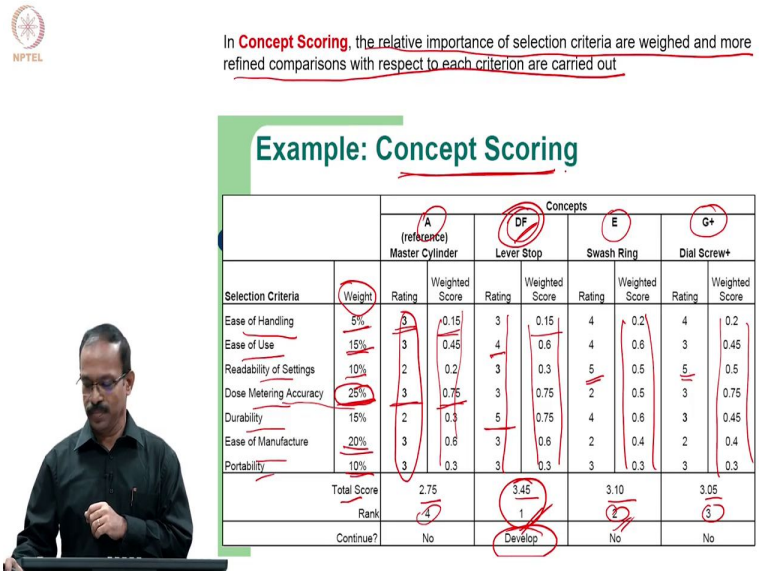
Functional and Conceptual Design
Professor Dr. T. Asokan
Department of Engineering Design
Indian Institute of Technology, Madras
Lecture No. 27
Concept Scoring

(Refer Slide Time: 00:13)



		Concepts							
		A (reference) Master Cylinder		DF Lever Stop		E Swash Ring		G+ Dial Screw+	
Selection Criteria	Weight	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score
Ease of Handling	5%	3	0.15	3	0.15	4	0.2	4	0.2
Ease of Use	15%	3	0.45	4	0.6	4	0.6	3	0.45
Readability of Settings	10%	2	0.2	3	0.3	5	0.5	5	0.5
Dose Metering Accuracy	25%	3	0.75	3	0.75	2	0.5	3	0.75
Durability	15%	2	0.3	5	0.75	4	0.6	3	0.45
Ease of Manufacture	20%	3	0.6	3	0.6	2	0.4	2	0.4
Portability	10%	3	0.3	3	0.3	3	0.3	3	0.3
	Total Score	2.75		3.45		3.10		3.05	
	Rank	4		1		2		3	
	Continue?	No		Develop		No		No	

In the last discussion, we found that concept selection has got two stages; that is concept screening and scoring. We use the Pugh's method to do the concept screening and at the end of the concept screening we will bring down the large number of concepts to a smaller number and we will do a more objective evaluation of this smaller number of concepts using the method concept scoring.

So, we will look into the concept scoring here, where the relative importance of selection criteria are more refined in comparison to each criterion. In this stage of the concept scoring, we will look at the relative importance of the selection criteria and they are weighed and more refined compared with respect to each criterion done.

We will give a weightage for each criterion and then we do a more objective scoring to get a better comparison of the concepts. So that is the concept scoring methods. We will take the same example as in the previous case; that is the concept screening. We will try to find out the concept that we want to take forward that is the concept A master cylinder, then D and F that we

combined D and F and got a new concept DF and then we had this E concept, and then G+ which is the modified design G.

So, we take these 4 concepts for scoring. And the selection criteria are ease of handling, ease of use, readability. It is the same criteria we use but in this case, we give some weightage for each one of these criteria. We assume that they are not of equal importance, some of them are more important than the other criteria and therefore we want to give a better weightage for these criteria.

And this weightage can be decided by the design team, there are no rules on how to give it but we assume that some of them are more important, so we give a 25 percent weightage for dose metering accuracy, saying that it is more important compared to the other one. And then we say, manufacturing is a criteria, so we put this the next weightage.

