Lecture - 53
Cost Control (Tools and Techniques)

Hello friends, I welcome you all in this session. As you are aware in previous session we were discussing about ITTO of cost estimation and cost budgeting. And now we will talk about cost control. We have seen different inputs for cost control. And let us look at tools and techniques. So there is something called cost change control system, a procedure by which you can change cost baseline right. So, you need to have several documentations, several approvals done to get the base line changed. Then you got performance measurement analysis are there is there is very famous techniques called earned value management right or earned value technique.

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Cost Control: Tools and Techniques
2. Performance Measurement Analysis: Performance measurement techniques help to assess the **magnitude of any variances** that will invariably occur.
The **earned value technique** (EVT) compares the value of the **budgeted cost of work performed** (earned) at the original allocated budget amount to both the **budgeted cost of work scheduled** (planned) and to the **actual cost of work performed** (actual). This technique is especially useful for cost control, resource management, and production.
An **important part of cost control is to determine** the **cause of a variance**, the **magnitude** of the variance, and to decide if the variance **requires corrective action.**

So, we need to find out what are the reasons for variations in time as well as cost of the project. So, let us look at couple of definition related to earned value management technique are earned value technique. There is something called planned value. Planned value is budgeted cost for the work schedule to be done you are not completed that work. But you just you have a budgeted cost for that work which is to be done right.

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The earned value technique involves developing these key values for each schedule activity, work package, or control account:

• **Planned value (PV):** PV is the **budgeted cost for the work scheduled to be completed** on an activity or WBS component.
• **Earned value (EV):** EV is the **budgeted amount for the work actually completed** on the schedule activity or WBS component.

So, that is planned value, earned value is the budgeted amount for the work actually completed. So, planned value is for work to be done and earned value is whatever you have done right.

So, how much value you have you have earned in a project is earned value right.

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•**Actual cost (AC):** AC is the **total cost incurred** in accomplishing work on the schedule activity or WBS component. This AC must correspond in definition and coverage to whatever was budgeted for the PV and the EV (e.g., direct hours only, direct costs only, or all costs including indirect costs).

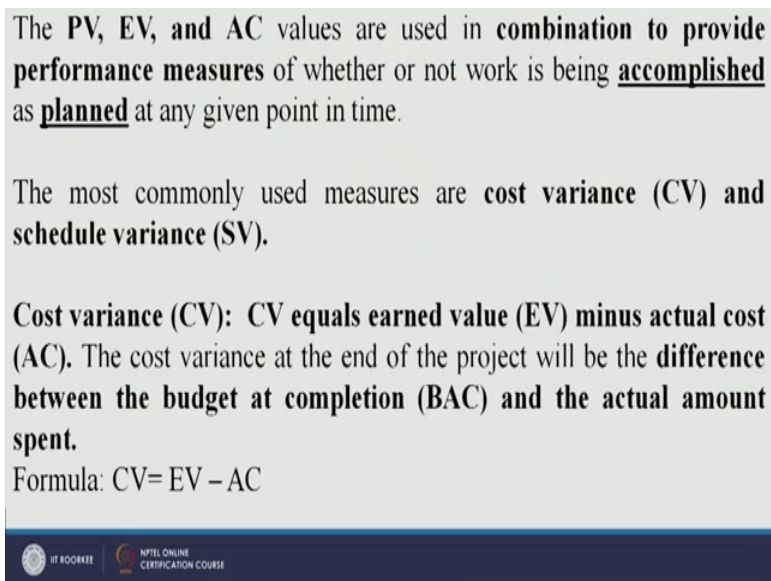•**Budgeted cost at completion (BAC):** This represents the total budget for a project.

We will we will take up an example we will calculate how to find out earned value in a project, then you have got actual cost. Actual cost is the total cost incurred in accomplishing work on the schedule activity or work break down structure component.

So, cost which we have incurred right. It is not at planning stage you incurred that cost. This actual cost must correspond in definition and coverage to whatever was budgeted for planned value and the earned value right. There is something called budgeted cost at completion this is nothing but the total cost of the total budget of the project right.

So, the final point which I have shown in previous session, on a cost base line the final point is nothing but the total budget.

