Earned Value Management Tutorial Module 6: Metrics, Performance Measurements and Forecasting

Prepared by:

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Welcome to Module 6. The objective of this module is to introduce you to the Metrics and Performance Measurement tools used, along with Forecasting, in Earned Value Management.

The Topics that will be addressed in this Module include:

- Define Cost and Schedule Variances

- Define Cost and Schedule Performance Indices

- Define Estimate to Complete (ETC)

- Define Estimate at Completion (EAC) and Latest Revised Estimate (LRE)

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Let's quickly review what has been covered in the previous modules.

- There are three key components to earned value: Planned Value, Earned Value and Actual Cost.
    - PV is the physical work scheduled or "what you plan to do".
    - EV is the quantification of the "worth" of the work done to date or "what you physically accomplished".
    - AC is the cost incurred for executing work on a project or "what you have spent".

- There are numerous EV methods used for measuring progress.

The next step is to stand back and monitor the progress against the Performance Measurement Baseline (PMB).

Performance measurement is a common phrase used in the world of project management, but what does it mean? Performance measurement can have different meanings for different people, but in a generic sense performance measurement is how one determines success or failure on a project. How then can performance measurement have different meanings for different people?

To answer this question, consider the ACME House Building project. You have two major stakeholders on this project, the Buyer and the Builder. Do you think they both measure success on the project identically or do you believe their definition of project success may be different? Let's take a look on the next page.

It seems logical to say that they both want a home that provides security, meets building code, and keeps them warm in the winter and cool in the summer. Now let's look at possible differences in the way they define successful performance on the project.

Buyer	**Builder**
– Home has 4 bedrooms, 3 bathrooms – Backyard is landscaped for children to play – Two car garage – Walls don't have paint streaks – Carpeting is correct color	– Completed on time – Within contract price – Sells within first two months – Less than 10% Post-sell maintenance

Can you see how different parties or individuals can have conflicting views of what defines project success?

The Stakeholders (Buyer and Builder in the ACME House Building Project) should understand how each party defines project success and what each party measures to determine that success.

In the case of Earned Value Management, performance measurements focus on cost and schedule management.

The Cost Management focuses on the cost performance of the project. It looks at the relationships between the Earned Value (EV) and the Actual Cost (AC).

The Schedule Management focuses on the schedule performance of the project. It looks at the relationships between the Earned Value (EV) and the Planned Value (PV).

Now let's look at these relationships in more detail on the following pages.

Earned Value: Metrics and Performance Measurements

Earned value performance measurements look at the project cost and schedule performance by analyzing the cost and schedule variance along with cost and schedule efficiency. The formulas used are as follows:

Variance Analyses

Cost Variance (CV) = Earned Value (EV) – Actual Cost (AC)

Schedule Variance (SV) = Earned Value (EV) – Planned Value (PV)

Performance Indices

Cost Performance Index = Earned Value (EV)/Actual Cost (AC)

Schedule Performance Index = Earned Value (EV)/Planned Value (PV)

Let's take a look at the Variance Analyses on the next page.

The **Cost Variance (CV)** is the difference between the earned value of work performed and the actual cost.

Cost Variance (CV) = EV – AC

If the result is POSITIVE, project is experiencing an "Underrun"

If the result is NEGATIVE, project is experiencing an "Overrun"

Using the ACME Home Building project information from Module 5, let's calculate the Cost Variance (CV) for the project.

