Product Design using Value Engineering

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Lecture - 19
VE: Success Stories - II

Namaskar Friends! Welcome to session 19 of our course on Product Design using Value Engineering. So, friends as per the duration of the course, we are at the fag end of our course. Since it is a four week course, we had to concise our discussion, we had to make our discussion very brief at some instances.

For example I am also not very much satisfied with the discussion that we had in the last case study on design as well as analysis of a sewage treatment plant, but as we have paucity of time the source is available to all of you, you can go through the book it is a very good book a practical approach for engineers by Zimmerman and Hart and the complete case study is given in the book. So, you can go through the case study, and see that what are the various ideas which were created or which were brainstormed by the team, different teams were created, and then based on those ideas certain modifications were suggested.

And we have seen just two examples, one was the change in the discharge column or discharge pipe which was used for the chlorination tank, and another one was related to the modifications in the pumps. So, from one type of pumps the modification was done for the other type of pumps as well as there was a planning issue related to what must be done now and what must be done later, in order to use the funds available in a most judicious manner in the most, we can say appropriate and effective manner.

So, today, again we are here with another case study. As you remember in the beginning of the course we have told or we have discussed and we have finalized that most of the course, would be related to the practical examples. And I am happy that we are coming towards the end of our course, and we have taken different examples, and try to understand the concept of value engineering from the product design point of view.

The product maybe a simple pencil, it can be household divan, it can be a sewage treatment plant, it can be lamp post it can be any other facility we have take an example

of a machine also, we have taken an example of universal testing machine. So, we have taken a large number of examples, and we have tried to see that how the concept or how the step by step procedure of value engineering can be applied.

And therefore, we have been able to establish that there is a degree of success most of the case studies have implemented and shown that there is a 100 percent chance of success if we apply the concepts in the most logical and step by step manner.

And today, again we will see that, if we apply the same strategy of finding out the problem area finding out different solutions by using our creativity, and then evaluating those ideas evaluating those solutions based on a certain set of criteria that has to be done mathematically, logically and as well as we must be able to statistically put forth that, this idea is better than the competitive ideas, and then we have to develop that idea and finally, we have to implement that idea.

So, let us take now this case study, this is related to all of us, because these days all of us use computer tables, we use the computer tables in our offices, sometimes, we have a working place at our house also, we try to buy a computer table, where we can sit and work, similarly in our office also, we use the computer table. So, this case study is related to the value analysis of a computer table, and how the creative ideas can help us to achieve the desired functions provided by the computer table at the minimum possible cost, without affecting the performance durability, reliability of the system or of the computer table in this case.

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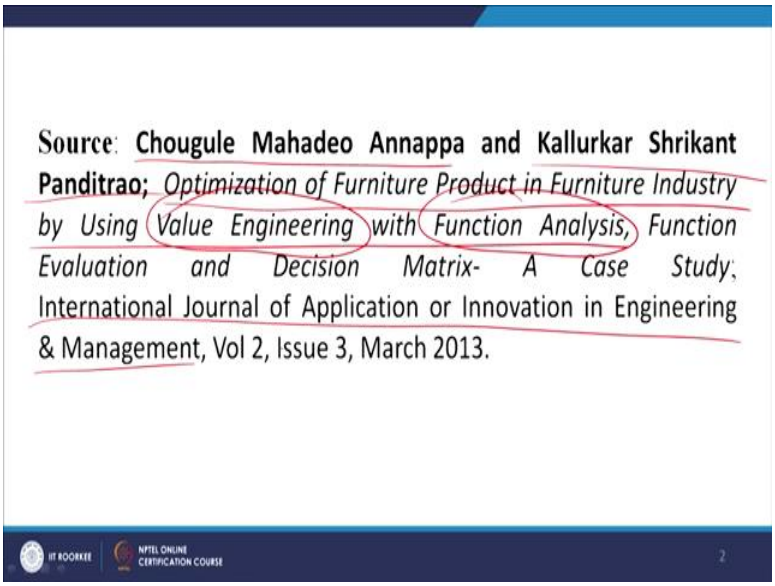

Now, this case study, we have taken from an article, the title of the article is optimization of furniture product in furniture industry by using value engineering with function analysis. So, again in the title only, we have the term value engineering and we have the term function analysis and the authors of this article are Chougule Mahadeo Annappa and Kallurkar Shrikant Panditrao. So, this article has been published in International Journal of Application or Innovation in Engineering and Management.

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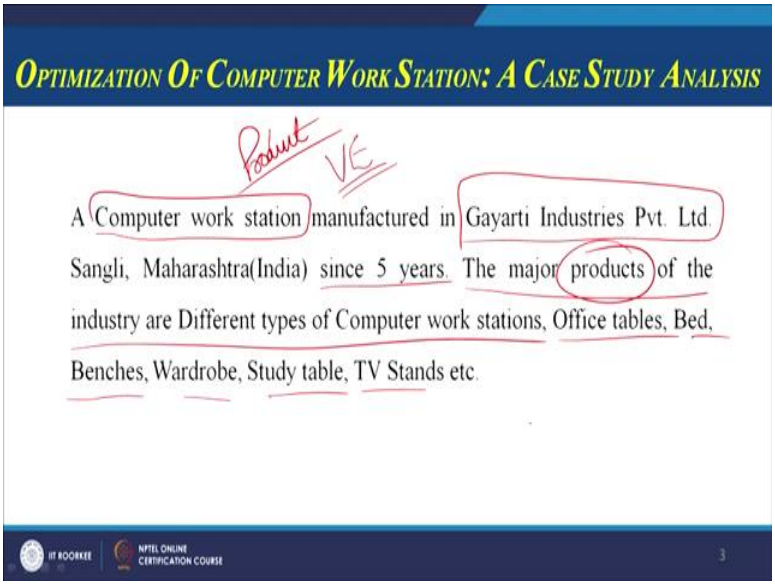

So, the authors have conducted a case study in a company, the name of the company is Gayatri Industries Private Limited.

So, computer workstation, this is the product, since our course as all of you know is product design using value engineering. So this is the product, a computer workstation and now this has to be analysed using the concept of value engineering. So, this is being manufactured for the last 5 years. The major other products which is the company is producing are computer workstation, official tables bed, benches, wardrobe, study table, TV stands extra, but our title or our focus, today is a computer workstation.