Then we have the ease of use as the next one, then portability, readability, and then finally the ease of handling. So, the total weightage, I mean 100 is the total, so you actually divide them and give them weightage based on the design teams understanding. So now you can see, this is the highest weightage dose metering accuracy.

Now, for each of these concepts A, DF, E, and G+ you give some value. What is the value that you can give for this master cylinder in absolute times, so that is what we do? Here, you give the value like this. So, suppose you have the, so you give the rating 3, 3, 2, 3 like that. So, you can give a maximum of 5 and then you can give 3, 2, 1, 4 and whatever you like to have given and then find out what is the weighted score.

So, this has got a rating of 3 against ease of handling for the reference master cylinder, then you see 3 multiplied by 0.5 will be 0.15 will be the weighted score. Same way you get dose metering accuracy, the rating is 3 so you will get 3 into 0.25 if 0.75 is the weighted score. So, this way you will be getting all the weighted scores for the concept against the criteria and you will do this for all the other concepts also.

So, for example, DF, E, and G you give the values, so again you can give here 3, 4, 5, etc. So, we can see this lever stop has got a 5 score for the durability and therefore, for the ease of use. Here

also this readability is better in swash ring and this also the readability is good, so 5, given 5 rating. Now you multiply this rating with the weightage and then get the score here, weighted score for each concept you can get the weighted score.

And finally, you get the total score and it is 2.75, 3.45, 3.1, and 3.05 and now give the ranking. So now once you have the total score you give the ranking, so you will see that this is the first one, so you have got a rank 1 for the D and F. If you look at the concept screening stage both D and F are actually not good, the decision was not to take it forward because they were the lower ranking concepts.

But now compare, on combining these two you will see that it has actually become the number 1 concept and then you have number 2, 3, and 4. And then decide whether to, which one to take forward, so you develop these concepts further and do the prototyping and testing. And in case of any problem at any stage, you can actually look back and then see where you went wrong and then you can decide to drop this and then take the next one forward.

So, this becomes a very systematic analysis with the proper record of how did you arrive at the ranking and in case you want to come back and then check, you will be able to get this and then see what kind of criteria is used and if you feel that the criteria used was wrong, you can go back and then again change the criteria and then do the analysis and get it done.

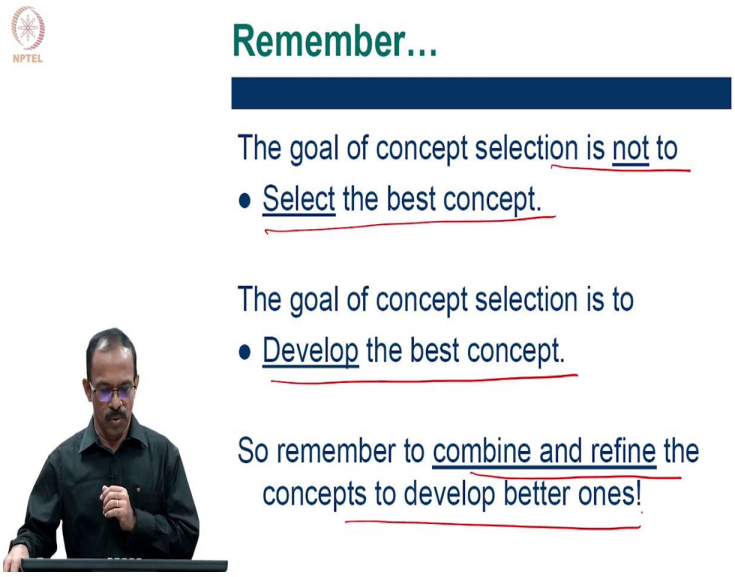
So, it becomes a very systematic way of deciding on the top-ranking concept. And this will actually be approved by all the members also, since it is not based on anyone's intuition or anyone's personal choice, it is more based on the objective criteria that we are using in order to get the top level concept. So, this is the way how we develop the, how we get the concept selected based on objective evaluation and that is the concept scoring stage.

