Production and Operations Management
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Lecture 06
Product Design

Welcome friends. Now, we are entering into the second week of this course of Production and Operations Management. In our first week, we discussed some of the basic issues related to operations management; what is operations, the current global environment, what is the role of operation in productivity, different types of manufacturing systems and services system.

And now I request all of you that we will like to use all this knowledge not only for manufacturing systems but for services systems also. And therefore, I request you all to actively participate on our discussion forum, so that we can give you example or you can raise questions with respect to how these concepts are relevant or how these concepts can be implemented in a services system.

Because in theory, or in our routine way of discussions many a times, we give example of only manufacturing system. So, you have to be more careful to take this discussion to the service systems also. In today's session we are going to start our discussion with product design and that is one very important aspect of operations management.

Though this is a particular area where we require input from various functional people. It is not purely operation management area but the product management or product design we are discussing in the beginning of this course so that the output of this session can be used as input in various other sessions.

So, therefore, we are discussing this product design just in the second week of our course. Though it looks very, very difficult over a period of time for designing a new type of product. Particularly if I say in India, we need lot of product designers. Lot of innovations are required for designing better products which are more suitable for our local requirements and I will also like to take two minutes time to tell you that Government of India has started a scheme of Design Innovation Center - DIC in different institutions where the focus is only on this product design, that how to develop products which are fulfilling the local requirement.

We are not talking products which are related to rockets, which are related to jets, though the process is same even for those products also but here our interest is more in the products

which are fulfilling the local requirements, which are not very much technological advanced products.

So, if you are in hilly region and you want to carry heavy load on your back, so what type of product I can offer you so that your efforts can be reduced? You must have seen the pedal rickshaw. Now, in pedal rickshaw we have a problem where the rickshaw puller is putting excessive efforts and there are lot of safety issues for the passenger also. So, both are not very comfortable. So, can we improve that rickshaw design so that it requires less efforts of the puller and the ride of rickshaw user also becomes more pleasant, so all these kind of smaller issues.

I am from Uttarakhand. So, can we have those harvesters which can be used for cutting the crops in hilly regions where you do not have large size farms? You have very small size farms but what types are more suitable? So, all these questions are there where the knowledge of product design will help us for providing better products so that these products can fulfill the need of local people.

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Now, for this purpose the objectives of this particular session that what are the phases of product design development? Now, the important point, if you remember we discussed in one of our session the history of operations management and we discussed that the present era is the era of customization. So, you have to design your products according to the requirements of your customers. So, designing for the customers is another important aspect of today's discussion.

Design for manufacturability, can your product be manufactured? You have developed a design which is very good, which is fulfilling the customer's requirement but it is very, very difficult or it is very, very expensive to manufacture. Or you do not have proper infra; you do not have proper toolings for manufacturing that product. So, that aspect also need to be seen whether we have enough strength, capabilities for manufacturing that particular product.

Then what are the different types of processes available, process flow structure, process flow design and then what are the global product design and manufacturing practices? So, these are different objectives we will like to cover in this particular session. Now, coming to the first point that what are the typical phases of product design development?

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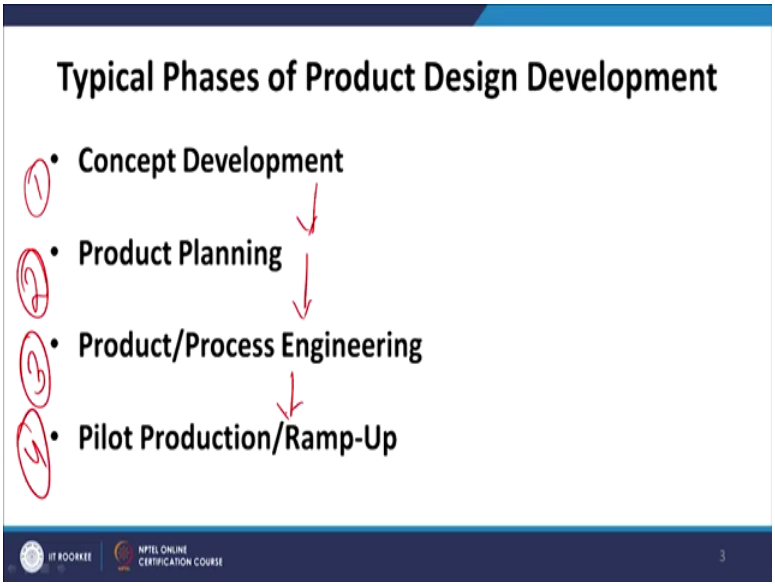

