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Ergonomic Design for Manufacturing and Assembly
Lecture - 47
Product Design Assessment and Important Measures, Manual Assembly Design Efficiency: Use of Boothroyd Technique

Dear students and participant, this is the second lecture session of week 10.

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I will be discussing two important issues. Those are: Product Design Assessment and Improvement Measures and Manual Assembly Design Efficiency: Use of Boothroyd's Principles.

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So, now let us discuss first issue that is product design assessment and improvement measures. Given a particular product design or process design or workstation design you have to assess or you have to evaluate the existing design from the ergonomic or the human factors perspective.

There will be certain deficiencies and there will be certain recommendations and how to you to remove those deficiencies. What are the measures you can take; which are called improvement measures.

It is a design improvement measures have to be implemented. So, a product consists of a number of parts is, so in a typical manufacturing or production system what you will find part manufacturing, several kinds of machine tools and the process details are known followed by the assembly.

And we assume that there must be synchronous manufacturing. That means, we find that all the manufacturing shops or work places they are working, there is lot of noise.

Whereas as soon as you go to the assembly shop you will find there is hardly any noise. And if there is no noise what you will assume that there is no activity and immediately you conclude that this entire manufacturing system is not a synchronous.

And what we find that many a time the persons are involved in manual work while doing assembly. And because many such activities are not ergonomically designed. That is why the job satisfaction is less and people are not intrinsically motivated.

A product consists of a number of parts, and these parts are to be assembled following a number of steps in a sequence.

While assembling work is on, parts should be of certain features and quality that facilitate or simplify assembly operation at each step.

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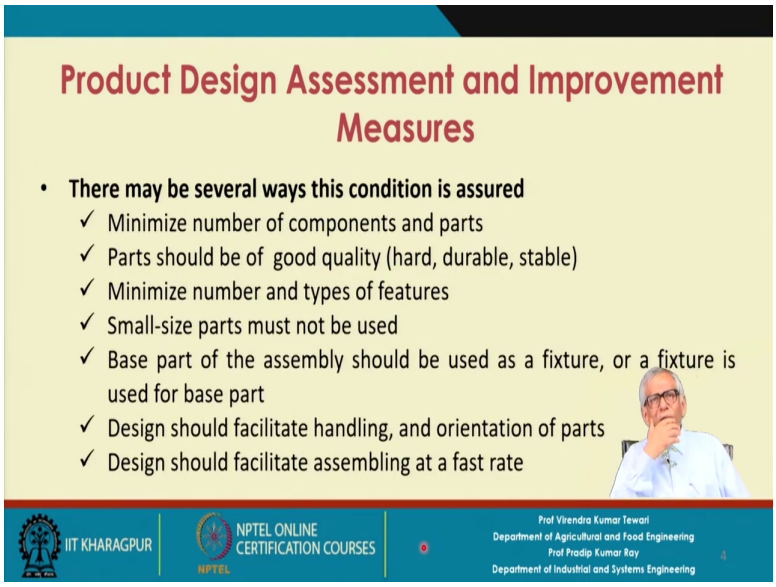

So, at each step you have to consider this aspect how you know this condition is assured. There may be several ways this condition is assured, they are as:

1. Minimize number of components and parts.
2. Parts should be of good quality (hard, durable, stable).
3. Minimize number and types of features.
4. Small-size parts must not be used.
5. Base part of the assembly should be used as a fixture, or a fixture is used for base part.