So, we have two stages in concepts selection; the first one is concept screening which is more of a subjective evaluation, and then the second one is the concept scoring where we do a much more objective evaluation with giving with some weightage for the criteria and then giving absolute rating for each concept and getting the total score and deciding on the top concept.

Again, some one important point here is that the concept selection is not merely to choose from the existing concept, the concept selection process should be used to improve the concept also that is one important point to be understood.

Because by analysing the concept against the criteria you are able to understand the good features and bad features of a concept and that will help you to address the negative features and then improve the concept or you will be able to identify complementary concepts which can be used to improve the concept. So, any concept selection process should be the objective should be to improve the concept rather than simply to choose the best concept.

(Refer Slide Time: 08:11)



Remember that the goal of concept selection is not to select the best concept but to develop the best concept. So you should always keep this in mind, the concept selection process is to develop the best concept, so as you try to analyse the concepts you will understand the concept which has the highest potential to be developed so you can develop the best concept.

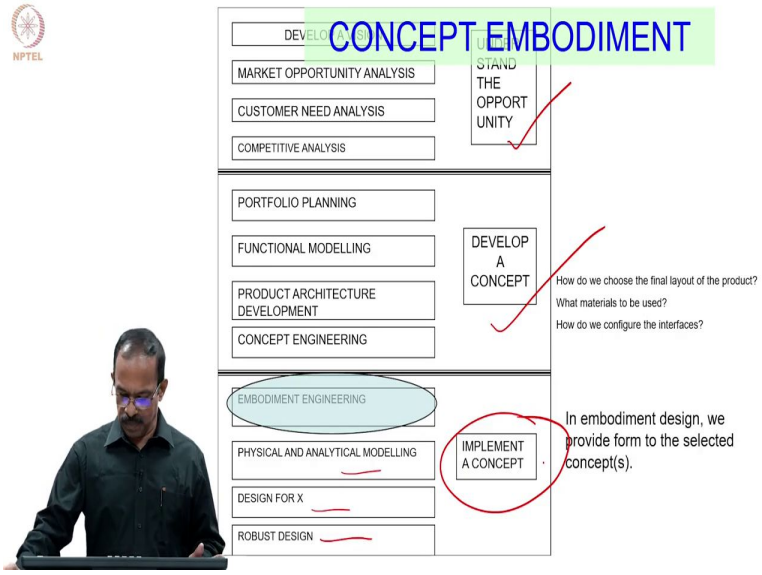
And remember to combine and refine the concepts to develop better ones. This is something which you need to keep in mind when you are doing a concept selection process. I hope you understood this process of selecting the concept and that is the last topic that we wanted to

discuss. So, we have gone through the whole process of product development starting from the mission statement to the development of concept.

The functional and conceptual design part is completed. And of course, the concept and in the product development the next stage is to give the, give a shape to the product which we called as embodiment design. So that is the third stage, where we give shape to the concept to make it as a product.

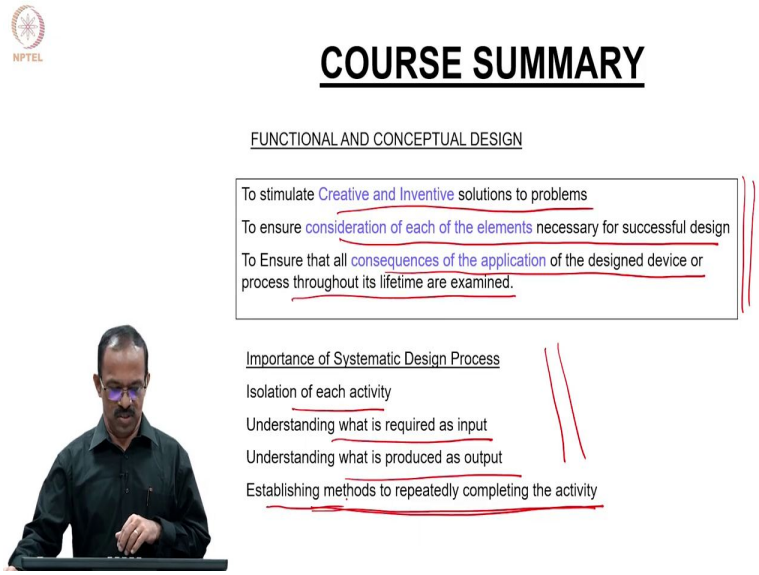
Ofcourse, we will not be discussing that in this course. And in order to understand the embodiment you need to have more information or more knowledge about the, the analysis of products for its strength and other aspects, so we will not be discussing that in this class.

