**Automation in Production Systems and Management**
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# Flexible Manufacturing Systems - II
## Lecture - 45
## Types of FMS Layout, Main Benefits of FMS

During this lecture session of half an hour duration, I will be specifically referring to FMS layout. For implementing an FMS in a manufacturing system, you have to install all the physical subsystems of an FMS.

When you install all these physical subsystems of an FMS, you have to follow certain rules. There will be floor space and you have the line; we have to install them in a particular manner. When the installation is over then, you just look at the layout of the FMS. In majority of the cases, FMS is a part of the total manufacturing system.

If it is a large one, the entire large manufacturing system is converted into an FMS. It may not be possible or it may not be necessary at all. Only for specific purposes, you must go for FMS. There are specific objectives. During this lecture session we are going to discuss the types of FMS layout.

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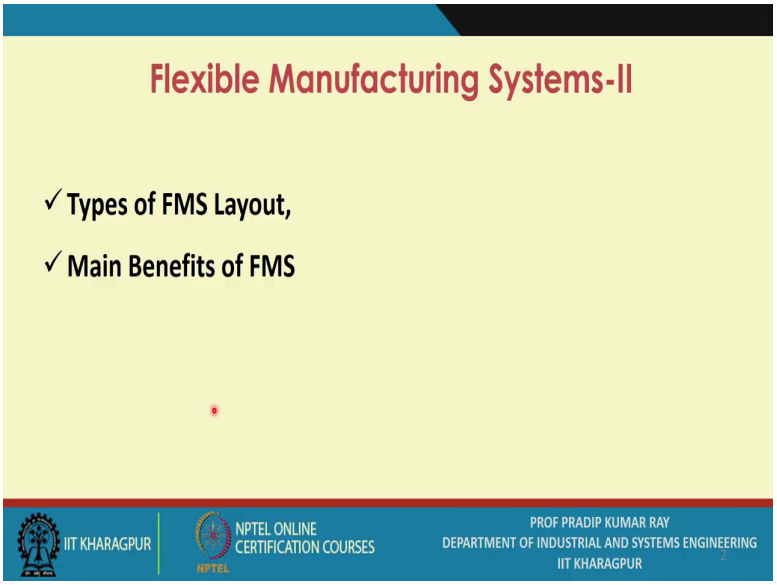


FMS is the state-of-the-art technology; but then you have to look into these aspects also like say what could be the performance, can you prove that FMS is instrumental in improving the financial performance of a company?

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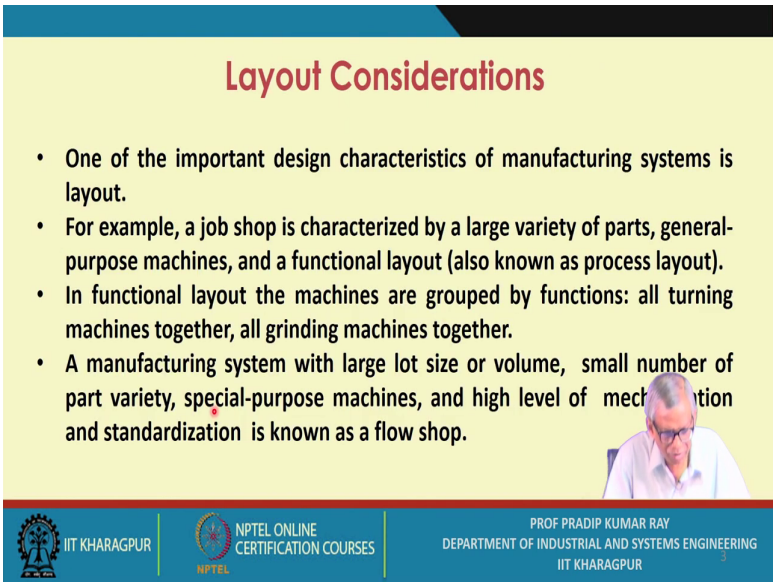


That is why the benefits must be known. If I design as well as if I install and if I run the FMS correctly as per the norm, what could be the benefits? Suppose you have not designed your FMS properly and you expect benefits. Your design is perfect, but during installation you

have so many deficiencies. You may not get benefits even if your installation is perfect, but the way you run the FMS, there are lot of improvements required.

Ultimately your performance will be affected and you may not get the adequate amount of benefits from FMS. One of the important design characteristics of manufacturing system is layout.

