Product Design and Development

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Lecture - 08
Functional Analysis

[FL] friends, so here we are again to discuss lecture number 3 in week 2 and today our focus will be on Functional Analysis. As all of you are well aware we have already taken two lectures on value engineering. In lecture number 1 we discuss the basic aspects of value engineering in which we have seen that what is value engineering, what are the historical perspective of value engineering and what are the application areas of value engineering and we try to see that what type of problems can be solved using value engineering.

Then going to slightly on application side of value engineering, in the second lecture we discussed that what are the issues related to value engineering why do we need to solve a problem using value engineering and how we can identify a problem that is problem identification for value engineering or for value analysis. Also we have seen a systematic method or solving a problems related to value engineering that is value engineering job plan. In our first two lectures we have also discuss that why a poor value enters into a product, if you remember there were 5 or 6 points in which we have seen that why products have poor value.

Moreover we have also seen that why value engineering is helpful in solving the problems related to construction activities, related to service sector, relating to manufacturing of the different types of goods or products. So, we have seen by now we have basic understanding that value engineering is a helpful technique and it can be employed in various diverse fields of engineering and management and this can be help us to save lot of money for our organization.

So, functional analysis or functions are the backbone of any value engineering study. We have to understand that what is the function the product is delivering or; what is the function the service is delivering. If we take an example of a banking sector initially in order to withdraw the money we have to go fill a form deposit the form we will get a token and then we have to wait for some time the token number will be called and then

we will be called to the counter to collect our money, but over a period of time the procedures have changed.

Now, you have a single counter you go to the counter give your requisition and you get the money there itself. So, what is that, that is saving money for the customer and the time also is saved for the customer may be money is saved for the bank because less number of people are now there in the bank, activity of you can say serving the customer has been improved and from the customer point of view he has to spend less time in the bank.

So, slide modification in the procedure has lead to benefit, not only for the banking system, but also from the customer point of view. So, these are simple examples where we can see the basic concept of value engineering can be easily applied. So, we have, we need to understand the function now in this particular you can say example what is the basic function the function can be withdraw and money. So, the basic function is withdraw money.

Now, we have to see how easily we can satisfy this function so that it is beneficial for the bank as well as it is beneficial for the customer. So, with the change in the procedure it is a basic function was satisfied the customer is coming to the bank he is withdrawing his money and he is going back. So, the basic function is satisfied only change that has taken place is a change in the procedure and because of the change the customer is also feeling happy and the banking system is also maybe more efficient and effective.

So, the summary over all is the overall value of this particular transaction has improved similarly any product that you see around you will be having some value associated with it which will be directly proportional to the function that the product is delivery. So, we need to first understand that: what is the function that product is designed for and how that function can be achieved at the minimum possible cost.

So, our today's discussion will be to understand the different types of functions that are there in the product then we will see the functional cost analysis or functional cost mapping and try to understand that how that mapping will help us to identify the functions which can be eliminated or combined or may be added. I am not saying that always we have to go for function deletion or function elimination many times in value

engineering we will be adding some functions to the product in order to improve the overall value of the product.

So, let us now go through the presentation and try to understand the fundamental aspects related to the functions and functions are the fundamental or backbone of the value engineering technique and therefore, we are emphasizing on functions because all other things in the approach are more or less systematic and is equivalent or it can be analogous to any product design process. But the only difference is that value engineering technique has is the it is the function based technique and our focus is always on the functions that the product are suppose to deliver or products are suppose to achieve.

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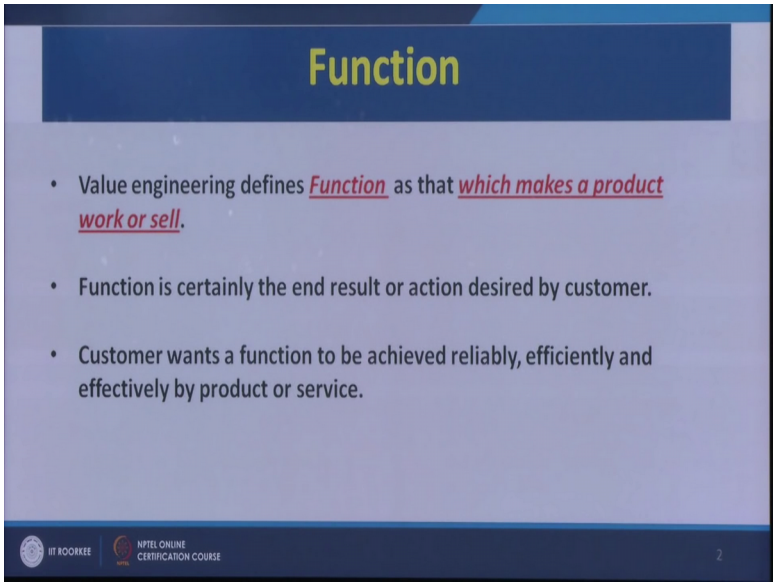

