Fundamentals of Manufacturing Processes
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Lecture - 09
Break Even Analysis in Manufacturing Processes

Hello, I welcome you all in this presentation related to the subject fundamentals of the manufacturing process. And this presentation is related with the break even analysis in manufacturing processes. We know that as a manufacturing engineer or as a mechanical engineer the role is to find out the best manufacturing process so, that a given product with the desired properties can be achieved at the lower price.

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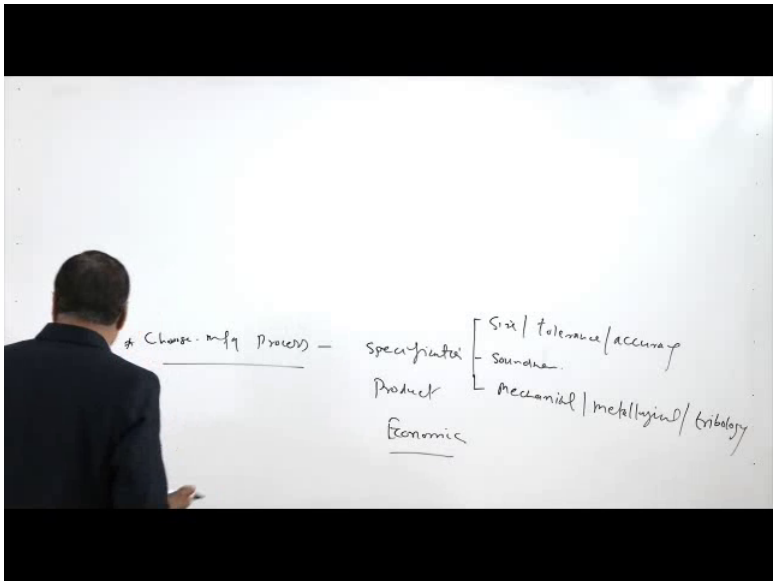

So, if we see this role, so we have to actually choose, the manufacturing process. Since there are various options available to make a product using different manufacturing process. So, from them we have to choose one or a combination of the processes. So, this is first thing.

So, process which can make the product with the desired specification. So, whatever specifications are there in terms of the size, tolerance, accuracy, all those should be met by the process. And then soundness with the desired reduced size of the inclusion or reduced porosity or whatever; acceptance criteria is there, that product should be doubt

and then what kind of combination of the mechanical, metallurgical or tribological properties as per the function of the product. Tribological properties whether they are there or not. So, whatever manufacturing process is selected that should read result in the product with the required specification. And all that should be achieved economically; at the lowest possible price; because, if the same thing can be done by the number of processes or number of combination of the processes, then we need to select which one which combination of the process will be economical.

So, for this purpose only, what we need? We need to do the economical analysis. Break even analysis actually helps in identifying the best process or best combination of the processes. In such a way that we get the desired; we get we are able to manufacture the product with the requisite properties and characteristics at the lowest possible price. So, for this purpose, what we need to see? We need to see like say; the aspect is break even analysis of manufacturing processes.

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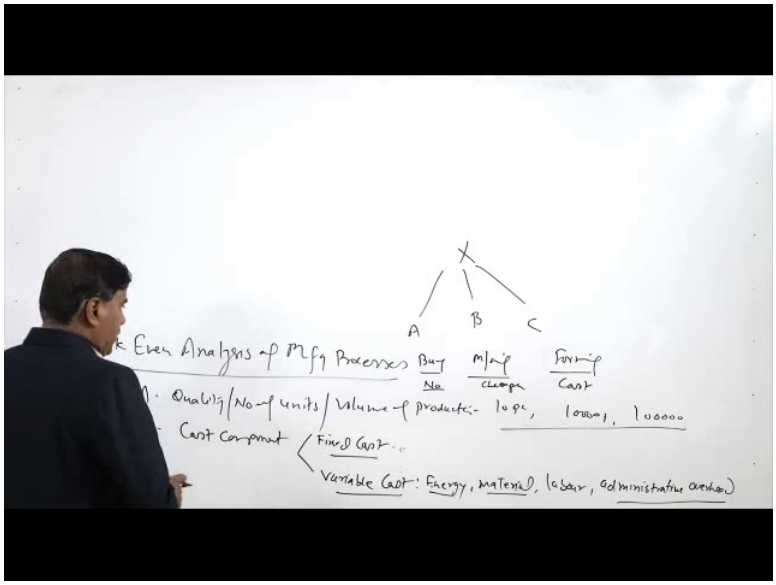