A job shop is characterized by a large variety of parts. General purpose machines and a functional layout also known as the process layout.

In functional layout, the machines are grouped by functions; all milling machines together, all grinding machines together, all the drilling machines are together, the drilling machine and its varieties, milling machine and its varieties, etc.

All the machines of a specific type are grouped together. You go by the functions that is why it is referred to as functional layout. A manufacturing system with large lot sizes or volume, typical example could be so the continuous processing. Small number of part varieties, you just refer to volume variety relationship against a particular manufacturing system.

Special purpose machines and high level of mechanization and standardization is known as a flow shop. When we refer to the flow shop, we refer to the standard components or standard products the kind of layout you have is referred to as product layout or line layout.

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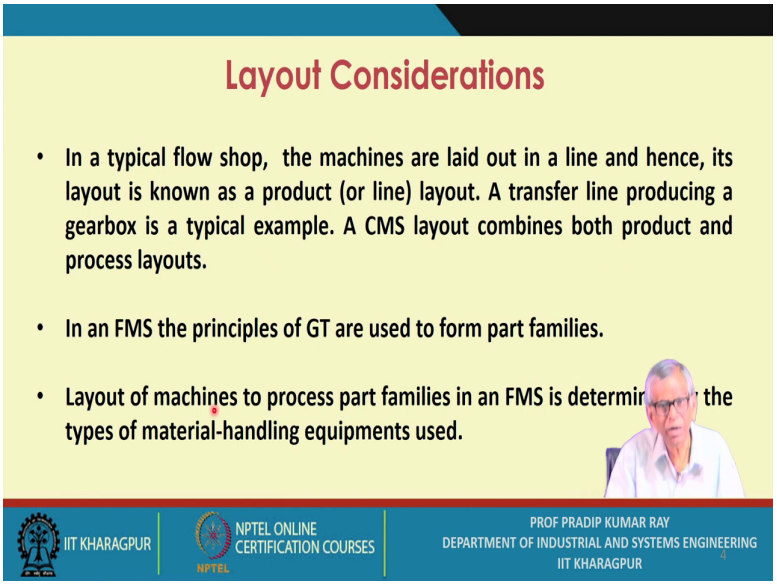


These two types of layouts are very common and they are referred to as the pure layouts; mutually exclusive. When you the create the CMS, you try to combine both; that means, if you refer to the line layout or product layout, there are advantages, there are disadvantages. Similarly, once you opt for functional or process layout, there are advantages or the merits and there are also disadvantages or demerits.

Now, the question is can you combine them and get a layout where the advantages of both the systems are made available. That system is called cellular manufacturing system and for implementing cellular manufacturing systems, you have to apply the group technology principles. In a typical flow shop, the machines are laid out in a line and hence, the layout is known as a product or line layout.

A transfer line producing a gearbox. Transfer line is highly automated, if not 100% automated; the actual definition says that it is a 100% automated assembly line. A CMS layout combines both product and process layout. In an FMS the principles of GT are used to form part families.

Each of the machine cells in an FMS can be referred to as an independent the machine cell or the work cell. Layout of machines to process part families in an FMS is determined by the types of material handling equipment used.

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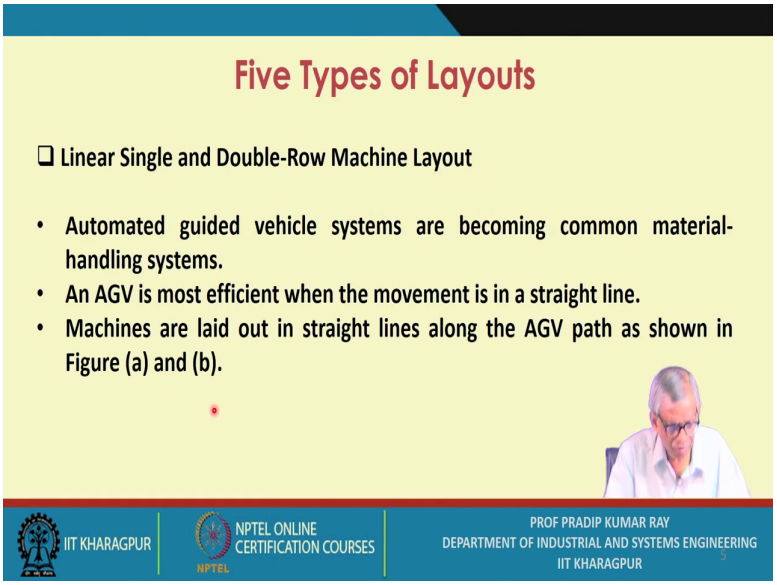


Let me just explain the determining factor while you propose a layout for an FMS that is basically the material handling equipment. In order to make the system automated, you have to also make your material handling systems an automated one. Many a time, the different types of material handling robots you have to use.