So, let us now slowly try to understand the different types of functions that and then try to understand the function cost relationship with the help of an example. Now you can see on your screen value engineering defines function as that which makes a product work or sell. So, a product works or sell if it achieves the desired function reliably function is certainly the end result or action desired by the customer. Now if this pointer the what is the function to point on the screen. So, it is the end result of this product. So, function is certainly the end result or action desired by the customer, customer wants a function to be achieved reliably efficiently and effectively by the product or service or

we can reframe the sentences a product or service should achieve the desired function reliably, efficiently and effectively.

Now, form product designer point of view if I am designing a product I should ensure that I must ensure and I will ensure that the product delivers is its intended function reliably efficiently and effectively.

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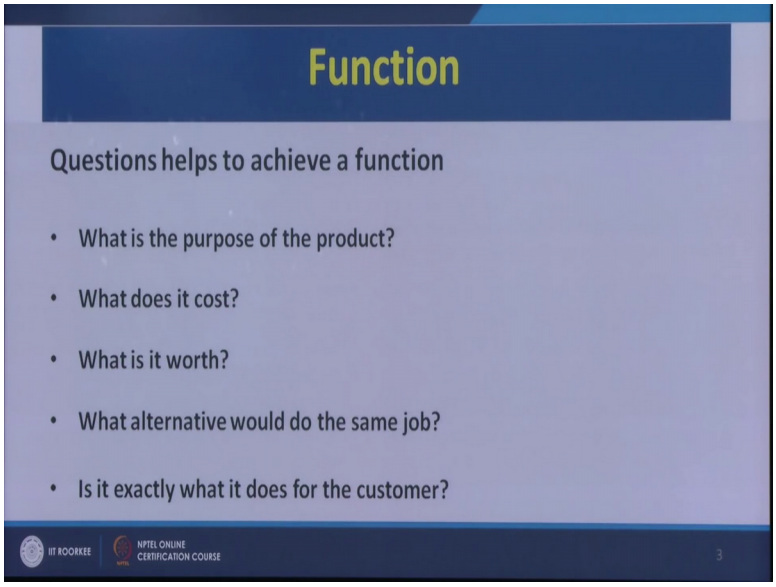

Now, questions that help us to achieve a function are what is a purpose of the product. Now suppose we have to now identify first thing is identifying the function of a product, second stage can be analysing the function, third stage can be finalizing the function that how technically we will achieve that function. First thing is identify, now to identify if I say what is the function of the camera very easily we can try to write it with the help of pen and a pencil that what is the function of a camera, somebody will write a sentence to record the audio as well as the video of something.

So, maybe it is a long sentence and it may clarify the scope of the camera or may not clarify, there may be other things also like the camera is also storing the information it will may be converting the information from a audio file into some other format. So, the overall functions are not clarified by the single sentence that it is used to record the audio and the visual details of any object or any system

So, the point is we need to first identify that what are the functions. So, for that what we need to do? We need to break down not physically breaking, but we need to divide the complete system into its individual components and then try to analyse that what is the function of individual components and how it is contributing to the overall system or the overall product as in the case of the camera. So, we will have to first identify the function and that we can do with simply asking a simple question what is the purpose of the product second what does it cost because we have to relate the two things function and the cost.

So, we have to see what is the purpose, what is the cost, what is the worth now worth you can say can be the value of the product that whether it is worth to spend that much money to acquire that product that will add to the worth of the product or that will be analogues to the worth of the product. What alternative will do the same job now once we have identified the function what has to be achieved then comes the creativity phase in which we have to see that what are the other alternatives available what are the other methods of achieving the same function, but at a relatively lower cost and is it exactly what it does for the customer. And that is the two points are summarized, can be summarized in a single sentence only that we have to see that what are the other alternatives possible to achieve the desired function, but at a relatively lower cost. So, that is our target of doing the functional analysis.