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The **PV, EV, and AC** values are used in **combination to provide performance measures** of whether or not work is being **accomplished** as **planned** at any given point in time.

The most commonly used measures are **cost variance (CV) and schedule variance (SV).**

Cost variance (CV): CV equals earned value (EV) minus actual cost (AC). The cost variance at the end of the project will be the **difference between the budget at completion (BAC) and the actual amount spent.**
Formula: CV= EV – AC

So, we will use planned value earned value and actual cost in combination to provide performance measures of whether or not work is being completed as planned or not. So, our combination of these 3 things planned value earned value and actual cost would be used to see the performance of the project. So, basically we will use 2 type of measures there is something called cost variance, and schedule variance: variance in cost due to some reason and variance in time, why you could not do things in time, right? So there is something cost variance to measure changes in cost and to measure reasons for delay or early completion of the project right.

So, cost variance and schedule variance. So, cost variance nothing but, cost variance is equal to earned value minus actual cost. The cost variance at the end of the project will be the difference between budgeted completion and actual amount spent. So, whatever is the budget at the end of the project and how much amount you have spend. So, that difference is cost variance right. And if you want to calculate cost variance then it is the

difference between earned values minus actual cost. So, this is cost variance, similarly you have got schedule variance, and schedule variance is nothing but this is the difference between earned value and planned value right.

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- **Schedule variance (SV):** SV equals earned value (EV) minus planned value (PV). Schedule variance will ultimately equal zero when the project is completed because all of the planned values will have been earned.
Formula: SV = EV − PV
These two values, the CV and SV, can be **converted to efficiency indicators** to **reflect the cost and schedule performance of any project.**

So, schedule variance equals earned value minus planned value and schedule variance will ultimately equal to 0 when the project is completed because all of the planned values will have be earned right. So, cost variance and scheduled variance can be converted into efficiency indicators. So, you will come to know whether you are you your cost is under run or overrun right. You are your time is your before time are, I had of you are you are before time are there is a delay in the project right. So, you have to 2 types of indicators you have got cost performance index and schedule performance index. So, CPI and SPR 2 indexes right.

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Cost performance index (CPI): A CPI value less than 1.0 indicates a **cost overrun** of the estimates. A CPI value greater than 1.0 indicates a **cost underrun** of the estimates.
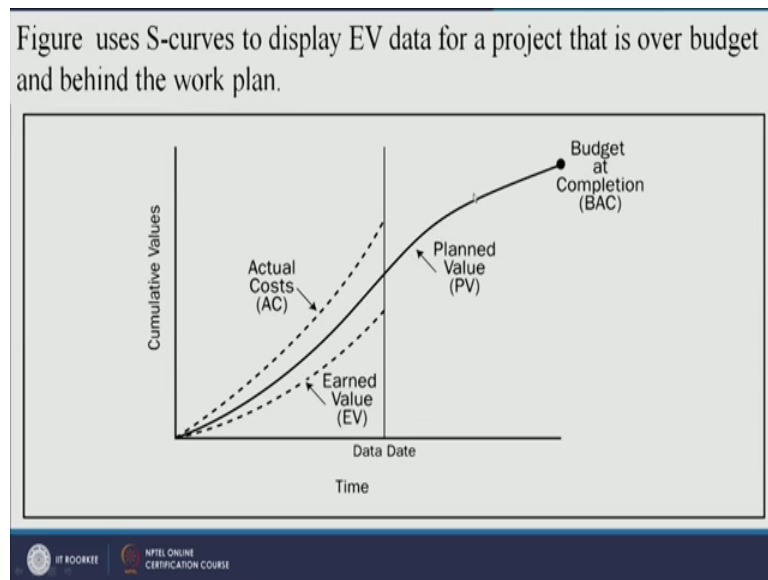The CPI is the most **commonly used cost-efficiency indicator**.
Formula: **CPI = EV/AC**

Schedule performance index (SPI): The SPI is used, in addition to the schedule status, **to predict the completion date** and **is sometimes used in conjunction with the CPI to forecast the project completion estimates**.
Formula: **SPI = EV/PV**

So, if you look at cost performance index, which is the ratio of earned value to actual cost. So, if actual cost is more than earned value then it is say case of cost overruns right. So, CPI value less than 1 indicates cost overruns of the estimate. So, CPI will be less than 1 one actual cost is more earned value right. That is it is situation should not occur right. A CPI value greater than one indicate cost under run of the estimates right. So, your earned value earned value is more than actual cost right. And is the indicator for cost right. Cost performance indicator. Similarly you have got scheduled performance index. In addition 2 schedule status SPI will help to in predicting got is the completion date of the project right. So, let us say if we if we if you are delaying a project if your project is getting delayed by let us say one month.

