Automation in Production Systems and Management
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Flexible Manufacturing Systems (Part - I)
Lecture - 36
Types and Definitions of Different Type of Flexibility in Manufacturing Systems

This is the 8th week. And during this week lecture classes I am going to discuss very important topic called Flexible Manufacturing Systems.

And when you try to automate a system the two important aspects should be known, that first one is kind of the technology and second one is an ideal automated manufacturing system.

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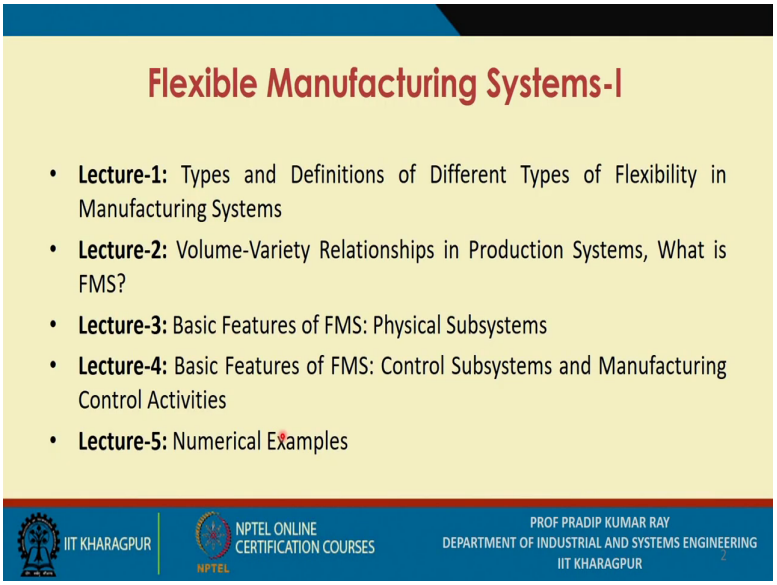

During this week we have 5 lecture sessions. In the first lecture session we will be discussing in detail the types and definitions of different types of. Lecture 2 deals with Volume-Variety Relationships in Production Systems, What is FMS? Lecture 3 deals with Basic Features of FMS: Physical Subsystems. Lecture 4 deals with Basic Features of FMS: Control Subsystems and Manufacturing Control Activities. Lecture 5 deals with types of problems in FMS.

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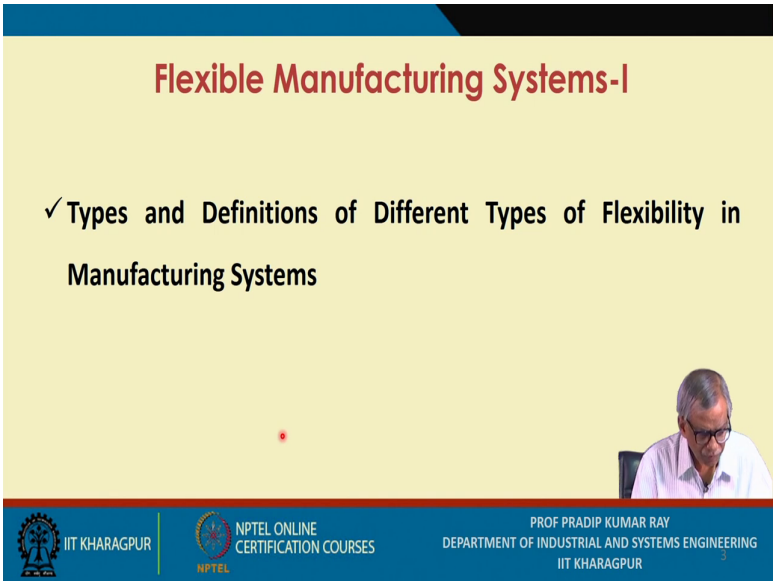

So, now during this lecture session I will be referring to the different kinds of the flexibility, you must be able to define flexibility from several perspectives in the given context. And you also must be able to measure them and we are always referring to the manufacturing system.