Now, let us see the word function usually there is a two word definition which is the apt and most crisp way of a representing a function. Let us see, project or a product is evaluated by identifying the function in two words, two words is the catch word here.

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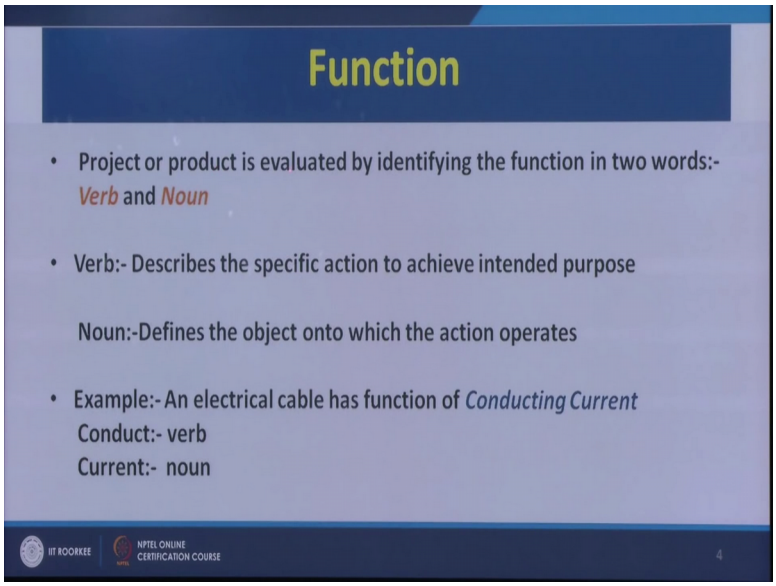

And many times in a from examination point of view also sometimes you may required write the two word functional definition of maybe some common products. For example, my watch what can be the two word functional definition for this watch it can be show time. So, it is a verb and a noun.

So, here you can see it is highlighted a verb and a noun. So, the first word will represent a verb and the second verb, second word sorry will represent a noun. So, it will be a two word combination which will help you to identify the function of a particular product now even as an exercise in your surrounding you can see maybe 4 or 5 different products and try to identify their function with the help of verb and a noun. One a simple example I can give you is a chair, all of you may be having chair around your some of you may even we sitting on the chair. So, chair if you see the verb and the noun definition you can say provide seat, provide s e a t seat. So, it is a verb and a noun definition of a chair and due to the functional definition of chair.

Now, once you do the further analysis you need to see that how this product can be redesign, how this product can or how this function can be achieved by without using this chair. So, now, we are focuses the solution you are removing solution is chair. So, we are removing the solution, but you have a function in your mind that I am standing and I need a seat. So, you will look at the various alternatives which can help you to solve the problem of providing a seat to any customer.

So, that is a verb and a noun definition one example I have already given you. You can do exercise you can identify 10 products around you and write their verb and noun definition. So, verb describes the specific action to achieve the intended purpose. So, again I am reading, it describes the specific action to achieve the intended purpose. So, noun defines the object onto which the action operates, defines the object onto which the action operates. For example, transmit torque, you can say what is the basic function of a shaft transmit torque. So, transmit describes the specific action to achieve the intended function, what is the intended function? To transmit the torque and then defines the object onto which the action operates. So, this is the second word that is noun that is torque.

So, you have verb and a noun definition for example, you can take a watch show and time. Example can be an electrical cable has a function of conducting current. So, conduct is verb and current is noun. So, you have a verb and a noun definition of a electrical cable that is conduct the current. So, that is basically you can see very simple way to identify the functions of the product.

Now, there are different types of functions there are different types of values for the product. If you see around you the different products for example, I am wearing a neck tie and in neck tie what can be the two purposes for wearing the tie one can be that it looks good only. So, I am wearing the neck tie another thing can be that it pro saves me for my chest from cold. So, way it has got maybe some other function also or maybe that function we call as a use function. So, different products that you see around you will have different types of functions.