So, and you also know how much was the budget how much actually you spent on the basis of all those available information you can predict. Now, how much time it will take you complete right? So, you have got SPIs ration of earned value to planned value right. So, the schedule variance is difference between earned value and planned value. Similarly cost variance is difference between earned value and actual cost, but here in this ratio term it is a ratio actual earned value to actual cost and earned value to planned value right. So, it is in it is very easy to remember. So, let us to look at this particular slide. So, you have got this is your planned value of a project and this is budget at completion right.

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Figure uses S-curves to display EV data for a project that is over budget and behind the work plan.

The total budget of the project; is this and let us say in a project you have incurred this much actual cost. So, you just at a particular date you have spent this much cost right. And earned value is only this much, but planned value this much. So, your much you did not earned that much value which is should not earned right. So, this is an S-curve approach, which will help you in knowing what you have planned and what you have earned right. So, this is one of the methods of measuring performance of the project right.

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Cost Control: Tools and Techniques

3.Forecasting: Forecasting includes **making estimates or predictions of conditions in the project's future based on information** and knowledge available at the time of the forecast.

4.Project Performance Reviews: Performance reviews **compare cost performance over time, schedule activities or work packages overrunning and under running budget** (planned value), **milestones due, and milestones met**.
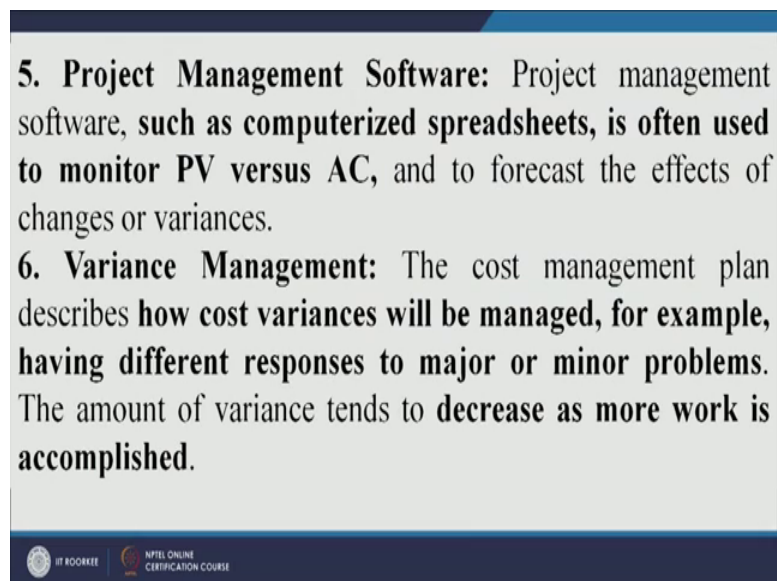
So, we have seen 2 methods, the first one was the documentation needed to change the cost base line and second one is earned value technique right.

Let us look at third one it is forecasting right. So, forecasting is again you can use different forecasting methods to control cost and you have got project performance reviews. So, performance reviews compare cost performance over time schedule activities or work packages overrunning and under running budget, milestone due and milestone met. So, this are this quit a theoretical type of performance measurement system. So, you will you will come to know in a meeting that we have achieve those many milestones we did not achieve this particular milestone and so on right. So, it is a kind of performance review meeting right.

Then you have got different softwares again you have got msp, primavera and spreadsheet and So on right.

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Then variance management you need to know where there is variance in terms of cost and in terms of time you need to manage those variances. You should try to minimize those variances right. If you minimize those variances it means you are moving towards a right direction right. You are moving in right direction.