This is done at the very initial at stage or at the in the beginning. So, what information we need to do to carry out a breakeven analysis. For this purpose, what we need the first thing? The quantity or the numbers of the units of a product are to be made which is also termed as volume of production.

Like, we needed 10 pieces or we needed 10000, 1000 or 10000 pieces or we need 1 lakh of the pieces. So, as per the requirement, we need to do the analysis for choosing the

suitable options. Another thing which we need for this analysis is the what equipment and what investment we have to make to manufacture the product using the different options; like say for making a product X there are three options A, B and C. So, these options will be using the different equipments for making them; like say option one: where investment is nil, we can buy directly. Another option like we can go for the machining purpose or option C we can go for the forming purpose.

So, the equipments that we need for this is it different this may this maybe there is a no cost or this is may be cheaper as compared to the equipments which are used for the forming purposes may be very costly an extensive set up the equipments may be needed. So, what we need the cost components? Cost components related with the one manufacturing process of the product can be made using one or if it needs the number of the processes, then the fixed cost and variable cost related with the each process also we need to make the choice of a now out of the number of combinations. So, the cost component involves the two aspects one is fixed cost; which is like a in the form of the initial investment to be made for procurement of the machine or equipment. So, that the given set up can be or sometimes if it is unique, then tools are also incorporated in this.

And then variable cost variable cost so this fixed cost is termed so or it is called fixed because it does not change, no change with the volume or the quantity to be produced. So, it remains fixed; it does not change with the volume or the number of units or with the quantity to be produced. On the other hand, variable cost is directly related with the number of units to be produced and it considers like, how much energy we have to invest inform of then like say the power or how much material we have to use for you making unit product or it will be it will be changing directly with the number of units to be made.

So, the cost related with the production of each unit; like the how much energy is consumed by each unit? How much material is consumed by each unit? And then how much labour cost is involved, and then we need to take care of the administrative aspects like the security or the rent of the building or other administrative costs related with which are also which also from the part of the variable costs. So, we write that in terms of the administrative overheads. So, this is also, this also falls under the variable cost.

So, these are the three things that are used for the break even analysis. To identify the kind of the best possible manufacturing process or the combination of the manufacturing

processes. So, let us first understand; that what we choose and what do we mean by the selection of a manufacturing process or selection of a combination of the manufacturing process. Say if we have to make one piston.

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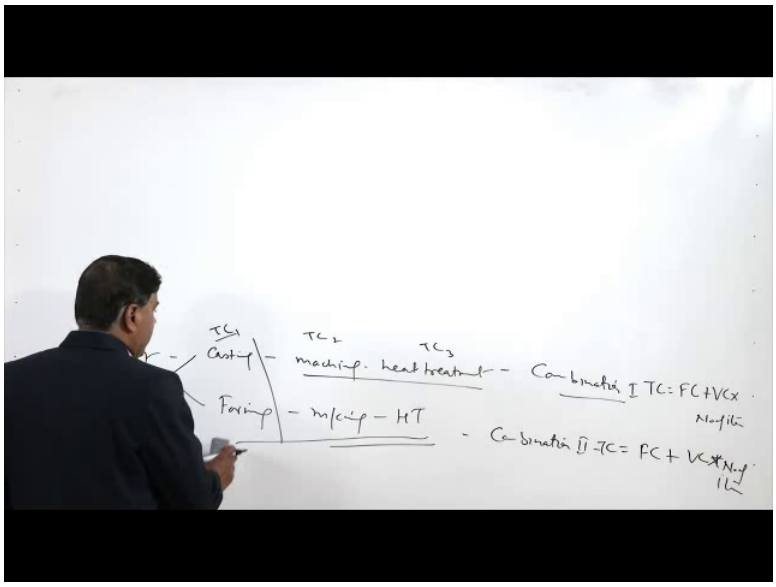

Then, first the we need to do the casting. And thereafter it requires machining, and then heat treatment.

So, in the casting also there can be number of casting process like die casting or sand mould castings. Similarly in machining we can do machining using the lathe machine or using the cnc machine on a heat treatment; like it is depending on the kind of furnace which is to be used for achieving the desired properties. So, if this is the combination this is like say one combination or another simpler example like if the same product instead of like say if this is instead of piston this is shaft. So, we are making first casting, then machining and then heat treatment. Another possible way is that we go for forming. Then machining and then heat treatment; so what is the difference here the combination here it involves casting machining and then heat treatment and it involves forming machining and heat treatment.

So, instead of choosing just one since here these two are the common ones and this is the difference so; however, the extent of machining which we will be required for forming process will be more and that will be less for the casting process. So, what we need to do? We need to consider, what is the total cost for casting? What is the total cost for

machining? What is total cost for the heat treatment? So, this T C 1, T C 2 and T C 3 for option or combination one is identified. And how T C is obtained it is obtained from the fixed cost plus variable cost into the number of items to be made this is the simple thing. So, similarly the total cost for combination two is identified in the same way T C.

Total cost obtained from the fixed cost involved in forming, machining or heat treatment related to the equipments plus variable cost into the number of items to be made. So, basically total cost for the total cost for the combination one and total cost for the combination two this is how it is determined. So, whichever is leading to the lower total cost that option is chosen from and if a it is simple like if the choices is to be made only between the forming and casting, then it becomes a pretty simple where just the total cost for manufacturing the given volume of the product by the forming and by the casting is identified.

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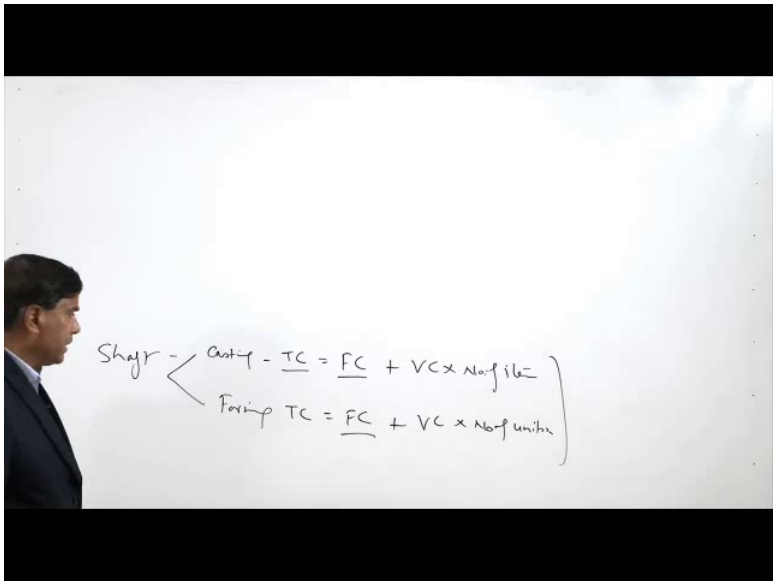

So, for the say; in this case it becomes simple like will be determining the T C for the casting and T C total cost for the forming. And how it is determined?

Like the total cost or the like fixed cost plus the variable cost into the number of items or number of product or volume of the units to be produced. For the fixed costing so here it may consider the kind of casting method we are choosing; like fixed cost is low for the sand mould casting and a high for the die casting. If the choices are to be made between the sand mould casting and the die casting. And if the cast and if you are the choices to

be made between casting and the forming we need to see which kind of forming process will be assumed; whether it will be forging or the rolling or extortion, and how much investment will be needed for that purpose.

So, fixed cost for the equipment required for forming process plus variable cost into the number of units to be made. So, whenever we do this we try to find out the total cost and whichever results in the lower total cost that option is chosen from. So graphically the same thing is shown; using a very common and the conventionally a very common a diagram.

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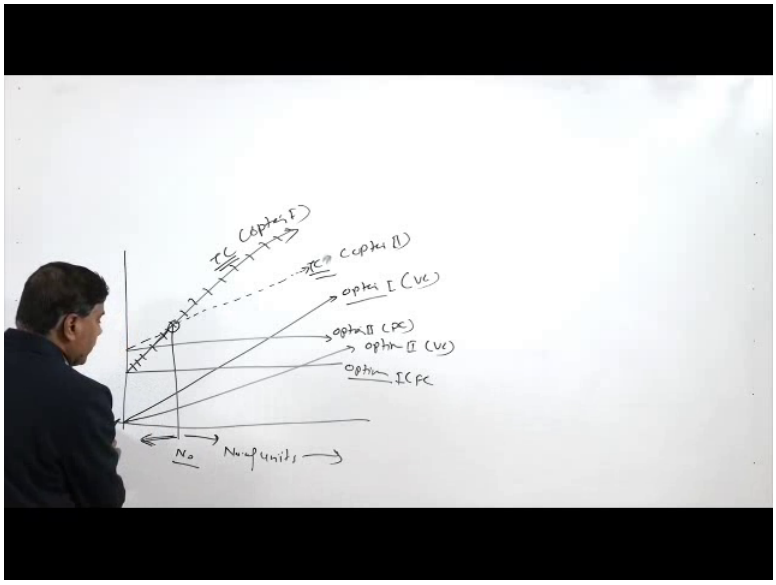

Where in a in the vertical axis, what we have? The cost component and in the x axis or in that axis of we have the number of units to be produced.

So, we know that variable cost directly changes with the number of units to be produced. And it always goes linearly like this. So, for it is possible that for option 1; option 1 linear cost is increasing at this rate and for option 2 it may increase at this rate. So, it is very much possible; a similarly the fixed cost for the option one maybe here like say fixed cost it does not change with the volume. So, this is fixed cost for the option 1 and a fixed cost for option 2 is here like say. So, this is for option 2 this is F C, this is F C, is this V C and this is V C variable cost.

So, what we can see here? Normally, whenever the fixed cost is high we normally get the variable cost at lower rate as compared to the other option where the fixed cost is low whenever the fixed cost is low; we normally get the variable cost high. So, to obtain the total cost, what we do? We just add up the fixed cost and that variable cost. So, in this case say this is the fixed cost for option 1 and this is the rate at which the variable cost is changing. So, our the slope will be going like this; for total cost option 1. So, this is the T C for the option 1. On the other hand, since the variable cost is increasing at lower rate for the option 2, so here for the option 2 it will be going at this rate. So, this is what we can see here this will be the parallel to the another option yeah. So, this is the T C for the option T C for option 2.

So, this is what we can see the total cost. So, both of these lines total cost for option 2 and total cost for option 1. If we see these two lines are intersecting each other, where that is this point; which means if the volume of the product to be made is lower. If the volume of the product to be made is lower than this number, then the option 1 is better because total cost is lower. And if the volume to be made is bigger than the then this particular value then the option 2 will be cheaper this is the simple logic we tried to identify the total cost for the two options and where ever these two lines intersect.

That, will be helping us to identify and the likewise; we can have n number of the total cost for various options and wherever they intersects that can be used to find out, what is the limit for the what is the limit up to which a particular option will be more suitable as compared to the other options. So, if you see here for the values less than this number the option 1 will be suitable and for values greater than this number option 2 will be cheaper; in terms of the total cost. So the number of units to be made becomes the significant factor in determining which option is to be chosen for selecting a particular manufacturing process.

Now, we will be going through one simple example. For example, we have to make a product. We have to make a product; product is X. So, there are three options possible options A, B and C option A. Is to just go and buy this and option 2 is use the like say the milling process to get the desired product and option 3 is the forming like rolling or extraction. So, these are the three options. And, if the number of units to be produced are changing; like say number of units required is 1000 number of units to be made are 2000 or if the number of units to be made is 3000.

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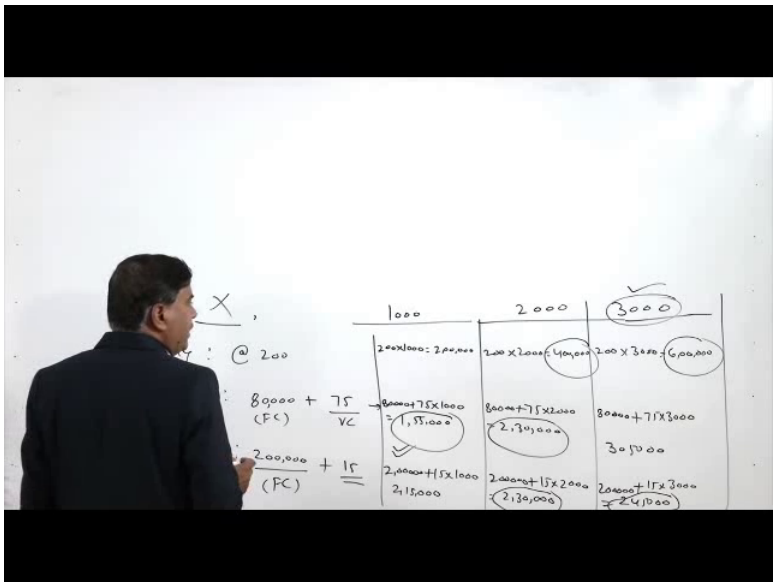

Then for these three different requirements, how the suitability of the options will be changing. How the cost effectiveness of the different options will be changing. Considering that the product if it is bought from the market, it is available at the rate of 200. So, and if the milling is used; then in that case say the fixed cost for the option for the milling is the initial investment is of the 80000 units in terms of the fixed cost. So, this is F C for a milling, and the variable cost is the rupees 75 per unit for is the V C. So, this for the milling and if the farming is to be used, then 200,000 is the units of the investment to be made.

As a fixed cost for the forming, and then product can be made at much lower variable cost that is say 15 units per a piece. So, in that case; what we need to do to determine the cost? So, it considering the total considering the number of units to be made is oh let us say units to be made is 1000 then what we get . So, in this case what will be there 200 multiplied by 1000 it will be like 2 lakhs. For milling if the 1000 units to be produced, than a 80000, 75 multiplied by 1000.

So, it will be leading to the total cost of 155000. And if the third option is used, then 2 lakhs plus 15 multiplied by 1000. So, our total cost is 2 lakhs 15000. So, if you see for if you have to manufacture sorry if you have a if our requirement is of the 1000 units then among the three, the best option is use of the milling machine milling or machining by milling to get the desired product instead of the buying or the forming. Forming is

coming out to be more costlier as compared to the buying and as compared to the buying and the cheapest one is the milling option.

As considering the same options if you have to make 2000 units, then the how the scenario will change. So, in this case, what we will have? Like 200 multiplied by 2000s in this case we will have 400,000 is the cost to be a cost at which it will be available or 2000 units can be obtained from the market. And if the milling option is used in that case 80000 plus 75 multiplied by 2000. So, the total will be like 230,000 and in this case it will be 2 lakhs plus 15 into 20 sorry 2000, so here it will be total is 230,000.

So, if we see this scenario; the costliest option is the option A of the buying from the market and, the other two options like use of the milling and a use of the forming both the both these are of the almost at the same total cost . So, any of the two can be chosen, but, if we consider the 3000 number of units to be produced, in that case, so here what it is suggesting the option two is good for making 1000 units and option two and three both are good for making 2000 units sorry; if I have to make 1000 units then option two is good, can we preferred and if the 2000 units to be made, then both any one of the two like milling or forming can be chosen. And what if the 3000 units to be made, in that case like 200 is the rate and three thousand units to be obtained and total cost will be 600,000 price.

And here for the option milling option that option two 80000 plus 75 multiplied by 3000. So, here our total price is 3000. So, here it is 25000 3000 35000 305000 and for the third option it is 2 lakhs plus 15 into 3000. So, the total price here in this case is 2 lakhs 45000.

So, in this third scenario; when if we have to make a 3000 units, then the costliest option is of this option of the buying and then the cheapest option is the option of the forming or milling. So, if you see here with the change in number of units to be produced the best possible option or the preferred option will be changing. So, here if you see for high volume production means for you making 3000 units forming is coming out to be better and for intermediate volume of the production both forming and milling are good. And if the numbers of units to be made are very less than the option one is good.

And in the same way we can do the analysis for like say even 100 units also; in that will give us a completely different picture and for that let us do that analysis also. So, we will

get more clearer picture. So, here for 100 units which option comes out to be the better one like say the 200 multiplied by 100 pieces?

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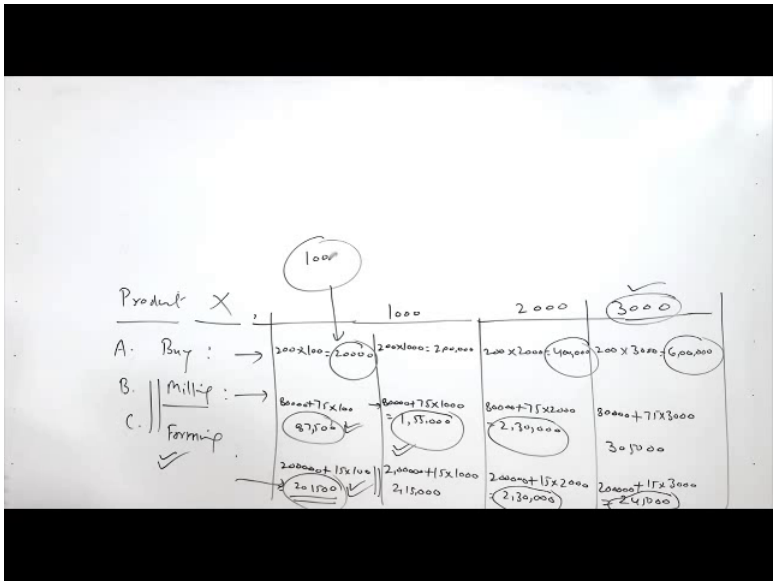

So, we are 200000 is the total cost and form the option B for milling it is 80000 plus 75 multiplied by 100. So, here 87500, so 87500 and 2 lakhs for third option 2 lakhs plus 15 into 100. So, total price will be 201500. So, here it will be like 201500 is the cost. So, in this scenario 20000 the minimum possible cost for the option B sorry; option A of buying directly from the market and the milling is the second costliest method and maximum is the costliest method is a the forming.

So, for the low volume production or low volume requirement, the best option is to go and buy from the market, because there is no initial investment requirement and there is variable cost, where we product can be bought directly from the market. And in case of the milling it is 87000 and for forming is 205000. So, here is what we can see how to choose the best possible or manufacturing process or combination of the manufacturing process in both the cases we try obtain the total number of the total cost of the product for making using particular option. So, what we have seen here.

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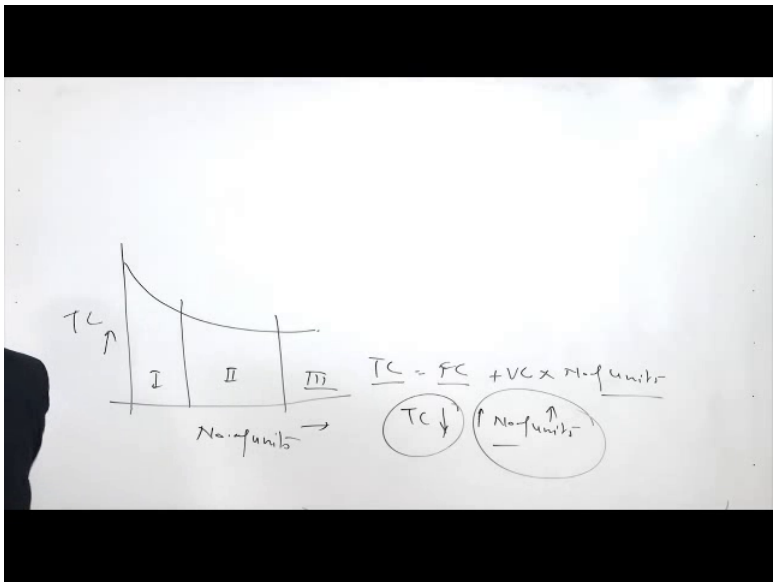

That since the in total cost the fixed cost is fix under the variable cost changes with the number of units to be made. And with the increase in number of units our T C keeps on decrease in T C in decreases with the increase in number of units to be made and this is what can reflect in the in this T C diagram number of units in the x axis and the total cost in the y axis and here what we can see? Normally the T C decreases rapidly; with the increasing in the number of units however.

So, this is a; but since there are the different options like say this is the may be the range for option 1, option 2 and for option 3. So, according to the suitability of the option the option may be chosen for option 1 or option 2 or option 3 may be chosen, but in general what happens? That with increasing number of products, the total cost of the item decreases. So, as per the number of units to be made, we can select the suitable option to be chosen from. So, now, we will see here graphical presentation are related with the manufacture this break even analysis.

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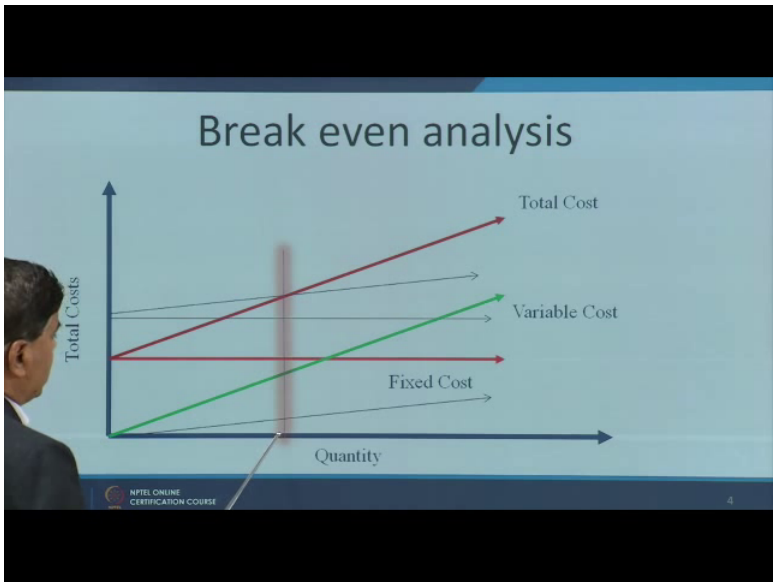

So, here which is there the horizontal line showing fixed cost and the variable cost is showed by the green line and sum of these two this line is all a is parallel to the variable cost and here this is the level of the fixed cost a level of the fixed cost. So, the total cost shows the total cost related to the manufacturing of a product in the given quantity. So, if there is another option like say for another option total cost is this is the fixed cost for another option and this is the variable cost for another option; all fixed cost is high, but variable cost is low. So, if you see here this variable cost total cost initially; the total cost is high and then for the low volume so; obviously, the total cost is high, but it becomes cost effective on going to the higher volumes.

So, if you see here the total cost for option 1 was this and total cost for option 2 is this. So, if we compare both of these total cost lines are intersecting at this point. It suggests that the option 1 corresponding to the green; sorry red line is it cheaper for making the low volumes and lesser than this particular volume and the option 2 corresponding to this line is this is a total cost line for option 2 and the it is the total cost is lesser for the higher volume so, beyond this particular limit.

So, now I will summarize this presentation. In this presentation I have talked about the importance of the break even analysis, and how can we choose the cost effective manufacturing process which can deliver the product with the required specification and if a product is to be manufactured using a combination of the processes then how to

select the suitable combination of the processes which will be leading to the product economically with a required properties.

Thank you for your attention.