6. Design should facilitate handling, and orientation of parts.

7. Design should facilitate assembling at a fast rate.

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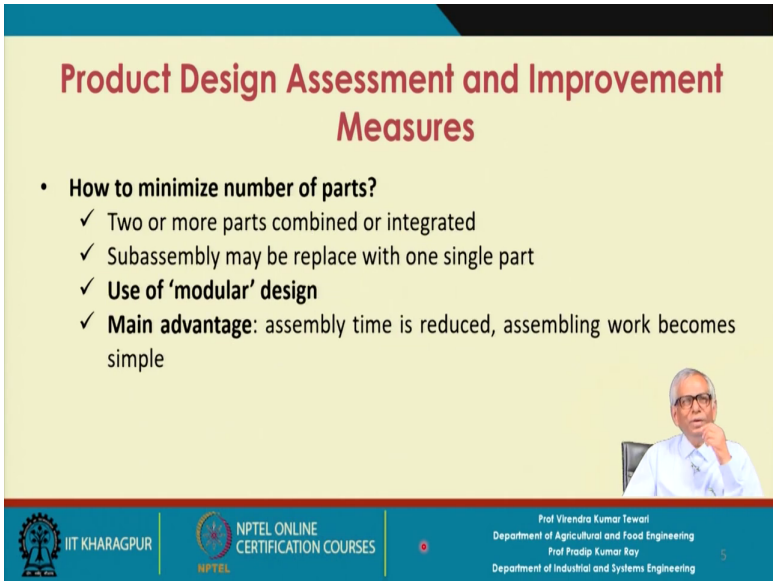

There are various ways to minimize number of parts, they are as follow:

1. Two or more parts combined or integrated.

2. Subassembly may be replaced with one single part.

3. Use of ‘modular’ design.

4. Main advantage: assembly time is reduced, assembling work becomes simple.

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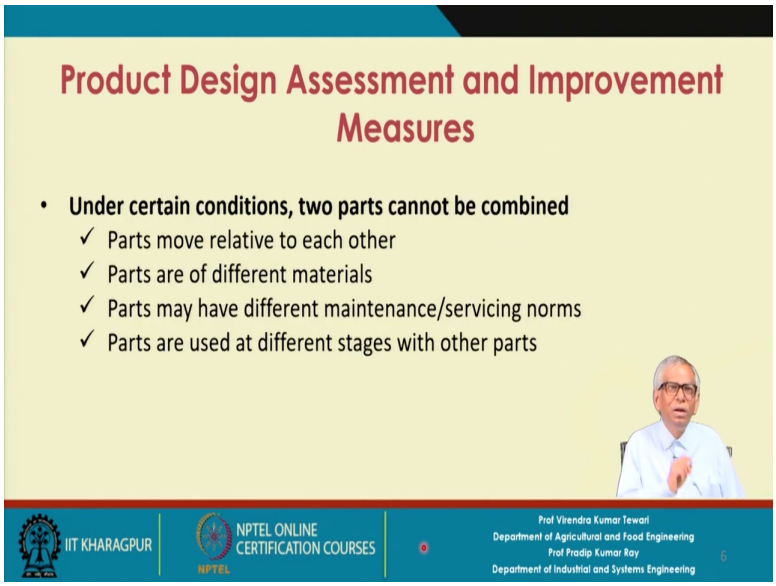

Under certain conditions two parts cannot be combined to minimize the number of parts the total number of parts. What are those conditions?

1. Parts move relative to each other.
2. Parts are of different materials.
3. Parts may have different maintenance/servicing norms.
4. Parts are used at different stages with other parts.

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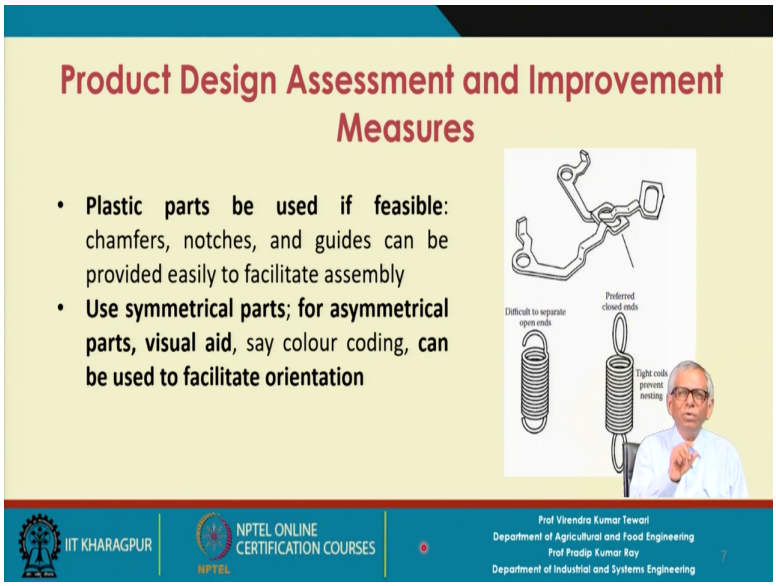