And there are several cost control outputs right. We will not look at these outputs right. We will look at some of other performance measurement techniques. So, whenever you

measure performance of the project you need to look at 2 important things, but you want to measure right, and when you want to measure? So, whether you want to measure the cost or time are let us say the availability of resources and when you want to do this performance analysis, should it be monthly? Or should be twice in a year? Or annually? Or So on right. So, you need to look at what should be measured and when should be measured right.

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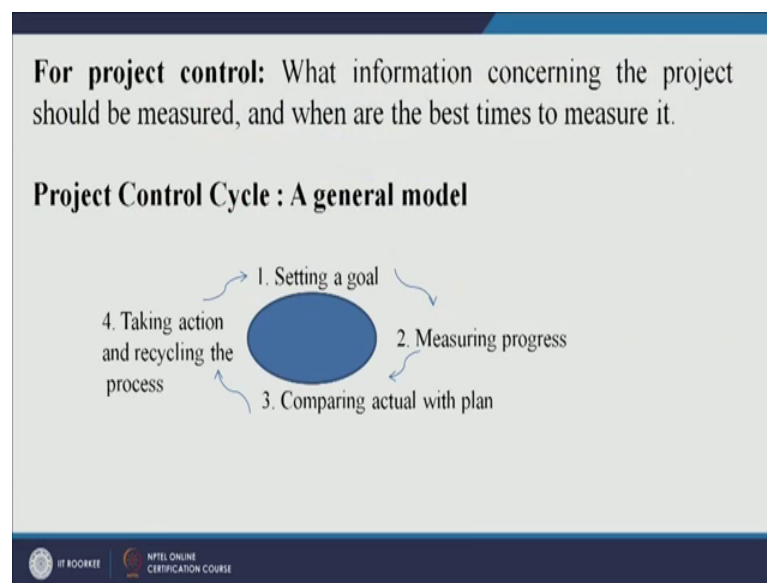
Let us look at a very general model of performance measurement or project control cycle. In fact, very old method of controlling any project is this is this is nothing but PDCA right. Plan do, check and act pds PDCA cycle. So, this is very similar to that. So there is a project control cycle and this is quite a general quit a generalized modal to measure performance of a project. So, first of all what we do; we set different goals that we have to achieve this much profit or we have to achieve this much you know, let us say this much value to our stakeholders right. And then measure those plans and policies which we have a applied to achieve those goals right. So, measure progress compare with actual plane right. Then only you will come to know where you are lacking right. And finally, take action and recycling the process right.

So, this is this is very simple cycle. So, it is also known as PDCA right. Plane do, check and act right. So, this is project control cycle right. Very general it is a generalized model to measure performance of the project right.

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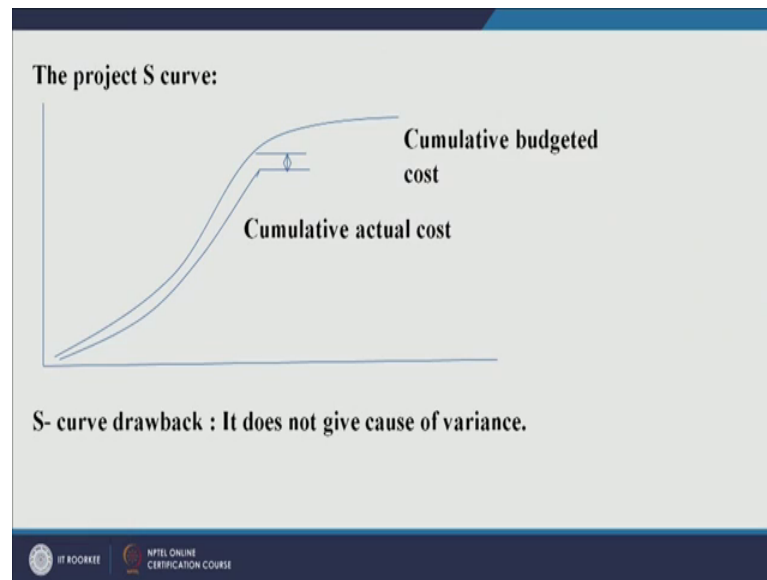
So, this is we have already seen S-curve model. In fact, the problem with this approach is that we will come to know that there is a variance, but it does not give you what are the reasons for variance right. So, this is a draw of S-curve approach right.