Now, let us quickly see that how if I give you maybe a 30 second break, and ask you how you will solve this problem and if after listening to 18 sessions or after discussing 18 sessions on the topic I think all of you will be confident enough to at least, write down the procedure for solving this issue. Already now you have a system which is a computer workstation what is our first stage? First stage of analysis is we will like to collect all possible information related to this design.

What is the design? What are the various elements, what are the various sub parts in this system? Then, we will go to the next stage that what is the functional analysis like what are the functions of each and every part of this computer workstation or computer table, and then, we will try to see, what are the basic and the secondary functions for each part or each element of this workstation and finally, we would like to brainstorm, create certain ideas that how this can be refined, how this can be further developed how the cost can be made competitive.

So, based on that we will finally, like to evaluate some of the selected ideas and develop the selected idea into a revised updated modernized or a new product. So, we want to convert this product which is already in place into a new product.

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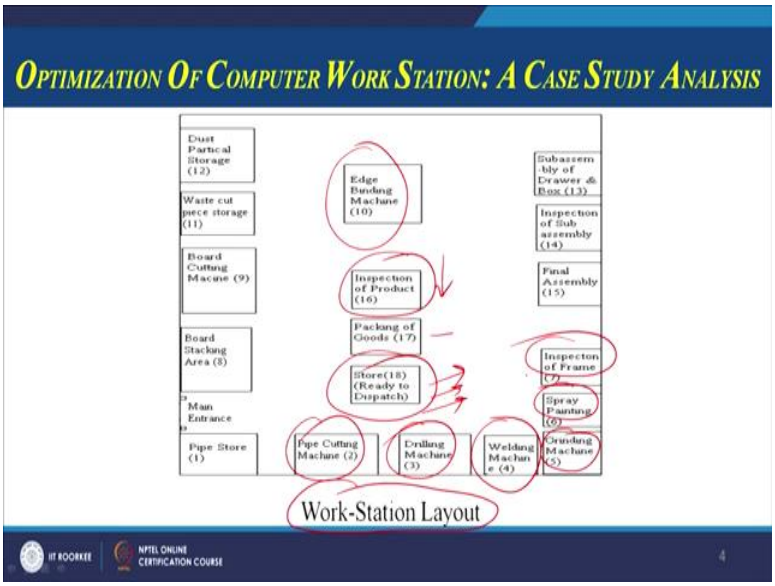

So, let us quickly now see. This is just the information collection, workstation layout how this is being manufactured; the authors have given a very clear idea about what are the machines. So, there is a edge binding machine available, then inspection of the product is done at this location, packaging of goods, storage, and this is a place from where the materials will be dispatched.

So, there are different types of machines available, grinding machine is available, spray painting, inspection of frame, there is a pipe cutting machine, there is a drilling machine, welding machine. So, this is just a layout that how the parts or the computer work table is being manufactured.

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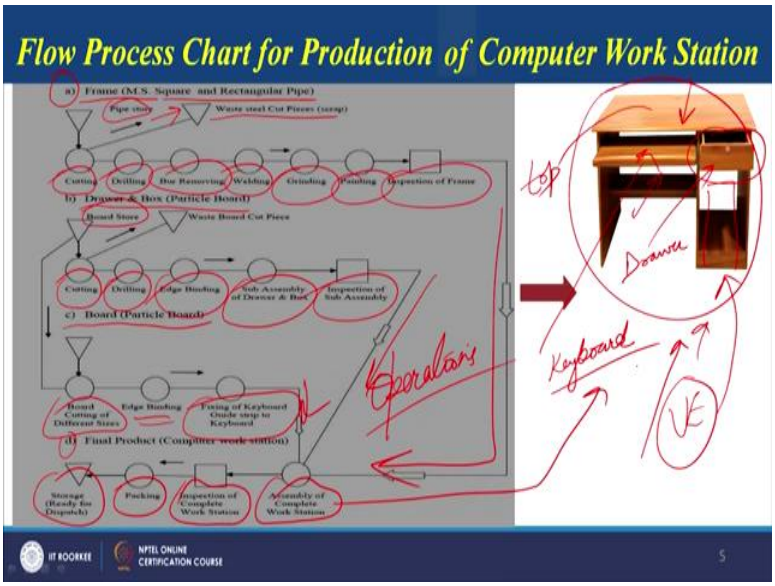

Then this is a flow process chart, this is a computer table how it will look like, we can see if this is a drawer here, this is the top of the table, this is a place to keep the keyboard. So, first thing is we need to have, a complete understanding of the computer table. This is a place where CPU will be placed then, this is another shelf to keep certain important thing.

So, we need to understand that what are the various elements of the computer workstation, and how it is manufactured that also we need to understand. The first part is the frame is a mild steel square and rectangular pipe is used; so here we can see this is a pipe store, waste pieces, whatever are cut, they are transferred to the waste steel cut pieces into the scrap. So, what is the raw material?

It is a MS square and rectangular pipes. So first is cutting, then drilling, then burr removing, welding, grinding, painting and inspection of the frame. So, there is a metallic frame which is being used then, for the drawer and the box there is a board store, from board store again, the operations are cutting, drilling, edge binding, sub assembly of drawer box and inspection of the assembly.

Then, the third part is the board, particle board, board cutting of different sizes, edge binding, fixing of the keyboard and guide strip on the keyboard. So, all these are the operations which are being done on the computer work table and then, you can see the final product how it is assembled. This is the drawer and box is coming from here, the

frame is coming from here and our board is coming from here. So, where assembly of the complete workstation is being done at this stage, then inspection of the complete workstation packing and it is ready for dispatch. So, this is something which is not directly related to the basic principles of value engineering.

Because in value engineering, we would like to attack this design of the table that what is the function of this drawer, what is the function of the stop board, what is the function of this keyboard table. So, we will attack, each and every element of this design, and try to see what is the basic function for which this particular part is included in the overall system or overall product. But this will give us an idea that what are the various operations involved, what is the cost implication of each and every operation with this all operations will add to the cost of the component.