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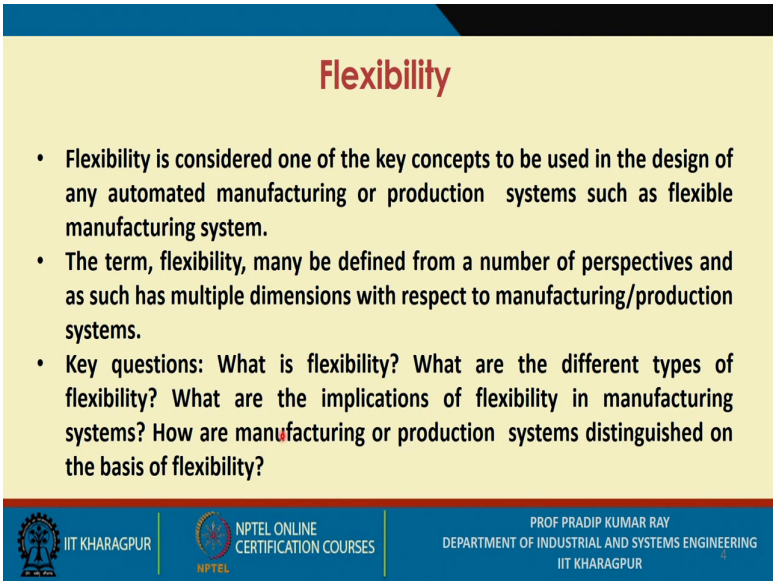

Let me just elaborate on these issues.

flexibility must be defined in explicit terms, the flexibility is considered one of the key concepts to be used in the design of any automated manufacturing or production system, such as flexible manufacturing system.

Manufacturing system within a company is having a product mix and in the product mix there are different types of products against each product there could be different models.

Flexibility is the cornerstone of and one of the key concepts used in the design of modern automated manufacturing systems such as flexible manufacturing system.

Flexibility has multiple dimensions and the concept of flexibility still remains vague.

What is flexibility? What are the different types of flexibility? What are the implications of flexibility in manufacturing systems? How are manufacturing systems distinguished on the basis of flexibility?

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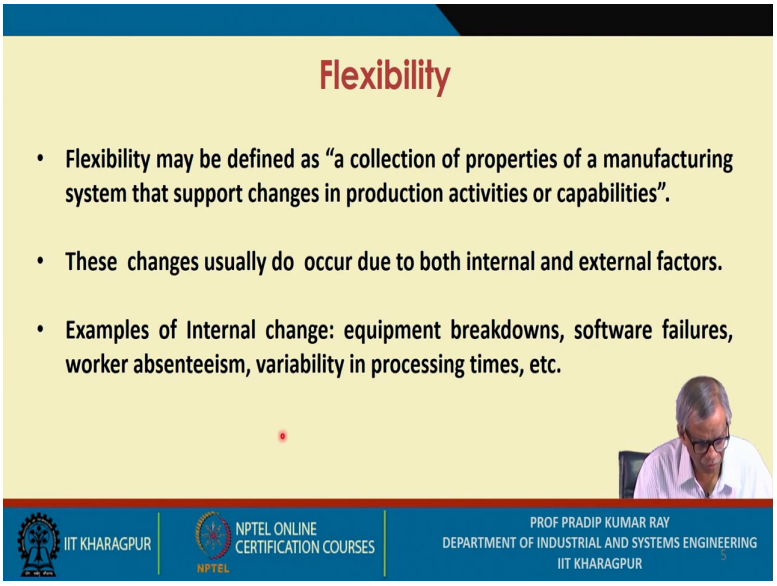

Flexibility can be defined as a collection of properties of a manufacturing system that support changes in production activities or capabilities.

Normally, the changes are due to both internal and external factors.

Why do you want to have the flexibility in your production system? It is assumed that there could be changes, and whether you are able to the address the problems related to such changes occurring. The characteristics are changing the operational characteristics of a manufacturing system may change at any point.

And whether you are able to meet or maintain the same level of production with same quality even if there are changes taking place, in the characteristic features or the operational features of the manufacturing system, these changes usually do occur due to both internal and external factors.

The examples of internal change like equipment breakdown. This machine is running suddenly it breaks down whether you can maintain the production level or not. So, if equipment is down and I cannot do anything, the flexibility from this perspective is 0 there is no flexibility at all as far as production is concerned, there is no production flexibility. Whether you allow this sort of condition right. You need to know what is production flexibility and you have one commitment, suppose per hour or per day I must produce this much.

There could be some variations, but if suppose there is no production at all then whether this condition is acceptable or not. And if you accept this then cost implication is it clear.