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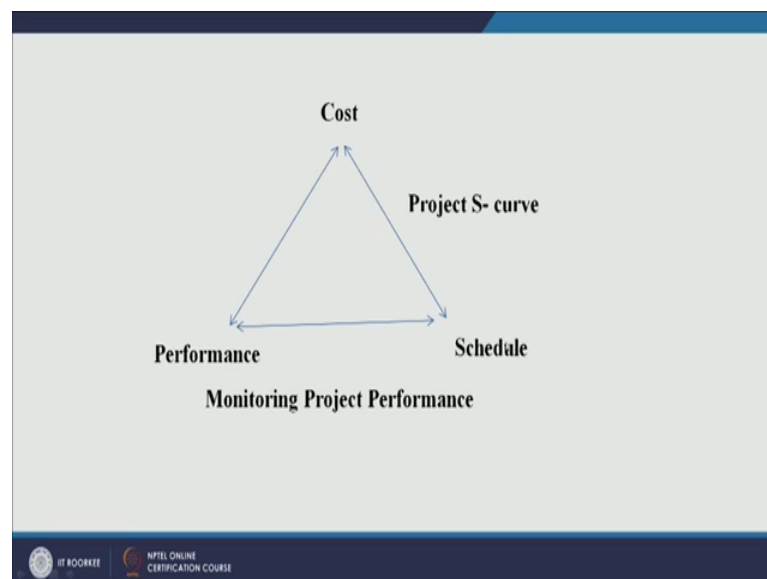
So, if you look at project S-curve approach, then it compares schedule and cost. In other words you are measuring only time and cost in a project you are not nothing at performance. But for successful completion you need to look at performance also right.

So, this is the drawback of project S-curve it does not look at performance. Then you have got something called milestone analysis. Milestone analysis means you will always have some special vocation in the project which we would like to celebrate for example, if you have achieved one particular one particular phase of the life cycle of the project right. Let us say you have completed let us say if you have making thousand kilometers road. So, let us say if you completed 50 percent. So, that would be milestone right. You can have different milestone either in terms of let us say saving cost or in terms of doing project before time and so on right.

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Another method of monitoring project progress **is millstone analysis. A milestone is an event or stage of the project that represents a significant accomplishment** on the road to the project's completion.

Completion of a deliverable, an **important activity on** the project's critical path, or even a **calendar date** can all be milestones.

They are reactive control system.

The tracking Gantt Chart: Future **projection of project's status** and **reasons of delay are not known** are the drawbacks of this method.

So, if you are you know looking at those milestones then that will also give you idea whether you are performing properly or not right. In fact, the other things can be let us say you have you have achieved a particular calendar date in your project right. Let us say if you completed one year of project, and that is let us say 50 percent of the total duration of the project. So, that is again a milestone right. So, so this milestone analysis is another method of measuring performance. But if you do not you know if you if you, if you do not meet a particular milestone then it will not give you the reasons for failure in achieving those milestones right. So, it so there quit in reactive type of control system right.

So, you need to do postmortem kind of you know thing in this particular milestone analysis system right. So, that is say drawback of milestone analysis. Then you have got

a something called Gantt chart right. So, you can also measure performance of the project using Gantt chart right. So, Gantt cart will help you we have discuss this type of chats in one of the classes, you will come to know what activities you have performed and how much those activity have been performed right. And how much those activity are left right. So, this is tracking Gantt chart right, is another method right.

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Earned Value Management: Unlike previous project tracking approaches , **EVM recognizes that it is necessary to jointly consider the impact of time, cost,** and **project performance** on any analysis of current project status.

Put another way: Any monitoring system that **only compares actual against budget cost numbers** ignores the fact that the client is spending that money to accomplish something –create a project. Therefore, EVM reintroduces and stresses the importance of **analyzing the time element** in the project status updates.

EVM also allows the project team to **make future projections of the project status** based on its current status.