Now, there are four different phases in the product design development and these are concept development, product planning, product process engineering and pilot production or ramping up. So, these are the four important phases. Now, let us see one by one that what is the meaning of these different phases. Now, before we go for detailed discussion about these four phases there are few terms which we need to know.

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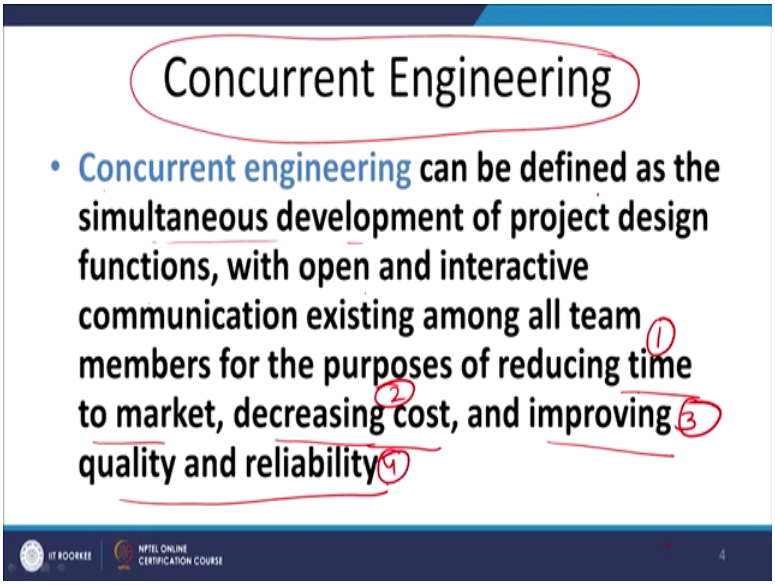

One very important term which is becoming popular these days that is concurrent engineering. Now, concurrent engineering is a term which has reduced the time of product development dramatically. Earlier we used to have various activities; like we have four phases of product design development. Earlier these phases used to happen in a sequential manner, one after another. But now in the concurrent engineering we are able to do multiple things simultaneously.

So, how it is read; concurrent engineering can be defined as the simultaneous development of project design functions with open and interactive communication existing among all team members for purpose of reducing time to market, decreasing cost and improving quality and reliability.

Now, how fast you can reach to market, that has become a very important competitive factor. If your product development time is more and your competitor's product development time is less so competitor will be there in the market, competitor will take the advantage of premium pricing because you are always behind your competitor, you will not be able to take a competitive seat.

Therefore, companies are continuously trying to innovate to reduce, to shorten their product development time, and concurrent engineering because here we are doing simultaneously multiple activities and therefore quickly the multiple people from different departments, the person who is bringing customer voice, the person who is telling you whether it can be

manufactured or not, all these people are sitting on the same table. So, it requires less time to do decision making. Simultaneously lot of decisions can be taken.

So, that is a very, very powerful tool and it is being practiced like anything in the modern organizations for the benefits like reducing, so these are the important benefits. It reduces time to market, it decreases the cost of product development and it improves product quality and it also improves product reliability. So, these are the important benefits because of which concurrent engineering has become so popular; if you see what we do in concurrent engineering.