(Refer Slide Time: 09:48)



So to provide a summary, 'the understand the opportunity' part we completed and 'develop a concept part' also we completed, and the next one is the 'implement a concept' which actually involves embodiment engineering, analysis, design for X, robust design, etc. which you will be able to learn in other courses as you can actually choose some courses which discussed the embodiment engineering, modelling, and design for X, etc. So that is all from this course.

(Refer Slide Time: 10:26)

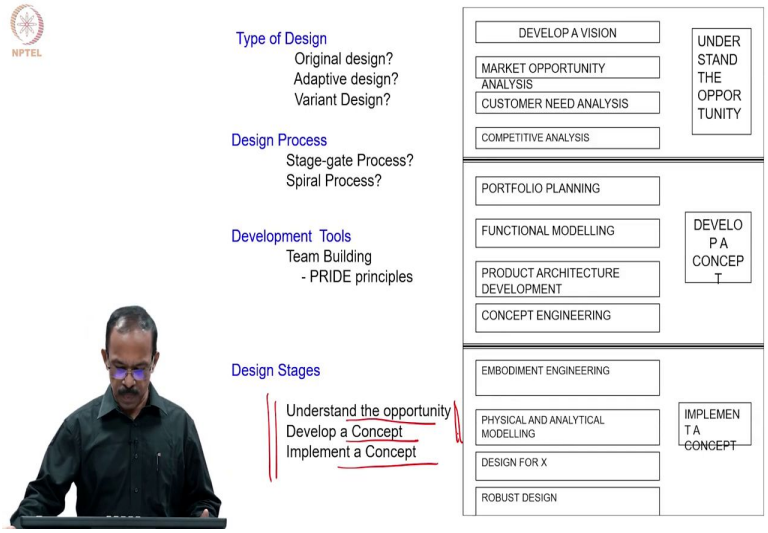


So, let us take a very quick look at the summary of this course. You have been listening to this course for the last 25 or so lectures. So the functional and conceptual design started with the importance of having a creative design process or a creative systematic way for developing products, and we wanted to stimulate the creative and inventive solutions to problems.

And consider each and every element necessary for successful design and to ensure that consequences of the applications of the design device or process throughout its lifetime are examined. So as we progress with the design, we look at various elements, which actually contribute to the product and its life cycle and try to address those issues.

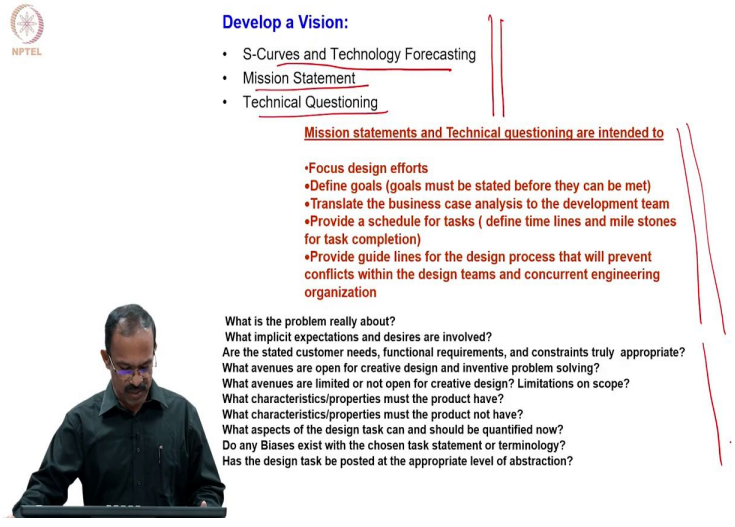
And we talked about the importance of systematic design process, isolation of each activity, understanding what is required as input, what is produced as output, and established methods to repeatedly completing the activity. So, one of the reasons why we need to go for a systematic design activity is this one because we want to repeatedly complete the same process of design. So, you design something and you do not have it as a systematic process, the next time you will be doing it in a different way. You do not want to do it in a different way or completely different way without looking at the positive aspects of your design process. So, we want to have a systematic process established for developing new products.