Software failures might happen means, entire flow of materials gets stopped there will be no flow of materials, there will be no production. Worker absenteeism there could be many reasons for this one.

Variability in processing times, the variability is not by small variability the value of sigma is very high. And if you do not have control on the sigma then you may lose control on the entire system.

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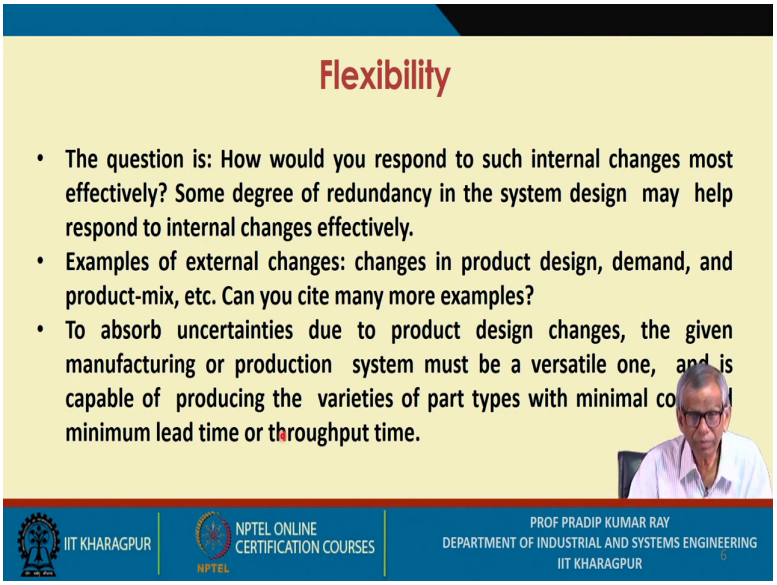

The question is: how would you respond to such internal changes most effectively? Some degree of redundancy in the system design may help respond to internal changes effectively.

There are many kinds of problems those problems are to be formulated and all will be numerical examples we will be referring to, but the key issue is the flexibility, if suppose you run a particular FMS and you run it only for a specific product mix so that cannot be justification for running FMS.

Examples of external changes there are many examples like changes in product design, this is a very important issue changes in product design and normally what happens you start with one design, but it does not mean that you will not be getting an improved design.

So, suppose you create your manufacturing system only for one particular design or one type of design that is referred to as the design level. Now, in the next month or the next year the new design has come up for the same product as the technology has changed and the new design is based on the newer technology or the state-of-the-art technology, but then you say that the same manufacturing system cannot be used.

It is rigid with respect to a particular product design means, there is no flexibility. So, this is not acceptable in today's context.

But, suddenly suppose the demand changes to some higher value and then you say that I cannot produce the extra one, what will happen? Ultimately its implication is that the production cost will be will be increasing very much. And at certain point in time that the production cost they become out of control and their entire system suffers entire company suffers.

This is the demand and there could be change in the product mix.

To absorb uncertainty due to the product design changes the given manufacturing or production system must be a versatile one and is capable of producing the varieties of part types with minimal cost and minimum lead time or throughput time.

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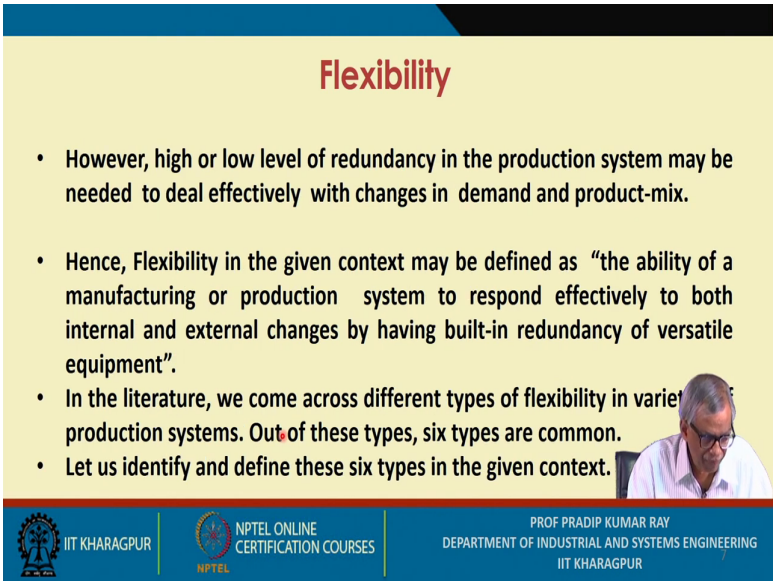