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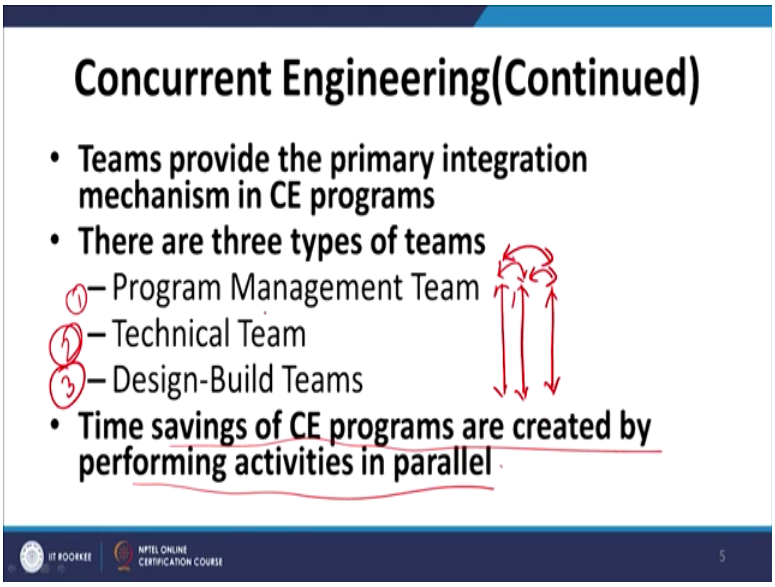

Teams provide the primary integration mechanism in the concurrent engineering programs. So, you develop some teams which are going to be there in your concurrent engineering program. And there are these three types of teams; program management team, technical team and design build teams. So, these are three types of teams which are going to provide you primary integration mechanism. And time saving of concurrent engineering programs are created by performing activities in parallel.

So, now all these three teams are working at the same time. All these three teams are working parallely and they share their output. So, in a very iterative manner, simultaneously things are being done and all these three teams reach to the conclusion at the same time. So, this is how we practice the concurrent engineering.

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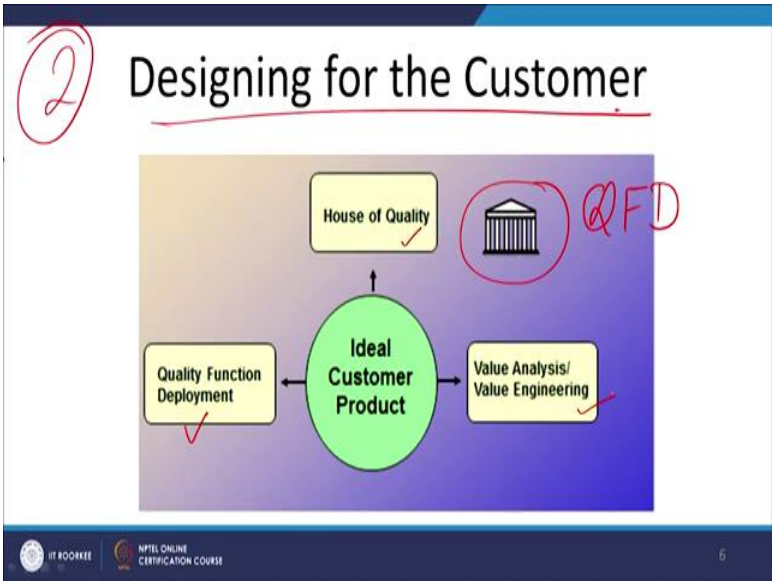

Then another important thing that is part of concurrent engineering because people from this particular aspect those who are responsible, that you have to design for customer, they are also members of concurrent engineering teams. Now, designing for the customer, because we know customization has become one important key for the success of your organization. How far you are able to fulfill my individual requirements? How far you are able to understand my needs; that is a guarantee of success.

If you are able to provide a product which is uniquely designed for me, then I am always with you. So, that is designing for the customer. So, therefore, now I am not designing product according to my strength, I want to produce product which is acceptable by the customers and for that purpose this concept of designing for the customer is coming.

Now, what is happening in this designing for the customer? We have this House of Quality. We will discuss this House of Quality in detail also but this is a very important thing, quality function deployment - QFD where what customer is wanting, we convert the customer's requirement into some product specifications.

Customer wants lightweight pen. Customer wants lightweight pen. So, as a customer I give this kind of input. But converting this lightweight pen into some specification that the weight of the pen should be 40 grams, the earlier weight of the pen was 45 grams. Now, still customer says that he wants lightweight pen, means 45 grams is still a heavy pen for the customer. So, customer wants a lightweight pen.