There are the five types of layouts as far as the layout of FMS is concerned. First one is the linear single and double row machine layout.

Automated guided vehicles systems are becoming common material handling systems; but then, again, there are certain limitations of using AGVs. An AGV is the most efficient when the movement is in a straight line

If it is a straight-line layout, no problem at all. Like say you have a transfer line, the partially completed part to be sent to the next work station in a straight line. So, use AGVs as a straight-line path it moves. Machines are laid out in straight lines along the AGV path as shown in figure (a) and (b).

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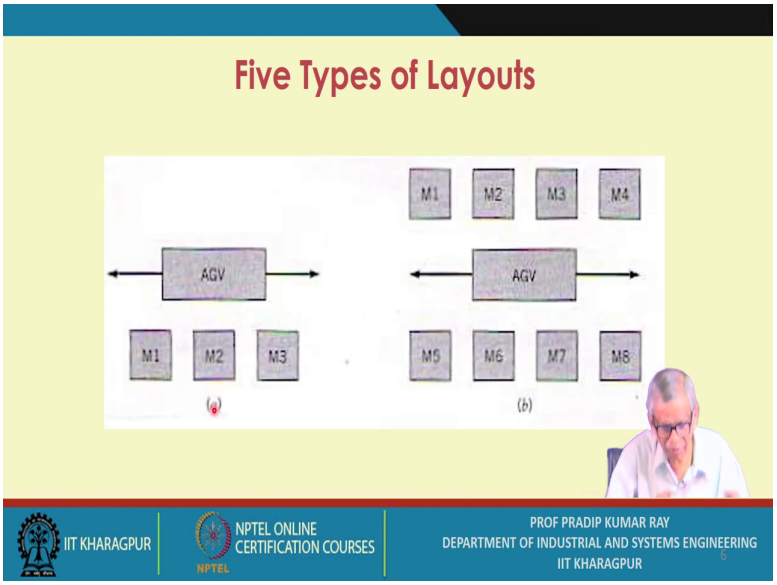


This is the typical the layout. This is M1, M2, M3 and the part moves in a straight line, the AGV moves in a straight path.

The part is processed over here and then, put it over there AGVs, it goes to the next station and then again, you get this item is the further processed and then again, the AGV takes it to the third machine and then, all these processing is over and then the AGV takes it to another place.

What is double line layout? Here, you have 4 machines on one side and on the other side, again you have 4 machines and they are laid out on a straight line. So, obviously, a greater number of machines you need to use because the types of the parts to be manufactured are also increasing.

When you look at the product, when study its design, you find that more or less it is a standard design and that is why the selection of the machine becomes easier. The path you take to complete or carry out all the is a straight-line path.

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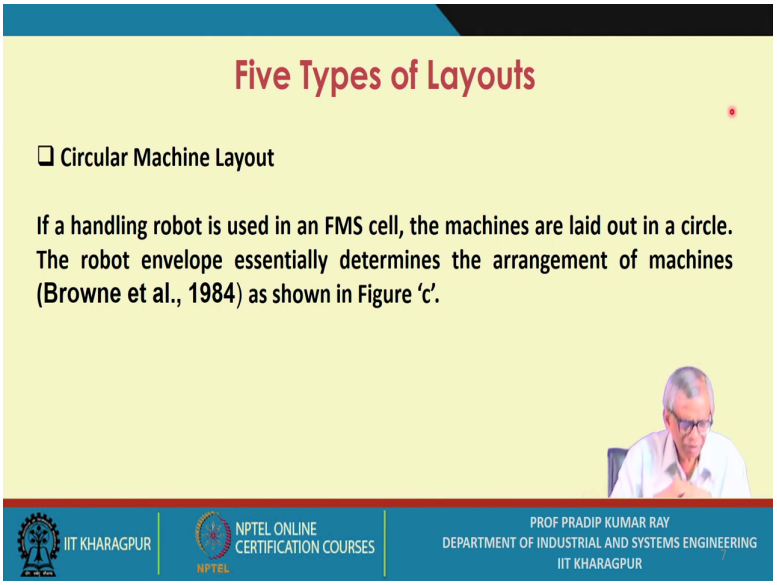


Second one is the circular machine layout. If a handling robot is used in an FMS cell, the machines are laid out in a circle. You must know the robot envelop. The robot envelope essentially determines the arrangement of machines.