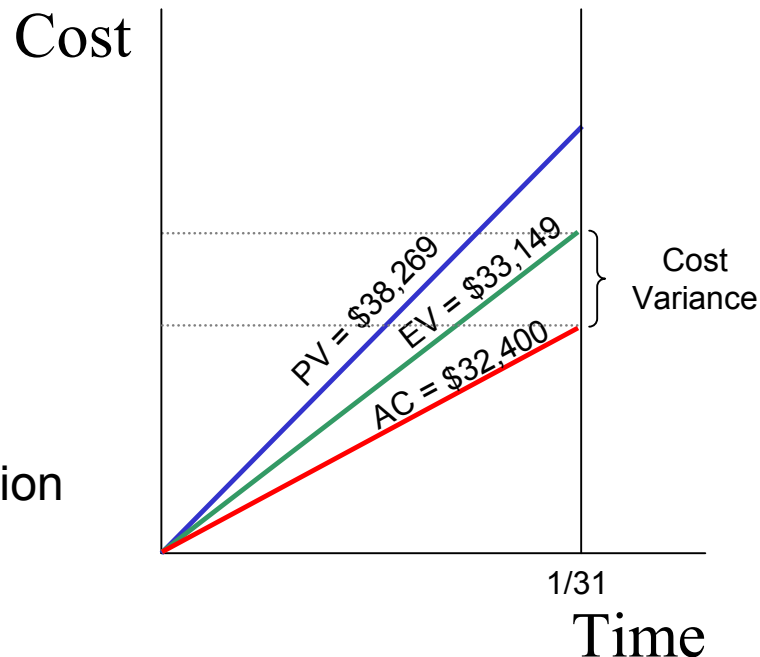| as of 1/31	PV	EV	AC
Foundation	$15,394	$15,394	$15,850
Patio	$8,166	$8,166	$7,200
Exterior Walls	$8,748	$6,608	$6,250
Stairway	$5,961	$2,981	$3,100
Project Total	$38,269	$33,149	$32,400

CV = EV – AC

CV = $33,149 - $ 32,400

CV = $749

What does this tell you? Look at the explanation on the next page.

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A Cost Variance of $749 tells you that the project is "Underrun" or under budget.

Please note that the cost variance, along with all other performance analyses tools, can be computed (or assessed) in terms of cumulative and current. Since we are in the first status period in our example, the cumulative and current are the same.

Using the graph to right, you can see that on 1/31 the EV line (green) is above the AC line (red). This means that it cost less to accomplish the work then was budgeted, thus a positive cost variance.

Let's look at another Cost Variance calculation on the next page.

Cost

PV = $38,269

EV = $33,149

AC = $32,400

Cost Variance

1/31

Time
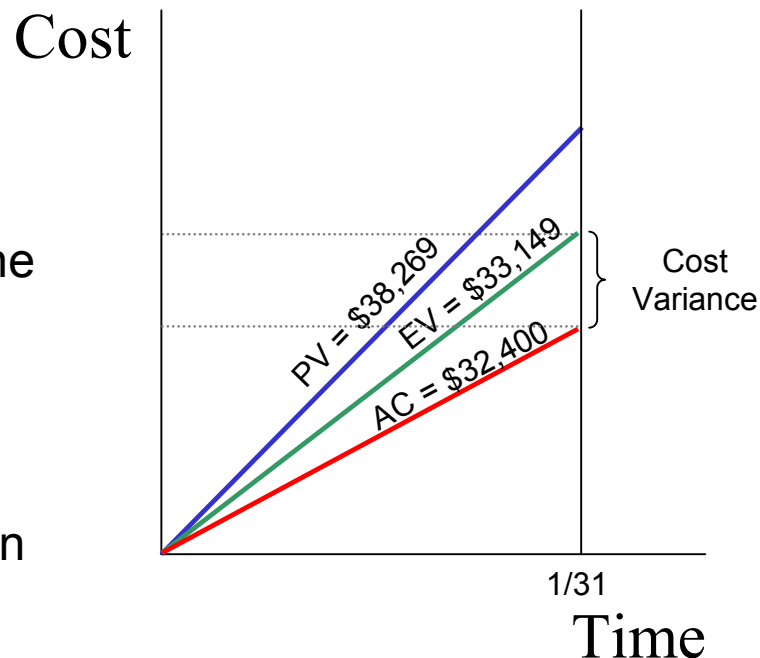
Another calculation for reviewing Cost Variance (CV) is CV%.

Cost Variance (CV)% = CV/EV
Tells you what percentage cost varies from what has been earned to date.

Using our example, what is the CV%?