(Refer Slide Time: 12:00)



And we talked about the type of designs, original, adaptive, variant design. We talked about the design process stage gate and the spiral process. Development tools, basically the team building and pride principles we discussed during the laboratory session and we had few laboratory sessions also covering almost all these topics. And the design stages, the 3 important stages we identified are the; understand the opportunity, develop a concept, and implement a concept. We focused on these first two where the functional and conceptual design was covered.

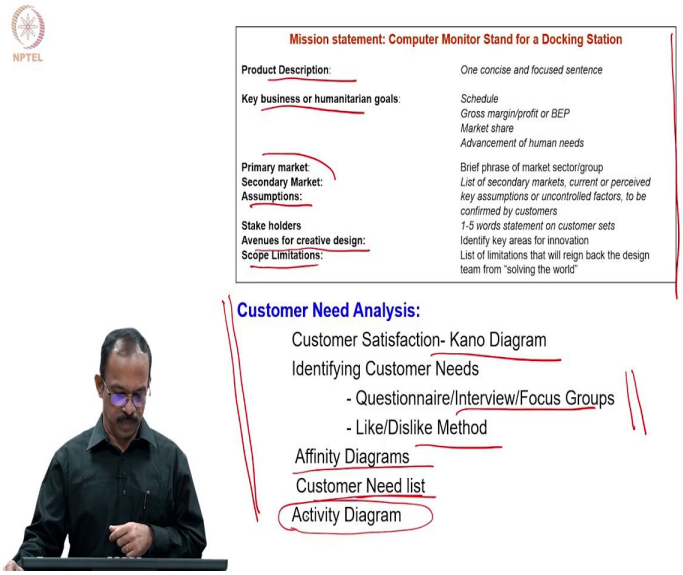
(Refer Slide Time: 12:38)



And then about developing a vision for the new product, we talked about-S curves and technology forecasting, we talked about mission statements, and technical questions. So, we saw

how to conduct technical questioning, and get the answers and based on the answers develop a mission statement which will help the design team to focus its efforts, and the design goals, and then set their business goals also. So, these are some of the technical questions we mentioned : what is the problem really about, what implicit expectations and desires are involved, and things like that. We asked all these questions to get the answers and based on the answers we can develop the mission statement.

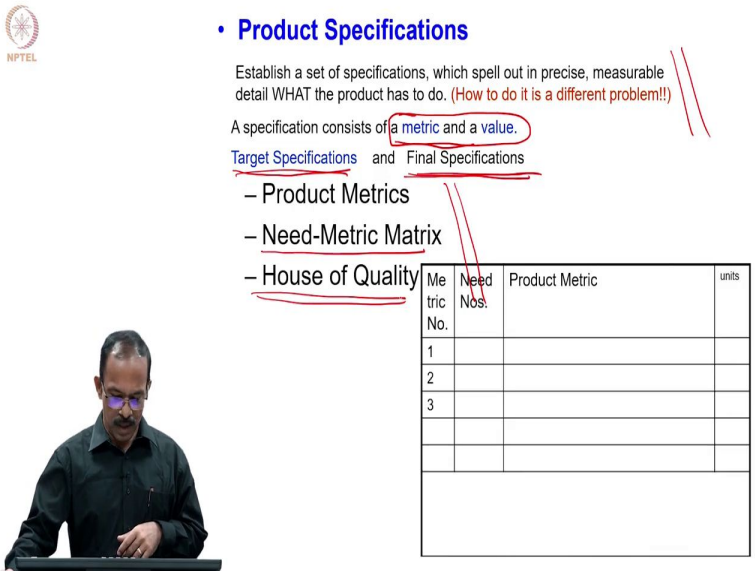
(Refer Slide Time: 13:27)