However high or low level of redundancy in the production system may be needed to deal with effectively the changes in demand and product mix, some sort of redundancy has to be there, whether it can start with a low-level redundancy, later on it could be the manufacturing system expands. So, you can opt for say high level redundancy, any manufacturing system has its own configuration.

when you look at the configuration and you can definitely get an idea and you can also measure the level of redundancy. Hence flexibility in the given context may be defined as the ability of a manufacturing or production system to respond effectively to the both internal and

external changes, by having built in redundancy of versatile equipment or general-purpose equipment.

In the literature we come across different types of flexibility in varieties of production systems out of these types 6 types are common so now, let us identify them and define these 6 types.

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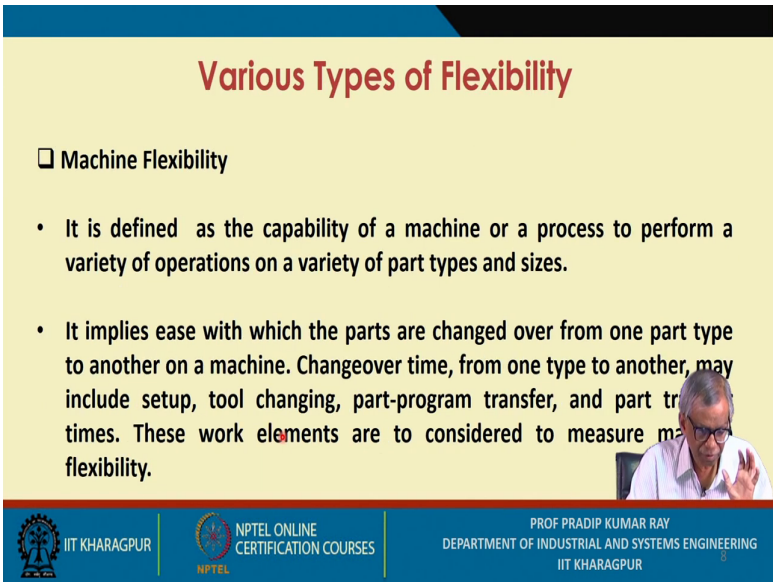

First one is the machine flexibility. It is a capability or ability of a machine or a process to perform variety of operations or a variety of part types and sizes, it implies ease with which the parts are changed over from one part type to another on a machine.

The changeover time, which includes setup, tool changing, part-program transfer, and part move times, is an important measure of machine flexibility.

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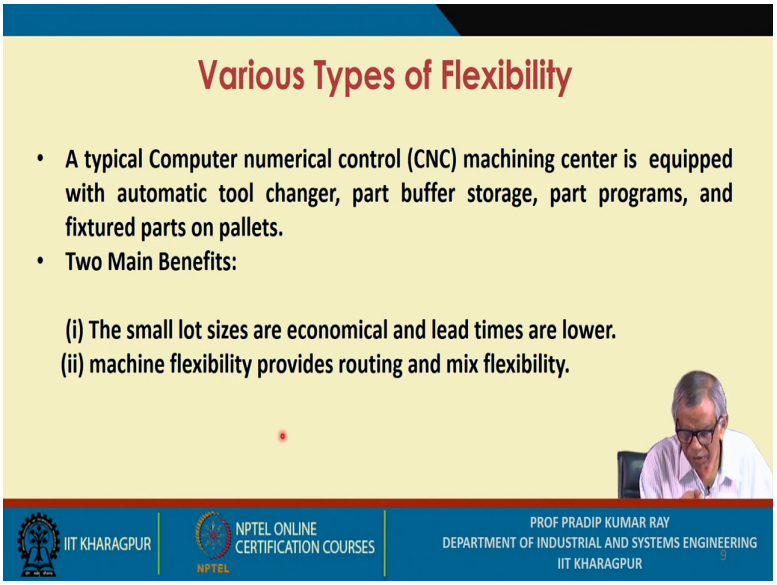

Computer numerical control (CNC) machining centers are normally equipped with automatic tool changer, part buffer storage, part programs, and fixtured parts on pallets.

Two main benefits are, the small lot sizes are economical and lead times are lower and the machine flexibility provides routing and mixed flexibility.