So, customer will not know; customer will not give you what is the weight of the pen. Customer will only give you this type of qualitative answers. Customer will say that it should be comfortable to hold pen for longer duration. Now, what is the meaning of comfortable? You have to convert this into some kind of specification that what should be the surface hardness of this pen. So, converting the various qualitative aspects into product specification is one very important aspect.

So, the ideal customer product, it has three different aspects. One is QFD; another is House of Quality and third is Value Analysis and Value Engineering. So, with the help of these three things we will be able to design products as per the customer requirement.

In our coming sessions also we will be discussing these particular aspects to develop ideal customer products in more detail, that how to prepare House of Quality, how to prepare QFD, how to perform value analysis, these are important parts of operations management, and people are expert, people do lot of career-related activities just by doing value analysis, just by preparing QFDs, just by preparing House of Quality.

So, even if you are not a master of everything but you should know the overall scenario and within that overall scenario if you are master of just one particular tool, that is going to give you lifelong bread and butter.

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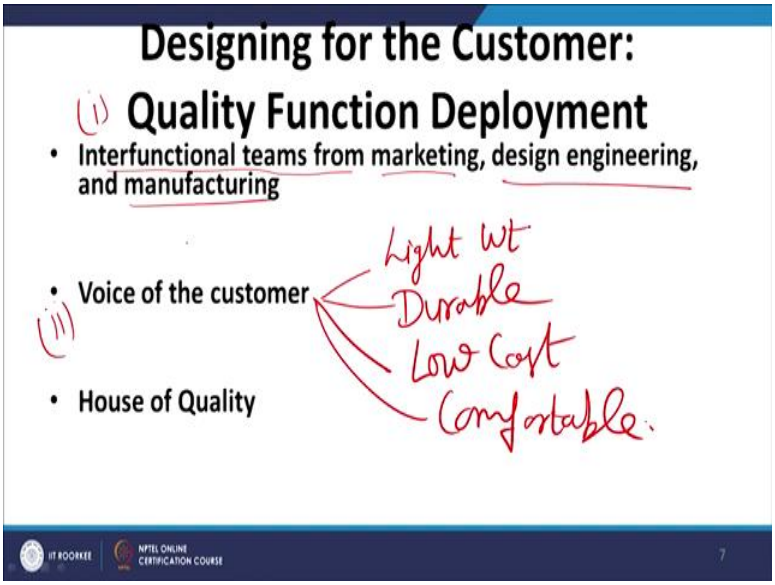

Then in this designing for the customer, the first important thing is QFD - quality function deployment and in this quality function deployment we have three important things. It is a interfunctional team from marketing, design engineering and manufacturing. So, people from

different disciplines are involved in developing QFD. It is representing voice of the customer; like I told you lightweight, durable, low cost.

So, customer's input normally come in these kinds of variables. Customer cannot give you specification. Customer does not give you specification. You go to a customer, what type of shoes you want? I want comfortable shoes. Customer will give you this kind of response.

Now, it is you who need to convert this comfortable in some kind of specification. So, you never expect from a customer that customer will provide you specification. Customer will always give you only qualitative answers. And third thing important is preparing House of Quality with the help of voice of the customers.

Now, this is a very simple diagram for quality function deployment and in this simple diagram we see that how we are tracking, how we are tracking different types of issues related to customer's voice. Customer's, customer is giving you answers in terms of these qualitative variables, lightweight, durability, low cost, more reliability, better functionality etc, etc and you have to convert all these things in the form of a doable things, in the form of specifications.

