Product Engineering and Design Thinking
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Module - 02
High-Level Design and Fuzzy Front End of Innovation
Lecture - 10
FAST in Functional Design

Welcome back again to this series of lectures that is on, in Module 2 that is High-Level Design and Fuzzy Front End of Innovation, this is the lecture number 10, where I will be talking about the Function Analysis System Technique, which is in Functional Design. We had discussed functional design earlier and in previous sessions we have discussed the decompositions, functional decompositions, physical decompositions.

We also touched on, touched upon quality function deployment for the need assessment and the meeting with them with the technical descriptor descriptors and which are the engineering requirement, the customer requirement versus engineering requirement or the descriptors as I just said and also we talked about the design thinking methods.

Now, logically it flows to the discussion where we need to find out a methodology by which this analysis is possible as to how if we have to design a system, a product, what will be the its function, how that function will be met and that is an analysis technique which is very very powerful and that we will be discussing today.

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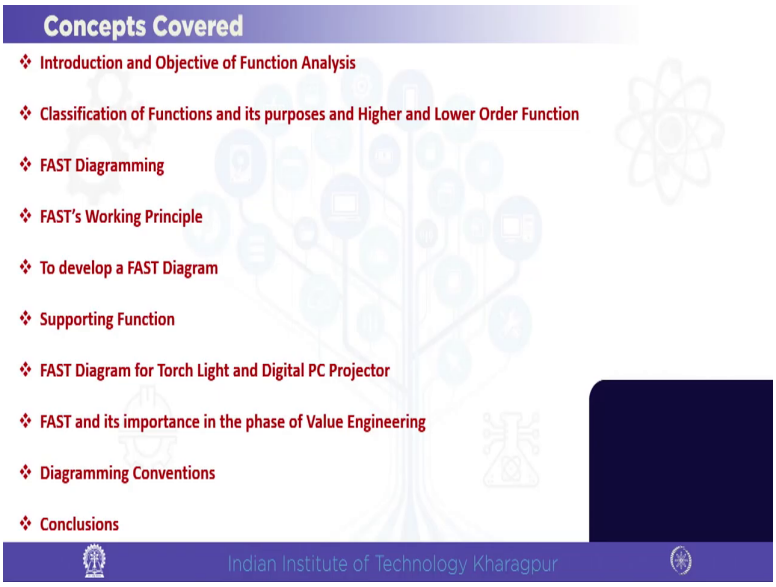

So, we go into the discussion and the concepts covered are primarily focused on the FAST that is Function Analysis System Technique. We will start with the introduction and objective of function analysis, then we would talk about the classification of functions and its purpose in higher and lower order functions. We will describe this higher and lower order. Then we will discuss about the FAST its diagram, the working principle, to develop a FAST diagram.

Then also we are talking of we will talk about the supporting function, how the supporting of secondary function helps in achieving the basic function or the primary function it is called. Like say for a pencil if we have to hold the lead or the graphite we have to use the wood to the wood does not have any purpose as such, but without the wood the graphite will not be able to withstand its strength so, that protection it is necessary. So, and then we will just go further with the illustration with examples.

So, first we will give an example of a very simple product which is a torch light and then a relatively complex product which is a digital projector, which you find in your classrooms and other places also. Digital projector is very common these days. Practically the old projector that is an overhead projector where the you know transparencies or the slides were to be placed or gone.

So, we will take up that thing and then in very briefly we will give a diagramming conventions, but that I would consider a nominal part, but before that let us understand the core things which I have just now told you.

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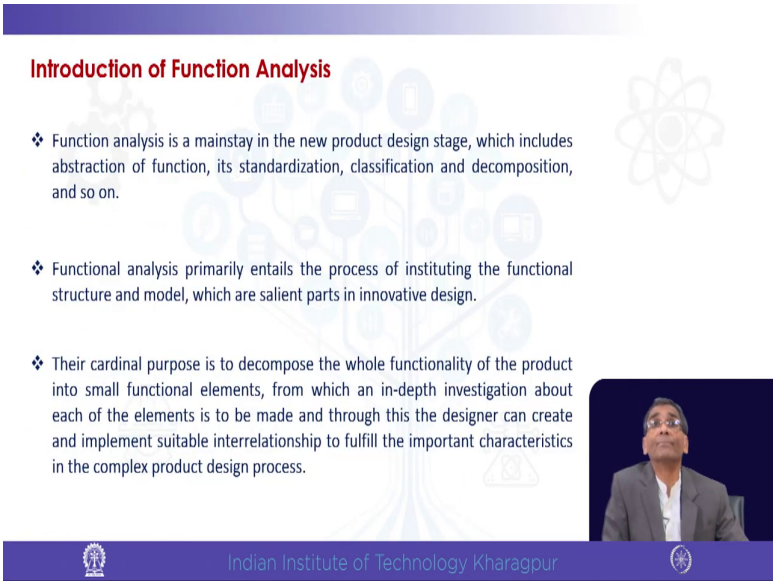

Now, so if we go into the introduction the function analysis is a mainstay in the new product design stage, which we also emphasized earlier that includes abstraction of function, its standardization, classification and decomposition and so on. Functional analysis primary

entails the process of instituting the functional structure and model that we will discuss in the FAST diagram subsequently, which are the which are very important for innovative design and innovative design creation.