Earned value, directly links **all three project success matrices** (cost, schedule, and performance)

Let us look at EVM earned value management. EVM actually focuses on not only on time and cost, but is also focuses on performance. So, actually you are focusing on all those success criteria right; RN triangle which we have called in the very beginning right. RN triangle means cost time and performance right.

So, any monitoring any monitoring system that only compares actual against budget cost number ignores the fact that client is pending that money to accomplish something some something tangible right, or let us called that as a project right. So therefore, earned value management reintroduces and stresses the importance of analyzing time element in the project status update right. So, it looks at time cost and performance right. So, earned value management also allows the projecting to make future projection of the project status based on it is current status. So, that is the plus point of earned value management right.

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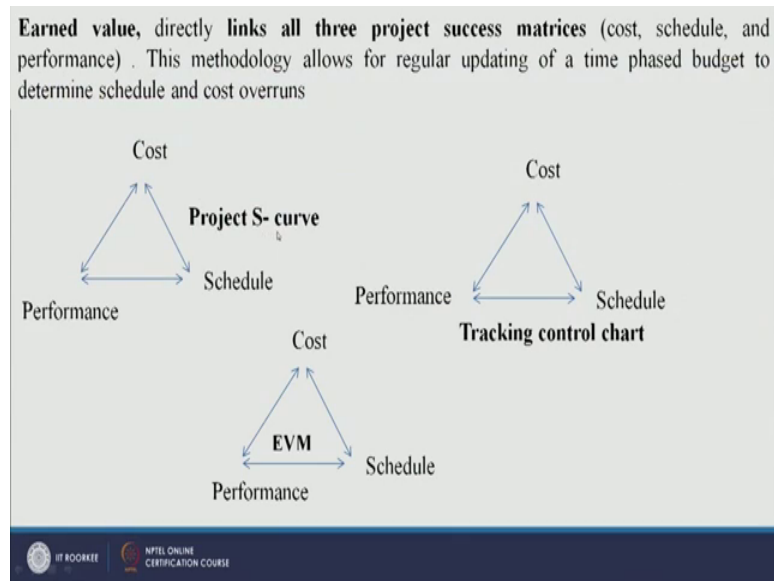
And I said it focuses in all these 3 success mattresses right. Let us look at all these 3 methods right. So, we have seen project S-curve right. So, project S-curve method compares cost and schedule right. Not actually compares, but looks at only cost aspect and schedule aspect, if you look at Gantt chart right. Gantt chat look at only schedule and performance, but does not look at cost, while earned value management focuses on all these 3 right.

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Now, let us look at how to draw budgeted cost of a project. So, let us say there is a project, whose duration is 45 weeks rights. And these are different activities to be performed in that project. So, you have got design activity and the budget for design activities in fifth week it is let us say 6 lakh, in 10th week the budget is 2 lakh right. Similarly you have got engineering they have got installation you have got testing and this total right.

So, total budget in fifth week is 6 lakh right. Similarly total budget in 10th week is 6 lakh, 8 lakh, 12 lakh and so on right. So, at the end of the day you have got cumulative budget right. So, 6 12 20 30 60 68 74 78 and 80, and this is your cumulative budget budgeted cost right. From all from this particular row we have drawn this curve right.

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Percentage of tasks completed for above project: Suppose that on 30th week, design and engineering are 100% complete and installation is 50% complete.

					Duration (in weeks)					
	5	10	15	20	25	30	35	40	45	% completed
Design	6	2								100
Engineering		4	8	8	8					100
Installation				4	20	6				50
Testing						2	6	4	2	0
Total	6	6	8	12	28	8	6	4	2	
Cumulative	6	12	20	32	60	68	74	78	80	

Duration (in weeks)			
	Planned	% complete	Earned value
Design	8	100	8
Engineering	28	100	28
Installation	30	50	15
Testing	14	0	0
Cumulative Earned value			51

Now let us look at this example in which we will be calculating how to find out earned value of a project right.

