people can order any color of car as long as it is black.
-Henry Ford
Flexible manufacturing System
Presented by: Group II,
MBA 2k8
How FMS came?

At the turn of the century FMS did not exist.

Since W.W.II, U.S. manufacturing has dominated the world ... until the middle of the 1960s, when market competition became more intense.

During 1960 to 1970 *cost* was the primary concern.

Later *quality* became a priority.

As the market became more and more complex, *speed of delivery* became something customer also needed.

A new strategy was formulated: *Customizability*.

The companies have to adapt to the environment in which they operate, to be more *flexible* in their
Why FMS

Once GT (Group Technology) for the parts & products is available.

Computer can be used to design production operation.

It can be used to control the parts flow in small batch type of production situation.
What is FMS?

A **flexible manufacturing system** (FMS) is a manufacturing system in which there is some amount of flexibility that allows the system to react in the case of changes, whether predicted or unpredicted.

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

Two categories of flexibility

**Machine flexibility**, covers the system's ability to be changed to produce new product types, and ability to change the order of operations executed on a part.

**Routing flexibility**, which consists of the ability to use multiple machines to perform the same operation on a part, as well as the system's ability to absorb large-scale changes, such as in volume, capacity, or capability.
FMS and FMC

Early FMSs were large and very complex, consisting of dozens of CNCs and sophisticated material handling systems. They were very automated, very expensive and controlled by incredibly complex software. There were only a limited number of industries that could afford investing in a traditional FMS as described above.

Currently, the trend in FMS is toward small versions of the traditional FMS, called flexible manufacturing cells (FMC).

Today two or more CNC machines are considered a flexible cell and two or more more cells are considered a
FMS Goals

Reduction in manufacturing cost by lowering direct labor cost and minimizing scrap, re-work, and material wastage.

Less skilled labor required.

Reduction in work-in-process inventory by eliminating the need for batch processing.

Reduction in production lead time permitting manufacturers to respond more quickly to the variability of market demand.

Better process control resulting in consistent quality.
The Manufacturing Cell

A flexible manufacturing cell (FMC) consists of two or more CNC machines, a cell computer and a robot.

The cell computer (typically a programmable logic controller) is interfaced with the microprocessors of the robot and the CNCs.
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Source: Groover (1990)
Equipment of FMS

Primary equipment
work centers

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

Process centers

• Wash machines
• Coordinate measuring machines
Equipment of FMS

Secondary equipment

Support stations
- Pallet/fixture load/unload stations
- Tool commissioning/setting area

Support equipment
- Robots
- Pallet/fixture/stillage stores
- Pallet buffer stations
- Tools stores
- Raw material stores
Types of FMS

Sequential FMS
Random FMS
Dedicated FMS
Engineered FMS
Modular FMS
Application of FMS

- Metal-cutting machining
- Metal forming
- Assembly
- Joining-welding (arc, spot), glueing
- Surface treatment
- Inspection
- Testing
FMS different approaches

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

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

Several actions must be decided on before we 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.
Illustration example of a FMS

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Basics of FMS

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
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
Flexible Manufacturing system

By implementing the components of robotics, manufacturing technology and computer integrated manufacturing in a correct order one can achieve a successful Flexible Manufacturing System.
An example of a simple and modern manufacturing
Components of FMS

ROBOTS
CONVEYORS
PLCs
Barcode Reader
Metal Detector Sensor
ROBOTS

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  - Fourth level
  - Fifth level
COMPUTERS AND SOFTWARES

The Robot is controlled by a General PC, using a visual basic program to read the barcodes and also control the robot’s motion. For each part the program decide Where to be placed according to the parts’ barcode.

e.g. The robot can be controlled by a PC using special software e.x. “Robotica”. Generally, this software has a GIU (Graphical User Interface) which can be used for programming the robot remotely. After writing the program, by pressing the
How are the Robots Programmed

In this integrated system robots are programmed with visual basics. But first coordinates are defined with the help of ROBOTICA. ROBOTICA is a program to define the coordinates for a robot. Each robot has several axes which are controlled with this program.

For example here 3 programmers are written for the robot next to conveyor 2 to take the part to machine 1 or machine 2 or conveyor 1.
CONVEYORS
PLCs

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Barcode Reader

- Third level
  - Fourth level
  - Fifth level
Metal Detector Sensor

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Second level
• Third level
• Fourth level
• Fifth level
Computer integrated manufacturing and PLC

In today’s manufacturing units several PLCs are used to switch on or off robots, conveyor belts and other part of manufacturing systems. The advantages of PLC in automated systems made PLC one of the main component of any Manufacturing unit.
FMS Example: Ford Motors

One Design + One Assembly Process = Multiple

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Crossover  Sedan  Luxury  SUV  Coupe

When different models are designed to be assembled in the same...
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 Verification
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.
Thank You