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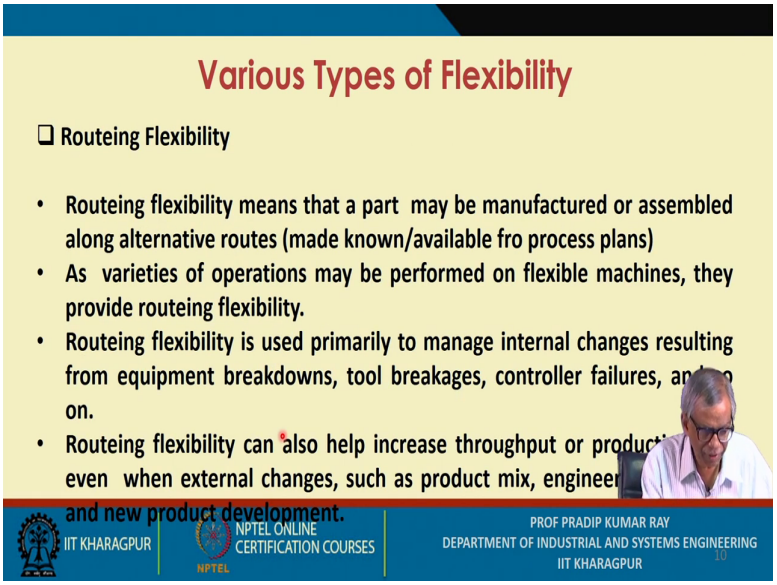

Next one is the routing flexibility:

Routing flexibility means that a part(s) can be manufactured or assembled along alternative routes.

Because a wide variety of operations can be performed on flexible machines, they provide routing flexibility.

Routing flexibility is used primarily to manage internal changes resulting from equipment breakdowns, tool breakages, controller failures, and so on.

Routing flexibility can also help increase throughput in the presence of external changes such as product mix, engineering changes, or new product introductions.

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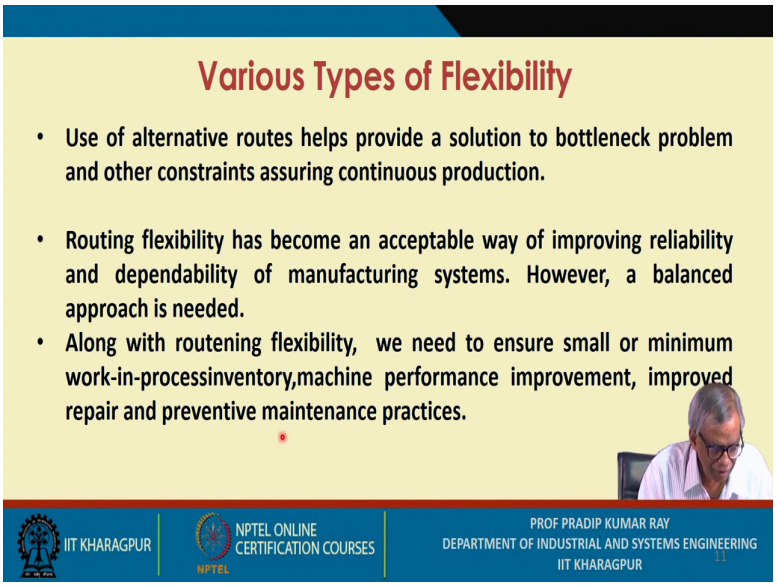

The use of alternative routings helps provide relief, thereby resolving the bottleneck problem and permitting increased production.

Routing flexibility is becoming a more acceptable means of improving the dependability of manufacturing systems. However, a balanced approach is required, employing a combination of small work-in-process buffers, machinery improvements, better repair and preventive maintenance practices, and routing flexibility.

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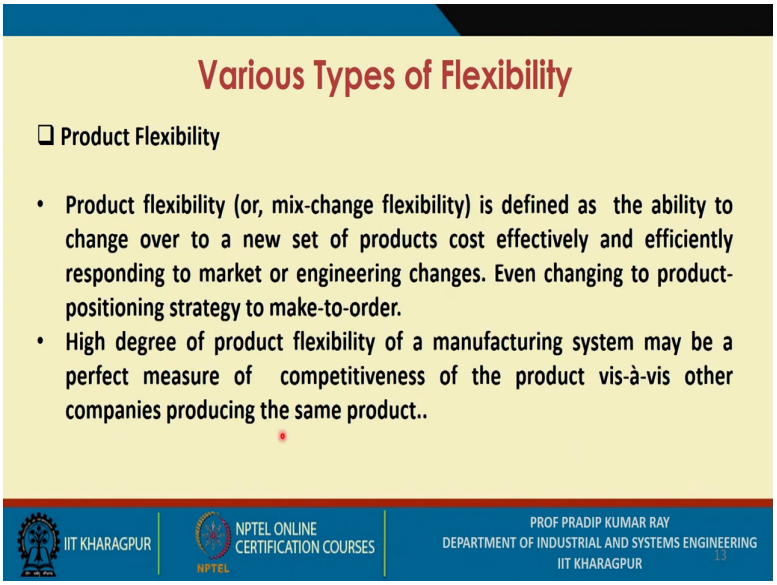

Next comes a process flexibility or mix flexibility product mix flexibility

Process flexibility, also known as mix flexibility, refers to the ability to absorb changes in the product mix by performing similar operations or producing similar products or parts on multipurpose, adaptable, CNC machining centers.

Mix flexibility provides protection against market variability by accommodating changes in product mix due to the use of shared resources.

However, extreme mix variations would result in requirements for a greater number of tools, fixtures and other resources.

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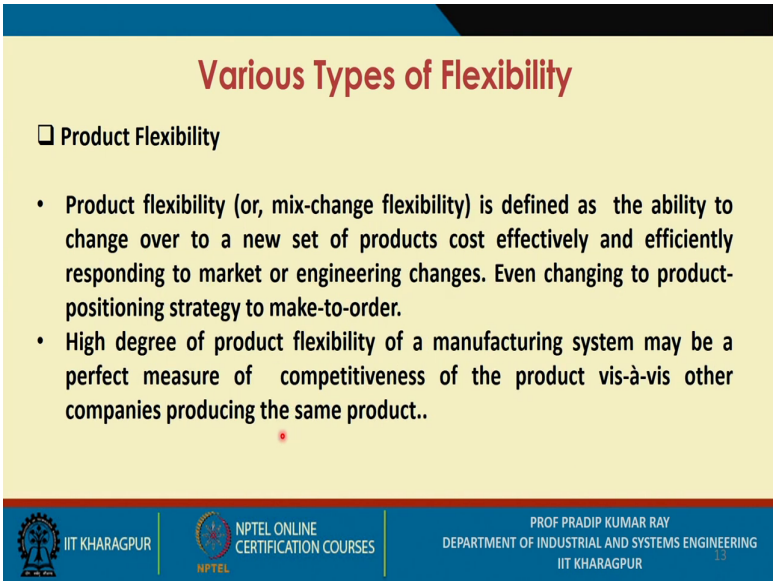

Next one is the product flexibility,

Product flexibility, also known as mix-change flexibility, refers to the ability to change over to a new set of products economically and quickly in response to markets or engineering changes or even to operate on a make-to-order-basis.

The product flexibility of a manufacturing system in a company is a barometer of its competitiveness.

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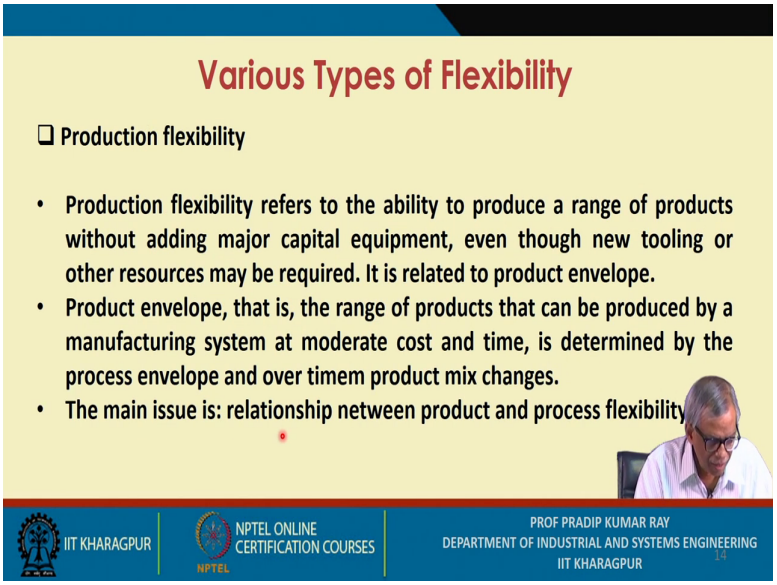

Production flexibility is basically the volume one, like today you can produce say 100 units per hour, suppose you need 150 units per hour to produce whether the same machine can be used or not or same manufacturing system can be used or not, with almost the same cost.

