Design for Quality, Manufacturing and Assembly
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Lecture - 29
DFMA in Product Design

Where do you think DFMA fits in a design process; a very interesting question. But, before that can you tell what are all the sub process in design; let us say that you are interested in a new product development.

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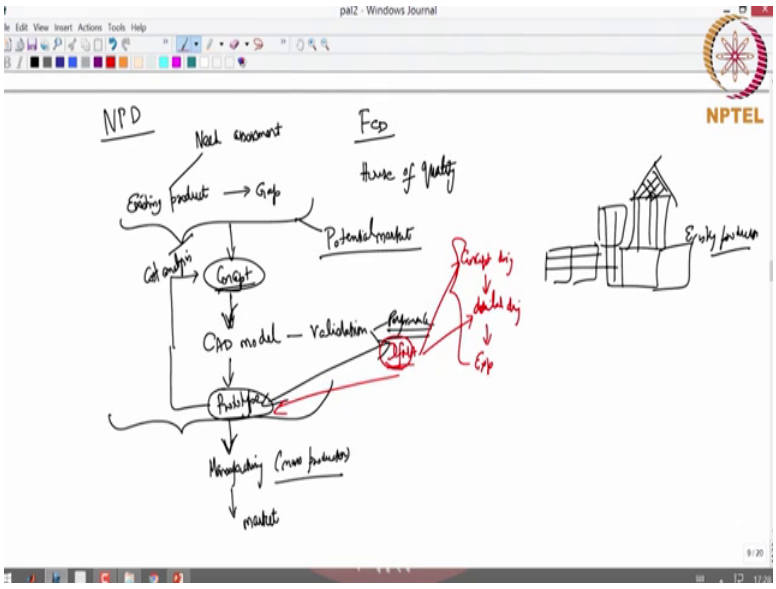

NPD stands for New Product Development. So, the question is what are all the different process that are involved, if you are to do a new product development where will you start it very rare there is now any boxes or answers for this where will you start?

Student: Identifying the need.

Need.

Student: What will be?

Need assessment then.

Student: A relevant product.

Sorry, relevant product.

Student: Same product in the (Refer Time: 01:17) existing product.

So, need assessment then.

Student: (Refer Time: 01:22).

Existing product: what is the process that let us you do this and then find the gap?

Student: (Refer Time: 01:35).

In FCD you might have studied it, but what is the tool that is used to understand this if you do not know.

Student: House of the quality; house of quality.

House of quality: you remember the house of quality? It had different boxes like this will go like this and something will come from here.

Student: They have triangle and (Refer Time: 02:11).

And finally, you have ranks that will go through this. Remember, a very bad way to show triangle and all that, but you remember house of quality. So, basically what I does is it goes and asks people what you want and then it tries to compare existing products here and the it is a nice method to quantify the difference and finally, it will give you ranks here that will give you that will identify the gaps for you. So, this is a simple, ok. So, this is level one. So, you know what is to be done or what will be the feature of the product that you develop, then?

Student: Potential market (Refer Time: 02:55).

Potential market: let say there is market, ok. You went to KPMG and then KPMG said that there is market for this. So, you are ready to invest. These days these are done by your funders you do not need to worry about it. Who is going to invest in your company will do that for you, ok. Now, after that let us let us limit this to the product design life cycle kind of stuff from here you try to come out with a concept design, ok. Then, then what you do?

Student: KYC – Know You Customer (Refer Time: 03:44) who are the customer, like middle class or?

But that is taken care here.

Student: Potential market.

Because, need assessment you need to know your customer to begin with. Then?

Student: Model. Model of the (Refer Time: 03:57)

What model?

Student: (Refer Time: 03:58).

So, that is not there in the concept level. So, you do a CAD model and do what with it?

Student: Optimization.

Optimization the CAD model itself?

Student: (Refer Time: 04:15) concept validation need to check. (Refer Time: 04:18).

Validation.; validation from what perspective?

Student: engineering, from engineering perspective. (Refer Time: 04:28).