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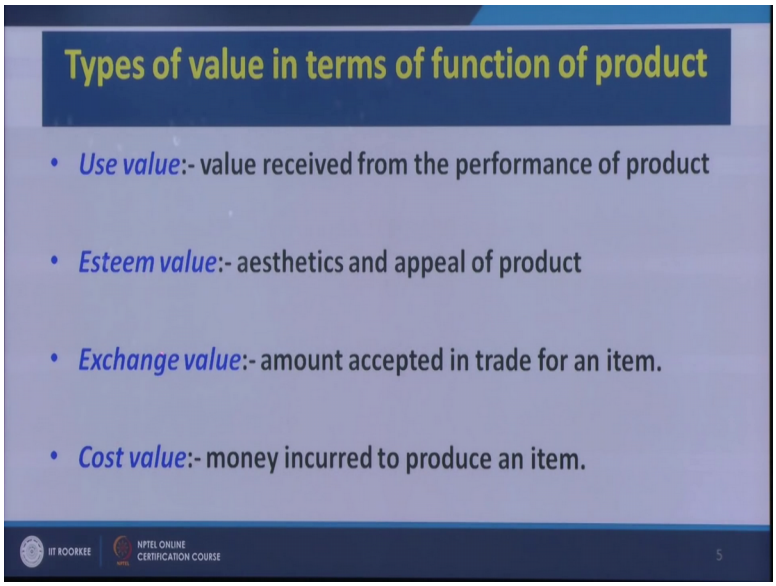

So, similarly the products will have different types of value. So, you can have a use value esteem value, exchange value, cost value. Let us see one by one what is the use value? Value received from the performance of the product. So, if you are having a car and we are driving from Roorkee to Delhi, 4 passengers travelling in that car, so the basic function of the car can be transfer passengers, or transfer people. So, if 4 people are getting transported or maybe they are moving or they are travelling from city a to city b by a particular car, so car is delivering its use value.

Esteem value aesthetics and appeal of the product. Now suppose that car has a tag of a well known multinational company and it is a very costly car it may have esteem value then it has a esteem value also maybe, it is having both the use value because it is the passengers are travelling in that car it has got esteem value also because it is a branded car of a very well known company.

Then the exchange value amount accepted in trade for an item now suppose you want to sell that car. So, that then it will certainly have some exchange value and finally, the cost value the money incurred to produce an item. So, you one somebody has bought it for a particular price or a company which has manufactured it by spending the resources we will have therefore, the car will have some cost value also. So, if you see all these 4 values will be different I have given the example of a car. So, for car use value esteem value exchange value and cost value all these values will be different.

But from a product designer point of view you have to take into account almost all the values, but some of value engineering point of view our major focus will be on the use and the esteem value. We may not be that much bothered about the exchange although we have to take into account these values also, but use value and esteem value are the most important value function that we have to take into account. We have to see that if a customer is going to buy a this product first thing will be the use value for which the product is useful for the customer.

Now, let us see these values can be related directly to the function if you see in our first presentation if you remember we have seen value is equal to performance by cost or performance can be performance of what performance of the functions for which the product has been designed.

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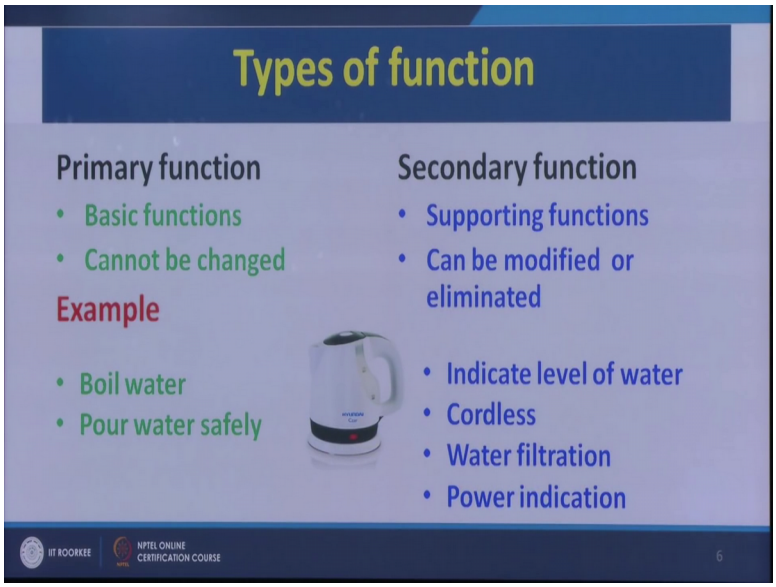

So, if you see prime with functions can be of two types primary functions and the secondary functions. Now primary functions can be may be for an if you see a pencil the primary function can be that you are able to make marks on piece of paper, so that is the primary function of the product, but suppose the pencil it is also printed that save trees. So, save trees become or that message becomes the secondary function for that particular product.