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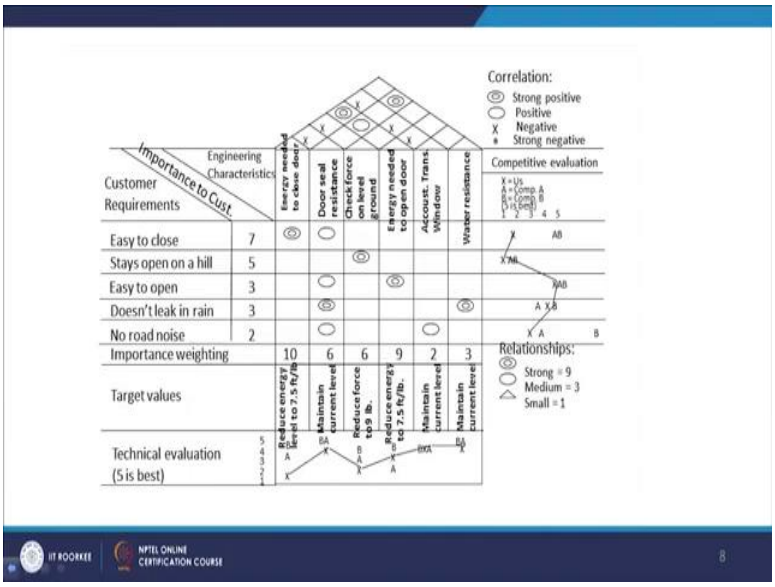

So, on the basis of that we have created this particular diagram. We will do right now, since we have not gone through the courses of quality management, so we will not like to spend much time on this particular diagram. I am just giving you the shape that what type of shape it will have but we will take a problem and based on that problem we will develop this quality

function deployment diagram so that we can understand that what type of input we will have from the customer and how we will convert that input into a desirable specifications.

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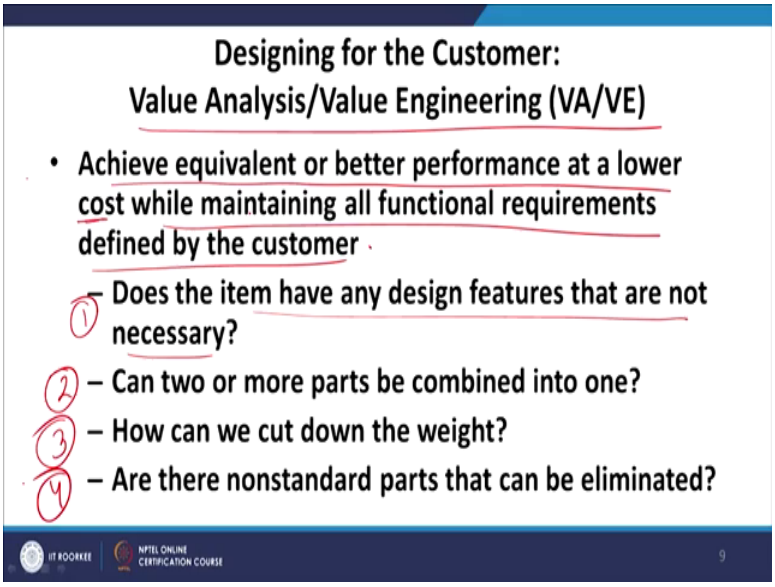

The third important aspect from designing for the customer's point of view is the Value Analysis or Value Engineering. You remember, in our very first session, we discussed that manufacturing is a value-addition process and Japanese give a more important definition that we need to understand what is value and what is non-value. We need to eliminate non-value from our processes. So, that is another important aspect for developing ideal product for the customer.

Now, for that purpose this value analysis is very useful and in this value analysis we achieve equivalent or better performance at a lower cost while maintaining all functional requirements defined by the customer. What we are doing, with the help of value analysis, we primarily working to improve the productivity.

We will keep the output constant and we will eliminate various negative things, various things which are not doing any value addition and with that our denominator becomes light and when denominator becomes light it helps in improving the productivity. So, value analysis is very useful in improving the productivity.

Now, what type of things we do? Does the item have any design features that are not necessary? If you have some design feature which is not necessary; now you see these are two pens. Now, in these two pens, in one pen we have this clip to hold this pen in my pocket.

But in this pen I do not have this type of clip to hold this pen in my pocket because this pen is not needed to be carrying in my pocket like this type of pen.

So, therefore, the designer has very rightly identified that there is no requirement of pocket clip in this pen. So, that is an example that there is, to these features which are not required need to be eliminated. So, we have eliminated that pocket clip from this pen. So, this is kind of value analysis.

