - The 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

2. Random-order FMS
   - Appropriate for large part families
   - New part designs will be introduced
   - Production schedule is subject to daily changes
FMS Layouts

- **Progressive Layout:**
  - Best for producing a variety of parts

- **Closed Loop Layout:**
  - Parts can skip stations for flexibility
  - Used for large part sizes
  - Best for long process times

- **Ladder Layout:**
  - Parts can be sent to any machine in any sequence
  - Parts not limited to particular part families

- **Open Field Layout:**
  - Most complex FMS layout
  - Includes several support stations
FMS In-Line Layout

- Straight line flow, well-defined processing sequence similar for all work units
- Work flow is from left to right through the same workstations
- No secondary handling system
• Linear transfer system with secondary parts handling system at each workstation to facilitate flow in two directions.
FMS Loop Layout

- One direction flow, but variations in processing sequence possible for different part types
- Secondary handling system at each workstation
FMS Rectangular Layout

- Rectangular layout allows recirculation of pallets back to the first station in the sequence after unloading at the final station.
Loop with rungs to allow greater variation in processing sequence
FMS Open Field Layout

- Multiple loops and ladders, suitable for large part families
Robot-Centered Cell

- Suited to the handling of rotational parts and turning operations
Application of FMS

- Metal-cutting machining
- Metal forming
- Assembly
- Joining-welding (arc, spot), gluing
- Surface treatment
- Inspection
- Testing
The capability of producing different parts without major retooling.

A measure of how fast the company converts its process/es from making an old line of products to produce a new product.

The ability to change a production schedule, to modify a part or to handle multiple parts.
Advantages of using FMS

- Produce a variety of Items under one roof
- Produce more product more quickly
- Improve efficiency
- Improve product routing
- Improve product quality
- To reduce setup and queue times
- Reduce time for product completion
- Utilize human workers better
- Serve a variety of vendors simultaneously
Disadvantage of using FMS

- Limited ability to adapt to changes in product or product mix (ex: machines are of limited capacity and the tooling necessary for products, even of the same family, is not always feasible in a given FMS)
- Substantial pre-planning activity
- Expensive, costing millions of dollars
- Technological problems of exact component positioning and precise timing necessary to process a component
- Sophisticated manufacturing systems
Several actions must be decided on before you can have a FMS. These actions include:

- Selecting operations needed to make the product.
- Putting the operations in a logical order.
- Selecting equipment to make the product.
- Arranging the equipment for efficient use.
- Designing special devices to help build the product.
- Developing ways to control product quality.
- Testing the manufacturing system.
Challenges with FMS

- Determining if FMS the best production system for your company (economically and socially)
- Possible expansion costs associated with implementing FMS
- Day to day maintenance of FMS operations
- Ability to adapt to engineering changes in parts
- Increase in number of similar parts produced on the system
- Ability to accommodate routing changes
- Ability to rapidly change production set up
Flexible Manufacturing system

How Does It Work?
Making FMS Work

By implementing the components of robotics, manufacturing technology and computer integrated manufacturing in a correct order one can achieve a successful Flexible Manufacturing System.
In today’s manufacturing units several PLCs are used to switch on or off robots, conveyer belts and other parts of manufacturing systems.

The advantages of PLC in automated systems made PLC one of the main components of any manufacturing.
An example of a modern manufacturing
When different models are designed to be assembled in the same sequence they can be built in the same plant. This maximizes efficiency and allows the company to respond quickly to changing customer demands.
Through the use of reprogrammable tooling in the body shop, standardized equipment in the paint shop and common build sequence in final assembly, Ford can build multiple models on one or more platforms in one plant.

**Body Shop**

In the body shop, where the sheet metal comes together to form the vehicle’s body, flexibility means more than 80 percent of the tooling is not specific to one model. It can be reprogrammed to weld a car or a truck or a crossover of similar size.

**Paint Shop**

In the paint shop, flexibility means robotic applicators are programmed to cover various body styles – as they move through the paint booth – with equal precision. This results in minimizing waste and environmental impact while maximizing quality.

**Final Assembly**

In the final assembly area, flexibility means the build sequence is the same among multiple models on one or more platforms allowing for efficient utilization of people and equipment.
Virtual manufacturing technology allows Ford to quickly add various models into an existing facility – or to reconfigure an existing facility to produce a new model. In the virtual world, manufacturing engineers and plant operators evaluate tooling and product interfaces before costly installations are made on the plant floor. This method of collaboration improves launch quality and enables speed of execution.