Primary function is to make marks, secondary function is the message that the pencil is spreading to whose we have (Refer Time: 17:40) reading or using that that save trees that

you have to save the trees for the betterment of the environment. So, every product will have primary function and secondary function let us take another example suppose you are using a nail cutter. So, the primary function will be cut nails, anybody is buying a nail cutter for simple purpose of basic function that is cut nails, but it may be having a filer also. So, filer may be the secondary function.

So, secondary functions help the product to sometimes the secondary function will help the product to achieve the primary function also. So, that is a combination of the function will always exist for every product. Now, you can see around you 4 or 5 or 6 different products and try to see that what is the primary function of that product and; what are the sorry additional secondary function for that product.

Now, same thing we will try to understand with the help of two examples. I have already taken two examples of pencil and a nail cutter. Now let us see the example of this electric cattle, primary functions are the basic functions cannot be change, for any product your primary function or the basic function has to be achieved it cannot be changed.

But secondary functions are the supporting functions can be modified or eliminated during the value engineering study or the value analysis procedure. So, we can work on the secondary functions and try to optimize the cost of the product we cannot compromise with the basic functions though those functions definitely we will have to be achieved in order to make a product successful.

Now, for electric cattle let us see base primary functions it is written green colour only. The primary function for electric cattle is boil water pour water safely secondary functions are indicate level of water it should be cordless water filtration process or this thing facility should be there and power indication should be there this red colour whether it is on or off.

So, for an example, basic function is boil water, but secondary functions are it can be cordless and water filtration facilities and all. So, you can see if you are buying a electric cattle these things have to be ensured, these things may be there if they are there may be they are adding some value to the product, even if they are not they are very basic model of this thing should have these two facilities or boiling the water and pouring the water safely. So, we have a combination of primary functions and the secondary functions here.

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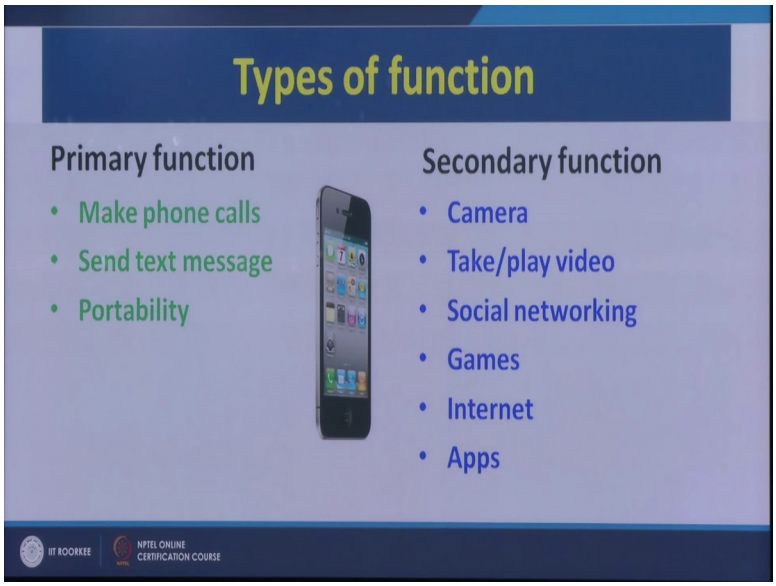

Similarly, let us take an example of a mobile phone, what are the primary functions? Make phone calls, send text message or portability. Secondary functions can be it may have a camera, it should be able to record a video or a play video social networking may be there on the side may be data and other internet connectivity should be there, games internet apps various apps it should support. So, these are the secondary function.

So, for a very basic model of mobile phones these three thing should be satisfied. But for advanced highly functional mobile phone all other thing should also be there. So, when you are designing a product you have to see that what is the basic function that the product has to achieve and then you have to see what additional secondary functions can be added on top of the basic functions so that the product becomes sailable or it becomes a success in the market. So, these are two examples we have try to explain.