CV = EV – AC   CV% = CV/EV

CV = $33,149 - $32,400   CV% = $749/$33,149

CV = $749   CV% = .023 or 2.3%

To date the project has a Cost Variance of $749 or 2.3%

The **Schedule Variance (SV)** is the difference between the earned value of work performed and the work scheduled. SV tells you the value of work performed less value of work scheduled.

$$\text{Schedule Variance (SV)} = EV - PV$$

If the result is POSITIVE, project is on schedule or exceeding the schedule

If the result is NEGATIVE, project is behind schedule

Using the ACME Home Building project information from Module 5, let's calculate the Schedule Variance (SV) for the project.

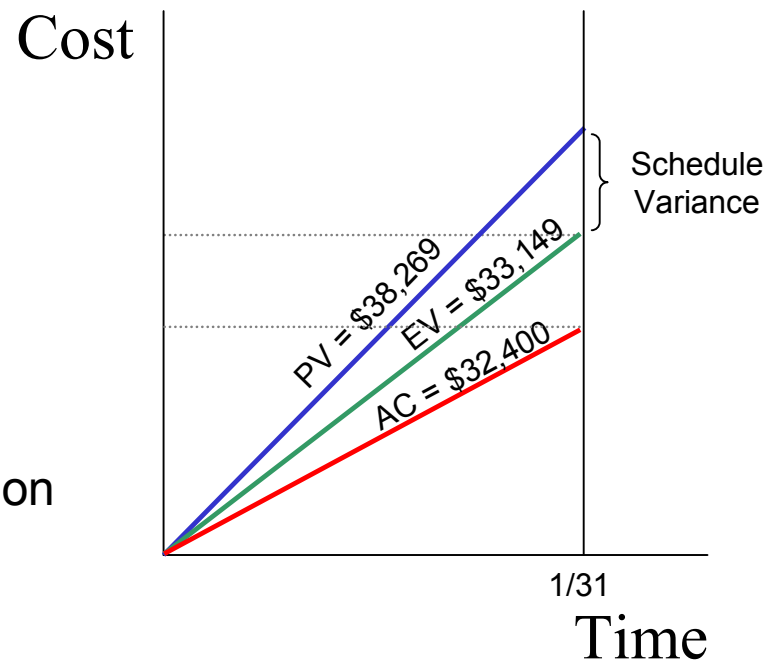| as of 1/31	PV	EV	AC
Foundation	$15,394	$15,394	$15,850
Patio	$8,166	$8,166	$7,200
Exterior Walls	$8,748	$6,608	$6,250
Stairway	$5,961	$2,981	$3,100
Project Total	$38,269	$33,149	$32,400

SV = EV – PV

SV = $33,149 - $38,269

SV = -$5,120

What does this tell you? Look at the explanation on the next page.

A Schedule Variance of -$5,120 tells you that the project is "Behind" schedule.

Using the graph to right, you can see that on 1/31 the EV line (green) is below the PV line (blue). This means that what was earned to date is less then what was planned to be accomplished.

Now consider on the following page what schedule variance does and does not address.

Cost

PV = $38,269 EV = $33,149 AC = $32,400

Schedule Variance

1/31

Time
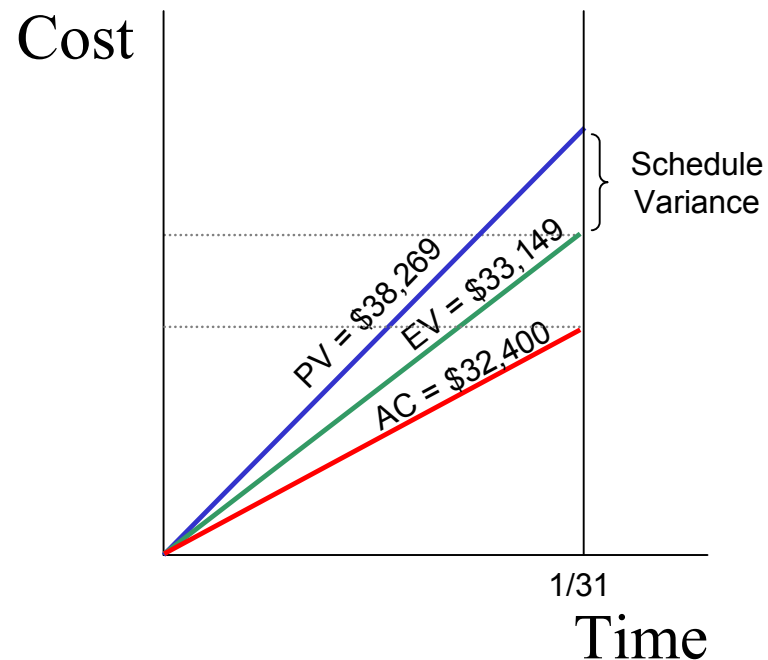
Schedule Variance status **does**:

- indicate the dollar value difference between work that is ahead or behind the plan
- reflect a given measurement method

Schedule Variance status **does not**:

- address impact of work sequence
- address importance of work
- reflect critical path assessment
- indicate amount of time it will slip
- identify source (labor & material) of difference
- indicate the time ahead/behind (or regain) schedule
- indicate the cost needed to regain schedule

Let's look at another Schedule Variance calculation on the next page.

Another calculation for reviewing Schedule Variance (SV) is SV%.

Schedule Variance (SV)% = SV/PV
Tells you what percentage schedule varies from what has been planned to date.

Using our example, what is the SV%?

SV = EV – PV   SV% = SV/PV

SV = $33,149 - $38,269   SV% = -$5,120/$38,269

SV = -$5,120   SV% = -.134 or -13.4%

To date the project has a Schedule Variance of -$5,120 or -13.4%

You should have a solid understanding of the cost and schedule variance calculations and what they mean. Let's review them now.

Cost Variance (CV) = EV – AC	Schedule Variance (SV) = EV – PV
If the result is POSITIVE→ "Underrun" If the result is NEGATIVE→ "Overrun"	If the result is POSITIVE → "On Schedule" If the result is NEGATIVE → "Behind Schedule"

Using these variance calculations, our project information is as follows.

as of 1/31	PV	EV	AC	SV	CV
Foundation	$15,394	$15,394	$15,850	0	-456
Patio	$8,166	$8,166	$7,200	0	966
Exterior Walls	$8,748	$6,608	$6,250	-2,140	358
Stairway	$5,961	$2,981	$3,100	-2,980	-119
Project Total	$38,269	$33,149	$32,400	-5,120	749

Now let's look at the performance indices on the following pages.

The **Cost Performance Index (CPI)** is a measure of Cost Efficiency. The CPI measures the value of work performed against the actual cost.

Cost Performance Index (CPI) = EV/AC

If the result is less than 1.0, cost is GREATER than budgeted

If the result is greater than 1.0, cost is LESS than budgeted

Example 1:

PV = $950
EV = $1000
AC = $ 900

CPI = $1000 = 1.11
           $900

Example 2:

PV = $1100
EV = $1000
AC = $1200

CPI = $1000 = .83
           $1200

Using the ACME Home Building project information, let's calculate the Cost Performance Index (CPI) for the project.

as of 1/31	PV	EV	AC
Foundation	$15,394	$15,394	$15,850
Patio	$8,166	$8,166	$7,200
Exterior Walls	$8,748	$6,608	$6,250
Stairway	$5,961	$2,981	$3,100
Project Total	$38,269	$33,149	$32,400

CPI = EV/AC

CPI= $33,149/$32,400

CPI = 1.02

What does this tell you? Look at the explanation on the next page.