Their cardinal purpose is to decompose the whole functionality of the product into small functional elements from which an in depth investigation is can be done. Say the thing is I why I read this line out may because then the explanation will be even more better and clearer that if we have a bigger system a complex whole system and if it can be broken down into its sub components elements and each element is then examined and this designer can create an implement suitable interrelationship to fulfil the important characteristics of the complex products then the complex product effectively would be built.

So, we need to investigate into the elements and then assemble at them in a real sense when we talk in physical sense then we talk of assembly then that becomes the product.

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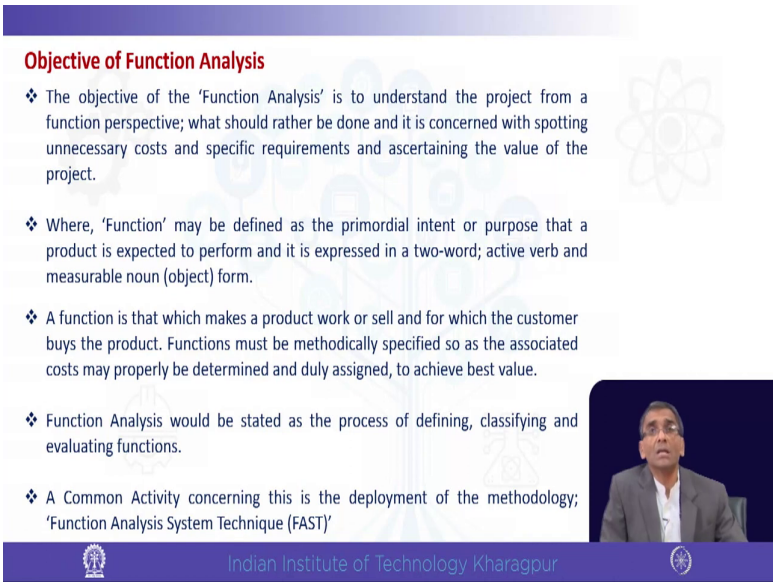

So, what is the objective of this, is to it is to understand the project from a function perspective, that is there is how what is it is to deliver, what it has to serve, what is the need it has to fulfil, what it should rather do and it is also concerns to find out what is actually not needed.

Therefore, the spotting of unnecessary cost or requirement cost is not there and so, specific requirements are met which actually ascertains or improves the value of the product because as we already know as we have already said in one of our earlier lectures the value is defined as ratio of function in the numerator and the cost in the denominator. So, function by cost or utility by cost. So, if we can reduce the cost then the value of the product goes up.

'Function' is the primordial intent or purpose that a product is expected to perform. So, that the purpose of a torch light which we will be discussing is to provide light. So, as we already

had said earlier that it is to be expressed in a two-word; which one is the first one is the active verb and the second there is a verb active of course, in characteristics and then there is a noun which is a measurable one which is an object. So, a verb and object together would define the function.

A function is that which makes a product work or sell so, and people would be paying for that only then it is actually a working or useful function. Function must be methodically specified so that associated cost may properly be allocated assigned to it is components and that will help us to achieve the best value.

So, it is a process of defining, classifying and evaluating functions. Common activity concerning this is the 'Function Analysis System Technique' or FAST that is what we just said we will be discussing now.

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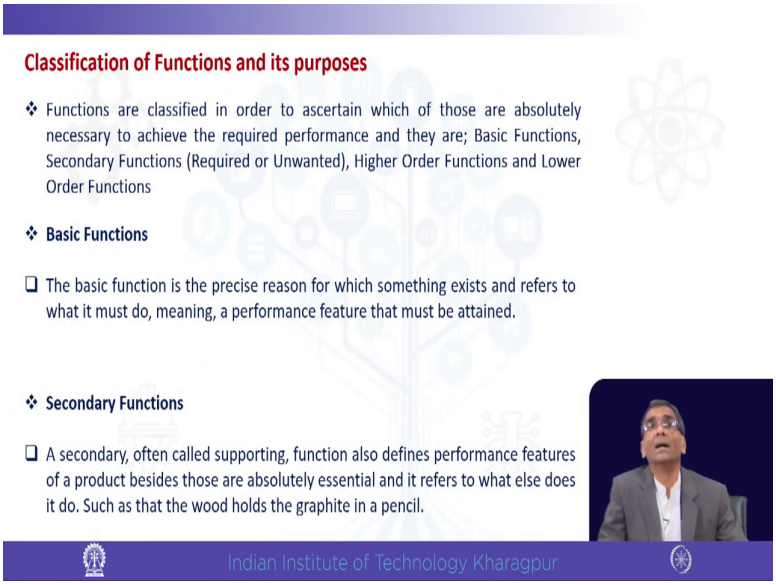

To understand that we have to understand certain terminologies, so because those terminologies will be used in the FAST diagram so, functions are classified in order to ascertain which of those are absolutely necessary. Say for example, the pen, the refill is absolutely necessary, but the holder has to support like as I gave in the example of the pencil.