So, let us look at this project, suppose the percentage of task completed for this project suppose that on thirtieth week. So, the total duration of this project is this is I said 45 week, is there here also in previous slide also right. And on thirtieth week I want to know what is the status. So, suppose that on thirtieth week design and engineering are 100 percent completed. So, deign is this you have completed 100 percent. Engineering you have completed 100 percent. And installation is completed 50 percent right. On 30th week So, I want to know how much value have been how much value we have earned in

this project right. So, how to do that? Total budget for design is 6 plus to 8 lakh right. And we have completed it 100 percent.

So, earned value is 8 and planned values are also 8 right. For engineering what is the planned value? 4 plus 24 28. So, 28 is the planned value and we have achieved engineering 100 percent. So, earned value is 28, as for as installation is concerned what is the total planned value of installation, is 4 plus 20 24 plus 6 30 and how much we have achieved? 50 percent. So, it is just 15 right. So, earned value is 15.

Similarly testing, did we achieve anything? Or we have not even started right. So, this is 0 percent completed. So, planned value is 14, how to get this 14; for testing is 2 plus 6 8 plus 6 14. So, this is 0 percent. So, this is 0. So, total earned value of this project is 5 one double 0 right. Are 51, if you want to take let us say if it in if you in terms of 100 right so, this is 5100 right.

So, this is how you should calculate earned value in a project. So, this is how you should draw a project baseline this is 6 12 20 30 60 68 74 78 and 80. So, this is your project baseline and this is what you earned right. You earned only 51.

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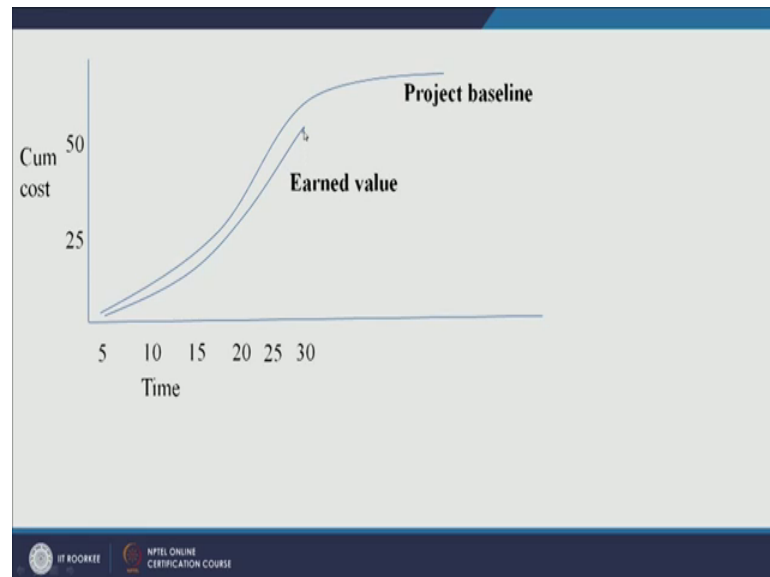
So, this is the difference. So, this how you can draw project baseline and earned value right.

The project has 8 months schedule and 118 budget. Calculate earned value at the end of June?.

	Jan	Feb	Mar	Apr	May	June	July	Plan	% Completed	Value
					Duration (in weeks)					
Staffing	8	7						15	100	
Blueprint			4	6				10	80	
Prototype			2	8				10	60	
Full design				3	8	10		21	33	
Construction					2	30		32	25	
Transfer							10	10	0	
Punch list						15	5	20	0	
								Σ 118		
Monthly plan	8	7	6	17	10	55	15			
Monthly actual	8	11	8	11	10	30	0			

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Now, let us look at this particular example, and find out earned value at the end of June. So, this is a project duration is 8 months and it is budget is 118 right. It is 118 100 are 118 thousand right. It is up to you. So, they are different activities staffing blueprint prototype full design, construction, transfer in punch list right.

So, the plan for staffing is 15 and you completed 100 percent right. So, what would be the value you can calculate? We did it in previous example: for blue print plane is 10 and percentage completed is 80; similarly, for prototype 60 full design 33 25 and so on. So, we want to know; what is the status at the end of June right. Similarly here you can calculate monthly plan right. So, 8 7 6, 6 plus 8 14 plus there 17 and so on, similarly you can have then cumulative monthly actual right.

So, this is monthly actual In fact, you should we will we will see how to get this monthly actual right. So, since in this project you know that the percentage completed for staffing is 100 percent value is 15.

The project has 8 months schedule and 118 budget. Calculate earned value at the end of June?.

	Jan	Feb	Mar	Apr	May	June	July	Plan	% Completed	Value
Staffing	8	7						15	100	15
Blueprint			4	6				10	80	8
Prototype			2	8				10	60	6
Full design				3	8	10		21	33	7
Construction					2	30		32	25	8
Transfer							10	10	0	0
Punch list						15	5	20	0	0
								Σ 118		44
Monthly plan	8	7	6	17	10	55	15			
Cumulative	8	15	21	38	48	103	118			
Monthly actual	8	11	8	11	10	30	0			
Cumulative actual	8	19	27	38	48	78				

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Similarly, for all other activities right, so earned value is 44 while planned value is 118. Now monthly plan is this 7 8 6 17 10 55 15 right. So, cumulative plan is 8 plus 7 15 and so on right. So, cumulative plan is this and monthly actual is 8 11, 8 11, 10 30 right. So, cumulative actual is 78. So, monthly cumulative monthly plan is 103 and cumulative actual is 78. So, you have got 3 set up information you have got earned value 44 you have got planned value 118 and you have got cumulative plus cumulative actual right. In fact, these 2 things are given to you monthly planned and monthly actual right. So, in next slide we have calculated cumulative right. So, cumulative monthly plane is 8 15 21 30 10 so on right.

And the monthly actual was the cumulative was 8 18 26 isn't it? Sorry 8 8 19 27 38 48 right, is there isn't it? So, these are cumulative values right. So, we will find out whether we are ahead of schedule are behind schedule; what is the status. So, we know that the planned total planned budget is 118 and earned value is 44. So, planned value is 103, planned value is 103. Earned value is 44. So, can you calculate cost performance index and schedule performance index this is very easy now right. So, planned value is 103 earned value is 44 schedule performance index is the ratio of earned value to planned value which is 43 percent right.

Is it good? No it is not good right. It should not be less than 1 right. It means since your SPI is 0.43 you are behind the schedule. So, you can also find out how much time it will

take to complete the project now, though it is known to you that you are behind schedule. So, you can easily calculate that we are running 10 months behind schedule, how to get this value? It is 1 upon schedule performance index multiplied by 8. Why 8, because 8 is the total duration of the project right. So, 1 by 0.43 in to 8 it is 18.60.

So, we are running 10 months approximately 10 months right, because total duration of the project is 8 months and we will complete this project in 18 month, so 10 months behind the schedule right. Similarly if you look at cost variances, then actual cost is 78 just look at this 78, 78 actual cost right, earned value 44.

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Total planned budget is 118 and the value realized is 44.	
Schedule variances	
Planned value (PV)	103
Earned value(EV)	44
Schedule performance index (SPI)	EV/PV = .43
Estimated time to completion	1/ (.43) * (8)=**18.60,** We are running 10 months behind schedule
Cost variances	
Actual cost of work performed (AC)	78
Earned value (EV)	44
Cost performance index (CPI)	EV/AC = .56
Estimated cost to completion	1/(.56) * 118=210

So, CPI is 0.56. So, actual cost is more than earned value not a good sign right. It is a it is a case of cost overrun right. So, estimated of course, to complete is 218.

So, of course, you should have completed this project in 118, but it will now take 210 days. So, we have looked at several issues in the particular session. We talked about earned value management. And we have talked about 2 more methods, and there are many more. And of course, cost management is an important area how you are managing cost of a control will reflect actually your strategies, your vision and your mission right.

So, you should focus clearly on some of the issues related to cost control. So, let me summarize what we did in this session. We looked at planned value, we looked at earned value, we looked at what is actual cost and we have seen that earned value management

is a method to measure performance of the project on all those 3 criteria. While the other methods like let us say milestone analysis or the let us talk about Gantt chart. These 2 methods have got several drawback similarly S-curve approach also has got a drawback. That is does not give you the reason for variance; however, you should always try to use EVM to measure performance of a project.

So, with this let me stop here, and then next session we will talk about different cost associated with a project.

Thank you very much.