Automation in Production Systems and Management
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Lecture - 13
Sequential and Concurrent Engineering Approaches for Product Development

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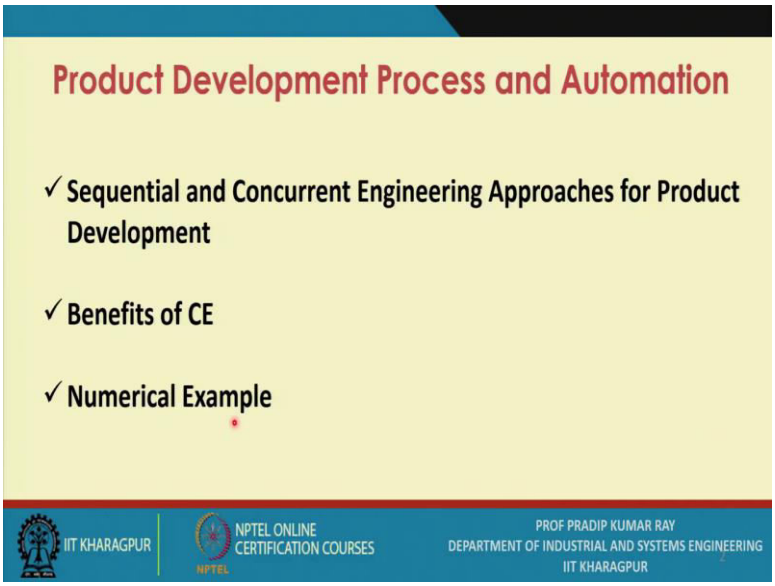

During this lecture session, I am going to discuss the Sequential and Concurrent Engineering Approaches for Product Development and I will also highlight the several benefits of Concurrent Engineering. There will be a few numerical examples and once you go through these numerical examples, the difference between the Sequential and Concurrent Engineering Approaches will be made very clear.

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You will also come to know that under what conditions you must opt for concurrent engineering. For adopting concurrent engineering approach you have to fulfill certain conditions and for fulfilling such conditions, many times, at the systems level, you have to make certain change.

Market share and profitability are the major determinants of the success of any organization Point number two is, the factors that influence and improve the competitive edge of a company are unit cost of products, quality and lead time.

So, these are the within the production system and you run your production system in such a way that you have sufficient control on the unit cost of products, quality and the lead time.

If you lose control on the cost of product or you lose control on the quality of the product or you lose control on the manufacturing lead time, you just cannot have market share as well as the profitability.

Concurrent engineering has emerged as a discipline to help achieve the objectives of reduced costs, better quality, and improved delivery performance.

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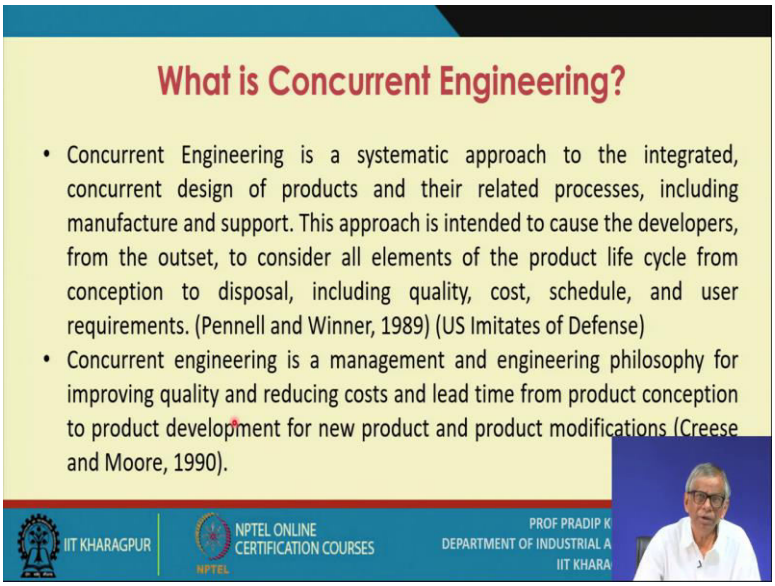

There the certain definitions are given. What is concurrent engineering? It is a systematic approach to the integrated, concurrent design of products and their related processes, including manufacture and support. This approach is intended to cause the developers, from the outset, to consider all elements of the product life cycle from conception to disposal, including quality, cost, schedule and user requirements.