And the mission statement will look like this, it will talk about the product description, the key business goals, market, assumptions, and avenues for creative design, and the scope limitations. And the next stage was the customer need analysis, which actually identifies all the needs of the customer before we talked about the design of a product.

So, we talked about the Kano diagram, we talked about the methods by which we can identify the needs, questionnaire, like-dislike methods, then we talked about affinity diagrams, and how we sort out these customer needs and based on that how we get the customer needs list. And this activity diagram numbers used to identify the latent needs of products, where the customers would not be able to tell it directly. The design team has to identify the latent needs by various methods, so one of the methods was the activity diagram.

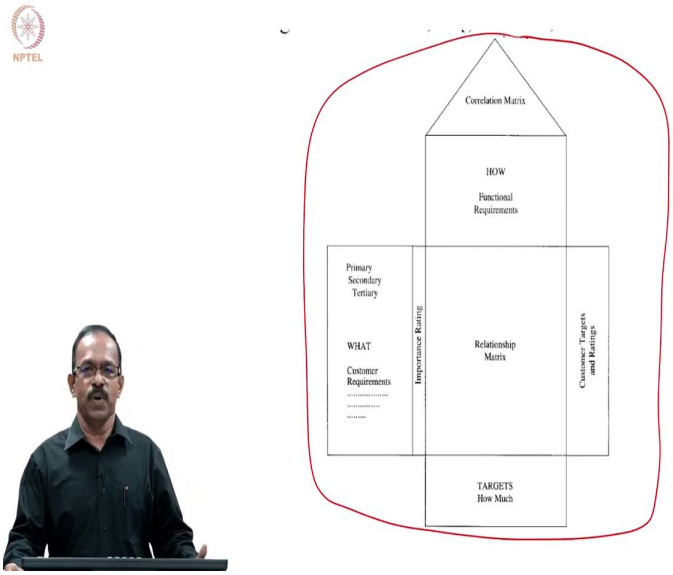
(Refer Slide Time: 14:26)



And then based on the needs, subjective needs of the customer we try to convert that into objective design specifications and that is where we talked about the specification, development of specifications. We talked about the specification about the metric and the value, so every specification will be having a metric and a value. And this we have a target specification and final specification based on the compromise we have been need to make between various parameters we get initially a target specification and finally we get a final specification for the products.

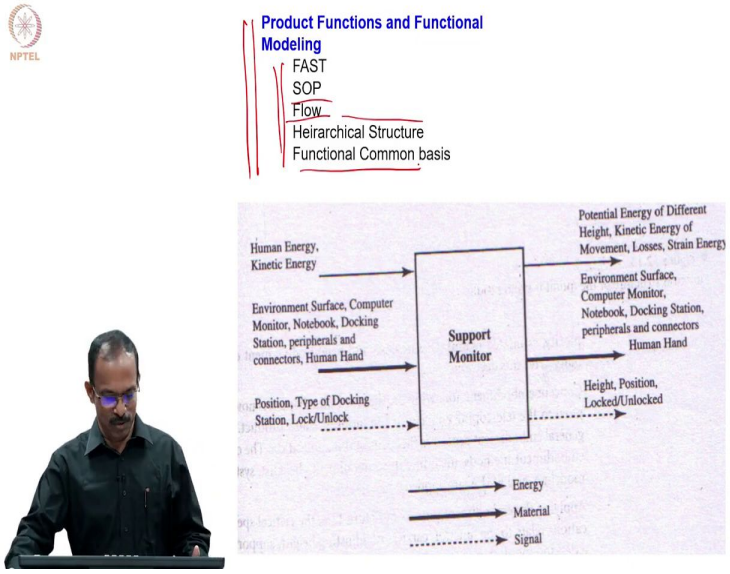
We talked about the different metrics, and then we talked about the need and metric relationship, and how to use the house of quality to have a combined view of customer needs, matrix, values, the technical difficulty and based on all these how do we actually fix the target values for the product. So, from customer needs we actually moved to the design specification, which is actually an objective measurable quantity, once it is satisfied then you are actually satisfying the customers. So that is the understanding of the specification for a product.