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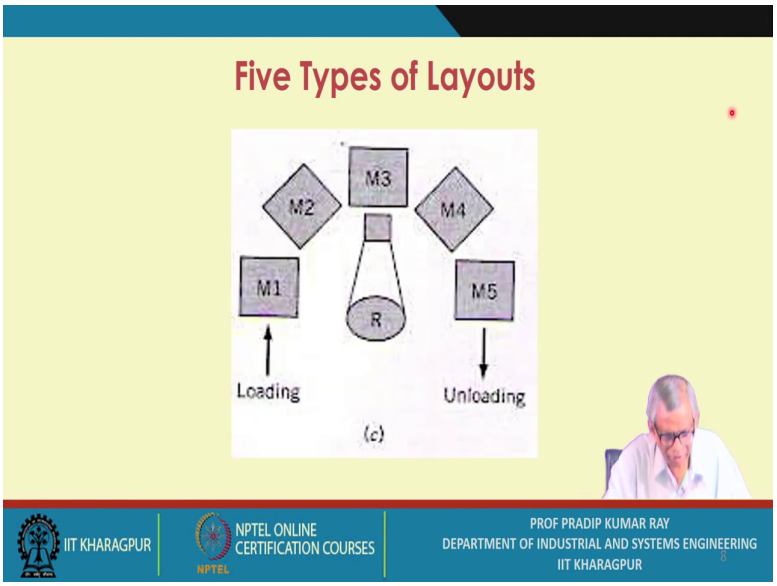


I will show you one particular figure. This is the robot. This is a robot envelope and this robot will be used for material handling, material transfer from one workstation to another.

Once the envelope is known, install all these machines around this envelope keeping a safe distance. You install machine 1 over here, then you go to machine 2 as per the process plan. As per the sequence operations, you install all these machines. The first machine you need is M1, next is M2, third one is M3, fourth one is M4 and the last one is M5.

All the operations are carried out. This is your starting point- loading the work part or the raw material and the values at each workstation is added and you get the required shapes and size of as specified in the design of the workpiece.

The finished product or the finished goods are to be unloaded from the system. This is the loading area of FMS. This is the unloading area and this is basically the work area.

All these robots actually are the envelope; in this case defined as the work envelope or work area.

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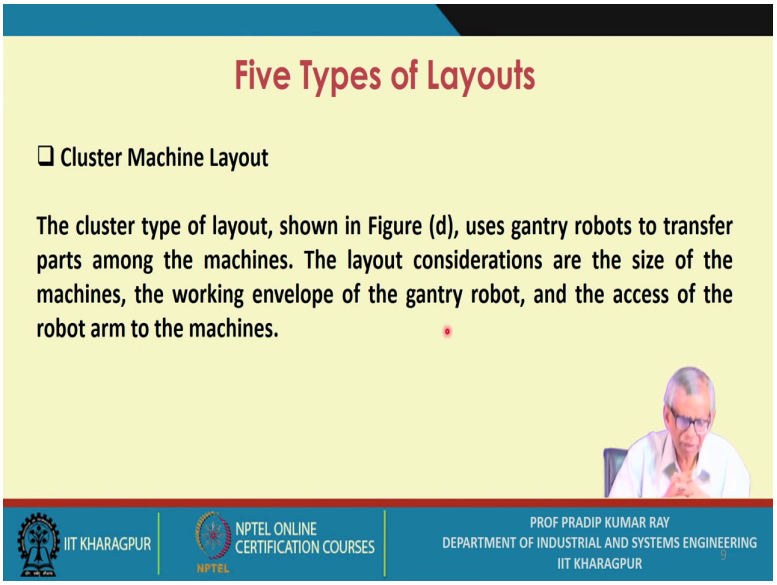


The next one is the cluster machine layout, where you can use different kinds of robots; the gantry robots are used quite frequently. The cluster type of layout shown in figure (8); the different types of the machines you have to use for the entire shop for the entire plant.

Many machines you have installed like you have the EOT crane. Looking after the material handling operations for the entire shop, EOT crane, either in the longitudinal direction as well as on the transverse direction.