So, what is absolutely necessary here is that called basic function or which is called higher order function and which supports are the secondary functions or are the lower order functions. Now, therefore, we are entering into the terminologies basic functions already said it is the precise reason for which the product exists, for which people pay, for which delivers a meaningful performance and that must be attained.

If the torch does not give light, but it has all decorative thing or it has all the cells it does not help. Similarly, a car, it may be a very beautiful car, it has a wonderful thing, but it if it first thing is the transport if that does not happen, then there is no purpose. So, that is one function which cannot be compromised with.

Secondary functions often called supporting functions as I just now said, also defines performance features of a product besides the you know the absolutely essential functions which are the primary function or basic function and, but that is necessary to perform the primary function, that is their requirement.

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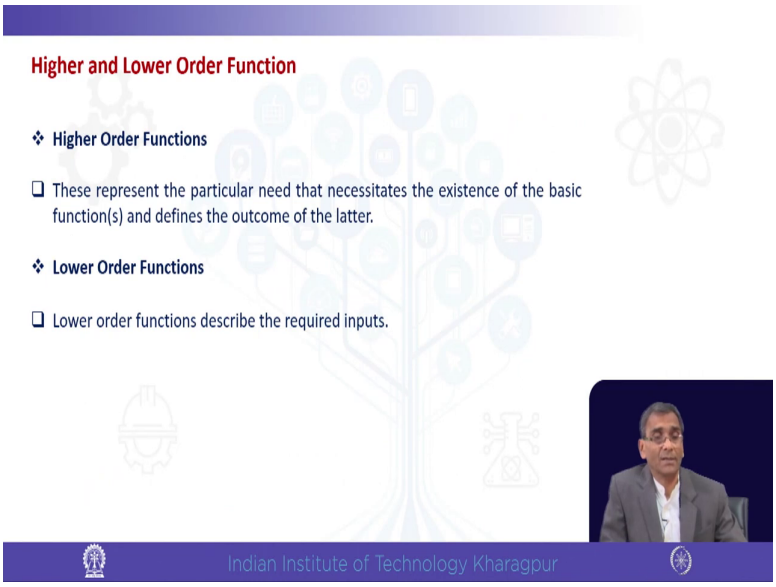

In the context, we would talk about the higher order function, already I have told you this, this is present the particular need that necessitates the existence of the basic functions and defines the outcome of the latter. And the lower order function goes without saying it actually describes the successive required inputs. These are the things to understand or to create a base, but it will be more clear as we use them in a model a graphically pictorially with examples.

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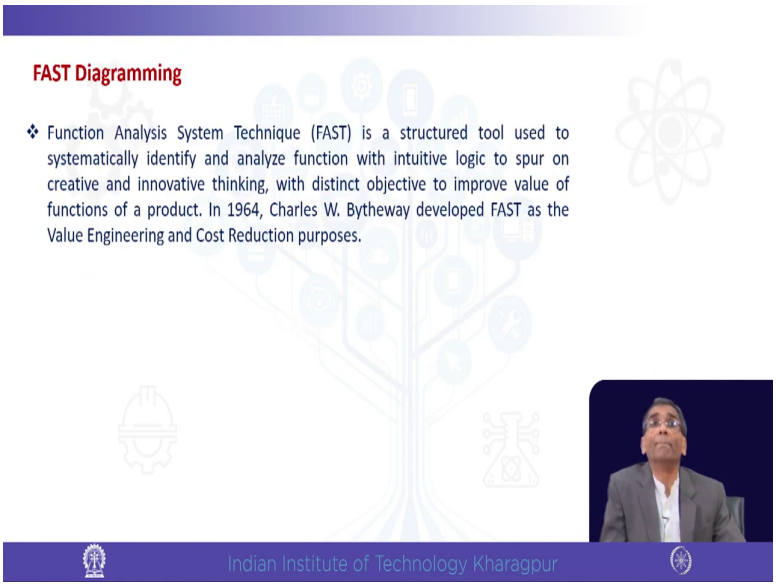

So, before we actually take up the examples, we need to talk about briefly about the FAST diagramming. Function analysis system techniques a structured tool used to systematically identify analyze functions with intuitive logic that intuitive in the sense how something will be realized and why it is required. These are the two things and then by and by as we move on to moving to this discussion or this investigation, it will be it will gain more clarity and then it will be more precisely defined.

And Charles Bytheway actually created this model while working on the value engineering project. So, as we say that value engineering is an inseparable part in product, design and development. So, FAST is very important or useful or powerful tool that in the value engineering we are discussing here today.