So, sometimes, it so happen having the background information, we may like to propose a change in the material based on the functional requirements. So, we may say that why do we need to use only material x for making this part, why it cannot be made by material y. So, that is the idea with which we will try to get as much as possible information as we can. This is just the information that we are trying to collect with respect to this design and now we will go to the functional analysis.

Now, we know at least that what are the various components which are being assembled together to make a computer table. So, that is a background information, we have already collected. We now know that what are the various operations or processes that are being done on the different parts or elements of the work table, and or the computer table and what are the improvements that are possible maybe some background concepts may have started building in our mind.

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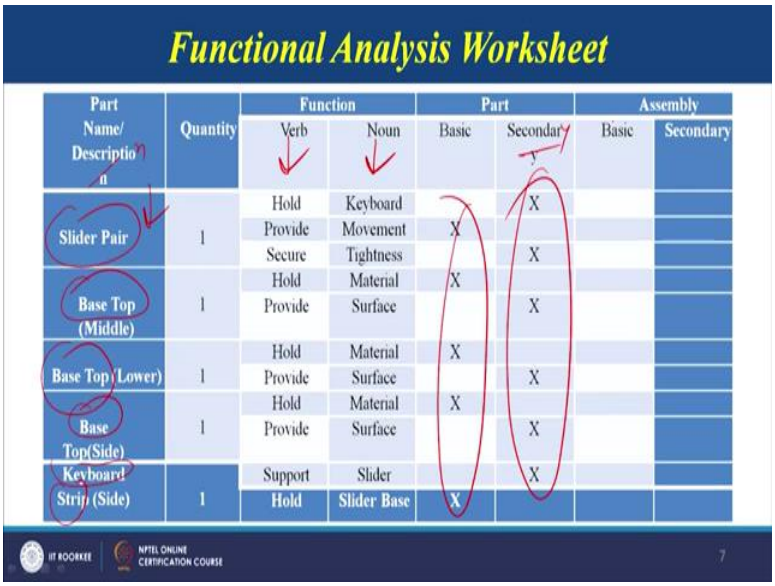

So, now based on the functional analysis worksheet as all of you know, first thing is we try to list the part name and the description. So, the first thing is drawer, and the box assembly, the quantity is 1.

Similarly, steel frame as we have seen, the cross section was also mentioned in the previous slide, then there is a keyboard assembly, then there is a tabletop, the quantity remains 1. I am just first listing the parts, then, there is a slide pair this is description then there is a base top, then the base top lower, then there is a base top and the keyboard strip. So, all these are the parts which are assembled together to make this computer table.

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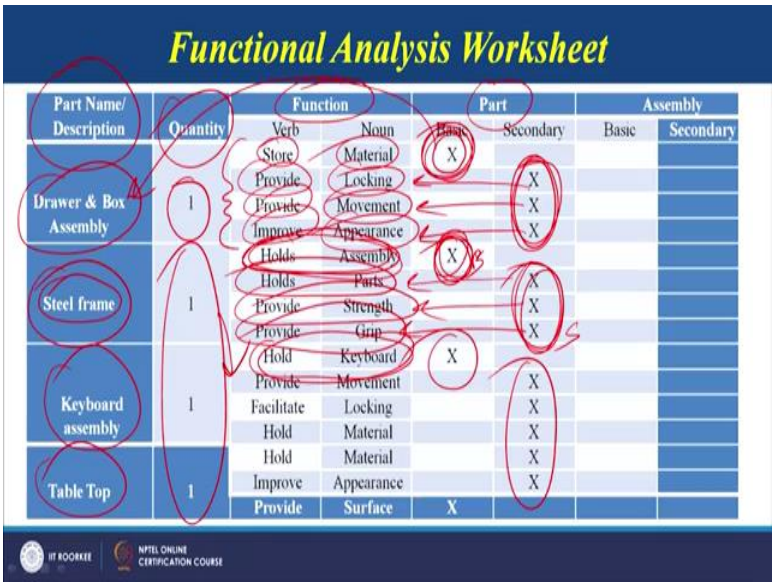

Now, let us go back and try to see the function. We have to define the function what is the purpose. So, drawer and box assembly, these are the functions store material, verb and actionable noun, so store material provide locking, provide movement, improve appearance. So, these are, we can say four functions, now we have to classify the functions also as basic and secondary. Now storing the material is the basic function for the drawer and the box assembly and the other three are the secondary functions so that is the classification.

Now, let us take one more example, suppose, we take the example of a steel frame. So, steel frame holds the assembly, holds the parts, provide strength, provide grip. Out of this hold assembly is the basic function and the other three are again the secondary functions. So, basically now we try to classify the functions into basic and the secondary functions, and try to define the function for each and every element part subassembly which is being used for making this computer table.

So, we can very easily now see for each and every element, we have what is the quantity, what is the function, whether the function is basic or the secondary function. So, here we can see the other parts also, the verb and the noun definition for each and every part or element and whether it is a basic or a secondary. So, this is secondary and this is basic.

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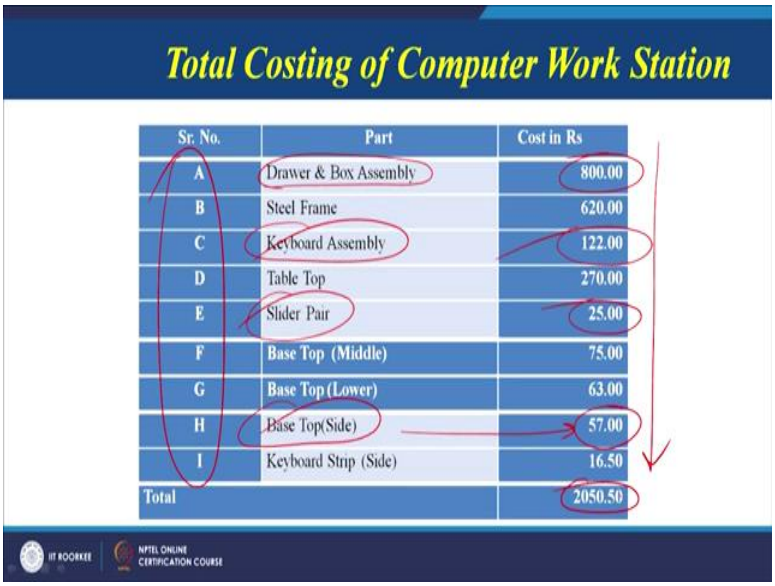

So, let us now see, the total cost because we have gone through the course now, we know that once we have established the definition the verb and noun definition for each and every component of each and every component of the product, each and every subassembly of the product, each and every part of the products, we try to relate the functions with the cost because all of you know value is equal to function by cost.