That means you have a firm control on the manufacturing processes. This is US department of the Defense and they have defined concurrent engineering like this and as we have already pointed out that there are many world class companies they have adopted concurrent engineering.

Concurrent engineering is a management and engineering philosophy defined for improving quality and reducing costs and lead time from product conception to product development for new product and product modifications. So, either for a new product you can use concurrent engineering approach and even for the existing products you can adopt concurrent engineering approach. You may find that what the existing product currently you are using by simultaneous engineering approach.

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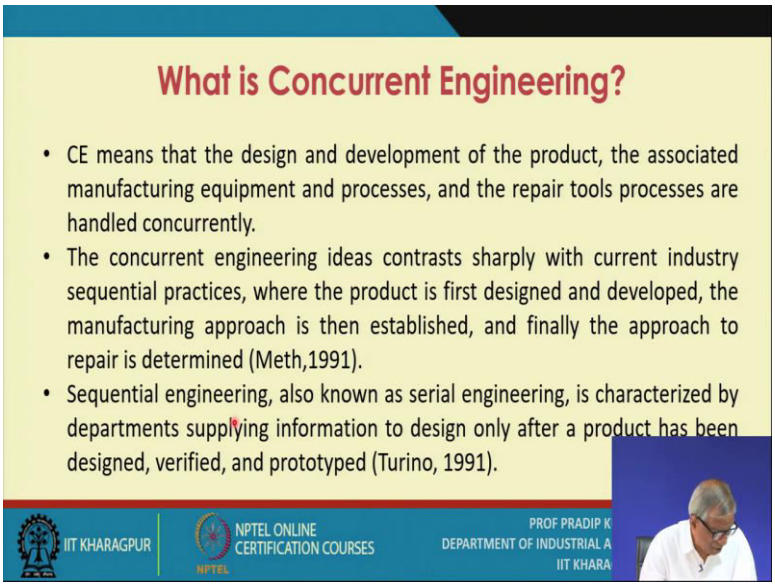

By making certain changes in the system, you can opt for the concurrent engineering approach even for the existing product. CE means that the design and development of the product, the associated manufacturing equipment and processes, and repair the tools processes are handled concurrently.

Primarily if you use computer at each level, then you need to have the best possible integration between CAD, CAPP and CAM (Computer Aided Design, Computer Aided Process Planning and Computer Aided Manufacturing).

The concurrent engineering ideas contrasts sharply with current industry sequential practices, the industries which are still continuing with the sequential engineering or serial engineering, where the product is first designed and developed, the manufacturing approach is then established and finally, the approach to repair is determined.

Repair means related to the maintenance. When you go for manufacturing, fundamentally you are referring to the operations and against each operation there could be maintenance always.

You cannot think of any operation without maintenance. For all these activities, their relationships should be known and you must adopt an integrated approach.

Sequential engineering, also known as serial engineering, is characterized by department supplying information to design only after a product has been designed, verified and prototyped. The design department is working separately.

Similarly, the production department is working separately or and you will not find that the designers at the shop floor and similarly you will never find the production personnel at the design department. There is no group activity involving design and manufacturing.

First you get the design and then the manufacturing system is asked to produce as per the design. It is just one way whereas, if you opt for concurrent engineering approach it is a two-way communication. That means, is a closed loop control.

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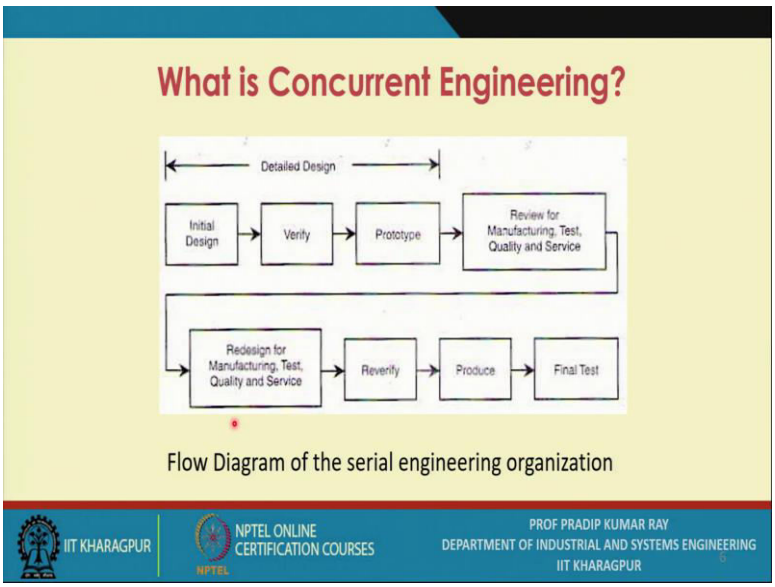