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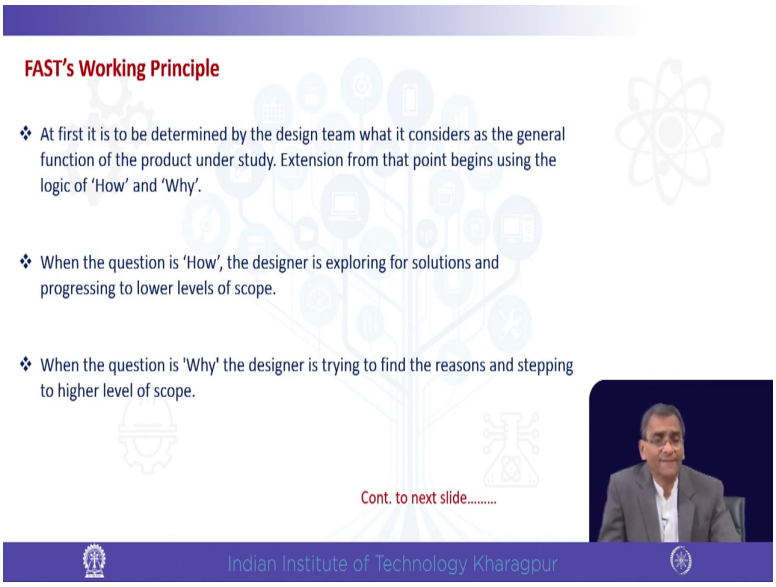

So, what is the working principle? At first it is to be determined by the design team what it considers as the general function. General function is overall function the ultimate function of the product which is called the overall general function. Then there would be other general function subsequently, but then those would be comprised of other function sub functions against sub functions. So, in a sense every function may be considered to be having subsequent functions, preceding functions and subsequent functions.

So, it is based on the logic as I said 'how' and 'why'. Of course, there is another thing called when, but these are the two main props how and why, when is when something parallelly or simultaneously is acting then the when basically comes up. It may be all the time working, it may be one time working, but sometime the switch is on and then it works then is one time, but if it is constantly be there to support then it is all the time.

So, that when part is there in the structure, but then two main thing is are the how and why, we will see to it. When the question is 'how' the designer is exploring for solutions and progressing to lower level of lower levels of scope. When the question 'why' then the designer is trying to find the reasons and stepping to higher level of scope. So, these are the two ways how is starting from the left and why is starting from the right.

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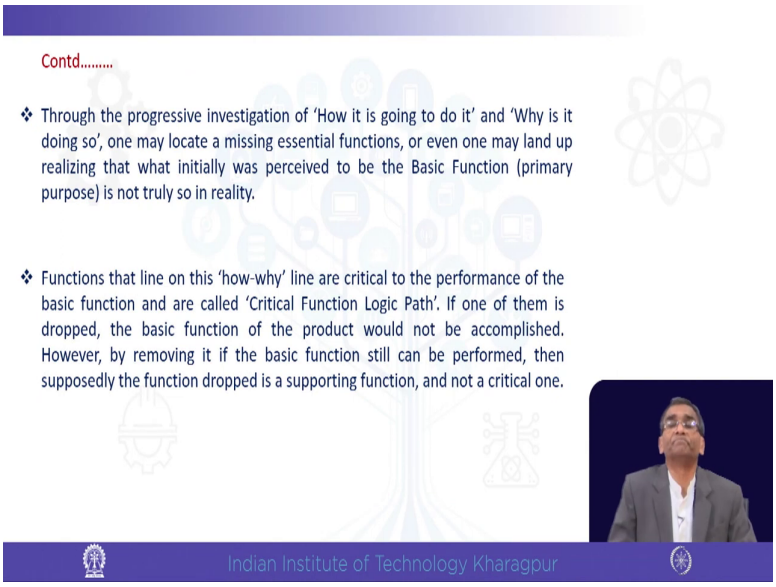

If we consider a line or path, we will talk about that path very soon. Through the progressive investigation of this 'how it is going to do it' and 'why it is doing so', one may locate the missing essential functions that when it is the when there is a mismatch, why it is to be done, how it is to be done and why it is required.

If there is a mismatch, if the answer or the logic is not clear then there is something missing, essential function is missing which therefore, needs to be considered or one may perceive that

with this mismatch in answer or response, what was initially perceived to be the basic function or the primary purpose is actually not so, which is a very important or crucial revelation. So, that is possible through this fast.

Functions that line on this ‘how-why’ axis of line we may call are critical to the performance of the basic function and are called ‘critical function logic path’. The or in short sometimes people call it critical path also, but those who have studied the a project management methodologies like path CPM, the critical path is a different thing, but here usually people call it critical path, but it is understandable that it is critical function logic path.

If in that line if any one of this is dropped, then the basic function of the product would not be accomplished and then only it is the a survey the basic function. But if it is found that it can be dropped and still the basic function is being performed, then one has to understand that that function is not essential or can be dropped.