(Refer Slide Time: 15:46)



And we talked about the house of quality, which is a pictorial representation of the customer needs, metrics, values, and benchmarking information.

(Refer Slide Time: 15:59)



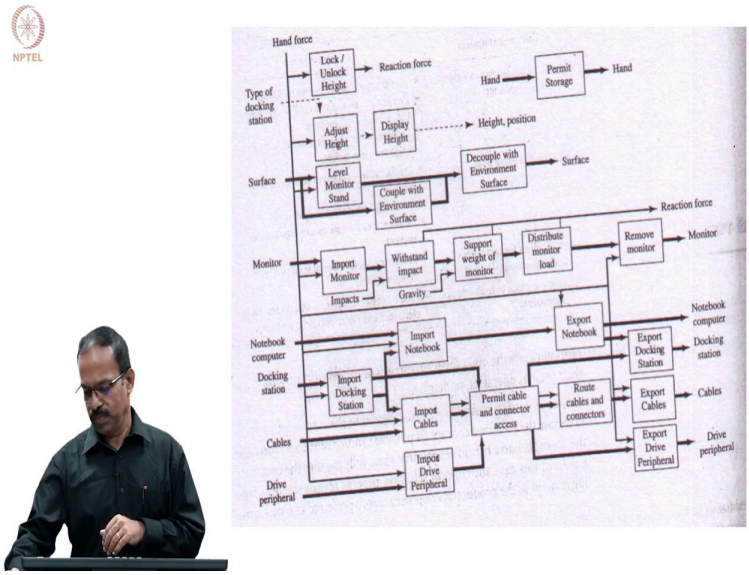
And to meet the needs of and meet the product specifications we need to improve or modify some of those features in the product. And what feature to be modified to get decide a specification or decide performance requirement we need to look at what is happening within the

product and decomposing the, the main function of the product into smaller functions is known as the functional decomposition.

The big problem of designing a product can be simplified or can be decomposed into smaller design problems by looking at the functions and some of the functions, sub-functions can be modified to get an improvement in the overall function of the product. And we found many methods like, FAST method, SOP, then flow, flow method or the function structure methods and based on this we will be able to get the functional decomposition, and based on that you can create a function tree as well as a hierarchical structure of the product functions.

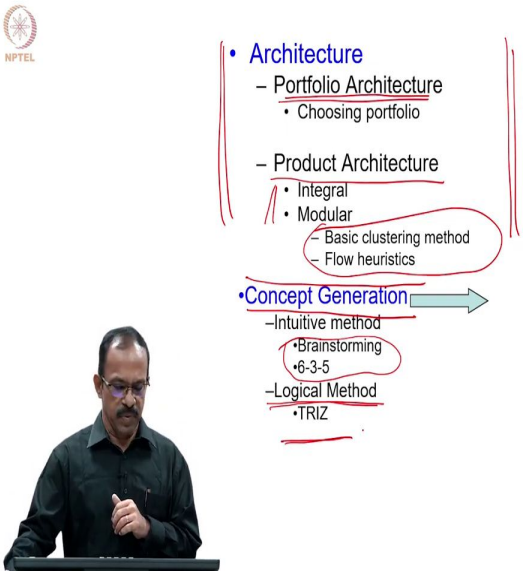
And to do this, we discuss that there are, I mean when we develop the functional decomposition, we have to use functional common basis, so that you will be able to represent the function irrespective of the domain. The next stage was to, this is an example for the flow method of functional decomposition.