You see in our mobile phones, in our calculators we have so many functions which we do not use but we are keeping those functions. We are paying for those functions. So, if we do a proper value analysis we can actually eliminate all those things and that will bring down the cost of those products dramatically.

The second important thing with respect to value analysis kind of thing, can two or more parts be combined into one? So, many a times, we do this type of analysis also that can we combine two parts into a single part so that the movement will reduce between two parts and number of components will also reduce.

If you have more components so there may be chances of wear and tear because of some movement, relative movement between those parts. So, if you can combine different parts, you can reduce, you can eliminate the relative movement between the components and that way you can reduce wear and tear so that is second type of issue we discuss in value analysis.

The third type of issue we discuss in value analysis is how can we cut down the weight? Weight is directly related with the material. We did a project on cycle rickshaw and we reduced the weight of rickshaw by about 40 kg. The rickshaw, the original rickshaw used to weigh somewhere around 120 kgs and we did lot of modifications and we achieved a weight of 80 kg.

Now, that was directly proportional to the cost of rickshaw and that also helped by the way, because it is a human-powered machine, so it also helped us in reducing the efforts of the puller also. So, how can we cut down the weight and weight is directly related to the cost so if your weight is less the cost will also go down.

Then another question we asked, are there non-standard parts that can be eliminated? We want to have more interchangeable parts, more standard parts. So, all those parts, all those spare parts which are non-standard, which are only developed, which are customized for that

particular machine, that particular product, try to eliminate those parts with more standard interchangeable parts.

So, when you have more interchangeability, when you have more standard parts, obviously you will realize the cost will be less. As the degree of customization increases cost becomes higher and higher. As degree of customization reduces you become more standard, the cost decreases.

So, if we are doing a proper value analysis with more standardization we can reduce the cost of our final output. So, these type of things we do in our value analysis. Then another important aspect in product design is design for manufacturability. Design for manufacturability is another very important aspect.

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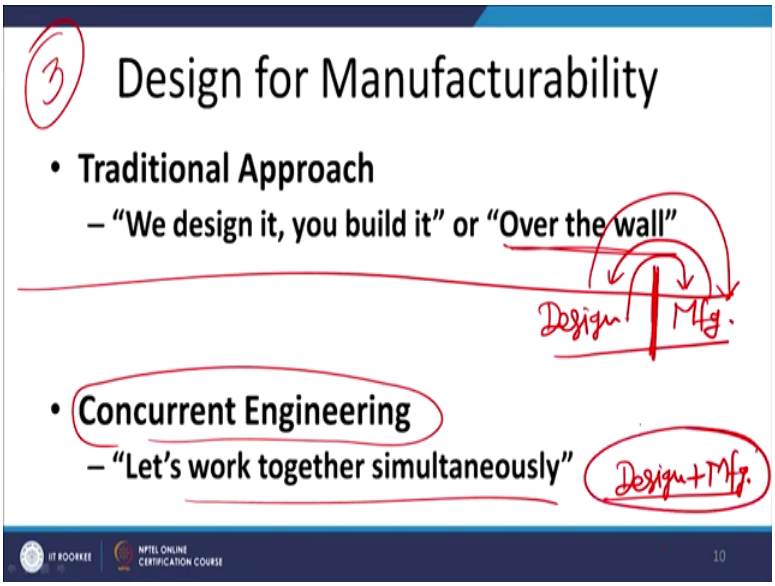

The traditional approach was, we design, you build it and people say that it is over the wall type of concept. The meaning is that there was a department known as Design Department and this is a Manufacturing Department. So, Design Department used to design and they used to supply the design over the wall. They used to check it for manufacturing and they say that it cannot be manufactured so it again comes to Design Department.

Design Department may do some cosmetic changes in the design and then again it comes to Manufacturing Department for manufacturing. So, this type of transfer of design over the wall used to happen in the traditional approach. But now what is happening in the concurrent engineering as we have already discussed, let us work together simultaneously.

