Automation in Production Systems and Management
Prof. Pradip Kumar Ray
Vinod Gupta School of Management
Department of Industrial and Systems Engineering
Indian Institute of Technology, Kharagpur

Flexible Manufacturing Systems (Part - I)
Lecture - 37
Volume – Variety Relationships in Production Systems, what is FMS?
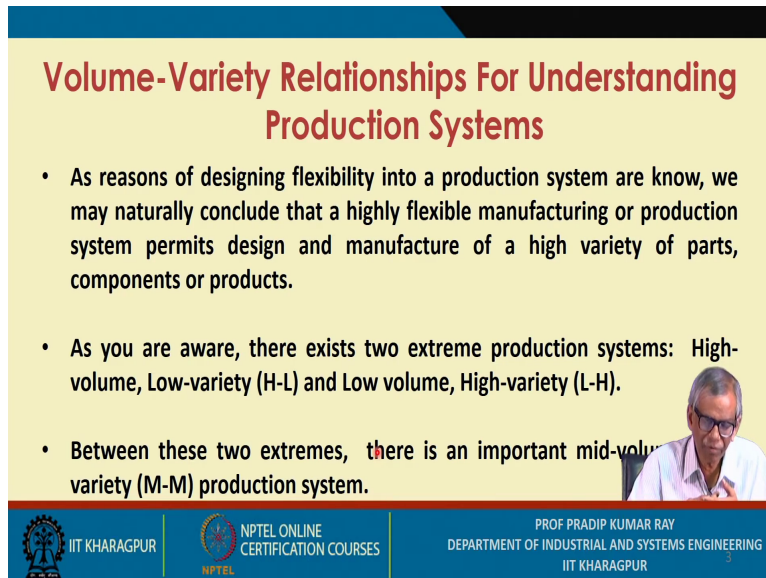
(Refer Slide Time: 00:21)

First thing is FMS but prior to defining an FMS you also must know what is this volume variety relationships. And, with respect to this volume variety relationships you need to define your production or manufacturing system.

(Refer Slide Time: 00:52)

As reason of designing flexibility into a production system are know, may naturally conclude that a highly flexible system permits manufacture of a high variety of parts.

Two extreme production situations are high-volume, low-variety (H-L) and low volume, high-variety (L-H).

Between these two extremes there is an important mid-volume, mid-variety (M-M) production situation.

.

(Refer Slide Time: 05:33)

Five types of manufacturing systems with respect to volume and variety are:

1st one is the transfer line at one extreme transfer line and then you have the second extreme that is the stand-alone numerical control machines.

Third one is called manufacturing cell. Fourth one is special manufacturing system special type and last one is flexible manufacturing system.

(Refer Slide Time: 07:13)
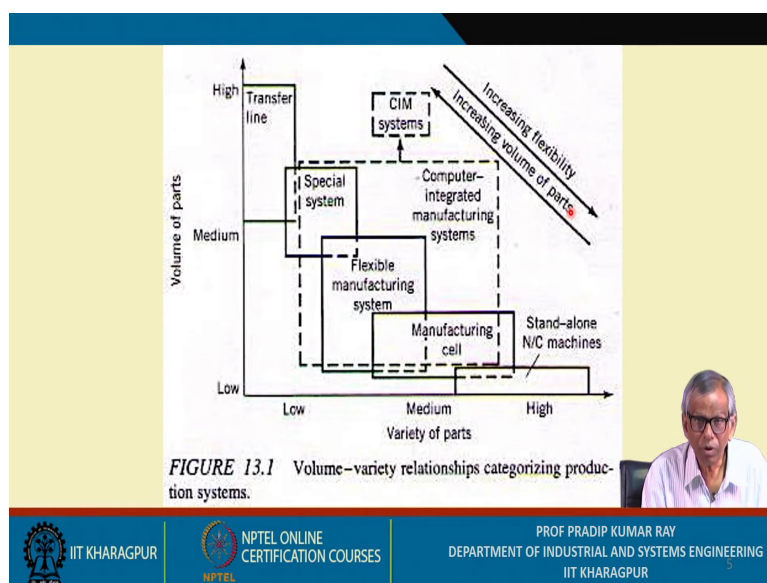
Now, let us look at this particular figure and in the text book we will find this figure is elaborately discussed. Now, here the x-axis is varieties of part varieties and y-axis represents the volume of parts or say production volume number of units you produce per unit, sometimes there are referred to the lot size also.