Value = function/Cost

So, there is a relationship between the value of the product with the functions, it is providing and the cost by user is going to pay to acquire that product. So, there we can see what is the cost distribution. So, drawer and box assembly is rupees 800, slider pair is rupees 25, keyboard assembly is 122 rupees, base top slide side is rupees 57 so all this adds up to 2050. So, these are all the parts. So, we can say from A to I these are 9 parts we can say which cost is rupees 2050 rupees 50 paisa.

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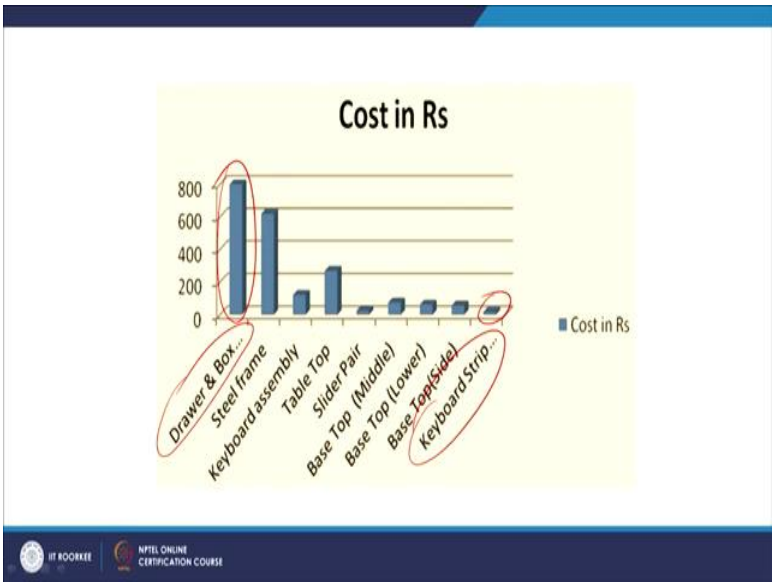

Now, total costing, this is the cost, this is the cost distribution. We can see that drawer and box is the maximum cost, and the minimum is for keyboard strip which is given here.

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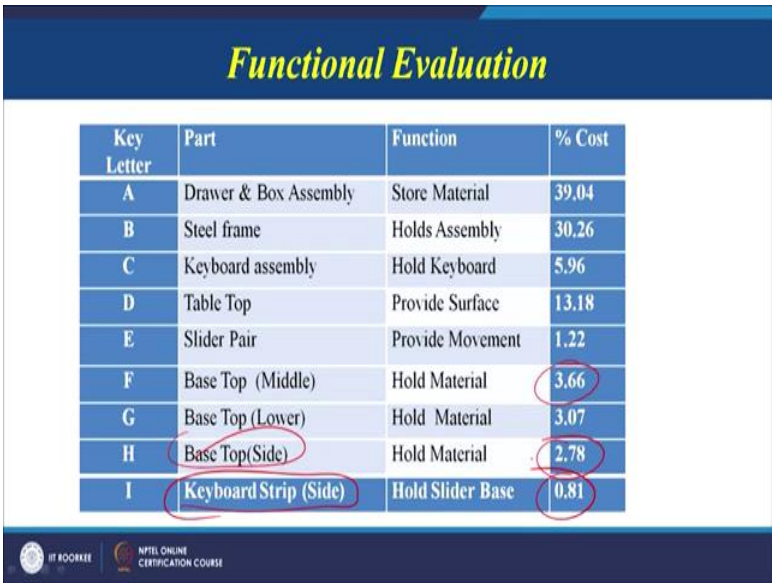

Key Letter	Part	Function	% Cost
A	Drawer & Box Assembly	Store Material	39.04
B	Steel frame	Holds Assembly	30.26
C	Keyboard assembly	Hold Keyboard	5.96
D	Table Top	Provide Surface	13.18
E	Slider Pair	Provide Movement	1.22
F	Base Top (Middle)	Hold Material	3.66
G	Base Top (Lower)	Hold Material	3.07
H	Base Top(Side)	Hold Material	2.78
I	Keyboard Strip (Side)	Hold Slider Base	0.81

If we can go back and see that the base top slide is 2.78 only and base top middle 3.66 only. So, we can see, this is the distribution and keyboard strip side is 0.81 only.

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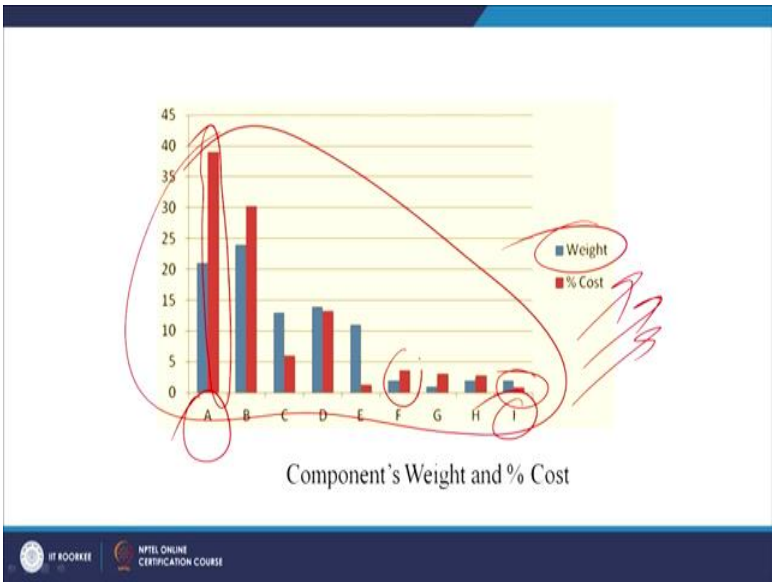

So, you can see now, the keyboard strip I number that is the showing the minimum cost. So, similarly the weight also, what is the weight of each and every part that is also listed here.