So, now this wall is not there. Design people and manufacturing people, they are coming together, and they sit together, they do lot of iterations together and together they are coming with the product. So, all these over the wall transfer of document is now reduced or eliminated, that is design for manufacturability which is now being replaced by concurrent engineering.

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When we are doing design for manufacturing and assembly which we call as DFMA. So, what are the important things, what are the important takeaways with respect to DFMA? So, in that case, simplification of the product that is one very important thing, by reducing the number of separate parts. More separate parts, you require more assembly of those different parts. You have one complete part, so limited requirement of assembly is there.

So, that is one very important thing which has happened with respect to DFMA. So, that is the biggest improvement that now we are thinking very aggressively that how to reduce the number of components, how to integrate the components so that the overall number of components can be reduced.

So, during the operation of the product does the part move relative to all other parts already assembled? Must the part be of different material or be isolated from other parts already assembled? Must the part be separate from all other parts to allow the disassembly of the product for adjustment or maintenance?

So, all these things are only exceptions but we try that how we can minimize the number of parts and that is the greatest improvement with respect to design for manufacturing and

assembly. Now, coming to another part of our discussion; that is what are the different types of processes?

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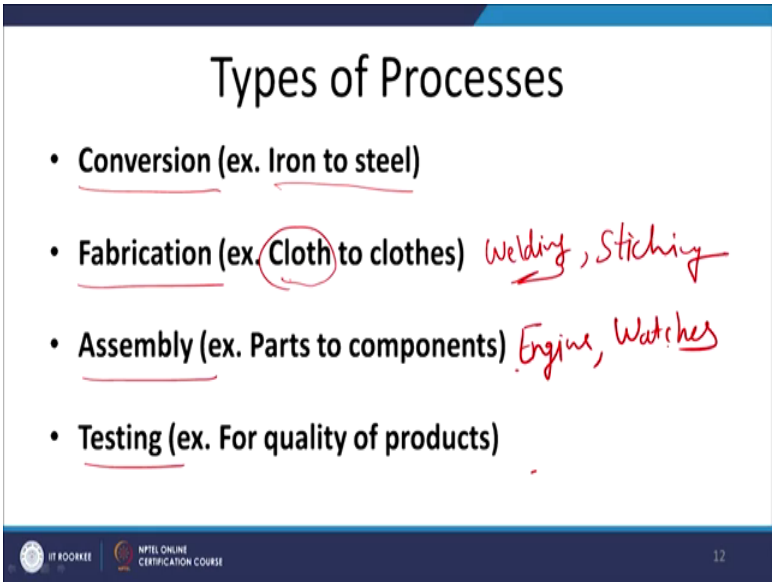

Now, the different types of processes are conversion, fabrication, assembly, testing. These are different types of processes and you see that iron to steel, that is a conversion process. In fabrication process, you are not changing the basic characteristics, but you are making some useful things. Like we used to say welding is a fabrication operation because you are joining two components. Similarly, stitching, this is a fabrication activity.

Then assembly, it is very similar to fabrication. So, now when you are making various components together and you make a product out of that. So, a very popular example is assembly of engine, assembly of watches. So, these are important examples where you are combining various small components to make a bigger product. And finally, the testing for the quality of finished output. So, these are the different types of processes.

We need to see a proper sequence of these processes that after conversion testing may be required. After fabrication also testing may be required. After assembly, testing may be required. You may do some fabrication then you can do some assembly. Then again you can do some fabrication so different combinations, different sequences are possible for these processes but according to the requirement of the product the sequence of these processes are designed.