Cost

PV = $38,269   EV = $33,149

AC = $32,400

1/31
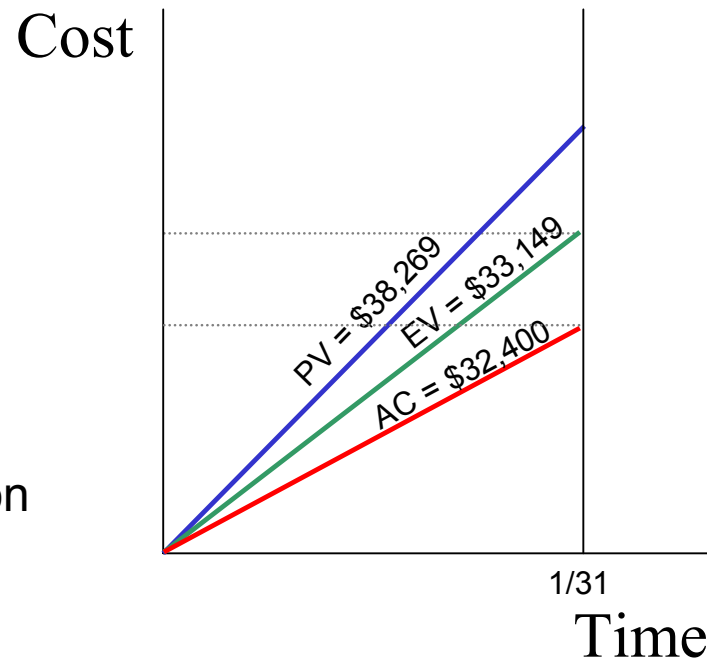
Time

A Cost Performance Index (CPI) of 1.02 tells you that your actual costs are less then what was budgeted.

You are getting $1.02 worth of work for every $1.00 spent.
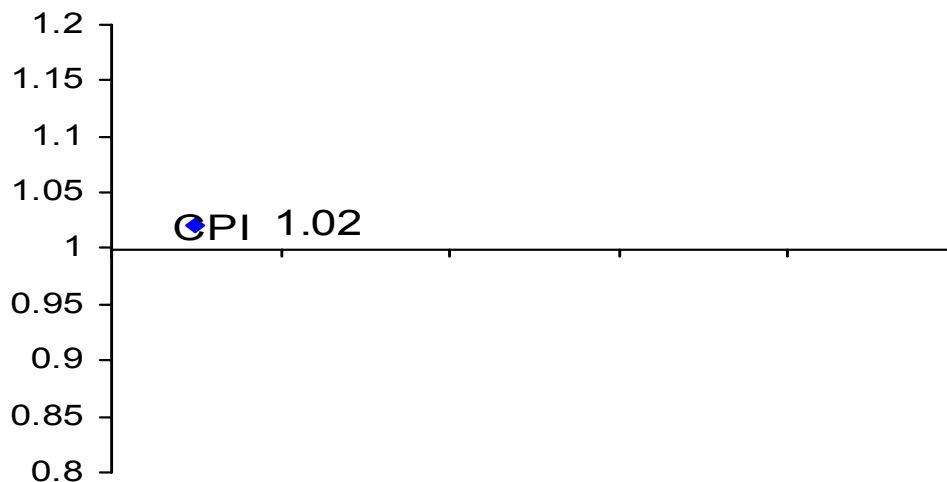
Now let's look at some causes of favorable and unfavorable cost performance.

Potential Causes of Unfavorable (-) Cost Performance	**Potential Causes of Favorable (+) Cost Performance**
• Work more complex than anticipated • Design review comments extensive • Rework • Unclear Requirements • Scope Creep • Unfavorable Market Fluctuations in the Cost Labor or Material • Overhead Rate Increases	• Efficiencies being realized • Work less complex than anticipated • Fewer revisions and rework • Favorable Market Fluctuations in the Cost of Labor or Material • Overhead Rate Decreases

The **Schedule Performance Index (SPI)** is a measure of Schedule Efficiency. The SPI measures the value of work performed against the work scheduled.

> Schedule Performance Index (SPI) = EV/PV
>
> If result is less than 1.0, project is "BEHIND" schedule
> If the result greater than 1.0, project is "AHEAD of schedule

Example 1:

PV = $950
EV = $1000
AC = $ 900

$$SPI = \frac{\$1000}{\$950} = 1.05$$

Example 2:

PV = $1100
EV = $1000
AC = $1200

$$SPI = \frac{\$1000}{\$1100} = .91$$

Using the ACME Home Building project information, let's calculate the Schedule Performance Index (SPI) for the project.

as of 1/31	PV	EV	AC
Foundation	$15,394	$15,394	$15,850
Patio	$8,166	$8,166	$7,200
Exterior Walls	$8,748	$6,608	$6,250
Stairway	$5,961	$2,981	$3,100
Project Total	$38,269	$33,149	$32,400

SPI = EV/PV

SPI = $33,149/$38,269

SPI = .87

What does this tell you? Look at the explanation on the next page.