You are using a kind of robot known as the gantry robot. Once you start using that for the entire shop, the machine layout you must have is called cluster machine layout-the group of machines or the cluster of machines you have been using.

The cluster type of layout uses gantry robots. The layout considerations are the size of the machines, the working envelope of the gantry robot, and the access of the robot arm to the machines.

While you select the robot, you take care of this particular feature access and the working envelope; that means, the working space of that particular robot you must know. You define the work space as well as the height. Height actually is taken care of by the access, and the width and length.

Shop floor is the area where the robot can handle those parts. Gantry robot and the access of the robot arm to the machines.

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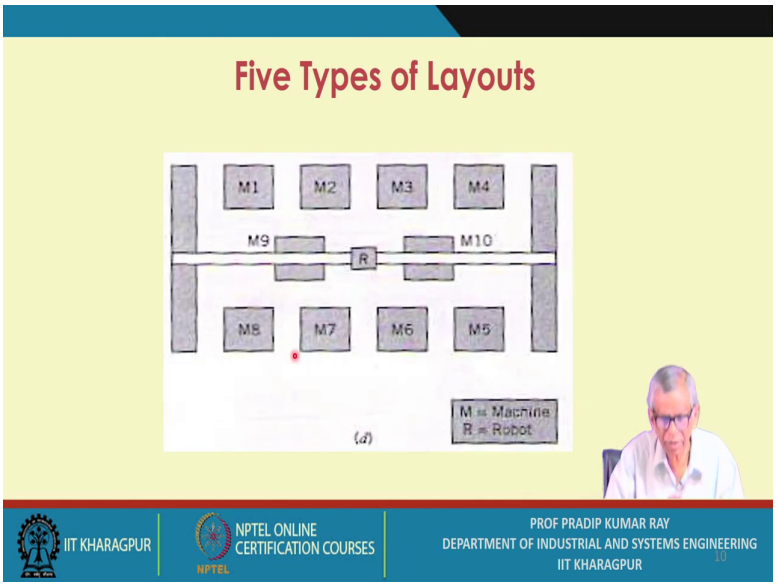

The cluster type layout. This is the robot. It moves from this corner to this corner. How many machines in this floor you have? Four machines on one side and the other side, you have four more and in between, you have two more machines.

This is a simple example. there are 10 machines. These are the machines and one robot is sufficient for handling of all sorts of parts from one location to another.

Adequate access the robot arm. When it moves, it can move across the entire length as well as the width as per requirement.

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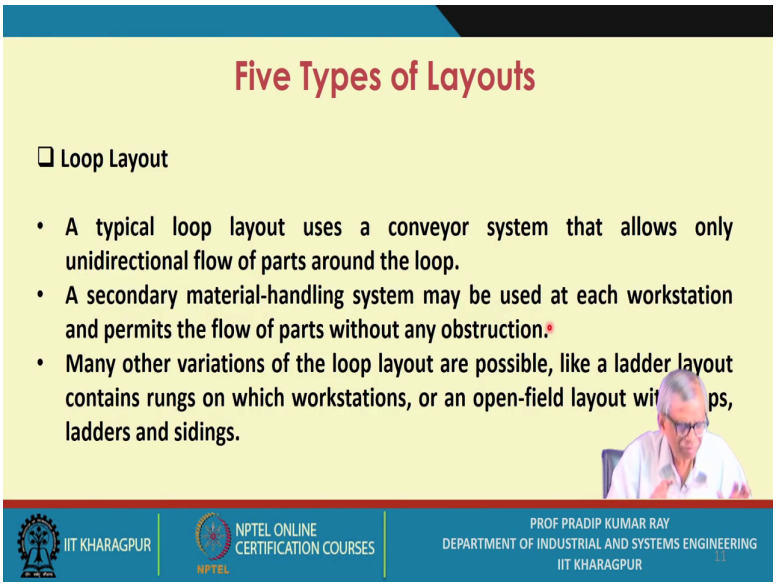


Now, the fifth one is the loop layout. A typical loop layout uses a conveyor system that allows only unidirectional flow of parts around the loop.

The part you manufacture is the standard one.

Over the years, you have established a system and this system will continue, that is your assumption. The production rate is also known and the production rate has to be ensured.

At regular interval, you from the system, certain number of parts or certain number of products from the assembly must come out and there has to be a fixed path. Definitely, the

conveyor you may opt for. But the conveyor is unidirectional; there will be a starting point, there will be ending time and ending point.