This is a typical serial engineering approach. First you go for Initial design, then you verify, then you go for prototyping. This is referred to as a detailed design, then you go for review for manufacturing, testing, quality and service. Then you redesign for manufacturing, testing, quality and service and then you go for reverify, then you go for produce and then you go for final test.

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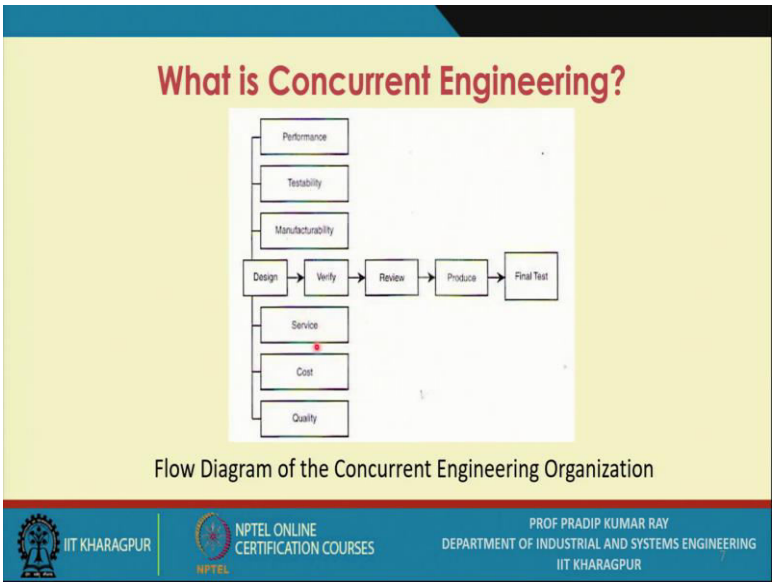

So, these are the activities you do. When you opt for concurrent engineering approach then at the design level you think about performance of the product, you think about the testability of the product, manufacturability or producibility of the product and then the serviceability of the product, cost of production, cost of product and similarly the quality of the product.

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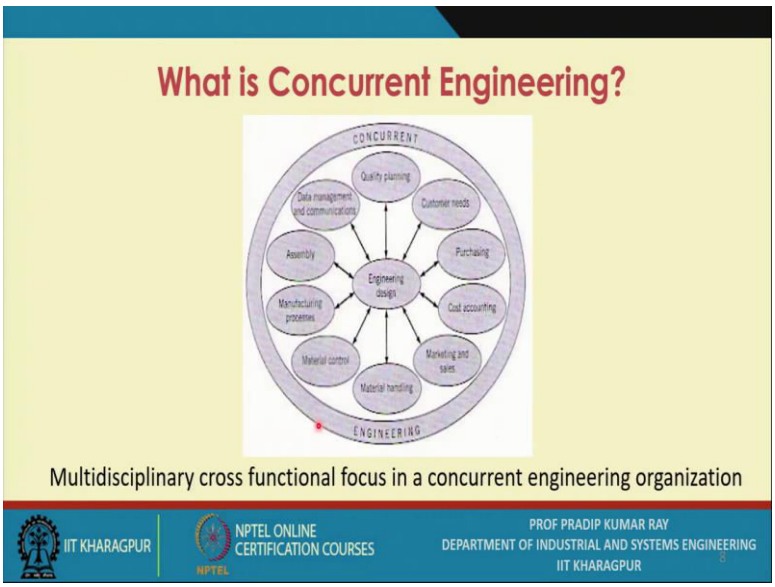

You try to create a central database which is referred to as the engineering design while you go for designing the product. You think of all these activities and how they are related to the quality planning.

Whether the kind of design you are offering, whether it is promoting quality planning or customer need satisfaction to what extent, then the purchasing related to the design and what is bill of material and you say, yes, 40 to 60% of the items listed in the bill of material are to be purchased from outside.