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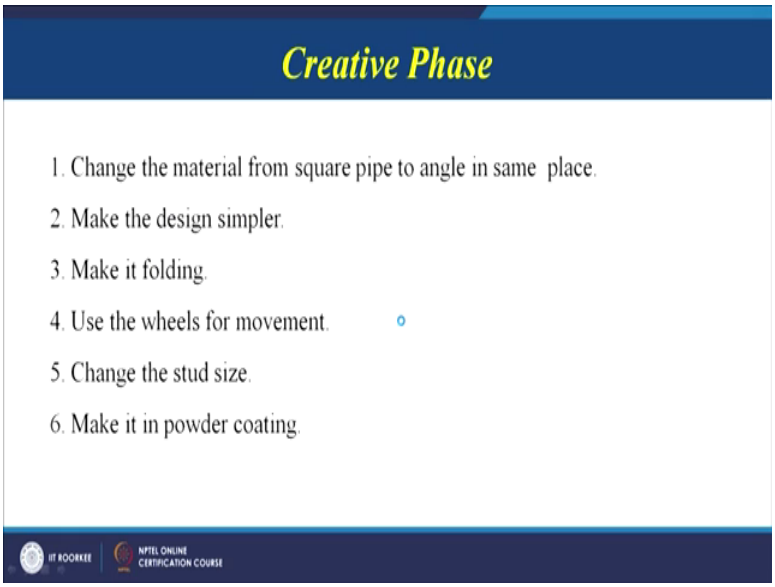

Now, we can see, first and foremost, we have to find out that what are the various elements, what are the various parts subassemblies which are used for creating our product.

Then finally, we have to establish the functions for each and every part or subassembly, then we have to classify the function as basic and secondary and then, we relate it with the cost, then, what is the cost of each and every part, what is the cost of assembly. So, that is the basic background with which we can work further. Now, we know, this is a very important diagram. Here we see, that A is the part which is having the maximum percentage of cost associated with it. So, sometimes when we try to locate the problem areas in any product, we try to focus on a high cost items that is our general tendency that here the maximum cost is going.

Is there some scope of improvement for this particular item? Because sometimes if we focus on very low cost item, we may not realize the true potential of the principles of value engineering. So, this kind of a distribution provides us just a direction that in which direction we should think, but that is not always true, sometimes, there can be a product which is used with the cost maybe low, but the quantities are so high that it may be justified to focus on that particular component also.

So, we have to use our creativity, we have to use our gut feeling, we have to use our judgment, we have to use our logic to locate the areas of improvement in any product. So, here, we have seen that we have now the distribution that what is the cost distribution for each and every component, and how the cost is distributed among different parts of the computer table.

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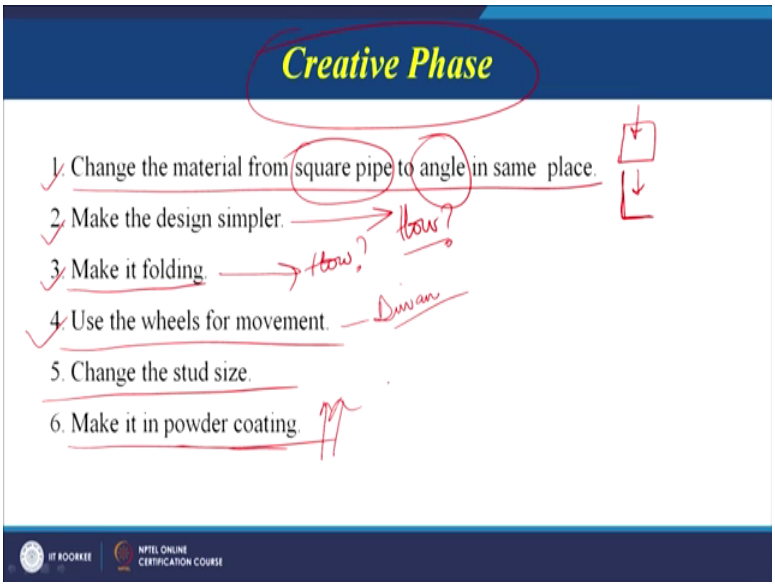

Now, using our creative team, we can create a large number of ideas. So, the authors have suggested there a large number of ideas I will read these ideas for you. First is change the material from a square pipe to angle in same place. So, we can say that it is suggested that from a square pipe change the material from square pipe to an angle. So, at some places we may be using this cross section of the pipe, which is being used or metallic pipe which is being used for making the frame. So, it is suggested, if possible we can use a angle for making those, we can make it angular maybe this is I am showing the top view. So, we can use a angle in place of a square.

So, this is just one idea, but this has to be implemented without compromising the performance rigidity weight extra of the product. If the weight is coming down, performance is not getting compromise certainly, we can go for this because it will save money. Other idea can we make the design simpler.

If we think of taking this idea forward first question that we have to answer is how to make the design simpler. Idea is good, but then we have to use our creativity to find out how the design can be made simpler. Then make it a folding table yes, this can be taken further, again the question will be how to make it folding whether this idea has some potential to be applicable. So, with that we have to see further.

Then, use the wheels for the movement. Good idea, this we have seen, even when we did the case study for our divan, there also we have seen that we can use the wheels for movement, change the stud size is another idea, make it in powder coating, that is another idea; for powder coating if we decide to do, it may lead to increase in the cost.