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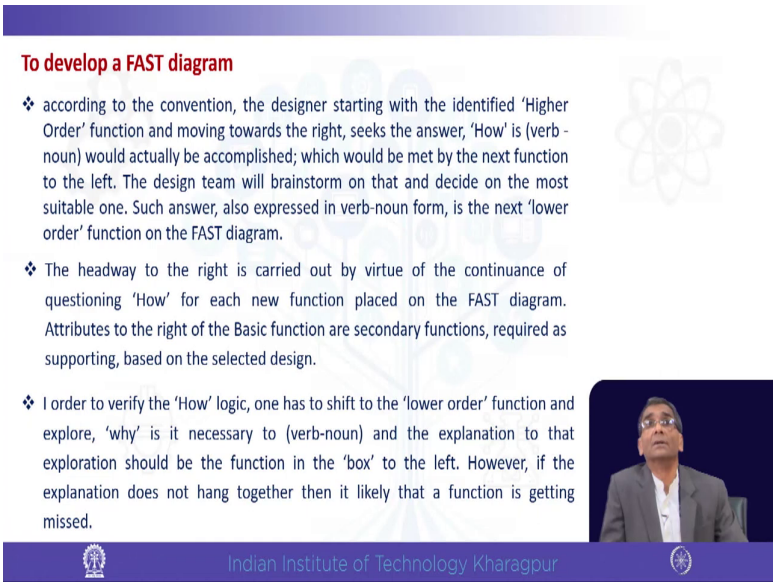

So, now we actually will be entering in the development the technique part of it to develop a FAST diagram. So, according to the convention we will follow the convention is that from the higher order we will go to the lower order that is the higher order means this function that is to be met the requirement to be met.

Then they we progressively go to the other side. The design team will brainstorm on the on that and decide on the most suitable one, such answer also expressed in verb-noun form, is the next 'lower order' function on the FAST diagram this how-why access and talk about.

The headway to the right is carried out by the virtue of continuance of question questioning' how' for each new function placed on the FAST diagram. Attributes to the right of the basic functions are the secondary functions. There are there could be many secondary functions a

series of secondary functions and the secondary functions can also have a parallel activity like I said that say one time or multiple time activities that we will see in the diagram.

In order to verify the ‘how’ logic, one has to shift to the ‘lower order’ function and explore ‘why’ it is necessary and the necessary and the it is in again bar now format. And the explanation to that exploration should be the function in the ‘box’ to the left. So, far as I am speaking left right etcetera you have a problem I know in understanding what is that left what is that right, where it is going where is the axis, but unless I tell you this now when I will go to the diagram it will be difficult for you to understand.

But then when I explain why I said left and why I said right now it will be very clear to you then and this methodology it is put in the slide in a bit descriptive manner you can see so that later on when you go through this video you would be able to understand it if you want to. However, if the explanation does not hang together then it is likely that a function is getting missed as I said that a mismatch should not be there.

If there is a mismatch it is a question it is an investigation that either that is not the basic function or that is droppable.

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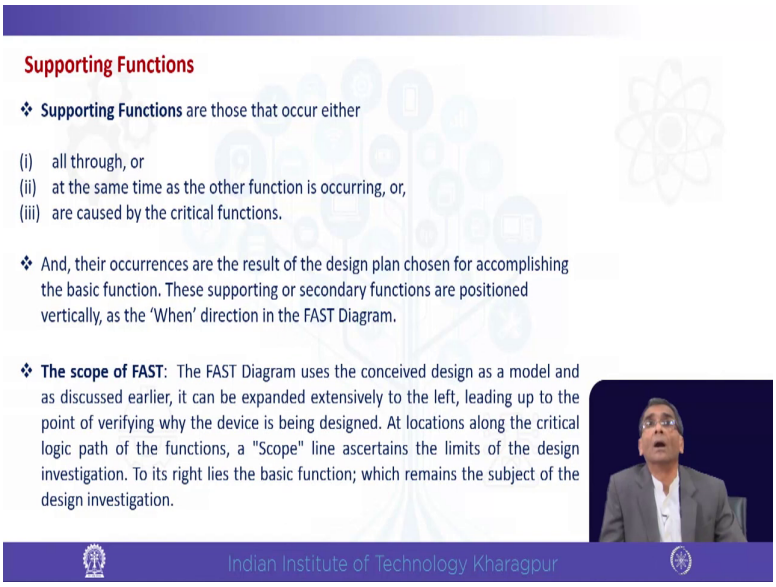

Supporting functions those are the secondary functions I already have said all time or all through it may be at the same time occurring at the same time or are caused by critical functions. And their occurrences are the result of the design plan because it their occurrences are how I chose the design method or the plan and that is how they arise in the system or in the conception concept.

So, what is the scope of the FAST diagram? So, it has to have a boundary. So, what is that boundary? It has already I have told you the higher order and lower order. So, finally, there is one extreme there is the input at one extreme the ultimately they need service.