Now, here at one extreme you have the transfer line means, the volume of parts is very high and, but the variety is very low. And then the other extreme not many parts you can produce with stand alone NC machine. Here as you are dealing with more varieties against stage variety the production the volume is less.

It is basically the low volume and high variety. In between, You have the CIM system, there will be some amount of overlapping, but ignore that overlapping part otherwise the CIM framework is applicable between transfer line and stand-alone NC machines between these two extremes.

And, within the CIM there could be three types of in the manufacturing system. The first one is the special system, this is very unique, few particular parts or the system you have developed your core competency and you are concentrating only those products or those parts.

So, in course of time your manufacturing system becomes a special type. There are some special characteristics you have in your manufacturing system and your manufacturing system is known by its special characteristics only.

And, when you refer to that particular company's manufacturing system and if you visit those manufacturing systems you will find that these are all special systems. And another extreme you go to manufacturing cell means, first you are dealing with hundreds and thousands of parts and the low-volume, high-variety. Your next step is to convert your manufacturing system into cellular manufacturing system.

So, the manufacturing system is referred to as the manufacturing cell formation approaches. And when the special system under certain condition may become a flexible manufacturing system or a manufacturing cell under certain conditions may move towards a system called flexible manufacturing system.

Usually when we study the characteristics of the FMS, you will find that it is more similar to cellular manufacturing system or the manufacturing cell and it is less similar to the special manufacturing cell. Now, there are other there are two other important the dimensions; one is the increasing flexibility.

So, at the transfer line level the flexibility is very less whereas, at the stand-alone NC machine level the flexibility level flexibility is very high. So, this is the increasing flexibility, but in the opposite direction you have the increasing volume of parts. So, these are basically inverse relationship between these two.

(Refer Slide Time: 12:47)

First one is the high-volume low-variety production system; next one is the low-volume high-variety production system, third one mid-volume mid-variety production system. And this is also the classified under three specific types within CIM framework.

Both integration and automation need to be considered simultaneously both flexibility and production volume objectives to be fulfill concurrently.

(Refer Slide Time: 14:24)

Now, depending on the degree of integration and level of automation, the M-M manufacturing systems popularly known as computer-integrated manufacturing systems can be further classified as:

i.   Manufacturing cell

ii. Special manufacturing system

iii. Flexible manufacturing system

(Refer Slide Time: 15:05)

Let us talk about certain characteristics of the manufacturing cell. The design of manufacturing cells is based on the concepts of group technology. Main objective is to process part families or a group of NC machines within a cell, so that the intercellular material-handling movement and cost is minimized.

Within a machine cell, CNC machines may be linked together by a direct numerical control system.

(Refer Slide Time: 16:18)

In a special manufacturing system, the machines are laid out to manufacture a family of parts based on the sequence of operations means, is a combination of not only one transfer line, but the several production lines or the transfer line or assembly lines, and from each assembly line the standard product is coming out.

Material handling systems determine links the machine layout as well as the sequence of operations the parts move on the material handling system in a sequence from machine to machine.

(Refer Slide Time: 17:16)

Volume-Variety Relationships For Understanding Production Systems

❑ Flexible Manufacturing Systems
- As stated already, a flexible manufacturing system or FMS lies between the two extremes, H-L and L-H: a manufacturing cell and a special manufacturing system.
- It is essentially a mid-volume, mid-variety manufacturing system, having a higher production rate than a manufacturing cell and much more flexibility than a special manufacturing system, closer to a cell manufacturing system.
- An FMS is characterized by a higher level of computer control and more non-machine activities, such as coordinate measuring machines (CMM), and part washers.

IIT KHARAGPUR | NPTEL ONLINE CERTIFICATION COURSES | PROF PRADIP KUMAR RAY DEPARTMENT OF INDUSTRIAL AND SYSTEMS ENGINEERING IIT KHARAGPUR | 10

A flexible manufacturing system lies between the two extremes, a manufacturing cell and a special manufacturing system. It is essentially a mid volume mid variety manufacturing system having higher production rate than a manufacturing cell. Look at this particular figure and much more flexibility than a special manufacturing cell, closer to a cell manufacturing system. And FMS is characterized by a higher level of computer control and more non-machine activities.