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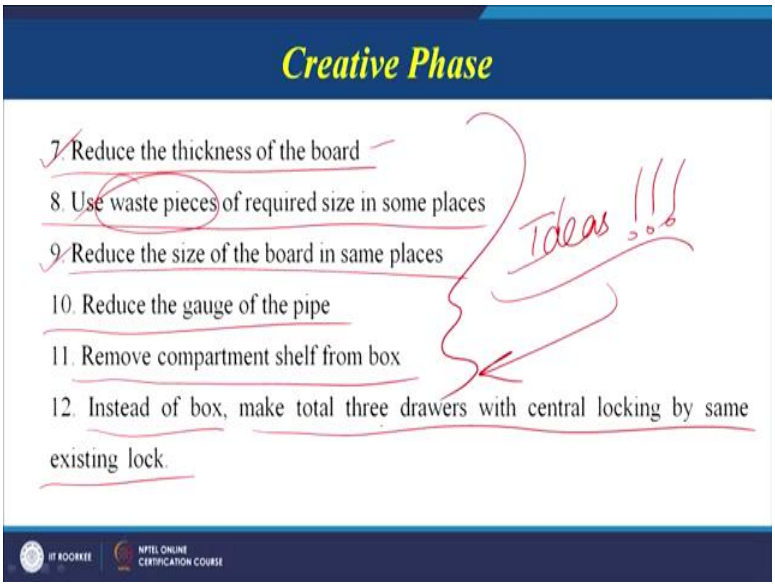

Then, reduce the thickness of the board another idea, the board that is being used to make the table, the thickness can be reduced, but it must not compromise with the rigidity with the performance of our table, then, use waste pieces of required size in some places.

We can see if you go back, I will not go back because of the paucity of time, but if you see we have seen that in our flow process chart, there was some waste piece being generated which were been sent back to the scrap yard. If somehow, we can make use of those waste pieces and if you remember Gayatri industries as I listed in the very beginning information phase of our value engineering study is involved in making large variety of furniture items.

So, some waste pieces from some other furniture item can easily be used as we can say raw material for making our computer table so that is a use the waste pieces of required size in some places, then reduce the size of the board in some places so, that is also a good idea. Reduce the gauge of the pipe which is used for making the structure or the frame, remove the compartment shelf from the box, instead of box make total three drawers will central locking by same existing lock.

These are some of the ideas, and all these ideas may not be implementable. So, we have to find out of these ideas which of these ideas can be implemented well all the ideas, there is sometimes a conflict among the ideas also. If we implement another one idea it

may have a negative impact on the other idea. So, that kind of analysis can also be done. So, there are a lot of ideas generated. Now let us see, how the authors have now gone ahead.

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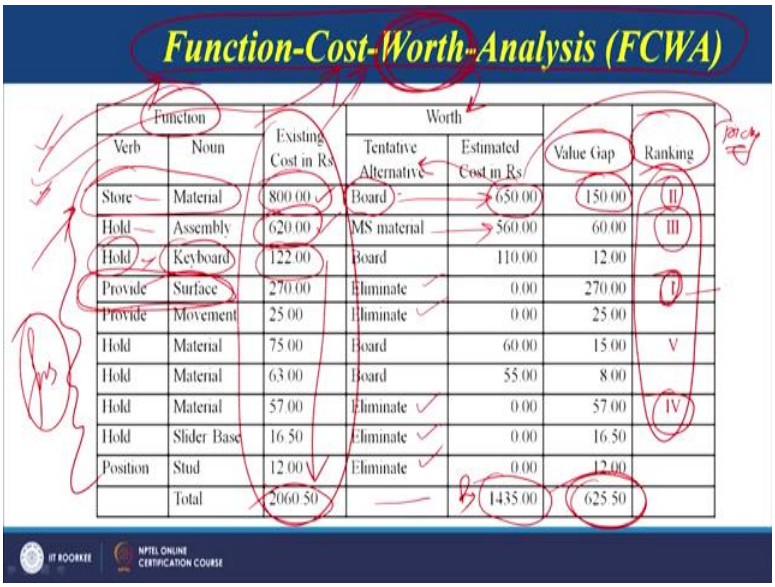

So, this is the functional cost worth analysis. So, now we know the functional analysis has already been completed, the cost components of each and every part also is listed in the previous slides, we know that for drawer assembly, what is the cost involved, for tabletop what is the cost involved, for steel frame, what is the cost involved; already this information is available with us, functional analysis has also been done. Now let us see that for the various elements of the product.

Now let us see the function, what are the functions. One is store material. What is a cost being spent? 800. Now if you see store material if you go back, and try to understand it, if we go back and see drawer and box assembly what is the purpose, store material so, that is the only basic purpose.

All other provide locking, provide movement, improve appearance all these are the secondary functions. Similarly for steel frame hold assembly, holder assembly is the basic function, rest all are the secondary functions hold assembly is the basic function rest all are the secondary functions. So, keyboard assembly, hold keyboard that is the basic function rest all are secondary. So, let us now go back and see that how we are not trying to achieve our target.

Now, store material 800, hold assembly hold keyboard. So, basically, our focus primarily now is on the basic functions only and what is the existing cost? 800 rupees hold assembly 620 rupees. If we go back and see what is 620, let us try to see what is 620. So, 620 is the steel frame, 800 is the drawer and box assembly then, 122 is keyboard assembly.

So, next will be 122 somewhere it will be of that cost me have been divided into some of the other components. So, where we can see 620 and sorry 122 is already written sorry and 620 is already written, this is for, the hold the keyboard assembly, this is steel frame then, this is drawer. So, this way we have listed all the cost and here, this is adding up to 2060. So, here we can see that this is the existing cost and what we are doing? Cost is ok, but we need to understand what is the worth.

Now, the worth can be tentative alternative can be board and estimated cost for that can be 650. So, this is a little tricky thing where we have to establish that this function material instead of spending 800 rupees, it can be done in 650 rupees using a tentative alternative. So, here, this value gap that is 150 that is established is very important. This 800 is known to us 800 figure is available because already, we are manufacturing the computer table, the company is manufacturing, they are aware that rupees 800 is being spent on this function of storage of material through the drawers and storage assembly.

But how to get this 650 that is little tricky, but with experience the engineers can get an idea that if we use alternative of board, we can very easily bring down, the cost from 800 to 650. Similarly for the frame that is holding the assembly 620, MS material we can reduce it to 560.

Here, we can see, in some of the cases we can even eliminate some of the parts or some of the functions, we can only focus on the very basic functions of the product, and the estimated cost is 1435 rupees. So, current cost and minus the limited cost, this is the value gap. So, there is a potential of saving rupees 625 in this computer table, and this is the ranking based on the value gap.