Well, Engineering perspective. In engineering what will you do, when you say engineering perspective can you give me like two three.

Student: (Refer Time: 04:38) manufacturing same.

Same thing, because we are discussing about that whether it is manufacturable or not, ok. Then?

Student: (Refer Time: 04:49).

Let us I mean do not forget, but let us imagine that you are not sitting through this course and I am asking this question. You did not you really did not think about manufacturable and assembly and all that, right. So, at the CAD model what would you do?

Student: Prototype.

From the CAD model directly prototype. You would have done this for your PD lab if you done your PD lab products. What did you do?

Student: Cost analysis.

You would have done a cost analysis, fine that is also similar to your see there is one step that you because you come up with that that is what the concept main, right. This is when you say concept this is not going to be a single concept you might come up with multiple concepts and you might evaluate them; and that is going to cost analysis using a cost analysis you do something that could be one or you can do you know efficiency analysis or it need not be just a cost it could be something else also, ok so based on that you come up with the concepts.

So, we just we set concepts, but the concept selection itself is a process after that you build a CAD model, you tried to validate it. What it was trying to tell is more from a performance perspective.

Student: (Refer Time: 06:02).

You try to simulate, what do you try to simulate? You want to look at the performance part of it, ok. You do not worry about the tolerance, you do not see whether it is workable right now you imagine that whatever I give it in drawing they should be able to do it. Then, what you do?

Student: Prototype.

You can go to prototype, ok. Then is it, go to the market, then what you do?

Student: I am showing the users name about (Refer Time: 06:40).

So you need to go back where?

Student: To the model to the design.

To the CAD model, is that all?

Student: To the concept.

To the concept you need to go back, ok.

Student: And (Refer Time: 06:56) kind of cyclic process.

This is a kind of cyclic process, ok. So, but when will you stop the prototyping?

Student: (Refer Time: 07:07) the prototype does not have any problems.

Any?

Student: The prototype does not have any problems.

The prototype does not have any problems with respect to what?

Student: Performance.

With respect to performance here, because that is what your validation on computer as being or anything what you are talking about it should these two should compare, well ok. Then, what you do? But, usually it is not computer gives you some value and prototype will give you some value, if you have built any product you would know this then what fine. So, let us say it is all correct. So, far you just did a cycle it is a cyclic process then you finally choose a prototype then what you do?

Student: (Refer Time: 07:51).

So then you go to manufacturing.

Student: (Refer Time: 07:58).

Actually this itself is manufacturing only.

Student: (Refer Time: 08:03).

So, you are talking about mass production, then that is it. Is that all? Go to the market, let us say market. Unless, you have the market you are not going to mass products, ok. Let say it is not comprehensive, but this is a fairly good list of things that you can think of for a product design stuff kind. Now, tell me where DFMA at what level it comes?

Student: From the CAD model (Refer Time: 08:38).

One thing even in this we are not gone into the details here. We are not gone into the details here usually this part is also divided into concept design, then you go into detail design then only you go into experiments, ok. So, these are stuff that we teach in our FCDR any design course. So, first you try to do with a you know back of the envelop calculation, then you do a analytical model calculation, then only you go into a simulation to try to understand. These are all different levels of stuff right, it is that is what I said this is not comprehensive. Now, tell me where DFMA finds a role in this list? Where do you or where can you use DFMA?

Student: It should be used before the after a CAD model. So, you (Refer Time: 09:45) a prototype.

So, you can you can talk about this, then.

Student: And, also the part of detail design.

It can also be part of the detail design. It can also the part of the concept design, I mean that is what I have written here. Then, obviously, in this part of the prototype because you want to do that ok. The question is this, let us you do before you go to the prototype, but obviously after prototype you check that always happen, good. So, let us see what I actually have where it is DFMA fit in design process?