(Refer Slide Time: 17:25)



They again show how we do the flow method of decomposition, this for a product like a monitor stand for a laptop and you want to use the laptop along with a normal monitor how can you make a monitor stand for that. So, this actually shows the functional decomposition of that product using the flow methods.

(Refer Slide Time: 17:53)



Okay from the functions the next stage is to move to give a form to the function, so that is where actually you want to convert that into physical building blocks. And the conversion of functional blocks to physical building blocks is known as the product architecture. And when we talk about the product architecture, we need to look at the individual product architecture as well as the number of products to be offered in a family of products and that is known as the portfolio architecture.

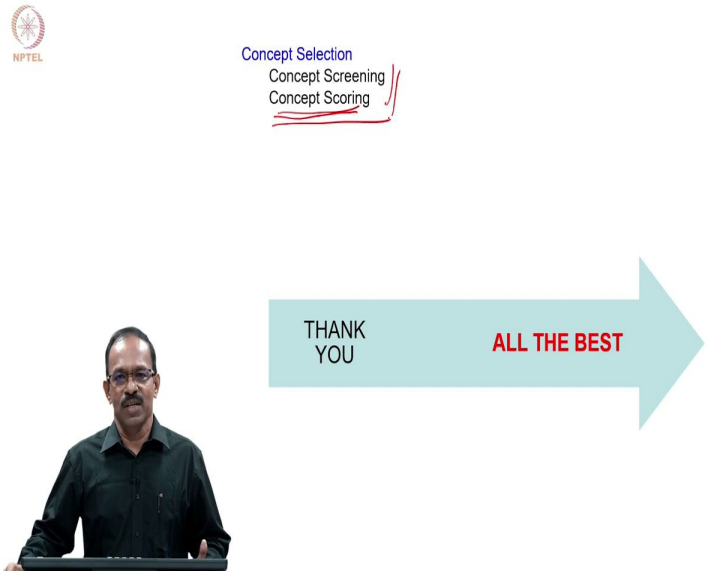
And then individual architecture of the product can be either integral or modular. And then we saw how the modules can be identified in the products based on different methods like, clustering method as well as flow heuristics. And once we identify those modules, then you will be able to create a geometrical layout of the product which will give some kind of a shape or a form to the product. So that was what we discussed in the architecture. And then once we identified the modules or the elements, which actually provide some function we need to develop concepts to have alternative options for providing that function and that is basically the concept generation stage which is more of a creative process.

And we saw that, for concept generation we need to have a large number of ideas to solve a problem. You have a particular function to be solved, for which we need to develop many ideas to solve it and these ideas can be developed using systematic idea generation exercises. There are

2 types of exercises; one is an intuitive mode, the other one is the logical mode. The intuitive method, we have brainstorming, 6-3-5 and we talked about the gallery method also.

And then we found that there is a logical method which is known as TRIZ or TIPS which actually looks at design problems as a contradiction between two engineering parameters. And whenever there is a contradiction between engineering parameters there are methods or there are standard solution methods to solve the problem and using a contradiction matrix will be able to solve all the design problems. So that is what we discussed.

(Refer Slide Time: 20:18)



And then finally, we discussed concept selection; when you have a large number of concepts, how do you choose the best concept? And we found that there are two stages; one is known as concept screening, the other is concepts scoring. Concept screening helps us to quickly bring down the number of concepts to a smaller number and then rank them and take it to the next level of concept scoring.

In concept scoring, we use more objective values and weighted criteria to evaluate the concepts and finally choose the best concept. So, that was the concept scoring. So that is all from this course, we started with the basics of engineering design and finally stopped with the generation of concepts and selection of the best concept to design a product or a part of the product. So, thank you very much. I hope you enjoyed this course. If you have any questions, you can always

contact me, email me. My email address is already available. Please feel free to contact me. Thank you very much, and all the best.