Cost

PV = $38,269

EV = $33,149

AC = $32,400

1/31
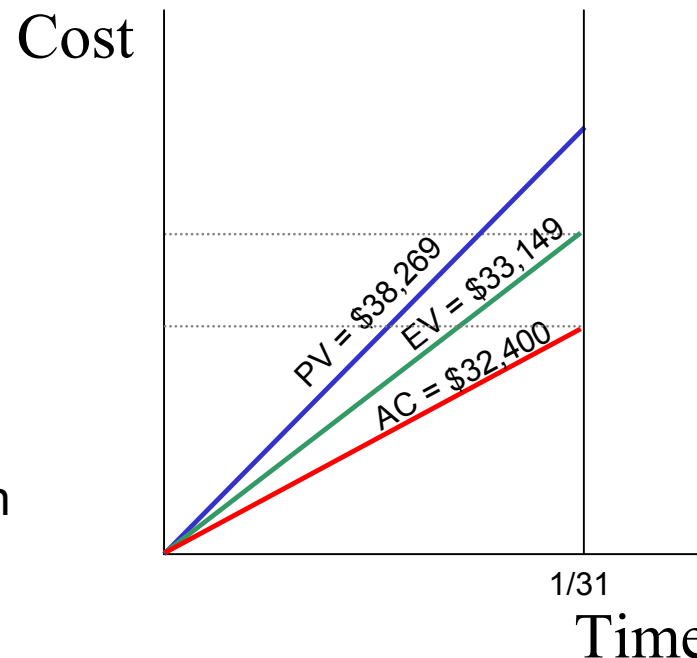
Time

A Schedule Performance Index (SPI) of .87 tells you that you are behind schedule. It can be defined in two ways:

You are 13% behind schedule
Or
You are working at an 87% efficiency
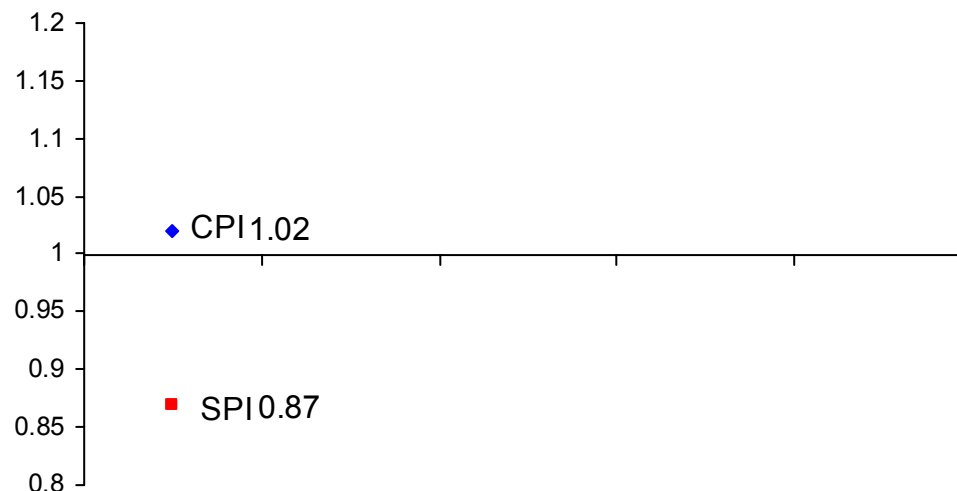
Now let's look at some causes of favorable and unfavorable schedule performance on the following page.

Potential Causes of Unfavorable (-) Schedule Performance	Potential Causes of Favorable (+) Schedule Performance
• Manpower shortage • Revised Execution Plan • Supporting organizations behind schedule • Late Vendor delivery • Delayed customer feedback/direction • Rework • Work more complex than anticipated • Design review comments extensive • Unclear requirements • Scope creep	• Efficiencies being realized • