Engineering Economic Analysis

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Lecture32

Cost Estimating Relationships

Welcome to the lecture on cost estimation. So in this lecture we will talk about some of the relationships which are used to estimate the cost. So basically when we estimate the total cost, it is better to estimate the factors which are affecting the cost because there are many factors which have a say on the cost. So rather than estimating the costs directly, we should also try to estimate the factors.

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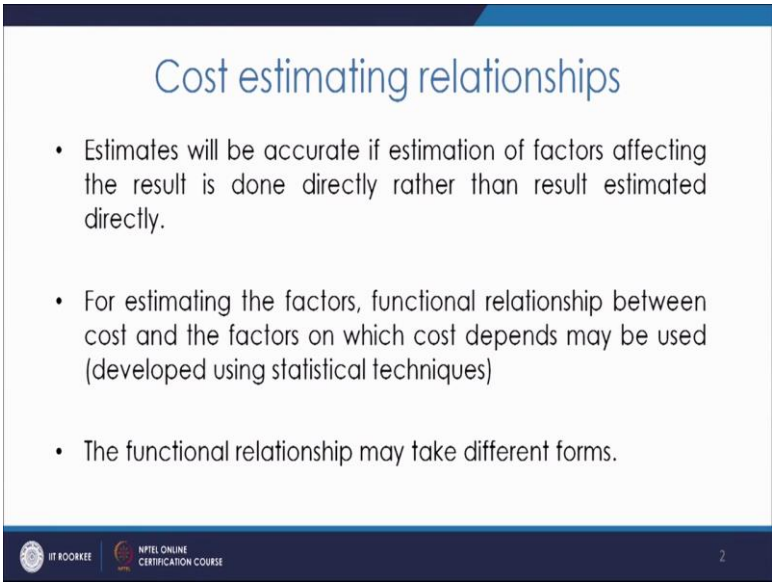

So estimation will be more accurate if estimation of factors affecting the result is done directly rather than result estimated indirectly. So basically first of all we should try to estimate the factors. Now these factors when to be estimated or even the cost is certainly dependence on these factors. So for that there are different kinds of relationships which are available. So basically these are the relationships about which today we will discuss.

Which are the different types of relationships by which we can have the estimation about the factors, about the cost or so because it may have the different forms. Let us say you may have the forms from linear type, so there may be a linear type of form.

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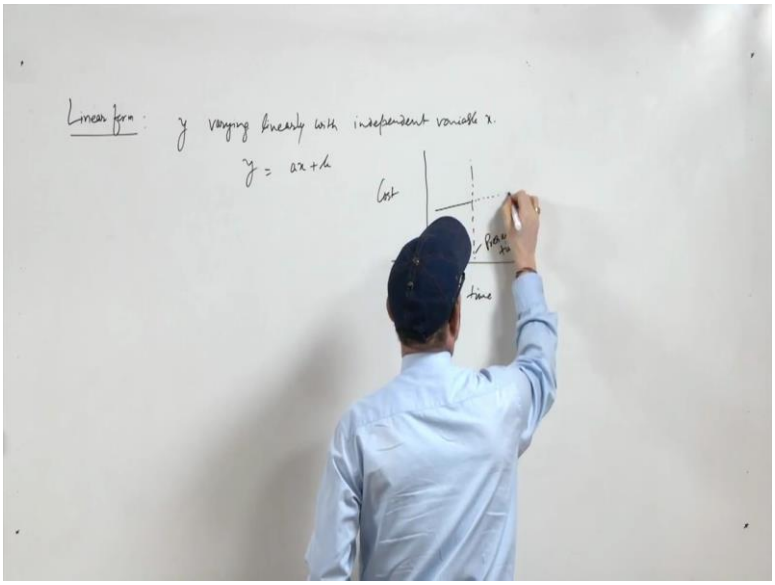

So as we know, in the linear form, the dependent variable Y will be varying linearly with independent variable X. So you may have Y equal to AX plus B. So what happens, if you have any linear dependence, you can basically forecast in the future. So if it is supposed the cost and this may be any independent variable, so if suppose this is the time or so, in that case if there is a linear dependence suppose this was the dependence which was seen in the past.

So if we see, this is the present time then something can be estimated in future by extending this line. So this way having the slope known and how it is moving, where it is intercepting with the y-axis or so, you can have a forecast of the cost corresponding to time or corresponding to any other factors. So these kinds of relationships are very common which are used for the estimation.

Next form which can be used is non-linear form. Now in the case of non-linear form the cost may vary in a non-linear manner, so it may not be purely linear, it may be something like this. So if suppose this is the present time, in that case if this is a time and this is the cost, in that case if this is a present time, by extending this further you can estimate and you can forecast in future time.

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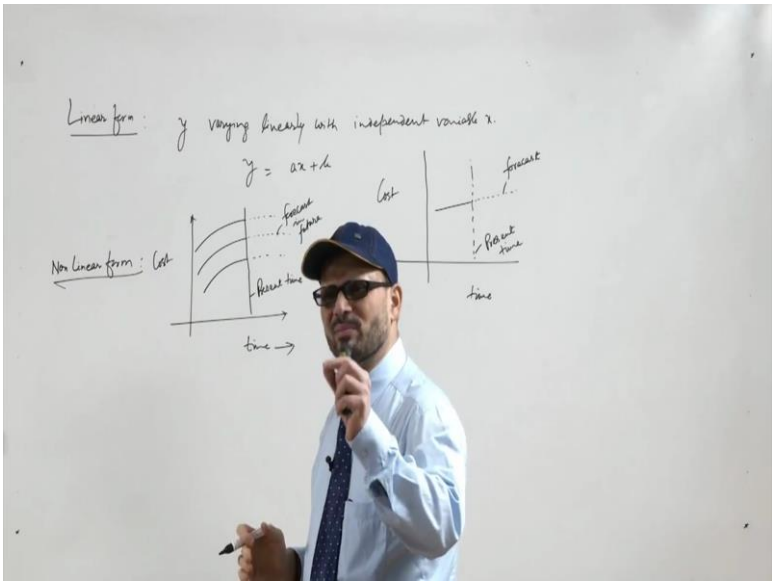

So this way non-linear functional relationships can be useful when we see that in the past there has been non-linear relationship between cost and a factor or cost and a time or in between cost and another factor, so in that case these factors can be used. Sometimes we may have these non-linear forms may be have having different type of curve may be upper bound nd lower bound type.

So this is known as a bound, this is known as the lower bound value and this is known as the median value. So this made me have certain extensions and in this way you can predict the upper bound, lower bound and the median values accordingly and you can have the estimate in a proper manner.

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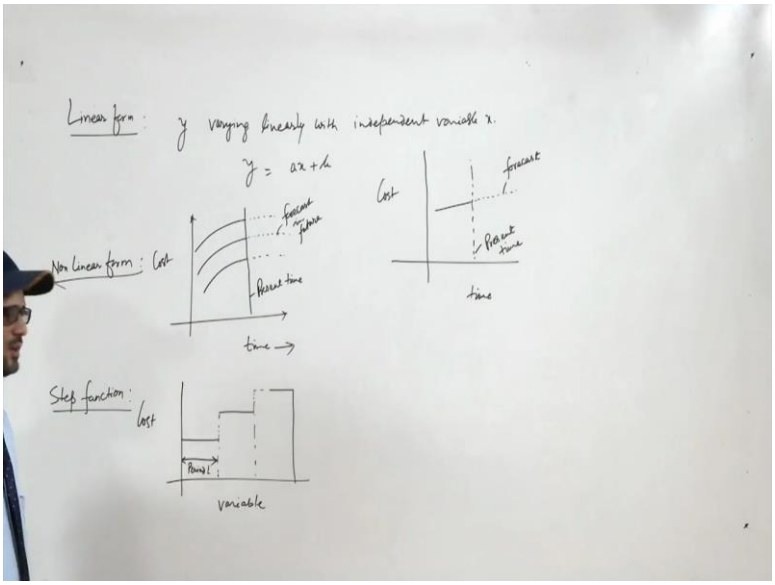

Now let us say the next is step function. Now what happens many times in the cost analysis or the economic analysis, the ranges basically I mean any parameter is defined for certain range. So once you go beyond that range, the values change abruptly. So basically these in these cases the step functions are very much used.

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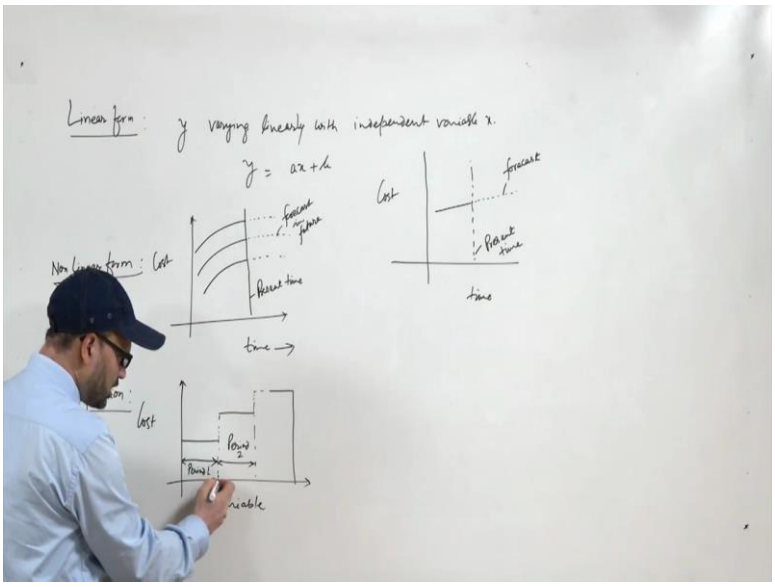

So suppose you have different periods, in this period any variable, the variable is changing and what you see is up to this variable, in this range this is suppose period one. So the value that we see is, it changes abruptly from here to this value. So this period once it goes from this side, this is period two. So what we see is, this is a step kind of function where things are moving in a step manner. Up to this range, this function is defined.

As we move from this value to further in the period two, the value abruptly changes and it comes here. So this is a kind of step function which are very much used in economic analysis where you have different periods and in between the periods you have different kinds of function. We have sometimes the distribution functions. Now this means that when your times we have the past data available.

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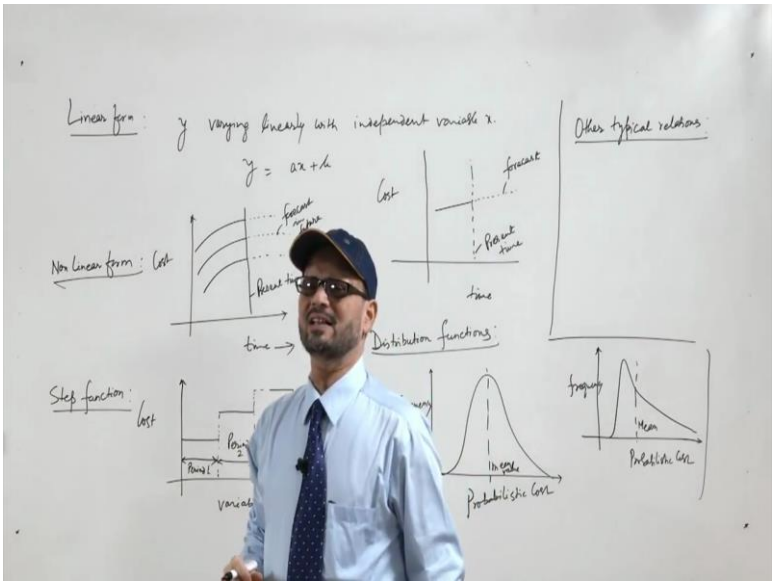

Using the past data we try to have a curve which basically represents, which tells about the frequency or average the cost can be predicted. So that may come into a a special kind of probability distribution functions. So the cost can be predicted like this, so you have probabilistic cost and you have frequency.

So frequency related to any particular parameter or variable and based on that what we see is, you get a typical type of distribution where you get this as the mean value and what you see is, this is the frequency distribution, so this is something like an nor normal distribution. Now this tells that what should be the normally value should be taken and based on that if you take the values it will talk about the accuracy of the estimated values.

So this may go in any fashion, it may be something like this where the mean may range in this range. This may be frequency, this may be the probabilistic cost. So this way there are different kinds of distribution functions which are defined and these distribution functions basically talk that how should use this distribution functions.

This data it can be erased for a particular kind of distribution functions and then depending upon the values, the mean values and if you take the standard deviation on both the sides, it will be having certain range and a data can be taken with certain confidence. I mean in at that particular confidence interval and it can be said that the estimates are likely to be certain percentage of truth.

So this way these distribution functions are used. You may use other kind of relations also, other typical relationships. Now many a case times as we have discussed that sometimes we

do the estimation by analogy. We may have some estimation based on some parameters like we may do the estimation of the labour cost based on the area of the floor.

So if suppose we are talking about the construction of the house, construction of an apartment, construction of a building, in that case the labour cost will be estimated as a function of the area over which the work will be done. Suppose the cost of plastering, that will be depending upon the area over which the plastering will be carried out. So this way those relationships can be used.

Similarly the amount of fuel consumed may be dependent upon how much the vehicle has to be used or what will be the vehicles duration for which it is used as well as the velocity at which it is used. So these kinds of special type of functions may be used, it may have the co-relations, some of the parameters will be there is which will be directly indicative of the cost total cost which can be estimated.

So these are the different kinds of functional relationships which can be used for finding the estimated costs and the interdependence of cost and the factors or in between the different factors can be found and then estimations can be done correctly. Now let us say, what we can discuss further is, if we involve the learning process it also affects the cost.

So we have already discussed about learning where it tell that the direct labour hours required to make the first unit, it is reduced by certain percentage when you make the second unit or the second unit takes suppose some hours, the fourth unit will take the percentage value of that many hours required for the second unit. So this where is the learning goes on, the direct labour hours required is going to be changed.

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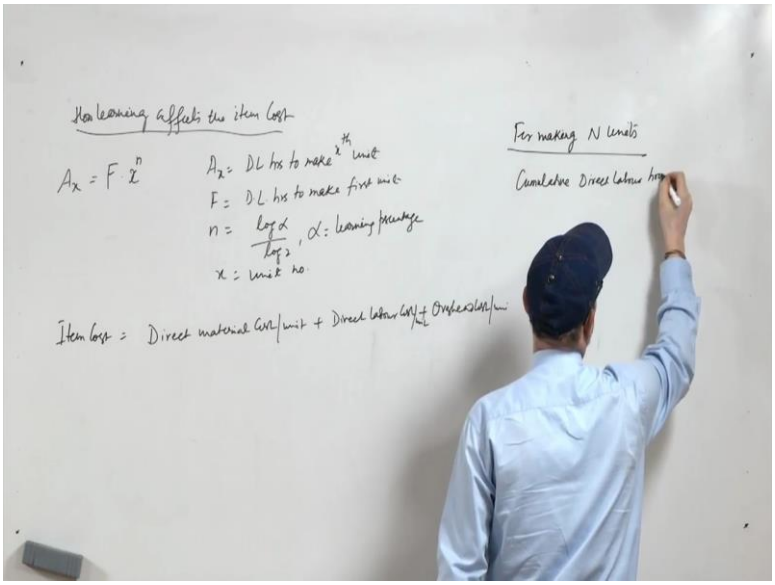

So sometimes how learning affects the item cost that can be seen. So what we have seen in learning was, in learning basically we had seen that F is the time or direct labour hours required to make the first unit and Xn it will be basically the time required for making the xth unit.

So Ax was direct labour hours to make xth unit and F was direct labour hours to make the first unit and N was log alpha by log 2 where alpha was the learning percentage and X is the unit number. So basically this is what we had earlier learned. Now based on this basically it involves the item cost, so item cost basically if you take that, item cost will be nothing but direct material cost per unit plus direct labour cost plus overhead cost per unit, so this is also per unit.

So basically what we see is, as we had discussed that you have basically three kinds of costs which are there in the industries. You have direct material cost, you have direct labour cost and apart from that other costs which are not under this direct material and direct labour cost, they are the overhead cost. Overhead cost basically is expressed sometimes in percentage of sum of this.

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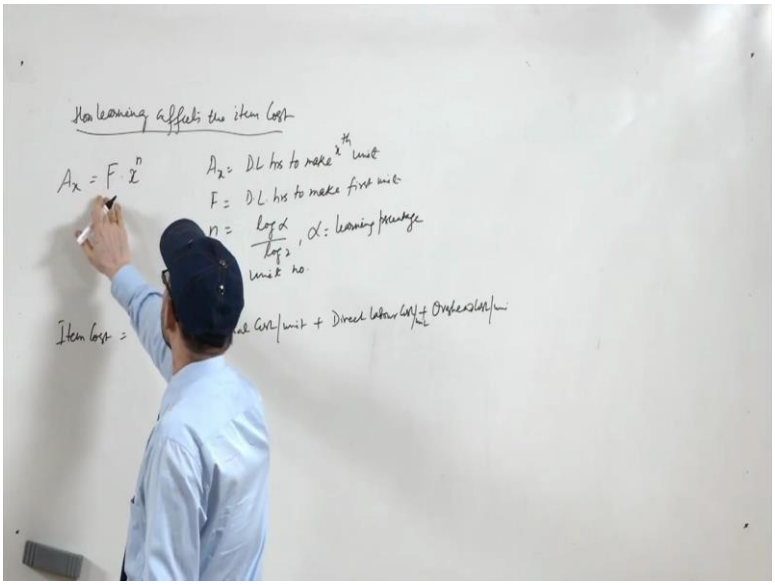

So suppose you take as on the basis of directly labour cost, so in that case if you take these values, you can express the item cost in these functions where basically direct labour cost will be depending upon this because for making number of units, you basically need less number of hours.

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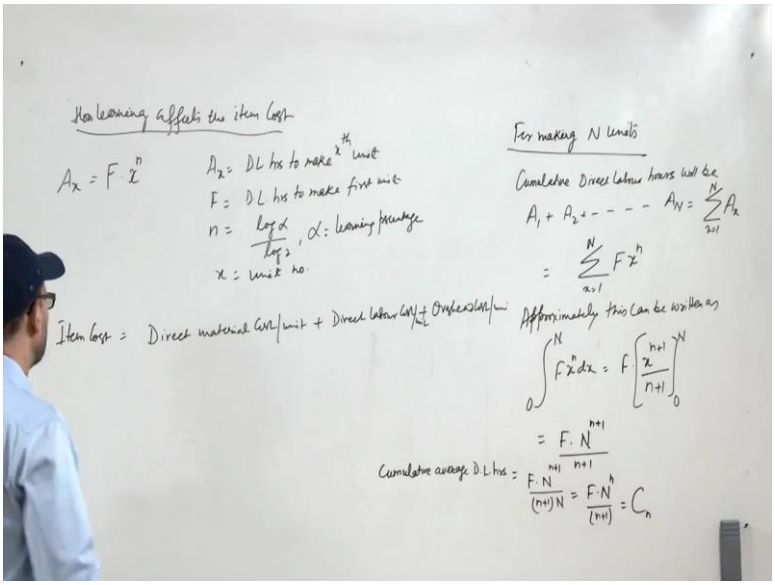

Now let us see if you are making N units, for making N units, for making N units basically cumulative direct labour hours will be, it will be basically A1 plus A2 plus upto AN. So this will be the cumulative direct labour hours. Now this can be written as summation Ax x equal to 1 to n. So this will be basically you can write it as summation of 1 to n and Ax as we know it is Fx raised to the power n.

Now what we can do is approximately this can be written as integral of Fxndx 0 to n. So this is basically just an approximation, approximately it will be this much. So this will be basically F x raised to the power n plus 1 upon n plus 1 and this will be 0 to N. So this will be equal to F multiplied by N raised to the power n plus 1 divided by n plus 1. So this is basically the cumulative direct labour hours required to make capital N units.

Now if we find the cumulative average direct labour hours required to make n units, in that case you have to divide it with capital N. So it will be F into capital N raised to the power n plus 1 by n plus 1 divided by capital N. So it will be F multiplied by N raised to the power n upon n plus 1. So when the learning is involved, this is the cumulative average direct labour hours. Now this if suppose we are taking as Cn.

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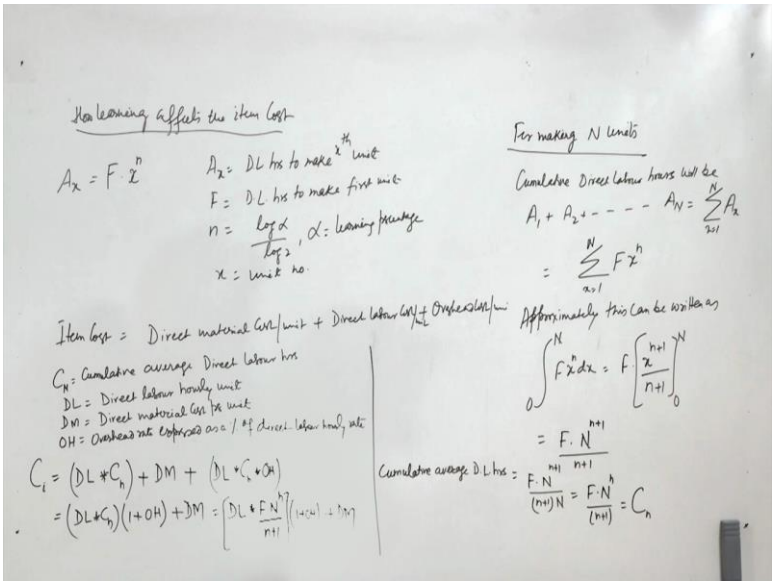

So now what we see is now here if suppose we have got Cn as cumulative average direct labour hours. Now DL is the direct labour hourly rate and DM is the direct material cost per unit and in OH you can take as overhead. Basically it will be overhead rate expressed as a percentage of direct labour hourly rate. So basically you can express this overhead in terms of either in terms of direct labour hourly rate or direct material cost rate or so, that we will discuss next.

So in that case you can write the item cost per unit as direct labour hourly rate that is DL, it will be multiplied with the average cumulative number of labour hours required. So it will be multiplied with our Cn. So this will be basically, this product will give the cost which will talk about the cost involved in labour hours.

Then further you have material cost that is anyway to find as DM that is direct material cost per unit plus now this overhead cost it is expressed as a fraction of direct labour hourly rate. So it will be DL into Cn into OH. Basically when we allocate the costs into direct and indirect costs, the indirect cost because they comprise of many types of cost, so they are expressed as a fraction of certain type of either direct labour cost, directly labour hour or direct material cost.

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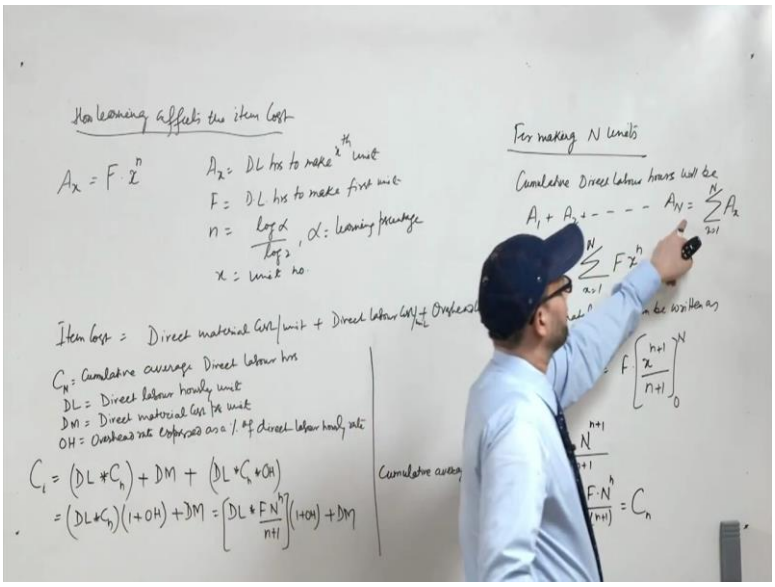

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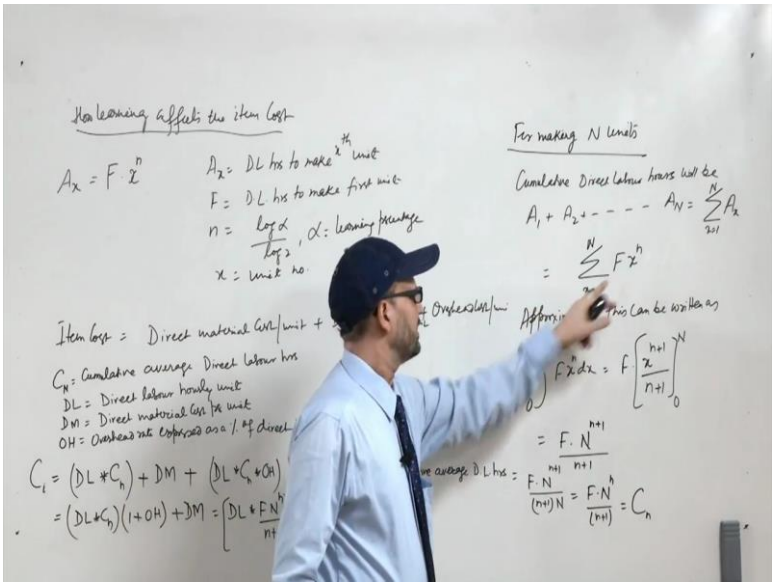

So they will be normally terms of certain percentage. So basically if you talk DL into Cn will be common, it will be 1 plus OH plus DM. So we can further write Cn as this so DL multiplied by F N raised to the power n upon n plus 1 into 1 plus OH plus DM. So this is how

you find the item cost per unit but this is a approximated type of cost because we have assumed the approximation, this one as this one.

So this will be basically the actual values can be found from here but this is the approximated value and for reasonable number of units, this may be taken as a very close values but otherwise there may be some difference. So you may deal with some questions where we will see that there will be differences in the actual values and the estimated values. Now we will also discuss about other models which are left.

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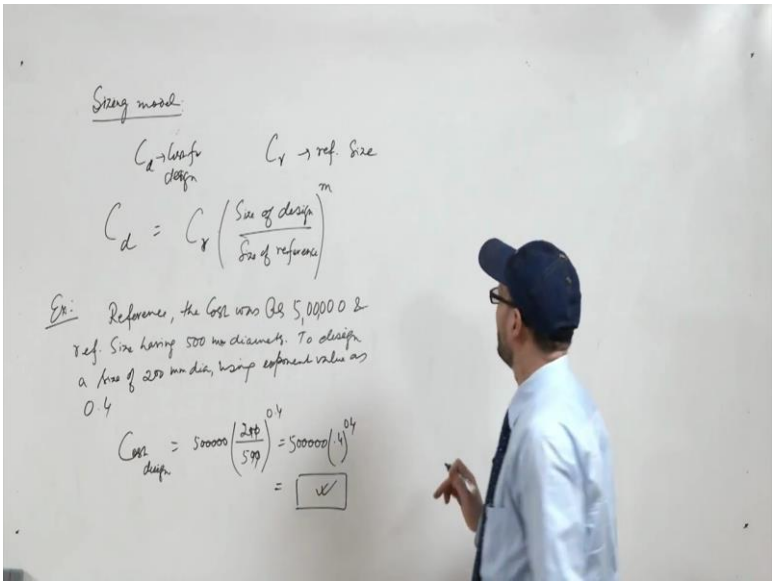

Now let us see there is a model sometimes which is known as sizing model. So what happens that many a times you are estimating something, you know the cost component for the similar item with smaller size and if you have to estimate the cost for the larger size, in that case basically there is an exponent which is used sizing model. So in that this exponent tells us how the cost can be further estimated.

So suppose you want to estimate some cause for a particular design, so and you have the cost for any reference size, for reference size and this is for cost for design. Now you may have a parameter which will be basically talking about the size differences of the two. So you can have this relationship as Cr multiplied by size of design upon size of the reference raised to the power some m.

So basically this m is an exponent which tells us that how you can co-relate this cost for the design when the ratio of the sizes of the two components design and the reference, the reference is set. For this Cr is known that is cost for the reference and size of the design if it is

known to you, you can get the values using this exponent which is also known as power law and sizing model because this is the power which is used, which is the exponent which is used.

So suppose sometimes you may have the problem like this that suppose the reference, for reference the cost was suppose Rs. 5,00,000 and reference size having 500 mm diameter. To design a size of 200 mm diameter 200 m diameter, this is 500 mm diameter, using exponent value as 0 point 4.

In that case you can basically have the size of the design, cost of the design as you can have this cost as 5,00,000 multiplied by then size of the design that is 200 you have to find. Then further you have to find the size of this that is 500, this will be given the exponent point 4 so you get 5,00,000 multiplied by point 4 raised to the power point 4. And if you look at this value you can basically get the values. So this is how you get the values of such problems.

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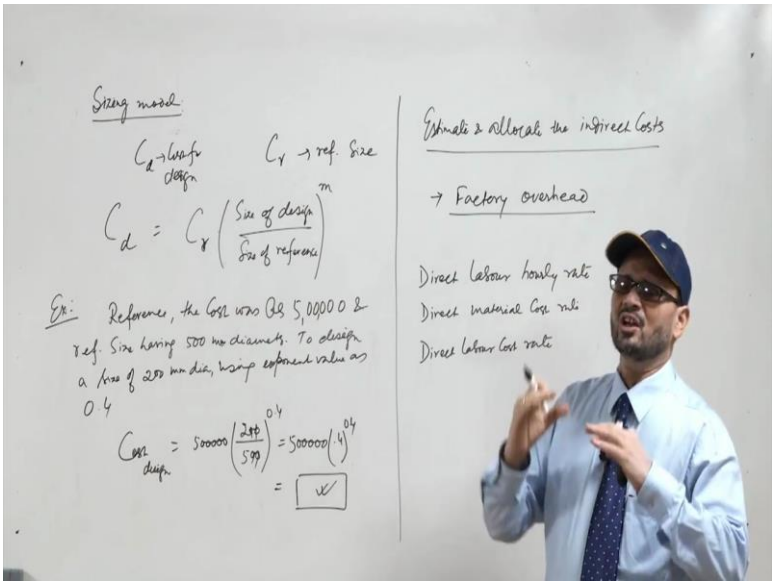

Next is what we are discussing, you have to estimates and allocate the indirect costs. This is one of the area which requires frequent use when we talk about the production operations. So as we had discussed, there are many basis by which you are basically estimate or allocate the indirect cost. So basically you are you have the factory overhead.

You can have the allocation of these factory overheads based on these values direct labour hourly rate or direct material cost rate or direct labour cost rate. So basically the overheads can be expressed as the percentage of these. So if these percentages are known to you, if you

know the direct labour hourly rate and if that fixed percentage is known to you, basically you can use this for estimation of the factory overhead.

So that percentage or that fraction or that number multiplied with direct labour hourly rate or direct labour hours, basically that can give you the estimation of factory overhead for any particular kind of estimation. So these are the three ways by which you can allocate or estimate the indirect costs. So this is how the estimation is carried out and production operations.

Also you will have discussed about many methods and this can be used for estimation of the cost elements. Thank you.