As soon as you afford the design, the design is frozen. So, you must know that what is the level of involvement of the purchasing department. Similarly, the cost accounting, marketing and sales, you have the material handling. Whenever you look at the design, look at its drawing, you will come to know that certain operations are to be carried out at different stages and what could be the transfer time between two stages and what kind of material handling system you will adopt.

Those details should be known. The process plan will be known and then the assembly part; when you refer to discrete part manufacturing system, the part manufacturing primarily we will be focusing on, but ultimately all these parts will be used for making the product; the product is sometimes referred to as the assembly.

How this design with the kind of design you offer, to what extent it is affecting the performance of the assembly department and then the data management and communication.

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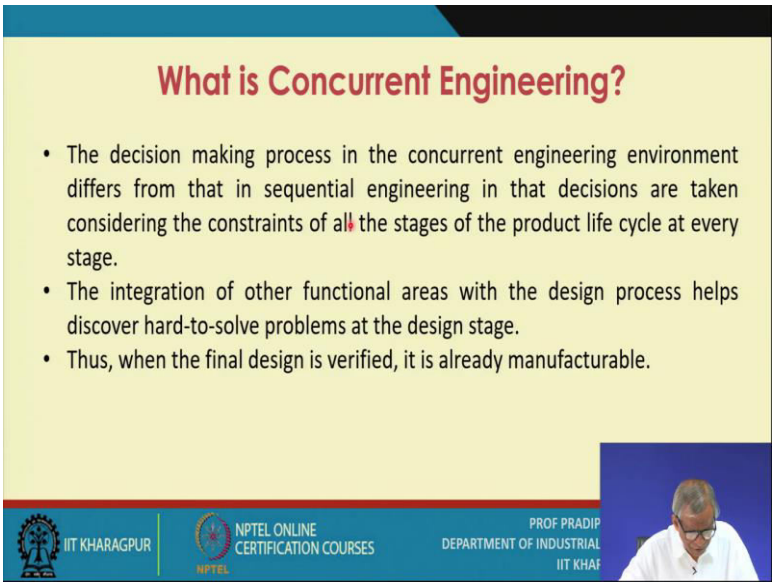

The decision-making process in the concurrent engineering environment differs from sequential engineering. The decisions are taken considering the constraints of all the stages of the product life cycle at every stage; what has happened in the previous stage and what is going to happen in the subsequent stage.

Those you must know when you are at the current stage and you are working on something to what extent it affects the performance of the subsequent stage as well as how your performance at the current stage is getting affected by the way the activities are being carried out in the previous stages.

While you try to integrate, while you try to optimize the performance of the entire system, you should be aware of this relationship. The integration of other functional areas with the design process helps discover hard to solve problems at the design stage.

You should be aware of the kind of design you are offering to, what extent it is affecting your performance of a particular system, called material handling system and to what extent it is affecting to the cost of production.

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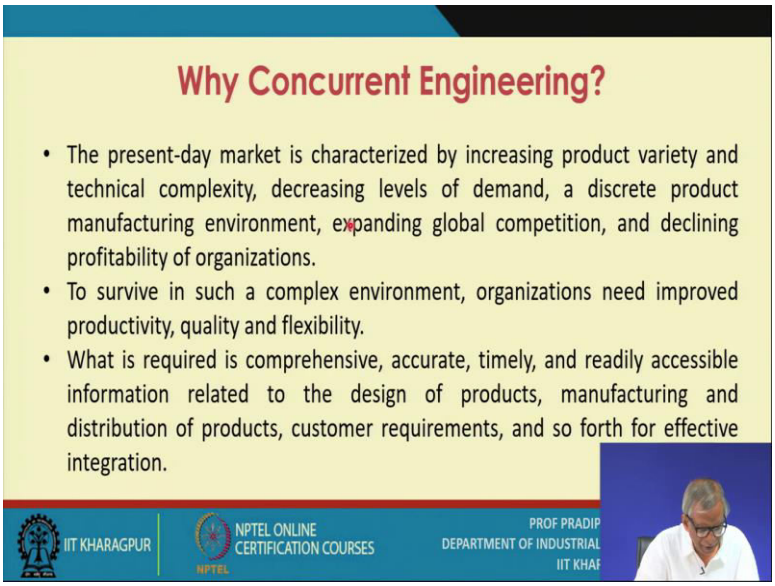

When you try to characterize the present-day market, you find that there are so many varieties of product with increasing product variety, constantly the change in the product mix and the technical complexity, decreasing level of demand, erratic demand pattern. Today, for a product you have a demand of say 140 units.

Next day or the next month your demand could be reduced to 10 and subsequent month suddenly the demand can increase to a level of 300 and the next month there may not be any demand at all-it is a erratic the demand pattern. If it is a decreasing level of demand it means that you are losing your market share, a discrete product manufacturing environment, expanding global competition, and declining profitability of organizations.

These are the problems majority of the companies face. To survive in such a complex environment, organizations need improved productivity, quality and flexibility. Flexibility has to be there, the flexibility in the product mix and the flexibility in the process mix also.

What is required is comprehensive, accurate, timely and readily accessible information related to the design of products, manufacturing and distribution of products, customer requirements, and so forth for effective integration.

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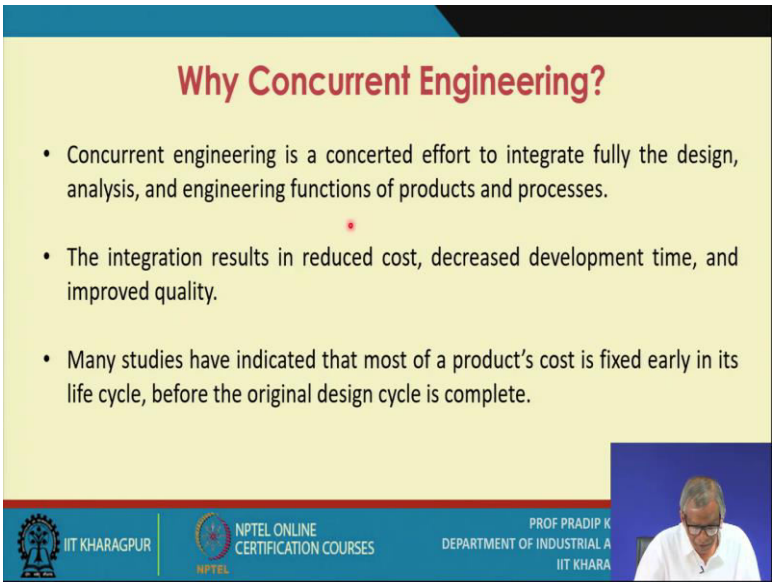

Concurrent engineering is a concerted effort to integrate fully design, analysis, and engineering functions of products and processes. The integration results in reduced cost, decreased development time, and improved quality. Many studies have indicated that most of the product's cost is fixed early in its life cycle; that means, once the design is frozen you will find that almost 80% of the product cost is already you have committed.

During the manufacturing stage, suppose you feel like changing the design, depending on the kinds of difficulties you find while you try to manufacture a particular design, but if you do that definitely you can make the changes, but its impact on the cost will be minimum, within 10 to 20% maximum.

While you freeze the design, make sure that this is your committed cost and committed cost is minimum and no further changes are required. That sort of assurance you have from the concurrent engineering approach.

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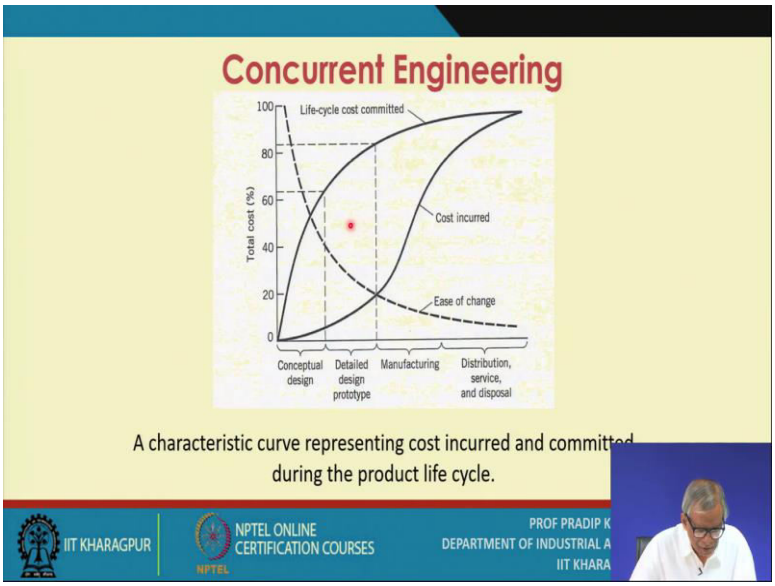