Non machine activities mainly like say non-machining activities say loading, unloading like fixturing, the clamping, these activities also will be there, and you also go for inspection. So, for inspection of the items being produced for FMS you use coordinate measuring machine the CMM, this is part of the FMS as well as the part washers.

(Refer Slide Time: 19:30)

These are the five types, already we have mentioned the five types of manufacturing system.
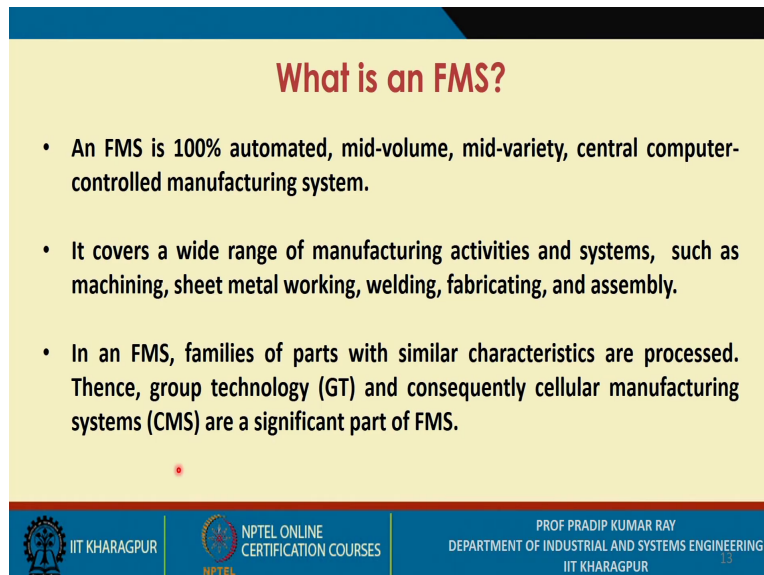
(Refer Slide Time: 19:36)

A mid volume mid variety manufacturing system consisting of a series of flexible machines., automated material-handling systems, automated tool changers.

Other equipment such as coordinate measuring machine, part washers an automated the part washing system and so on all under high level centralized computer control. These are the key features of a flexible manufacturing system.

When you start working with an FMS what are the kinds of problems you need to deal with. So, there are say 7 or 8 different kinds of problems you have to deal with, all these problems are to be the formulated, and once the formulation is done then you search for the solutions, the different types of constraints, the different objectives and decision variables, the parameters all these details need to be considered.

It allows both sequential and random routing of a wide variety of parts, there is no routing. That means, it is not only suitable for one process plan, but alternate the process plans for the same part you can also use. Higher production rate than a manufacturing cell and much higher flexibility than a special manufacturing system.

(Refer Slide Time: 22:19)
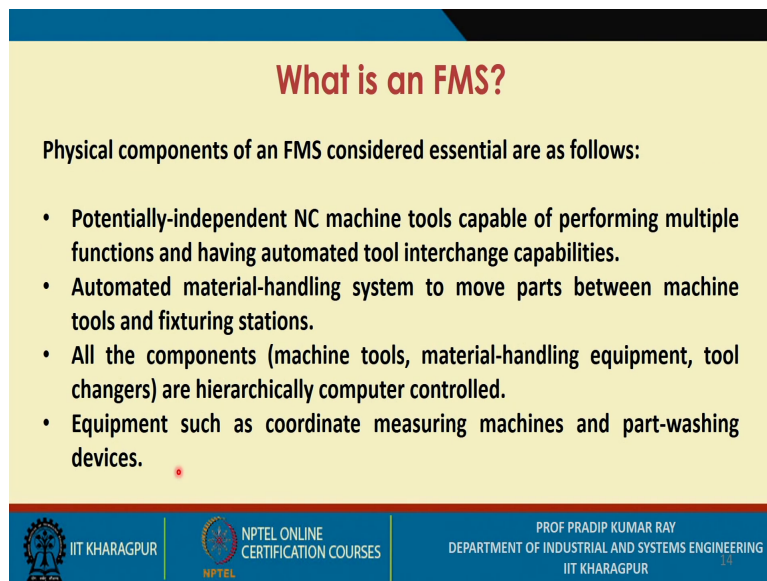
An FMS is an automated, mid-volume, mid-variety, central computer-controlled manufacturing system. It covers a wide spectrum of manufacturing activities such as machining, sheet metal working, welding, fabricating, and assembly. In an FMS, families of