Now, here what you find that many time the plastic parts be used if feasible. The chamfers, notches and guides can be provided easily to facilitate assembly. So, you have to explore the possibility of using plastic parts because of its advantages. Use symmetrical parts, for asymmetrical parts, visual aid, say colour coding, can be used to facilitate orientation. Colour coding is very important and can be used to facilitate orientation.

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This is related to the symmetric parts. Now all the figure given in left side is asymmetric whereas all the figures in right side is symmetric. So, it will be very difficult to use the asymmetric parts for assembly.

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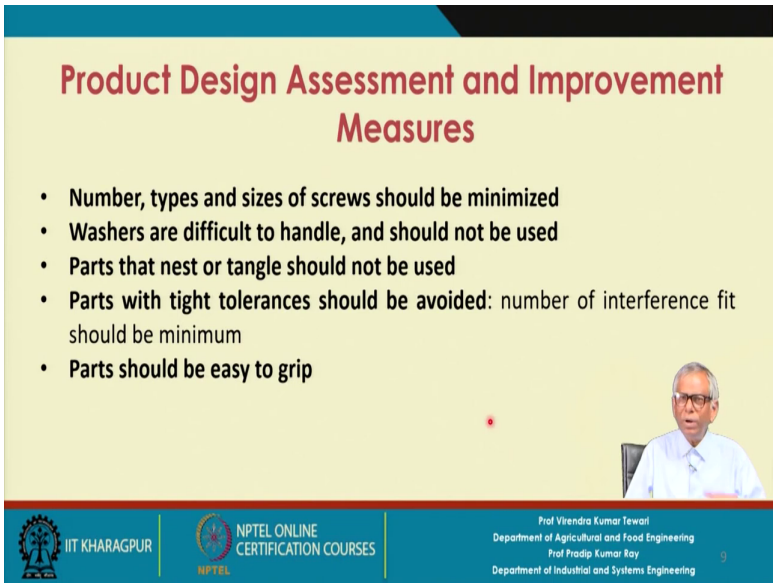

Always you try to increase the number of symmetric parts is a part of redesign exercise. So, some measures are as follow:

1. Number, types and sizes of screws should be minimized.
2. Washers are difficult to handle, and should not be used.
3. Parts that nest or tangle should not be used.
4. Parts with tight tolerances should be avoided: number of interference fit should be minimum.
5. Parts should be easy to grip.

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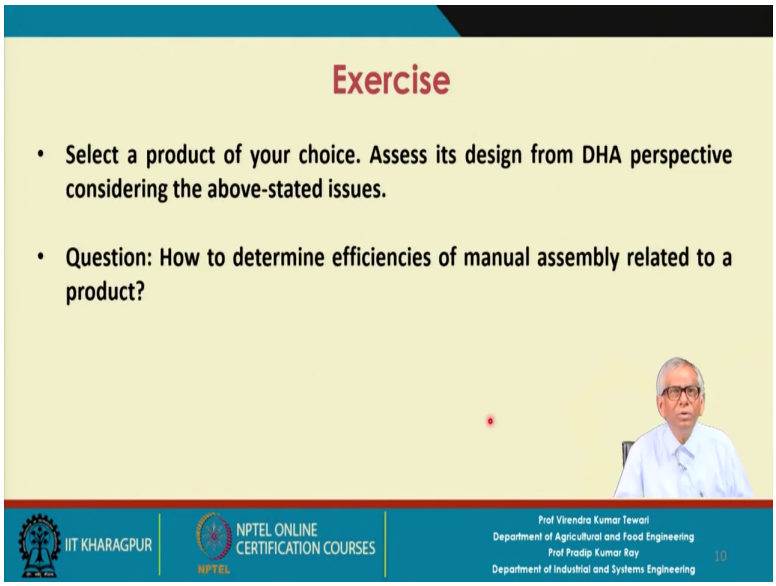

Here is one exercise.