This is the curve. This is basically the product development stages like conceptual design, detailed design, prototyping, manufacturing, distribution, servicing and disposal. This is your conceptual design and then before the manufacturing starts. Suppose you freeze the design. Your committed cost will be more than 80%; that means, during the manufacturing stage if you opt for certain changes in the design, in the committed cost there is hardly any effect. Less than 20% of the total cost you can reduce. The cost incurred curve is like this, the curve as you proceed further and changing the design becomes more difficult.

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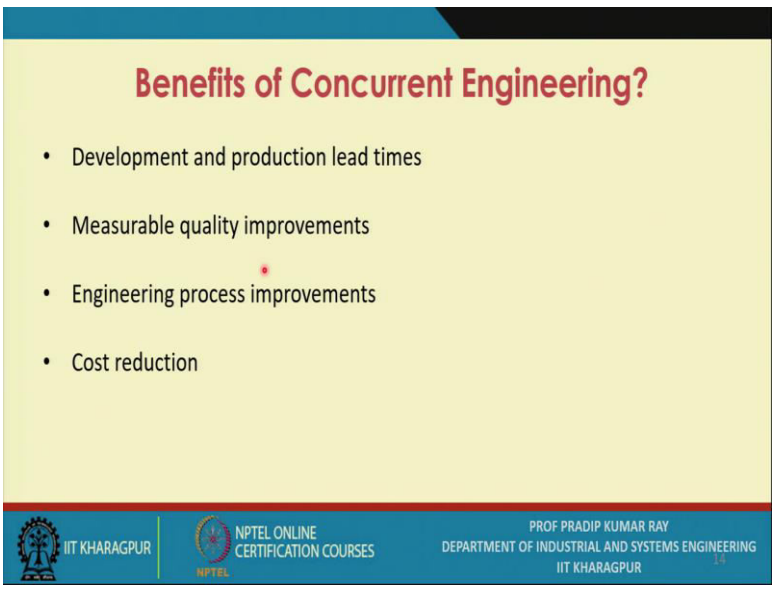

What are the benefits of concurrent engineering? There are many benefits when you implement the concurrent engineering approach. First is the development and production lead time. Development of the product.

If you opt for concurrent engineering, in majority of the cases, you will have enough control on the product development time. Similarly, when you start producing the product and the manufacturing system is working in very closely with the design department, you will find that the production lead time or the manufacturing lead time also is very less. The development time of for the product gets substantial reduction, significant reduction. The manufacturing lead time or the manufacturing lag time also will be reduced significantly.

Measurable quality improvements. You will find that if you opt for concurrent engineering approach, the data are made available to measure the quality performance criterion. How do you perform as far as the quality of design is concerned? Similarly, how do you perform when you consider the quality of conformance?

A number of the measures or the performance criteria you can recommend and you create the database in such a way that getting the data will not be a problem for measuring your performance with respect to the quality of conformance.

The product is put to use and the users or the customers are actually assessing or evaluating the performance of the product. Third advantage is engineering process improvements.

When you refer to a particular process, when you refer to a particular operation then a particular operation may be made available from not only from one particular machine tool, but also from several machine tools. You will opt for a machine tool where you get the minimum cost for carrying out that particular operation. This is one aspect.

Second aspect is the technological coefficient. The process performance improvement is assured once you adopt a particular improved technology by measuring two kinds of technological coefficient.

One is technological coefficient related to the input and the second one is technological coefficient related to the scrap.

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You can always estimate that cost and you say that if you adopt a new process to what extent the cost is reduced. In many large development projects, especially product development, lack of communication among members of the product development team can lead to extensive engineering design changes.

Each design change consumes time in the product development cycle. This increases in time to reach market can influence the acceptance of the product, market position, project cost and quality.