parts with similar characteristics are processed. Therefore, group technology (GT) and consequently cellular manufacturing are significant parts of the system.

(Refer Slide Time: 25:57)

The physical components of an FMS considered essential are as follow:

First one is Potentially independent NC machine tools capable of performing multiple functions and having automated tool interchange capabilities.

Second one is Automated material-handling system to move parts between machine tools and fixturing stations.

Third one is All the components (machine tools, material-handling equipment, tool changers) are hierarchically computer controlled.

Fourth one is Equipment such as coordinate measuring machines and part-washing devices.

(Refer Slide Time: 28:46)

What is an FMS?

How does an FMS work?
- Before machining is started on the parts, they are mounted onto fixtures.
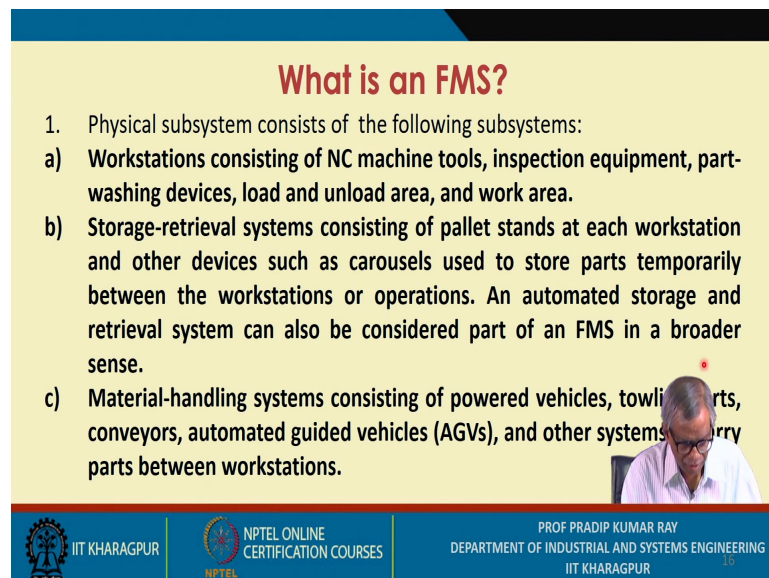- Both the parts and the fixtures are then mounted onto special pallets.
- The material-handling system moves the pallets to the machining centers for processing.
- If a machining center is busy, the pallets are automatically transferred to an idle machining center, thereby ensuring effective utilization of the FMS.
- An FMS consists of two subsystems:
  1. Physical subsystem
  2. Control subsystem

IIT KHARAGPUR

NPTEL ONLINE CERTIFICATION COURSES

PROF PRADIP KUMAR RAY
DEPARTMENT OF INDUSTRIAL AND SYSTEMS ENGINEERING
IIT KHARAGPUR

Before machining is started on the parts, they are mounted onto fixtures.

Both the parts and the fixtures are then mounted onto special pallets.

The material-handling system moves the pallets to the machining centers for processing.

If a machining center is busy, the pallets are automatically transferred to an idle machining center, thereby ensuring effective utilization of the FMS.

A flexible manufacturing system consists of two subsystems:

1. Physical subsystem

2. Control subsystem

(Refer Slide Time: 31:58)

(Refer Slide Time: 32:03)

The control subsystem required to ensure optimum performance of the FMS includes the following:

a) Control hardware, which includes mini- and microcomputers, programmable logic controllers, communication networks, sensors, switching devices and many other peripheral devices such as printers and mass storage memory equipment.

b) Control software consisting of a set of files and programs used to control physical subsystems. It is important to have hardware and software compatibility for efficient control of the FMS.

(Refer Slide Time: 32:15)