A secondary material handling systems may be used at each workstation, connected by the conveyor and permits the flow of parts without any obstructions. These are sometimes referred to as a feeder at each workstation. So, all these *n* number of work stations are connected by one conveyor and the conveyor is moving in one direction; say left to right.

At each workstation, certain operations to be carried out and for those operations or for doing some sort of joining or assembly, you need other parts. How do you get these other parts? Those parts are to be fed with the help of other conveyors also. It is a combination of conveyors of different types. Many other variations of loop layout are possible.

You visit different workplaces, you find different types of loop layout. A ladder layout contains rungs on which workstations are located; an open-field layout consists loops, ladders and sidings.

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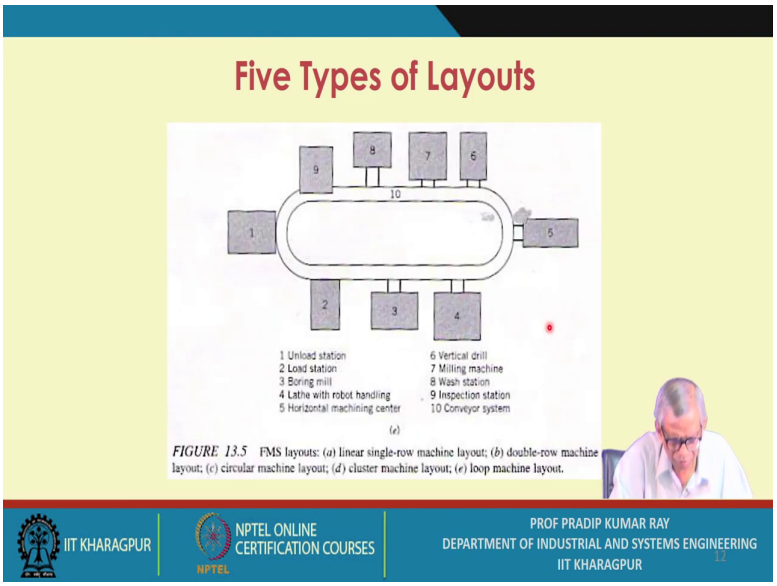


This is a typical example. This is your starting point, that is why it is 1. Then, it goes to over here; first one is the unload station, this is the loading station.

The first operation is boring, the second operation is the lathe, number 4. Then, it goes to with this conveyor once the operation is over, the part is put on the conveyor and the conveyor is the working constantly. It goes to station 5 and station 5 is having horizontal machining center.

In horizontal machining center the level of flexibility will be more compared to the vertical machining center. 6 is the vertical drilling machines. If you use a vertical drilling machine; the level of the flexibility will be less, then you opt for the milling machine of a particular type and then, the next one is the washing station.

9th one is the inspection station, here you can use the CMM or coordinate measuring machine and the washing system is also part of FMS.

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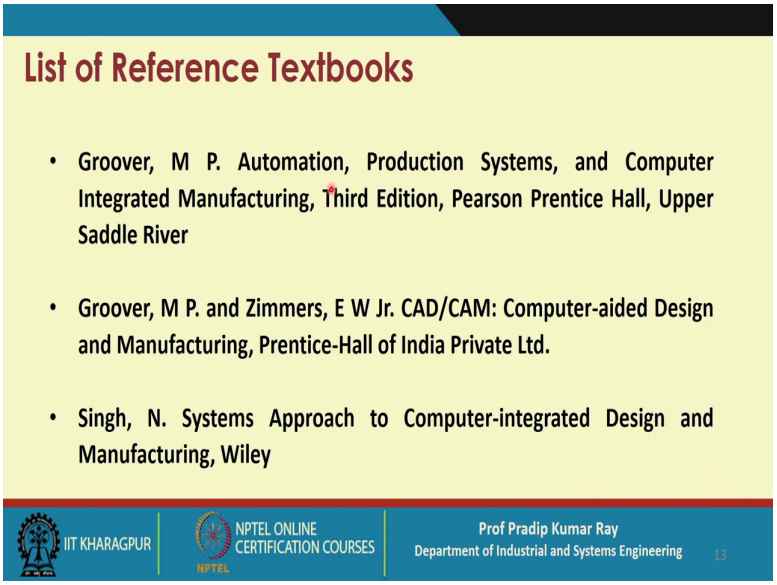


FMS is 100% automated mid-volume mid-variety, central computer-controlled manufacturing systems.