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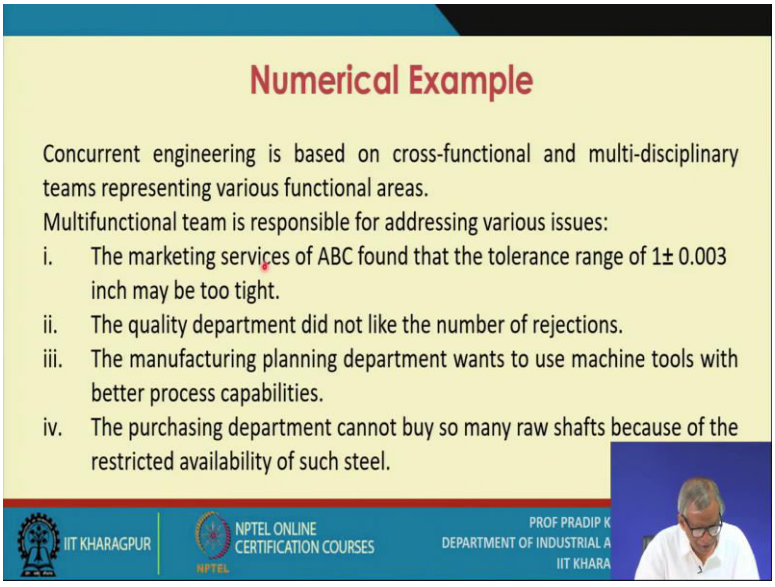

This is a numerical example. The marketing services of ABC found that the tolerance range of 1± 0.003 may be too tight. The quality department did not like the number of rejections. The manufacturing planning department wants to use machine tools with better process capabilities. The purchasing department cannot buy so many raw shafts because of the restricted availability of such steel.

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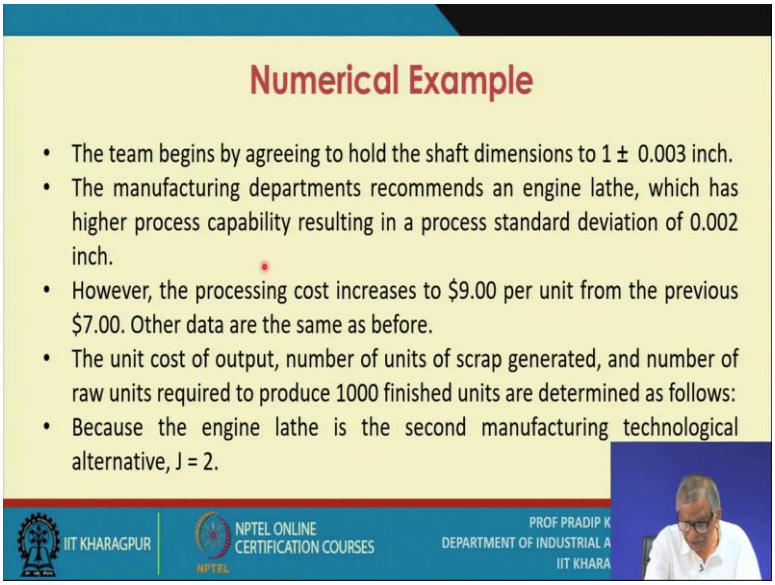

Ihe input quantity is quite high.

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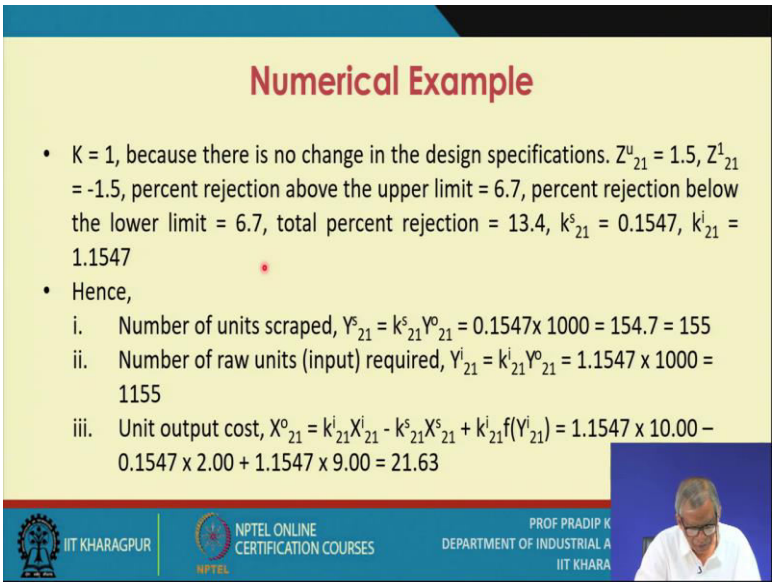

Ultimately what you find that the number of units scrapped with a better design. The team begins by agreeing to hold the shaft dimensions of 1 ± 0.003 inch, but then again you say that better you go for another process for which the process standard deviation is 0.002, that is the improved one, previously it was 0.003.