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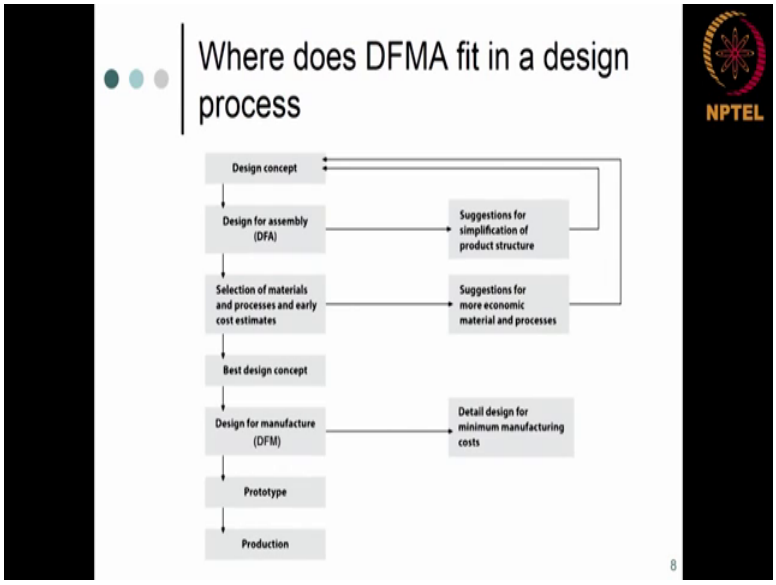

You will be surprised that you almost got everything on this block concept design, you go for you can use a design for assembly. It does not stop here because it gives suggestion for simplification of the product structure right now with the concept that you have. But, as you point it out this itself could be a cyclic process because this is not your final concept. Then what happens depending on the assembly see this is becomes very important that we comfortably ignore depending on the assembly you will have to choose you material and processes, this is something that we do not teach upfront in the design part, ok.

Design for assembly needs to come upfront or you are going to assemble it based on that is what I am going to choose my materials because not all types of materials can be assembled on all types of materials. It become very important; what is going to sit on top of what and what is going to sit under, what it becomes very important, ok? Then of course, I can do cost estimates and all that then I look from more economic material process. It is a combination of both material and assembly here, right here, and sometimes there also includes manufacturability. You cannot machine some hard metals it id good from an assembly perspective it is going to be good from a performance perspective from, but from a manufacturing perspective we do not want to use those.

So, then you will have to go back change your concept accordingly and come. So, so much iterations at the concept itself. We are not yet gone to the detail, ok. Then, we will know what is going to happen with the performance then you choose the best design concept as you guess pointed out, then we look for manufacturing, ok. Here also we might use manufacturing we use manufacture, then you do a detailed design for minimum manufacturing cost from there then you go to prototype and production. Very similar to what we discussed.

So, what the point that I am trying to tell you is there is no particular spot where you say I am going to use DFMA. People ask us where do you use optimization, at any stage of design you use optimization, but you cannot take an optimization course and be ready to apply it in any stage of your design process. Because, when we teach optimization me say that you need to have a function that describe your objective, you need to have a function that describes your constraint. Often time in real world you do not have that you need to know how to approximate them, and when you are talking about a concept you

need to be able to choose multiple concept concepts are; a, b, c, d. So, we need to have an algorithm that can evaluate a, b, c and d in a concept level such technique exists.

But, the only point is the notions are going to vary at the concept design level the notion of optimization is different. It only tells you given this is this kind of an objectives this is the best in design then you have to go into the detail design then you do a sizing or topology or shape optimization and the you look at a cost analysis and then you choose the best design, ok. So, it is not like you have to come up with the final design and you can only change the width or the thickness and hence save money, no. You can upfront you can say what your what is your important objective, if it is sustainability you say I am interested in a sustainable design then it is going to cost you more, but that is fine, that is objective. I want to maximize sustainability; it will let you do that. It will choose let you choose materials accordingly, then accordingly manufacturing process, then accordingly your design process, ok.