Select a product of your choice. Assess its design from DHA perspective considering the above-stated issues.

Question: How to determine efficiencies of manual assembly related to a product?

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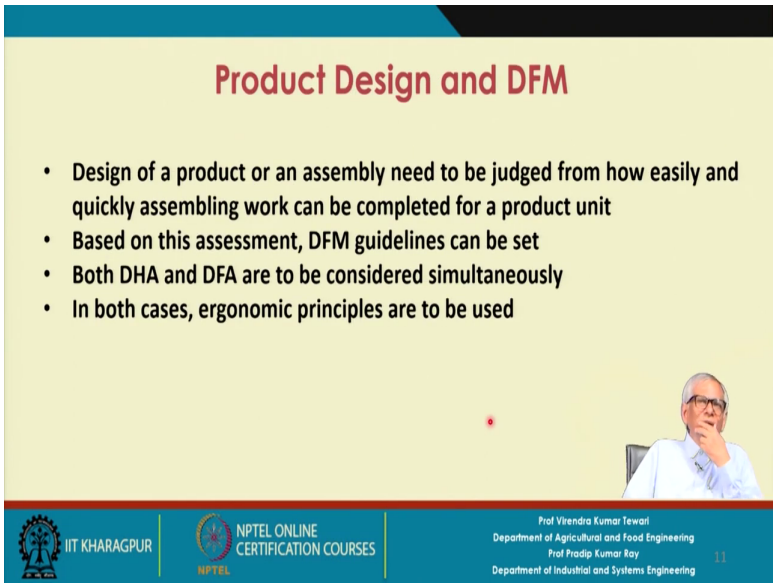

We try to relate product design with the design for manufacturing design. That means, you look at drawing and start thinking about the process plan you develop and then you

check the kinds of activities you carry out related to the process plan related to each and every operation you carry out in a sequence or there could be parallel operations also.

Design of a product or an assembly need to be judged from how easily and quickly assembling work can be completed for a product unit. Based on this assessment, DFM guidelines can be set. Both DHA and DFA are to be considered simultaneously. In both cases, ergonomic principles are to be used.

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Now, the design efficiency is measured and evaluated with respect to assembly time. And a specific method as proposed by Boothroyd is used to compute assembly design efficiency.

So, the Boothroyd's principle used to be applied for design improvement from assembly work perspective that for design for automation these principles are found to be very useful.

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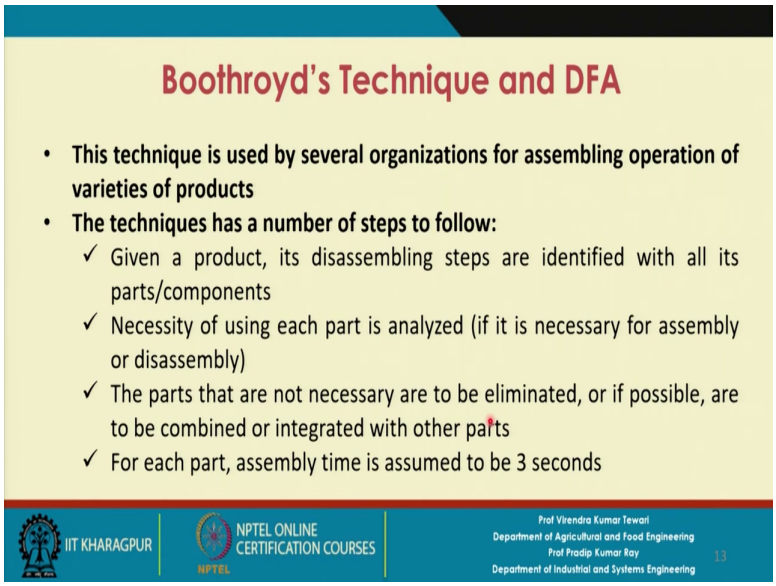

Now, what is this Boothroyds technique? This technique is used by several organizations for assembling operation of varieties of products.