Similarly, we can also say that there are huge functions and there are esteem functions. So, we have seen the 4 types of value it was use value for the customer, it was esteem value, it was cost value and it was exchange value. So, different types of values similar different, similarly different types of functions are also there you can have use functions you can have esteem function. For example, sometimes there will be product which only have use function and I have no esteem functions for example, the petrol or the diesel or the gasoline that goes into your vehicle may not be having any esteem function, but it has got a defiantly got a very important use function. Whereas, the jewellery items that we

wear or may be the nail that goes into or wall or the winding that is done over the motor has got use value sorry, but has not got any esteem value, but the jewellery items definitely has got the esteem value.

So, we need to identify the products that which products have got use value and which products have got esteem value as well as we have to take make a compromise that how much of use value should be added into the product and how much of esteem value should be added into the product. There was slight confusion so let me again clarify the difference between the two. Use value let us take at least two products use value first product can be the petrol or the diesel or the gasoline it has got use value, but it has no esteem value.

Similarly, the nail that goes into the wall it has got use value, but has got no esteem value all right, but now let us see the esteem value the celery that you decorate in your drawing room or in your sitting room has got the esteem value, but may not have got any use value. Similarly a flower vase in which you put the flower petals that will also have esteem value, but may not we having much of use value.

Third example can be the jewellery items that will like I am using I am wearing a ring may have got esteem value, but has got no use value. So, we can see that there are products which I have got use functions only there are product which I have got esteem functions only and there will be products which will have both the functions.

Now let us take an example suppose I am wearing a neck tie and I use a tie pin to support the tie now tie pin is holding my tie at it place. So, the tie pin has got a use value definitely it has got a use value because it is supporting my tie fixing my tie at it place, but it has got a esteem value also if I use a diamond studded tie pin. So, if it is a diamond studded tie pin it will be very costly, it may be of a very brand very high and multinational branded company. So, it will, there will be a logo of that company on the tie pin. So, costly tie pin, therefore we can say it has got a esteem value as well as the use value.

So, there will be products which will have both use value and esteem value or use function as well as the esteem function and as a product designer I have to take a call that how much should be the use function and how much should be the esteem function so that the product is cost competitive in the market.

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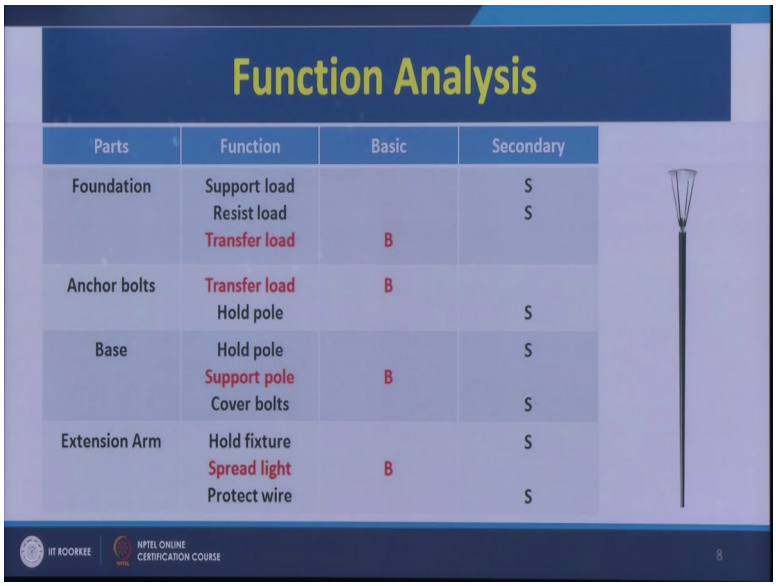

Now, let us see the functional analysis how do we do the functional analysis. If you have understood the basic and the secondary function very easily you can take a call on this functional analysis. Now we have taken this may be lamp post we can see what are the various parts here foundation is there somewhere here, foundation definitely will be there, there will be anchor bolts there will be base, there will be extension arm for holding the lamp, there will be housing, there will be of light bulb.

So, what we have done we have taken a assembled product and in that assembled product, in that assembled product there we have divided it into its individual components. So, here you can see what are the individual components foundation, anchor bolts, base, extension arm housing and light bulb then we have tried to see what is the function and if you see the function we have already seen verb and a noun. So, it will be a two word functional definition. So, functional we are representing by two words only. So, foundation what is the function? Support load, resist load, transfer load, verb and a noun definition. So, out of this the red colour is only the basic function for the foundation the other two are secondary functions.