Hence, DFMA is not just for one phase of product design, is it is applicable and applied across different phases. Whether it is concept design or it is detailed design or it is in prototyping in the entire design process it plays different types of roles trying to give you the same kind of information on the ease of assembleness or evaluate a particular design from an assembly perspective and the manufacturing perspective. This is the idea of this take home information from this line.

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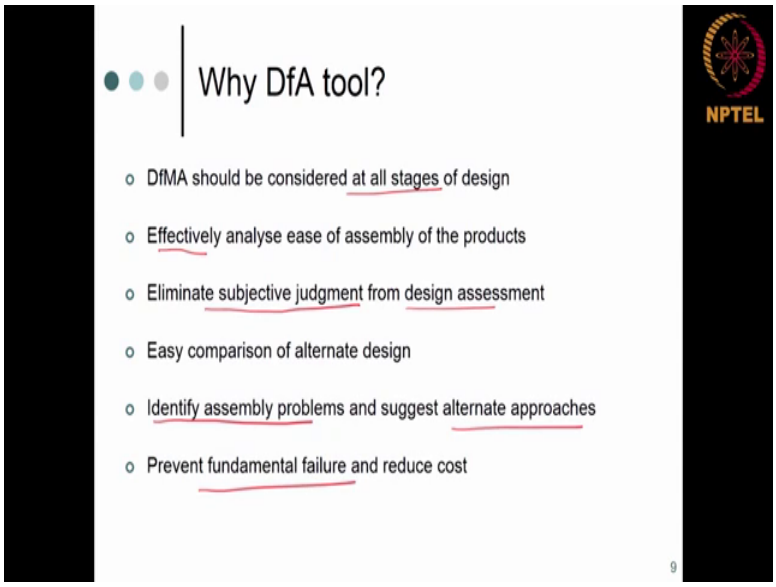

Why should someone require a DFA tool? Something the base things we have already discussed. It should be considered at all stages of design and someone need not be an expert in all stages. So, that is the problem and today there is a big field called knowledge management. Now, people are trying to use artificial intelligence any time. You go to a doctor ok. So, you go to a at least in India you go to a government hospital doctor. Any guess on how many patients they see on an average per day?

Student: 3 to 400.

3 to?

Student: 400.

3 to 400 patients, that is right. If you compare it to the west they are at least of by a factor of 50 into 20. They if they see 30 people per day I think he is a he or she is an overloaded doctor, they do not they do not meet. So, many people ok. So, 300 to 400 patients they meet per day, ok. So, look at the amount of information that is stored huge. Of course, there is a larger probability of error also is there, but the amount of diversity of the information and the cases that they see is huge today you need to be able to manage those knowledge that is one case, right.

If you go to any company let it be Manufacturing and Design Company, there are some there were few people called subject matter experts. They are the experts, legacy experts. They are been in the company for 30 years. You take a particular component and you ask them why this fillet was introduced, they know. You take a particular component and you ask in the supply chain to whom should I go to get the knurling done? They will tell you go to geography one to get the knurling done in the same component. Knurling has to be done there, the filleting has to be done here you need to come and cut the chamfer here, then finally you need to go to this person to get the blank done. This is the supply chain information that a particular person gives.

Now, the company obviously, does not want the informations stored with an expert, but this is knowledge, which is the company owns this knowledge and it needs to manage this knowledge. Tomorrow this particular expert retires I need to have my next person being able to deploy this easily, straight forward, right.

So, for instance you guys try to do some projects for your dual degree project, right. Let us say that it is just one module of a larger project. So, our knowledge management way is to ask you to give the codes, ask you to write a report, if you work part of one of such large projects you will know. We would have asked you to create an index table we will say what is what code you just click on, and it will take you to that code, and then a table this table is given here this is what you do that is what you do and all that stuffs. So, that is knowledge management, ok. So, basically today knowledge management is happening and in that stage people want to bring DFMA also in that best practices in a knowledge management framework.