The technique has a number of steps to follow:

1. Given a product, its disassembling steps are identified with all its parts/components.

2. Necessity of using each part is analyzed (if it is necessary for assembly or disassembly).

3. The parts that are not necessary are to be eliminated, or if possible, are to be combined or integrated with other parts.

4. For each part, assembly time is assumed to be 3 seconds.

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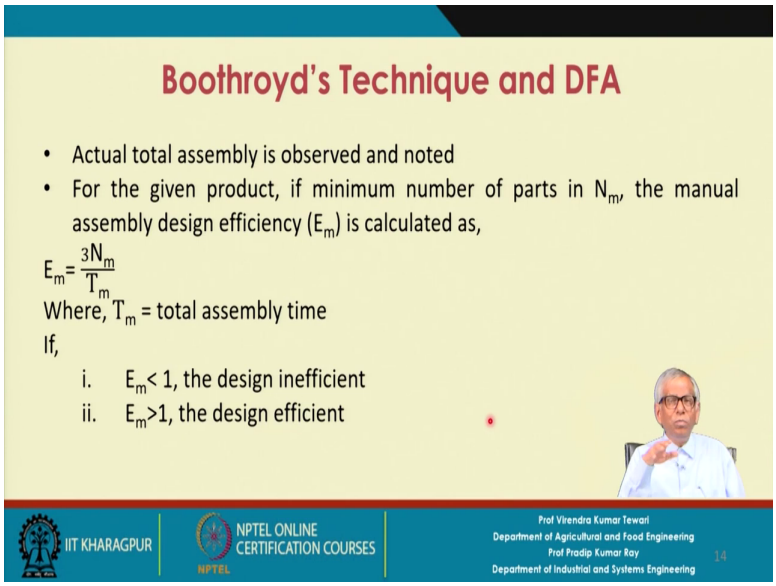

Actual total assembly is observed and noted

For the given product, if minimum number of parts in N_m, the manual assembly design efficiency (E_m) is calculated as,

$$E_m = \frac{3N_m}{T_m}$$

Where, T_m = total assembly time

If,

$E_m < 1$, the design inefficient

$E_m > 1$, the design efficient.

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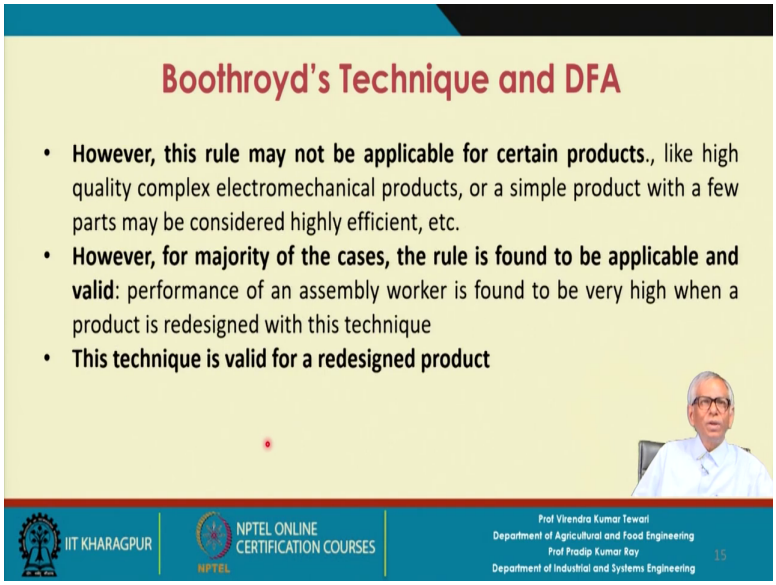

However, this rule may not be applicable for certain products., like high quality complex electromechanical products, or a simple product with a few parts may be considered highly efficient, etc.

However, for majority of the cases, the rule is found to be applicable and valid: performance of an assembly worker is found to be very high when a product is redesigned with this technique.

This technique is valid for a redesigned product.

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