Sometimes what happens that we refer to under utilizations over utilizations, previously we used to have a system where unless full capacity is utilized at least 80 to 90 percent of the capacity of the process is used, you cannot say that it is cost effective.

What has happened even if you go for under utilizations or over utilizations of a specific resource so the machine tool and there will be some changes in the cost, but those change in the production cost will be minimal or marginal, that is the advantage.

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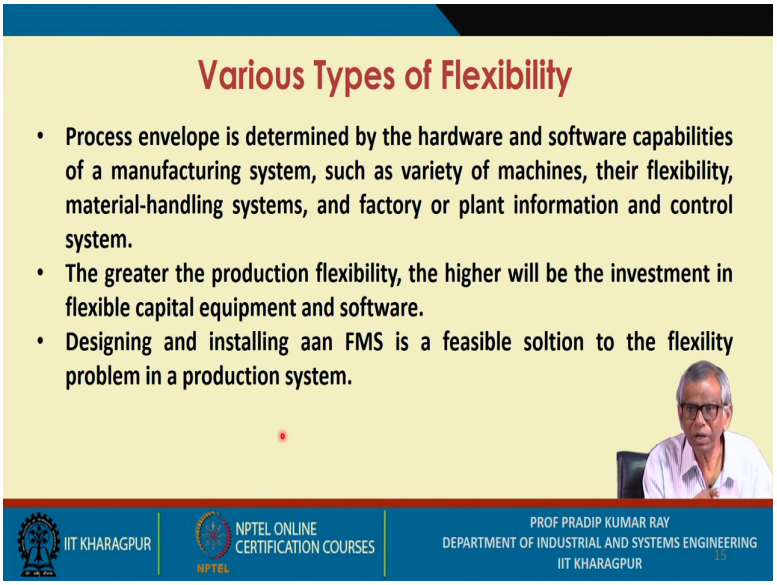

Process envelope in turn is determined by the hardware and software capabilities of a manufacturing system, such as variety of machines, their flexibility, the material-handling system, and the factory information and control system.

The greater the production flexibility, the higher will be the investment in flexible capital equipment and software.

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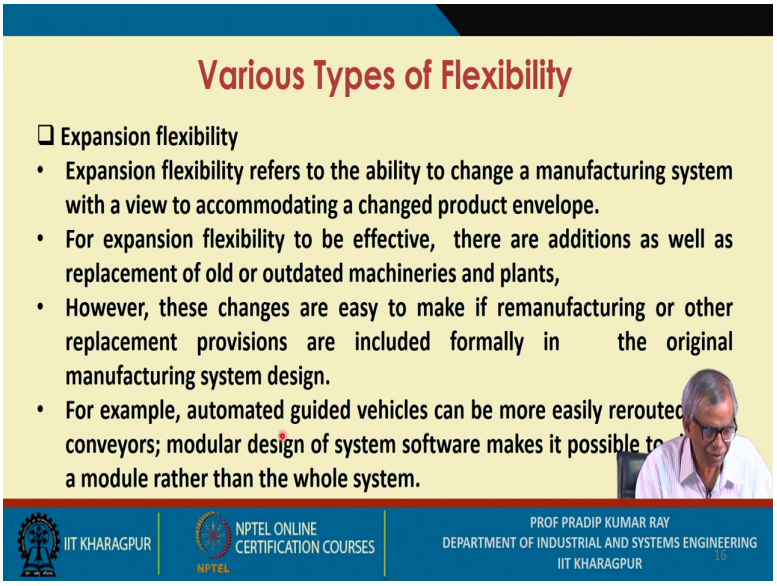

And the last one is expansion flexibility, you have a manufacturing system. And suppose a new machine is to be there to be installed how easily and effectively you can install it, this is referred to as expansion flexibility, it refers to the ability to change a manufacturing system with a view to accommodating a changed product envelope. So, there are 6 types of the flexibility measures we have referred to.

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