Similarly, for anchor bolts transfer load is the only basic function to the hold the pole is the secondary function for the anchor bolts. So, for each and every part or component of the you can say this pole or this lamp post we have divided it into the functions which are the basic functions what are the secondary functions.

Now, when we redesign this pole or we want to achieve this function what is what can be the overall basic function of lamp post it is to provide light or to provide illumination. So, then we will see whether all these parts are required what are the basic functions that are required or whether this is the only design that is possible to satisfy the function of providing illumination or there can be some other functions in which some of these parts can be illuminated and cost can be saved. But the target will be that we need not compromise on the level of a illumination the area the lamp post is covering the safety aspect also the reliability aspect also the durability aspect also. So, there will be no compromise what so our own any aspects related to the product design or the product quality.

But we will see that how this basic function can be achieved by minimum number of components and without compromising the quality. So, we will not go into the detail of each and every part, but the overall summary is that any product which is assembled product we can divide it into its individual components and then see for each component what are the basic functions what are the secondary functions and finally, try to find out and work on the secondary functions only in order to redesign the product or you can say come up with the alternate alternative product which can achieve the desired function at a relatively lower cost.

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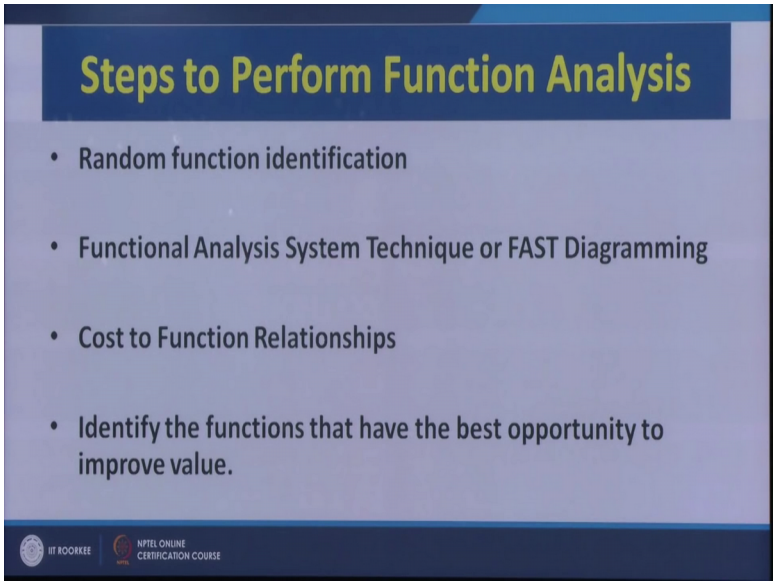

Now, let us take another example let us see the steps to perform the function analysis. Very quickly I will I go through this 4 steps - first is random function identification that is identification of the function we have already seen, random function identification then fast diagramming technique this we will cover in the next discussion. Cost to function relationships this we will cover today's lecture identify the functions that have the best opportunity to improve the value.

So, to summarize this slide we have to first identify the function and then establish a functional cost matrix or a functional cost relationship and then see what are the secondary functions or tertiary functions contributing to the cost and try to eliminate or combine those functions in order to improve the overall value of the product.

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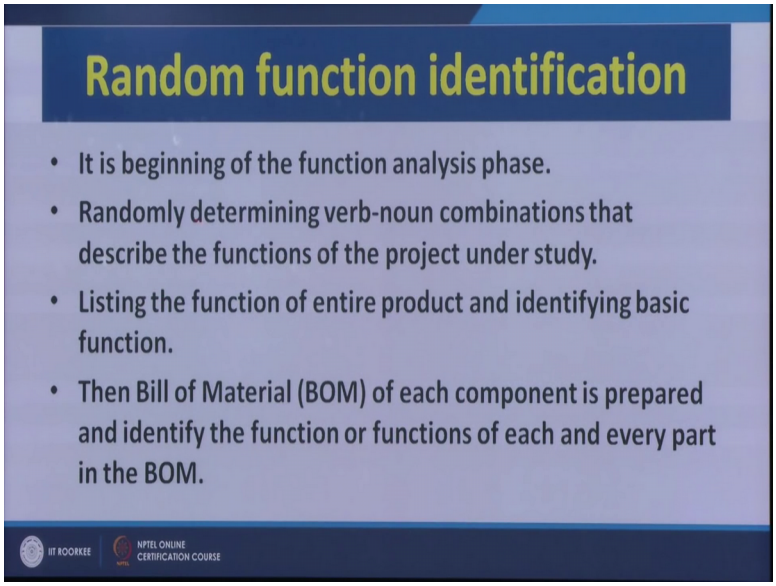