Effectively analyze the ease of assembly, ok. When I say effectively it is not dependent on a person it is not going to be dependent I cannot bring an expert. Any person today if there is a complex structure you want to analyze it you just plug it into a software. As long as you know how to run the software you will be able to analyze it is as simple as it is in such sense you should be able to analyze the ease of assembly.

Eliminate subjective judgment, this is what an expert brings still subjective. Subjective to my knowledge that is all I want to quantify it. So, it is not qualitative it is quantitative. You cannot say that is what I told you right it is blue color. So, I do not like that assembly let us go with the red that is not how you evaluate an assembly. We looked at simple matrix by which you can evaluate a assembly. So, it should be a quantitative judgment not a qualitative or subjective from a design assessment perfective.

Easy comparison; it should not be a; obviously, it should not be a complex comparison easy comparison. Identify the problems up front that is one part, say that there is a problem 2 – is also try to provide solutions. I tell you that this is not going to withstand 10 cycles that give you only half the solution. I need to tell you what you need to do to such that it will sustain more than 10 cycles that becomes important.

Prevent fundamental failure. This is what the role of a engineer is and these are the above bullet us are just tools that let you to that, ok. This is why DFA as a tool is required. Any questions?

(Refer Slide Time: 20:33)

Student: (Refer Time: 20:32).

Tell me.

Student: (Refer Time: 20:34) concepts that we studied (Refer Time: 20:36) that can be used to something similar (Refer Time: 20:44).

Sorry, latent needs.

Student: So, we just tried imagining all the entire life cycles of products, but using that can be.

Of course, you can use this.

Student: Is it exactly the same thing or (Refer Time: 20:58)?

No, it is not exactly the same thing. It is not exactly the same thing obviously because this is a field by itself as we go deeper you will know how people are nicely. Today, that is what I am saying you do not have to really take a screw and drive it and say that it will take you like 0.2 seconds. You can go to this and it will tell you it will take, if it is Allen screw it will take you this much if it is a different type of a screw it will take you this much time, people have analyzed to that extent, ok.

Anyway coming back, so there are two components and you want a product I get a product by assembling two components. What are the activities that are involved in this? Two components rather two components, but I have to keep it here then only, I handle them then I insert. So, two major activities are there, what is it? Components, I handle them and then I insert them. So, the process of assembly can be decomposed into in a very generic sense in a very generic sense I should be able to handle and then I should be able to assemble.

So, part handling and part insertion that is what assembly is. You can always say sir in this particular thing you had a hole. So, you are able to do this what if you had something like this, but you want to hole this together, yes, you hole this and then you put a screw on top of it. Still it is a same thing handling, inserting and fastening, ok. You can you can sub divide it if you want, but this is the wide way very generic stuff handling and insertion, ok.

Now, to give you an idea on why this might become important from an handling perspective, right? This is easy for me to handle because this was a pen, now imagine I wanted to do something larger, ok. I might not be able to handle it in one hand, I might need both my hands to do that or it might not be of geometry that it is easy for me to handle for whatever reason. Imagine that you had a rod with multiple what you call that which has sharp serrated edges like your cycle chain what you call that thing. The cycle chain runs over something. So, there is a bicycle chain that of it.

Student: Sprocket.

Sprocket; there were sprocket which serrated pointed edges for whatever reason I have a shaft on which there were lot of sprockets. I do not think I am going to able to just carry it in one hand just like that I will have to hold it in both the hands and then bring it to a place, then I need to be able to keep it on something then I need to be able to do it. So, that takes significant effort and time and all that, right. This is not only it does not mean that it is only for a bigger even for smaller things very small things you might want to use both hands.

For instance you might want to use forceps, right. If you go to a jewellery shop, ok, they usually use diamond is only very small. So, they do not know handle it with your fingers they use it a, they use a forceps that is for some other reason also some other reason, but

usually since it is small they use a forceps to use it, ok. You go to a hospital if they going to suture ok, you see they do not handle the suture by hand they always use only the tip of your scissors and the forceps, always. That is the best practice for a doctor correct.

In a similar fashion I want to talk about handling and assembling.