So, why do not you opt for another process for which the process standard deviation reflecting the variability is 0.002 only? With these changes, again you recalculate the values of Z, then the values of the technological coefficients, then the number of scrap units.

Number of the raw materials, the input quantity that also you determine and the unit output cost; that cost equation you use and get these values that is 21.63.

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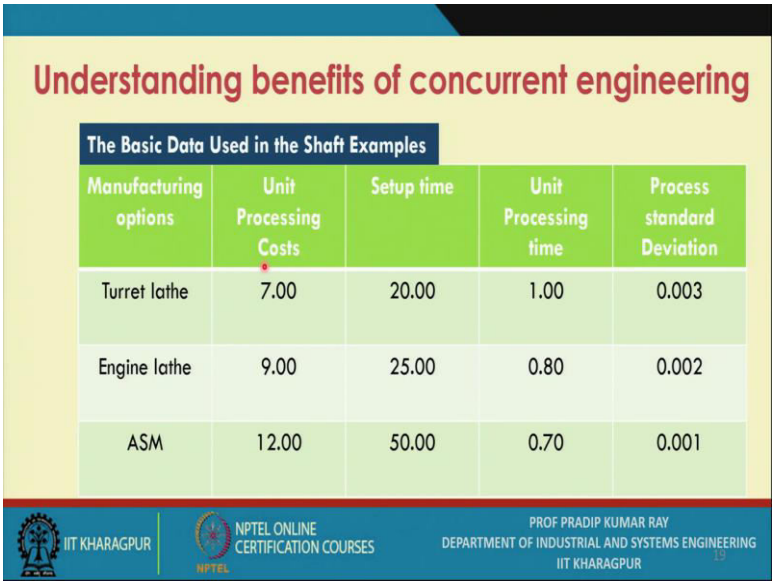

You can opt for turret lathe, you can opt for engine lathe, you can opt for automatic screw machine and these are the unit processing cost, setup time, unit processing time. You make a comparison.

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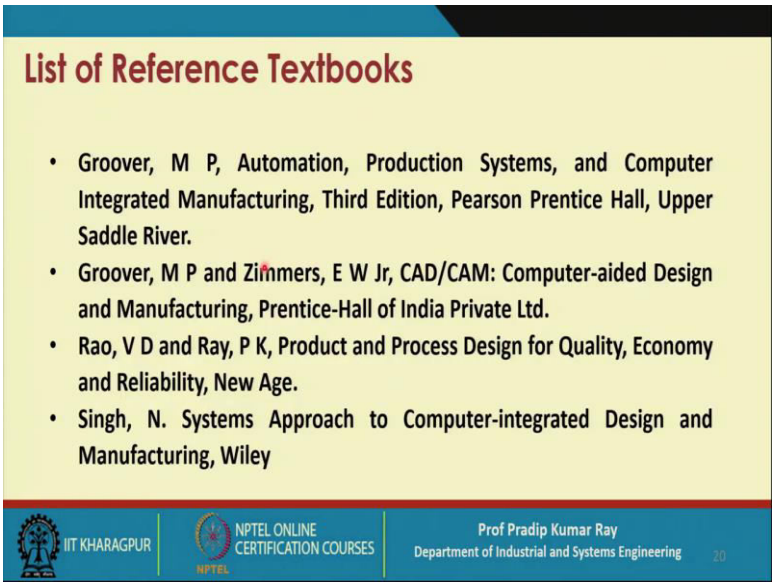

Given a particular design, most important thing is that you need to select a particular process and this relationship between a process and the design should be such that you have the enough control, significant control on the product cost.

You have significant control on the product quality in terms of the scraps you generate or the non-conforming you generate and you must have enough control on manufacturing lead time.

Under certain conditions you may opt for serial engineering, but for majority of the cases definitely you should opt for concurrent engineering or simultaneous engineering.