Now, let us take one example. In random function identification it is beginning of the function analysis phase we have to identify a two word functional definition. Randomly determining verb noun combinations that describe the functions of the project or the product under study, verb noun definition already explain to you. Listing the functions of the entire product and identifying the basic functions we will try to understand it with the help of an example. And the then bill of material of each component is prepared and identify the function or functions of each and every part in the bill of materials. So, same thing we have done for the lamp post same thing we can do, but cost we have not considered there let us considered the cost also here.

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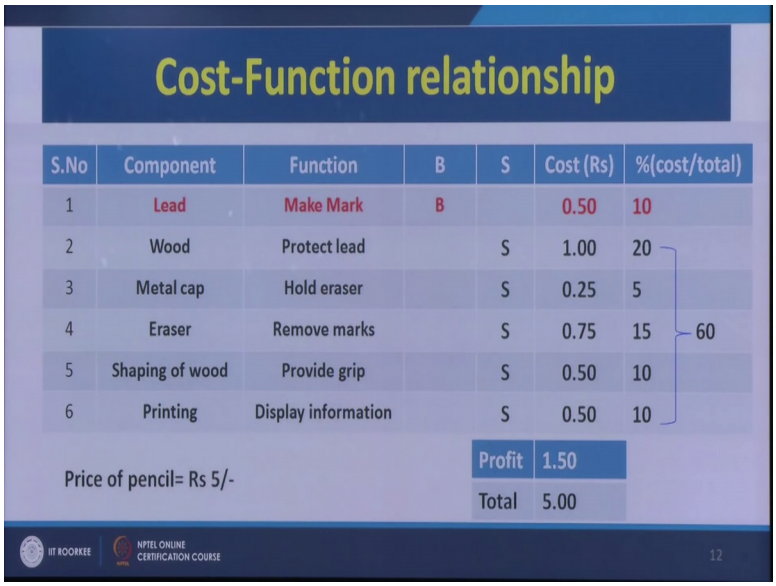

Now, this is a last you can say part of our discussion today that is the functional cost relationship. If you have understood the function, the basic function, the secondary function, the use function, the esteem function, it will be easy for you to appreciate this slide this is for the wooden pencil and in wooden pencil you can see what are the various component this pencil has got a eraser at its end and a metal cap is used to fix this eraser on the wooden structure or the wooden part.

Let us try to see now the component is lead, wood, metal cap, eraser, shaping of wood, printing. So, all these are going into the manufacturing of the pencil now lead will make mark again the functional definition two word functional definition verb and a noun functional definition - lead use to make marks, wood protect the lead, metal cap hold the eraser, eraser remove marks, shaping of wood provide grip, printing display information.

So, for each and every component that goes into this is add to the total cost we have identified the function. And what is the basic function of a pencil? To make marks and that is achieved only by one component other are all adding to the overall cost and are secondary functions and secondary functions are also important in order to ensure that the basic function of making the marks is achieved successfully.

Now, from the analysis point of view we can see only 50 paisa or 10 percent of the total cost is being spent on achieving the basic function of the product. The 90 percent of the cost is or may be the overall cost is going into making, or into ensuring that the basic

function is achieved successfully. So, our focus area has a product designer or a value engineer has to be this additional cost on secondary function and we can see what all are what all are the secondary functions that we can eliminate in order to or we can combined in order to make it a valuable product for the customer.

So, in this way we will do the functional analysis and we will be able to redesign or reinvent the product in order to improve its value. So, we will start our discussion in the next lecture from this slide only and we will cover the fast diagramming approach in our next lecture. I need to explain slightly more detailed analysis of this particular slide since for this lecture our schedule is over so we will start our discussion from this slide again in our next lecture.

Thank you very much.