So, the first one is provide the surface, this is the function, provide surface, this must be attacked first, then, there is a second is related to the drawer assembly, third is related to a steel frame, fourth is related, to hold the material. So, this way, we can see that where, we need to attack. So, we have a ranking of our value gap, that value gap where we have

the maximum value gap. Now this is we can see, the another representation of the same data, existing cost is given, estimated cost is given and green one is the value gap.

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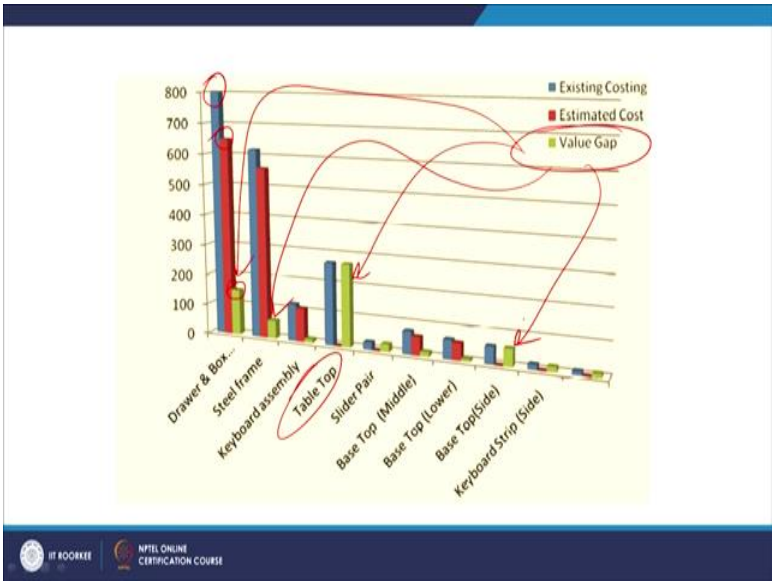

So, we can see the table top because in previous slide, it was little difficult to understand because here directly the functions were mentioned. These are the functions, the elements or the sub parts of the sub assemblies were not mentioned. So, now, this is reflected in this. So, here we can see, the value gap depicted in green colour is maximum here, that is for the tabletop, and then maybe the next one is for the drawer, and the box assembly, and then the next one can be for the base top, this is also a higher and another opportunity lies here, in the steel frame also.

So, we can see that we have a value gap and if we go back, we can see first is with the provide the surface. So, first again we can go and see first one is with the table top provide the surface, this is our first function for which the value gap is maximum.

And second is with the steel frame store material this is second store material which means what is the element or the product which is our target area, so the element or the product is this one that is drawer and the box and third one is the steel frame. So, you see third one is the hold assembly which is been done by the steel frame, the third one is the steel frame. So, similarly this is important.

Why this is important because here now we know that what are the focus areas if we attack these areas, we will be able to substantially improve the design of our product and we will be able to provide the similar or a better product satisfying all the functional requirement, but at a reasonably lower cost.

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Parameters Ideas	State of Art 10: Off the shelf 1: New Technology	Probability of Implementation 10: High Chance 1: Low Chance	Cost to Develop 10: High Cost 1: Low Cost	Time to Implement 10: No time 1: Maximum Time	Potential Cost Benefit 10: High 1: Low	Total
1	10	10	05	05	10	40
2	10	05	04	06	06	31
3	10	08	05	09	10	42
4	06	10	03	09	10	38
5	06	08	01	10	05	30
6	05	10	05	05	08	33
7	10	10	01	10	10	41
8	10	10	01	10	10	41
9	10	10	01	10	10	41
10	05	06	03	08	10	32
11	10	10	01	10	10	41
12	01	10	06	05	05	27

So, now let us see, what is the next stage. This we have already seen in one of our previous case studies also feasibility ranking matrix. Now here, we are taking four important criteria. First one is probability of implementation, second is cost to develop, third is time to implement, and fourth one is potential cost benefit.

Now we can say the ranking is given 10 means there is a high probability of implementation and 0 means that there is a very low chance of probability of implementation. 10 means, cost to develop is high and 1 means there is a low cost. So, the next is time to implement. So, if there is no time to implement means, it we can readily implement our idea the score will be 10, but it will take lot of time to implement there will be a less score that is 1.

Similarly, potential cost benefit, if the cost benefits are high, we will say score is 10 if the cost benefits are low, we will say the score is 1. Similarly state of the art sometime the change that we are suggesting is right there available with us, that is off the shelf it is available we need not do any research, we need not do any fundamental science or fundamental you can say experiments to establish the idea, it is already existing, we are

just implementing it in our product off the shelf score is 10, but if we have to develop a new technology score is 1.

Now based on these criteria 1 to 10 score and maybe adding up all these ideas for these scores for the idea. So, we have if you remember we have generated 12 ideas in previous slide it was discussed and adding these scores, we calculate a total score.

So, if we can see take one example suppose idea number 9. So, 10 plus 10; 20 plus 1; 21 plus 10; 31 plus 10; 41. So, this is the score for idea number 9. So, then, we will see that what are the ideas with maximum score. So, maybe idea number 3 here I feel score is 42 and I think there is no other idea with the score more than this. So, I think this is the idea which we can take forward. So, based on the criteria we will decide on the ideas. Now what are the parameters?

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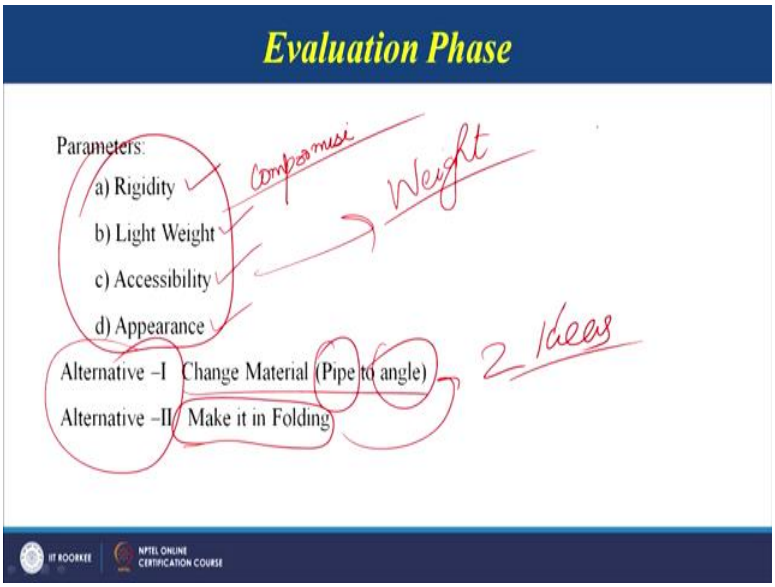