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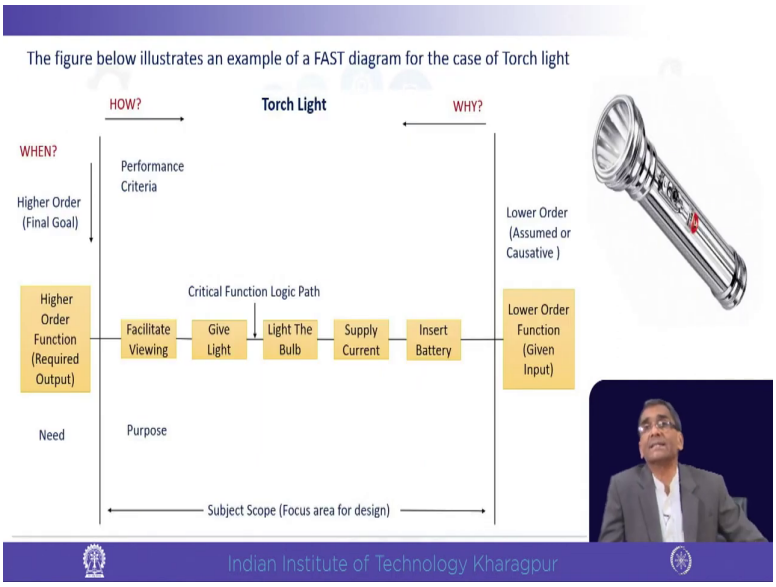

Hence, scope remains within these two limits and we can see this with this example of a torch light. Now, whatever I was discussing which now is absolutely clear with the diagram because that is the theory part or the narration part. I would say it is more of a narration part, without the narration part it is difficult to understand why suddenly some diagram is appearing.

Now, once you look at the diagram and if you have any clarification you can easily recall that discussion and would find this it is very helpful. Now, here you see the torch which is self-explanatory and, but still I would tell you that the higher order function is on the left that you can see and see what is it? It is to give light higher order function. So, what it is doing? Facilitate viewing right. So, how the facilitate viewing is happening?

See, I am questioning how? How the facilitate viewing is happening? Facilitate viewing is happening because it is giving light. How it is giving light? Then there is a bulb which is eliminated or lit and then it is giving light. How the bulb is lit? It is lit by supply of current, current of voltage view. So, that is how the bulb is lit? How the supply current is coming from battery, insert battery? So, here you we have seen and now if we question back from the other end; why to insert battery?

The answer is current is to be provided. Why current is to be provided? Because it will be required for the light bulb. Why light bulb is necessary to give light? Why to give light? Facilitate viewing. So, you see that how why access? Higher order and lower order it is matching. So, this is and here on the two extent that I was talking about the scope the subject scope or focus area for design that is the a limit or scope within which this is acting.

Now, we I have given a very simple example so that you can understand it very easily. Now, I will do very same thing, but a little more complex because see now it would be very easy for you to understand.

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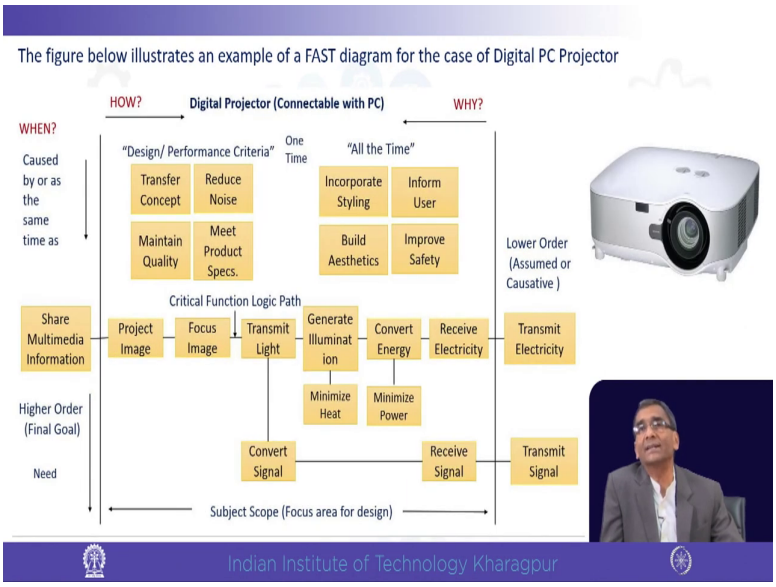

If I now talk about the you know of a digital projector which normally you see is a PC connected projector and which in your classrooms or other places you can you often see. Here you see again the higher end objective is the shear multimedia information. How the multimedia this thing is possible to project image. How the image is projected by focusing the image? How the focusing is happening? That is again by transmitting the light.

So, how the transmission is illumination or transmission of light is transmitting light is possible that is by generating illumination. While now see concurrently as I said there are couple of things happening I will talk it little later, but just would draw your attention here.

Here you see there is a two things minimize heat and minimize power. I will come back to that little later, but now I will go on with the generate illumination. How the generate illumination is happening? By converting energy. How the energy is being converted? By the

saving electricity. So, then the root thing is that plug-in the machine because electricity is required. So, transmit electricity.

Now, if we go back similarly from the why, well the here also there is other thing because it is a not only projection, but it has to be connectable with the computer. So, transmit signal. So, transmits light. So, this is a convert signal and convert signal is the receive signal and that is for that they need a transmit signal. Since, it is coming from the PC, PC or any computer PC here we would consider. So, here you say that there are the lower order or assumed or causative.

So, cause and effect so, cause and effect this relationship is happening. So, if we similarly question back through this why to transmit electricity? Because the electricity is to be received by the system, why it is required? It has to convert the energy to generate illumination then it generates illumination and then that illumination transmit light and that light helps to focus image.

Why the is a necessary it is to project the image, why the light is necessary? The what is focusing is necessary it has to project the image and by projecting the image we convey the information multimedia information. And here you see that there are certain functions sometimes it is a one-time function, sometimes it is a multi-continuous function or time function.

Here you see that two very important things are to happen one is the minimize heat because when there is a generation then heat is generated. So, in a computer, laptop your laptop you perhaps have seen there is a fan which fans out the heat generated and for conversion of energy there is another challenge that how to minimize the power.

And on there the design criteria basically what are the criteria they share information, what are you sharing information, the concept being transferred with the qualities to be maintained that is the durability, reliability of the system, clarity it should not give noise, generate noise or reduce noise rather and it must meet all these product specifications.

Specifics in terms of physical specification, weight, portability is there. So, all these are specifications, size and all the time is the styling aesthetics inform user, improve safety which are important all time considerations which we will go in this. So, now you see that with this breaking the clarity the functional clarity of a product is very much in place and the engineer of the designer can address them very precisely where it is not required or where it is required or what is to be done or where it is missing.

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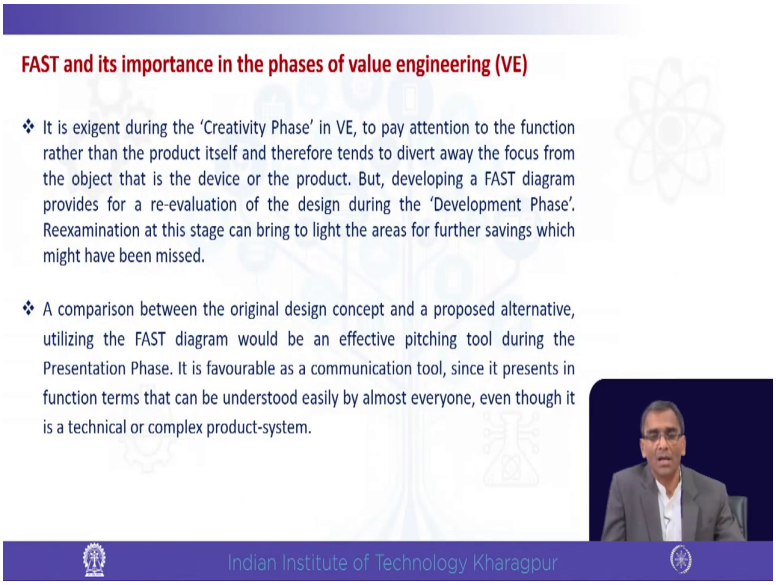

So, FAST and its important the phase of value engineering as we said because it has it is exceed there are quite a few phases of value engineering it is important for the 'creative phase' because the pay attention to the function rather than the product itself and, but you know the emphasis on function in creativity creative phase.

But, developing a FAST diagram provides the re-evaluation of the design during the ‘development phase’ and where it is re-examination happens and at this stage it can bring to light and bring to the surface the areas for further savings which might have been missed out earlier.

Again other aspects is that in the communication in the presentation and communication because which is very important to sale the idea because they when a designer is developing a product or concept the product concept is to be sold because it needs the backing or funding.

So, a comparison between the original design concept and the proposed alternative utilizing a FAST diagram would be a very effective pitching tool a comparison can be shown. It is a favourable as a communication tool since it presents the function terms in function terms that can be understood easily by practically all concerned and since it is a functional term it is deep technical or complexity technicalities or complexity will not be a big challenge for most of the people who are in connection in the context.