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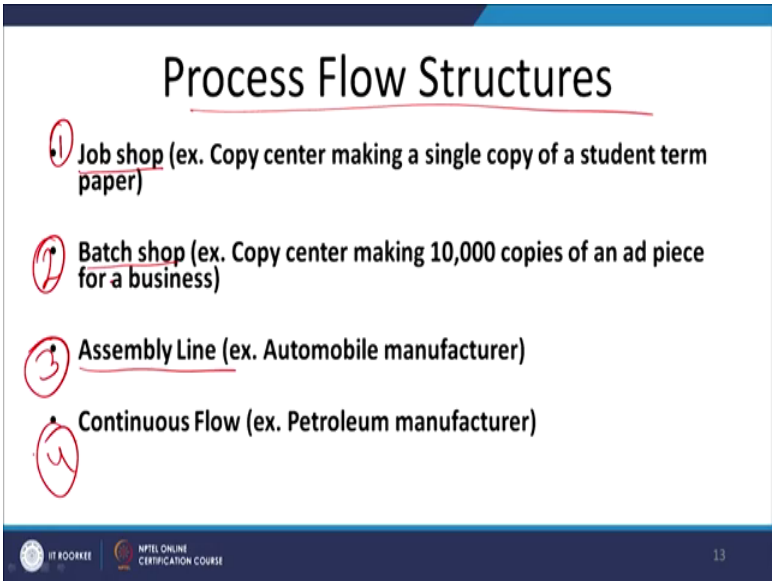

So, the sequences of these processes are known as process flow structures. That how different types of processes will be done and there are four very important types of process flow structures. These are known as job shop where each product has some unique requirement.

Then batch shop where you have limited variety and limited quantities; assembly line where you have a large number of products, very high volume and very low variety. Only few limited varieties you are producing. And continuous production, continuous flow where you do not talk of variety, almost zero variety and very high level of output you are producing. So, that is the continuous flow system. So, these are the four different types of process flow structures from job shop to batch shop to assembly line to continuous flow.

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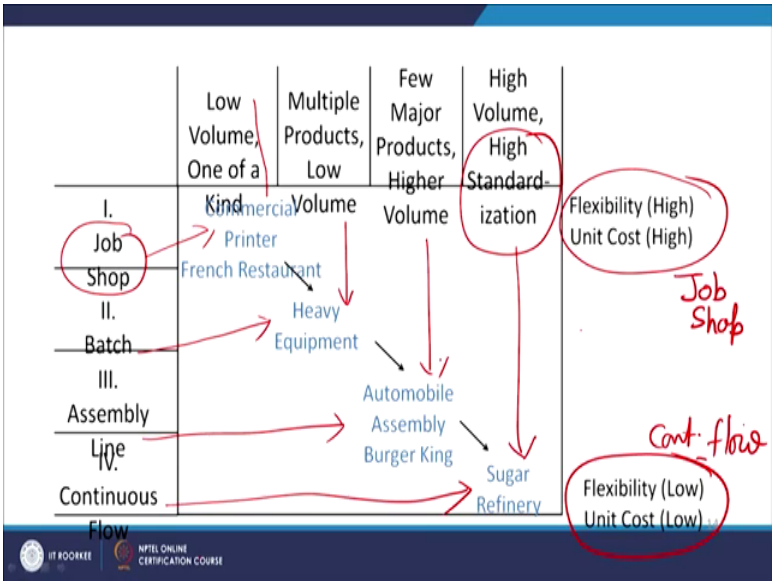

And you can see in this diagram that how this is arranged that job shop where you have a very specific requirement like commercial printer. Here you have low volume, very low volume and one of a kind type of product you are producing. Then you have batch type of production activity like heavy equipments where you have considerable amount of product variety but the volume of each product variety is low.

Then the another type of category is assembly line where you have automobile assembly like in case of engines etc, all these are the, so here you have some limited variety but each variety is producing in good amount of volume. And finally, we have continuous flow for an example, sugar refinery or petroleum products or for that example, hydroelectric products. So, these are the examples where you are having almost no variety, very standard products, highly standardization and high volume.

So, that is the spectrum of processes on the basis of volume and variety. If you are having no variety, if you are having no variety and very high volume go for continuous production system, and if you are having very low volume and high variety then go for job shop type of system. Job shop type of system offers you very high flexibility. This is job shop and this system of continuous flow offers you very low level of flexibility and unit cost is also low because of mass production.

So, that is about various types of process choices you can have from job shop to batch production to assembly line to continuous production, and we also discussed the characteristic of different types of processes, which process offers you flexibility, which process offers you low cost and which process is more rigid and does not offer you the cost advantage. So, with this we come to end of this session. Thank you very much.