Now, we have ideas, now we have to evaluate those ideas. We have seen based on a certain criteria, we have to know find out that which ideas can be taken forward, and we have already we can say made a ranking of our ideas based on four criteria, as we have seen in the previous slide; state of the art, probability of implementation, cost to develop, time to implement and potential cost benefit. So, authors have given this table and based on that, now further criteria that will be used for evaluation of this ideas is rigidity, that we cannot compromise on the rigidity of the computer table.

There has to be no compromise, rigidity, it must be light in weight, its accessibility must be good, appearance must also be good. So, two alternatives which are taken for further analysis are change the material. So, from pipe we can change to angle and make it folding. So, these are the two ideas which can be taken further, and how they will take these ideas further? We have to give weight to all these four parameters.

So, what is the weight to be assigned to these parameters that can also be calculated statistically and it is given in the article. So, you can refer to that article, and find out that how the weight is assigned. So, we have to do a relative grading between which idea is relevant to which criteria is affecting the other criteria positively or negatively and that based on that there will be a matrix, that will be created and a weightage will be assigned.

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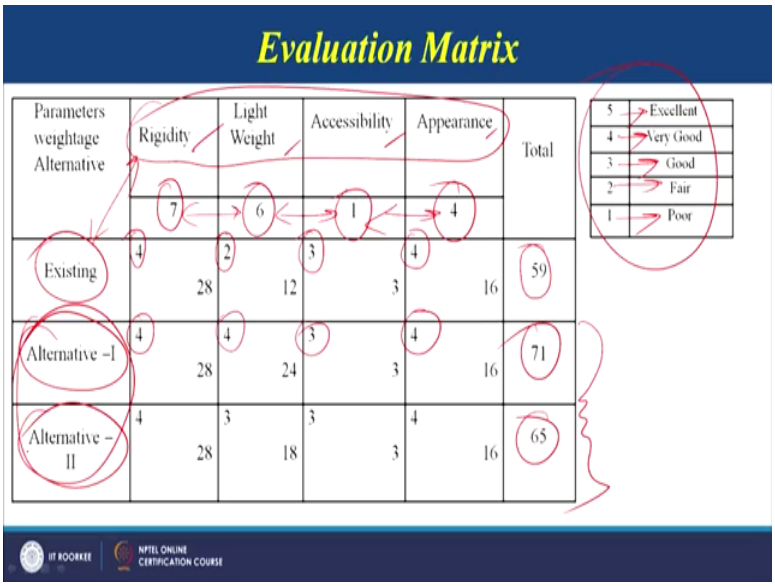

Now based on that a weightage has been given, rigidity is given, weightage 7, light weight weightage 1, accessibility 1 and appearance 4 and then, now, we try to compare our existing design with alternative I and alternative II and here we grade them 5 is excellent, 4 is very good, 1 is poor, 2 is fair, 3 is good.

So, based on this scale, now we try to calculate. Now, weightage already I have told you is calculated based on set of criteria and four criteria, we have rigidity, lightweight, accessibility and appearance. Now we give a score from 1 to 5. Now, suppose existing in on rigidity, the score is given 4 which means the rigidity is very good, lightweight, the

score is given 2, accessibility score is given 3 and appearance the score is given 4 and then we have a weightage 7 into 4 28, 6 into 2 12, 3 into 1 3, 4 into 4 16; the total score is 59 and similarly for alternative I that ranking is given as 4, 4, 3 and 4 and when we multiply it with the weightage assigned to the individual parameters the scores come out to be 71 and similarly for alternative 2 the score comes out to be 65.

So, now we have taken just 2 ideas, we have mathematically found out that which of the ideas is going to give us more benefit. So, previous case, we have short listed the ideas based on 4 or 5 criteria that again we can see.

We can see that we have taken five parameters here, state of the art, probability of implementation, cost to develop, time to implement and potential cost benefit and all the 12 ideas we have analyzed, and after short listing the ideas we have again evaluated the shortlisted ideas on four parameters, and then we have finally, done this matrix evaluation matrix and giving a score between 1 to 5, we have been able to now find out that the maximum score is for alternative 1 and it is even higher than the existing design that we are using.

So, with this we can see that there is a systematic approach for evaluating any product. So, if we revise what we have covered today, we have taken a computer table then, we have collected all possible information related to the manufacturing of this computer table, the materials being used for making this table and finally, we have done the functional analysis, try to relate the functions with the cost, then we have done the brainstorming, we have discuss the brainstorming I must say because this we have taken from a literature, we are taken from an article published in an international journal.

So, after the functional analysis and the functional cost worth analysis, number of ideas have been reported by the authors. Out of these ideas, then based on a certain parameters like probability of implementation, a level of technology available, cost to develop the idea, the 12 ideas have been compared and then finally, based on the performance characteristics of the product like rigidity, weight, durability and other criteria these only two ideas have been compared.

So, rigidity, lightweight, accessibility appearance the four criteria these two criteria sorry based on these four parameters have been compared and based on this we can finally, now zero down. It is not only we can say that only one idea has to be taken forward or

implemented, the out of 12 ideas if there are 3 ideas which have the potential of implementation we can take those 3 ideas, and implement those 3 ideas simultaneously towards the development of our final product.

So, with this come to the end of today's session. I think you might appreciate, the way the problem of value analysis and engineering can be solved for different products and we have tried to take products across diverse spectrum of engineering applications so, that a user can find out locate a product in and around, and find out that how value analysis can help us to redesign the product to evaluate the product in context of the value engineering tools and techniques and come up with a product which satisfies the functional requirements, but at a reasonable cost.

So, with this we come to the end of today's session, we will have our last session maybe next week and then we will be closing this course.

Thank you.