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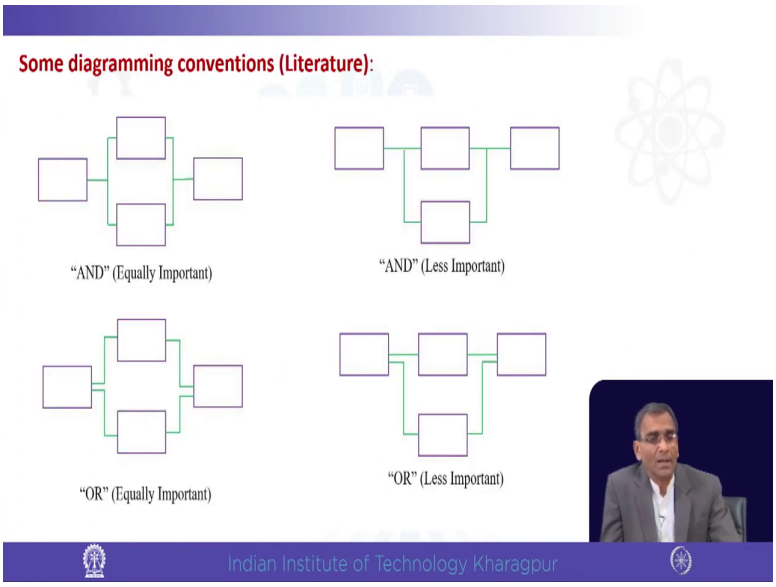

Before the diagramming part is concluded I will just say that there are certain conventions those are preferably followed these are how to present if the two functions are equally important this and that then it is put it in the way that the two things are connected as a parallelly after a serial connection and if it is or then it is parallel all through.

So, these are the presentations on this so, the less important and equally important would be differentiated by lowering the position down of the green lines green or whatever color lines you draw I am showing in the green lines.

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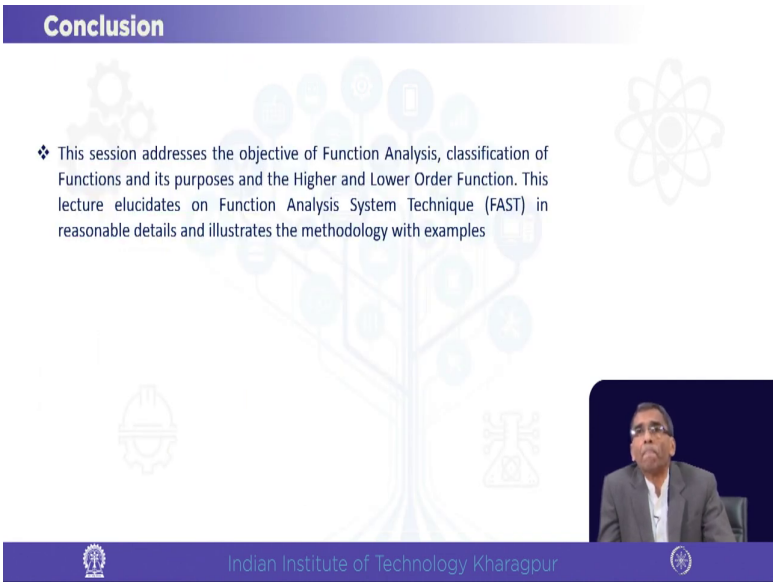

So, I would like to conclude this session by saying that this lecture has addressed the objective of function analysis the classification of functions and its purposes and the higher and lower order function. This lecture elucidates the function analysis system technique in reasonable details and illustrates the methodology with examples.

These examples are very useful and helpful with this you can try using this with other equipment like it may be washing machine, it may be a mixer grinder in the key used in the kitchen or it may be any product that you can sell it just try it just do it as a practice just do this FAST diagram of this.

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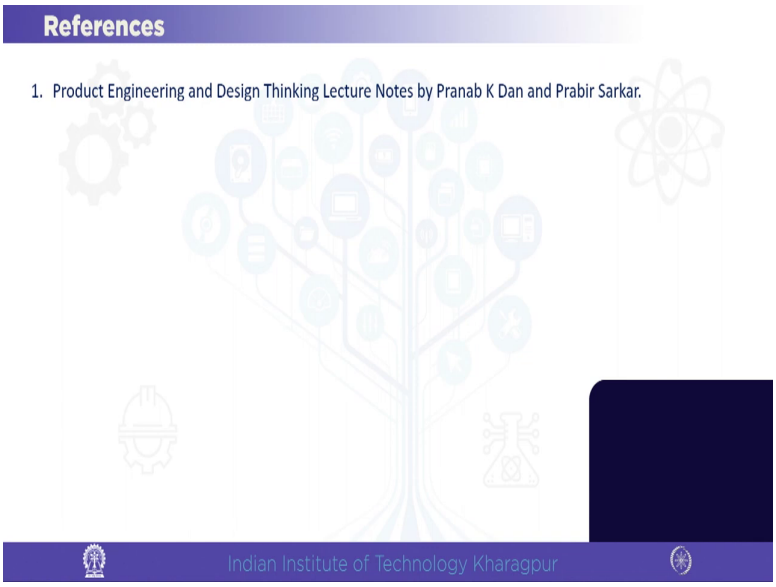

And here the reference would be the lecture material. So, that you can follow and I am sure that this would be this would be a long way in your design and development career because this is one area which is very very helpful.

So, we have come to the end of the discussion, even the conclusion has been discussed and the reference also has been discussed and now I hope that this discussion has helped you and will help and it will go in a long way in your design career and thank you very much for listening to this course.

Thank you once again.