So, this is all about your defender that is the current equipment. Now let us discuss about the challenger, that is a proposed equipment. The challenger's annual operating and maintenance cost is 90,000. So, you can see that it is lesser than your old equipment, so lesser than your defender. So, the defender operating and maintenance cost is 1,35,000 but your challenger operating cost is 90,000, so it is lesser.

And the salvage value for the challenger is 12,00,000 after 5 years. So, the life of the challenger we are considering is for 5 years, investment cost is 10% per year. Now we are supposed to compare the challenger and the defender, find out whether the defender should be retained or replaced with the challenger using time value or annual worth method. So, that is what we are going to do.

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Now let us look into the information about the defender. So, for the replacement analysis, as I told you your initial estimates should be ignored or neglected, they are not relevant. Your initial purchase price 35,00,000 it should not be considered in the replacement analysis. And similarly your initial estimate of salvage value 7,00,000 is should not be considered. And the estimated current book value using your depreciation accounting method 23,80,000, it is also not relevant in the analysis.

And the estimated life initial estimate based upon the remaining life was found to be 6 years, this 6 years is also not considered. All these are old estimates, old estimates should be neglected in the replacement analysis. And also, as I told you your sunk cost, so what is the sunk cost? So, it is a estimated book value of the machine, this is the estimated book value of the machine using depreciation accounting method it is currently 3,80,000.

But your current trading value is only 22,50,000 this difference cannot be recovered, this difference is called as the sunk cost, this is a cost which is spent and it is lost, it cannot be recovered. So, this difference is a sunk cost and this also should be neglected in the replacement analysis. So, all the old estimates, initial cost, initial estimate of salvage value, initial estimate of useful life **so** and the sunk cost are not consider the replacement analysis. So, these are not imparted from the outsider perspective or the third-party perspective.

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Now for the existing equipment that is defender what are all relevant in the replacement analysis or what are all to be considered in the replacement analysis, let us see that. Current market value is 22,50,000, this is your initial cost of your the first cost of your defender, this is what we are going to consider, what is your current trading value of the machine in the market. Now the salvage value, the final estimate of salvage value the recent estimate is 6,00,000, that you have to consider.

At after 5 years, after the remaining life of 5 years, the salvage value is going to be 6,00,000, the remaining life is 5 years according to the recent estimate. The annual operating and maintenance cost is 1,35,000. Based upon this you are supposed to calculate the equivalent annual cost of the defender. We are going to estimate the equivalent annual cost of the defender. So, for that you need to draw the cash flow diagram. Let us draw the cash flow diagram and do the analysis.

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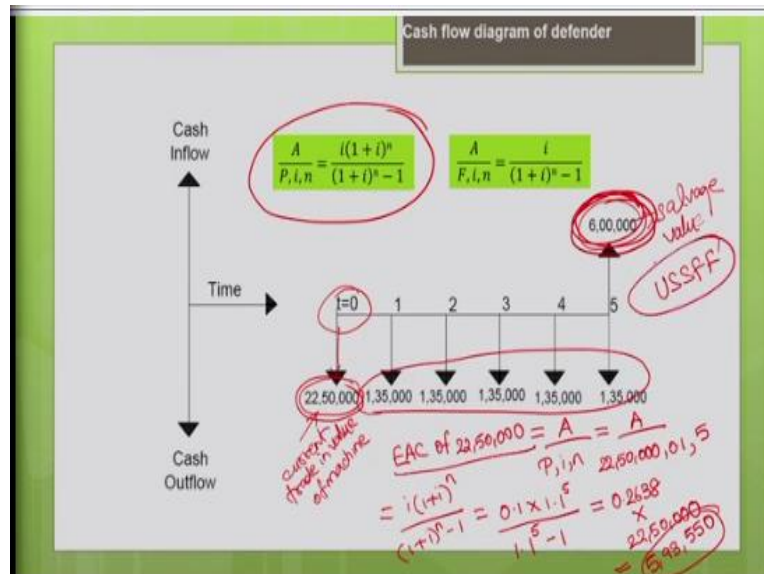
So, now the first cost of the defender is the current, this is nothing but your current trading value of your machine, that is nothing but 22,50,000. Every year the operating cost is going to be same and it is found to be 1,35,000, so the remaining life of the machine estimated is 5 years, you can see 5 years. At the end of 5th year, when you sell it you are going to get a cash inflow of 6,00,000.

So, this is nothing but your salvage value of your machine. Now, so based upon this you can estimate the equivalent annual cost. So, how to estimate the equivalent annual cost? You are going to convert this values all this values to time period of t = 0. So, now what you do is, your initial cost of the defender, initial cost of the defender is 22,50,000. So, this one you are going to converted into equivalent annual cost, this is already at t = 0 only.

This present value, I am going to convert it into equivalent annual cost, so how to do that? Equivalent annual cost of 22,50,000, so you need to calculate A for know P, i and n. So, what is

P? P here is present value 22,50,000, interest rate is 10% 0.1 and number of years is 5. So, it is nothing but you have to use your uniform series capital recovery factor to find this,

$$\mathbf{USCRF} = \frac{A}{(2250000,0.1,5)} = \frac{i(1+i)^n}{(1+i)^n-1} = \frac{0.1(1+0.1)^5}{(1+0.1)^5-1} = \mathbf{0.2638}$$

$$\mathbf{EAC} = \mathbf{0.2638} \times \mathbf{22,50,000} = \mathbf{5,93,550 \ rupees}$$

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So, this is the equivalent annual cost of your initial cost of defender, so we have estimated it. Already the operating and the maintenance cost already annual cost and they are equal, they are already annualized cost, so you need not convert them.

Now let us go to the salvage value, I need to convert this salvage value into equivalent annual cost. So, you can do it by 2 approaches as I told you can use the uniform series sinking fund factor. You can use uniform series sinking fund factor and convert it into equivalent annual cost or you can find the present worth of this future salvage value using present worth factor and then convert it into a equivalent annual cost using uniform series capital recovery factor.

So, both these approaches you can use any one of these approaches you can use. Now let us calculate using uniform series sinking fund factor approach, so let us see how to do that.

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Cash flow diagram of defender
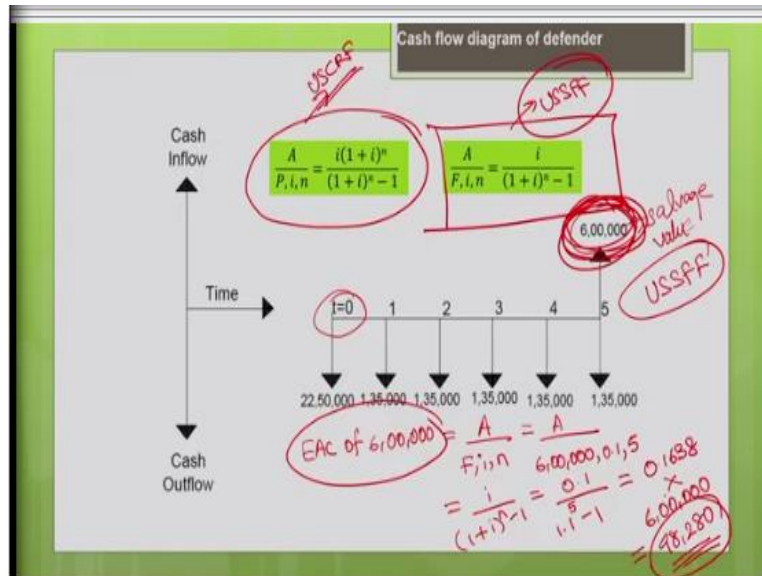
So, now you need to find the equivalent annual cost of 6,00,000, that is your salvage value. So, you need to find A for the known F, i and n, F is nothing but your future value, the future salvage value. So, what is the salvage value, F is nothing but 6,00,000 and the interest rate is 0.1 number of years is 5, you are going to use this formula, this is nothing but your uniform series sinking fund factor. So, using this we are going to calculate this, this is uniform series capital recovery factor, hope you remember. So, now we are going to use this uniform series sinking fund factor to find the equivalent annual cost,

$$\text{USSFF} = \frac{A}{(600000, 0.1, 5)} = \frac{i}{(1+i)^n - 1} = \frac{0.1}{(1+0.1)^5 - 1} = 0.1638$$

$$\text{EAC} = 0.1638 \times 6,00,000 = 98,280 \text{ rupees}$$

So, this is the equivalent annual cost of your salvage value 98,280. So, now let us see how it is done? Let me summarize whatever I have discussed so far. So, you are finding the annual worth or the equivalent annual cost of your defender. So, first you are converting the initial cost of the defender, it is 22,50,000 into equivalent annual cost using uniform series capital recovery factor.

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Your operating cost is already in the annualize form, no need to convert. Then you convert your salvage value 6,00,000 into equivalent annual cost using uniform series sinking fund factor. That is what is done here 22,50,000 to the factory is A, for known P, i and n, + 1,35,000 - salvage value you have to multiply with the uniform series sinking fund factor which is nothing but you are going to find A for the given F, interest rate 10% and n = 5.

So, now you substituted we will get it, the factor is corresponding to 0.2638, here the factor is corresponding to 0.1638, so when you simplify you will get this value. So, the annualize initial cost of the defender is 5,93,550, this is your outflow. Your operating cost is your cash outflow 1,35,000 add both the cash outflows, you will get the total outflow, then what is your inflow? Your inflow is nothing but your salvage value 98,280 you subtract it from the added value.

You will get the final equivalent annual cost of the defender or the annual worth of the defender as 6,30,270. So, this is the cost liability of holding the defender with you, so this is the cost implication or the equivalent annual cost associated with the defender. If you are going to hold this machine for 5 years. So, what is the equivalent annual cost associated is 6,30,270. A similar manner you are going to find the equivalent annual cost for your challenger machine, that is a proposed equipment.

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For New equipment (challenger),

○ Initial cost (P)= ₹ 27,50,000

○ Salvage value (F) = ₹ 12,00,000, Remaining life : 5 years

○ Annual O&M cost = ₹ 90,000

○ Thus the equivalent annual cost of proposed asset
(challenger) to be determined

So, for the new equipment challenger, the initial cost is given as 27,50,000. So, this is a cost for the acquisition of the machine to your project site. Then the salvage value is given as 12,00,000, after 5 years, so after 5 years it is going to be 12,00,000. So, here the life of the machine we are considering is 5 years. So, the annual operating and maintenance cost is 90,000, now you are going to find the equivalent annual cost of the proposed asset, that is a challenger, in the same manner, you can find it.

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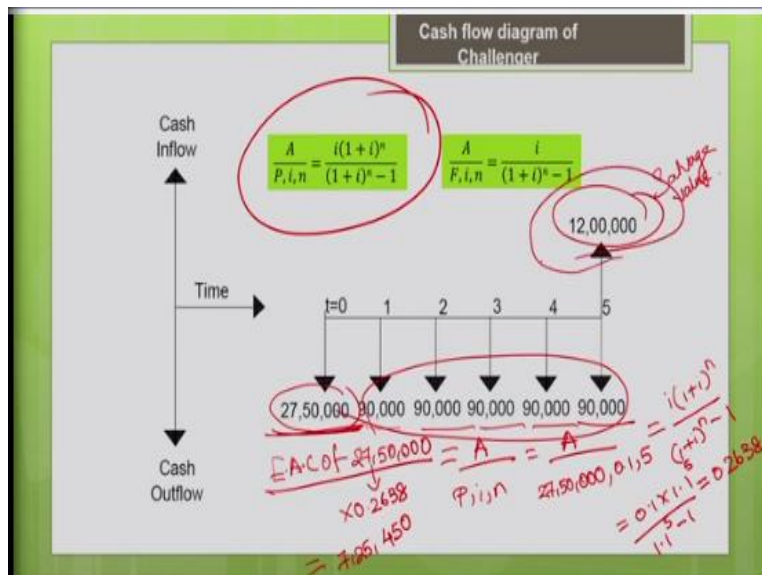
Let us draw the cash flow diagram first. Now the initial cost of the challenger is 27,50,000, the operating cost is same for every year. For the 5 years it is found to be 90,000, at the end of the 5th year if you are going to sell it your salvage value is 12,00,000. Now, find the equivalent annual

cost of your initial cost of a challenger that is 27,50,000, so how to find this? So, you need to find the A for the known P, i, n what is P here?

$$\text{USCRF} = \frac{A}{(2750000, 0.1, 5)} = \frac{i(1+i)^n}{(1+i)^n - 1} = \frac{0.1(1+0.1)^5}{(1+0.1)^5 - 1} = 0.2638$$

$$\text{EAC} = 0.2638 \times 27,50,000 = 7,25,450 \text{ rupees}$$

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You can see, so this is what their estimated. Now already the operating cost is annualized, you need to convert that, into equivalent annual cost, it is already equivalent annual cost. Now we are going to calculate the equivalent annual cost associated with the salvage value of the machine. So, let me now estimate the equivalent annual cost of the salvage value 1200000.

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Cash flow diagram of Challenger
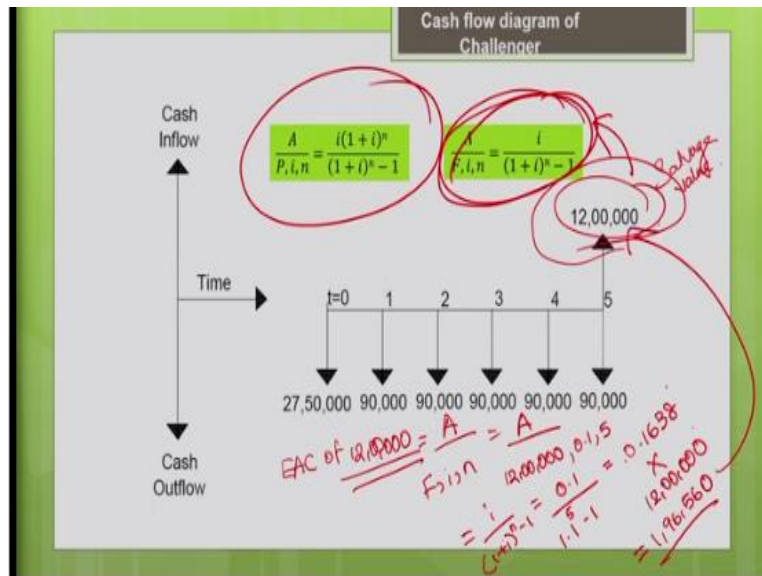
So, you are going to use the uniform series sinking fund factor, using this you can convert it. You need to find the A for the known future value i and n, the future value is nothing but your salvage value 12,00,000, interest rate is 0.1, number of years is 5.

$$\text{USSFF} = \frac{A}{(1200000, 0.1, 5)} = \frac{i}{(1+i)^n - 1} = \frac{0.1}{(1+0.1)^5 - 1} = 0.1638$$

$$\text{EAC} = 0.1638 \times 12,00,000 = 1,96,560 \text{ rupees}$$

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Defender vs Challenger
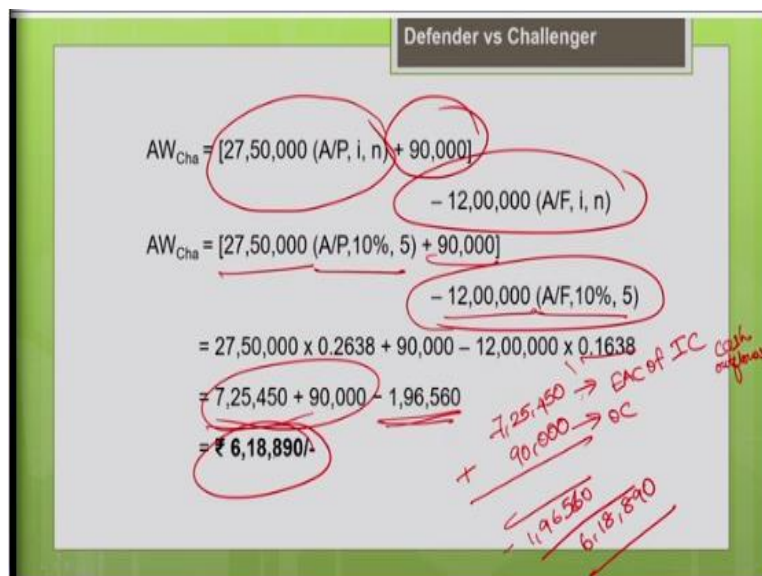
So, let me know summarize, we are finding the annual worth of the challenger. So, here we are finding the equivalent annual cost of the initial cost of a challenger plus the operating cost minus your salvage value, equivalent annual cost of the salvage value.

To find the equivalent annual cost of the initial cost you have to multiply by uniform series capital recovery factor, then add it with the operating cost. Then you have salvage value, you multiply it with the uniform series sinking fund factor and then subtract it from the cash outflow. This is the cash inflow, so these 2 are cash outflows. So, the 7,25,450 is your equivalent annual cost of your initial cost of machine, 90,000 is your operating cost of the machine.

So, both are cash outflows, you have to add both. Now your cash inflow is the salvage value - 196560, so you will get the final resultant as 6,18,890. So, this is the cost liability of holding the challenger with you. So, the cost implication of holding the challenger for 5 years the equivalent annual cost will be 6,18,890

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Now let us compare, from the above calculations you confine that the equivalent uniform annual cost of the defender is 630270. So, it is more than that of the equivalent annual cost of challenger which is 6,18,890. Hence it is advisable to replace your defender with a challenger. So, the construction company should replace the defender with the challenger, so this is a decision made.

So, in this approach we are comparing 2 different machines, your current existing machine defender and the proposed machine where estimating the equivalent annual cost for both things, and we are finding for which one the cost liability is minimum. So, whichever equipment the cost liability is minimum we will recommend that. In this case, the challenger cost liability is minimum, so it is preferable to replace a defender with the challenger.

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So, we are come to the end of this lecture 8. So, let me summarize whatever we have discussed so far. So, as I told you earlier, the replacement analysis is to be done from outsider perspective or the third-party approach. So, the outsider is not concerned about your initial purchase price. For him for the current equipment, he is concerned only about the current trading value of the machine in the market.

So, all your past estimates of your initial cost, your estimate of your useful life there, yearly estimates, the yearly estimates of salvage value of the defender and the sunk cost all are irrelevant in the replacement analysis. They should not be considered in the replacement analysis. You are supposed to consider only the current trading value of your machine, current trading value of your current asset that is only important for an outsider.

And I explained to you what is the sunk cost, sunk cost is the cost which cannot be recovered. Say for example, your estimated book value of the machine is going to be higher than the current
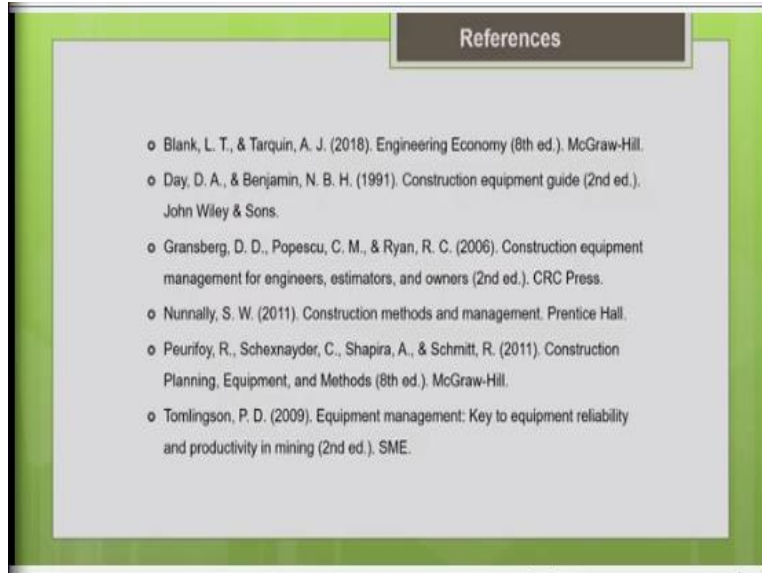
trading value of the machine, that difference is your sunk cost. The difference between the asset book value and the current market value, this cost cannot be recovered. So, that is a sunk cost, and this cost should not be considered in the replacement analysis.

So, basically the economic life of the machine is a time period at which the equivalent uniform annual cost is a minimum. So, we have discussed 2 different types of problems, in one problem we have estimated the economic life of the machine using the equivalent annual cost of the machine. In another problem we have compared the defender and challenger and we have estimated the equivalent annual cost for both the defender and the challenger.

And compare both the values for whichever equipment the cost liabilities minimum, we recommend that particular equipment. So, we have discussed 2 different types of approaches using this time value method. So, basically we have dedicated 3 different lectures, lecture 6, 7 and 8 for the equipment life and the replacement analysis. So, as I told you when you do the replacement analysis, we have to consider all the components of the equipment cost.

Then only you can get a accurate picture, all the cost including your downtime cost, obsolescence cost, your cost of inflation, everything should be considered in the cost estimation to get the accurate replacement decision. Also, you should consider the timing of the cash flows, time value factor you should consider. So, that you can get an accurate replacement decision. So, with this let me conclude with the lecture 8.

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So, these are the reference textbooks which I have used for the preparation of this lecture. I recommend you to procure some of these books for the preparation of topics later. In the next lecture we will be discussing about engineering fundamentals of the earthmoving operation. Like we will be discussing what are all the important fundamental terminologies related to earthmoving operation, I will introduce those terms.

And we will also discuss about different types of machines earth moving machines, their mode of operation, how to estimate the productivity of those machines? All those things will be discussed in the upcoming lectures, thank you.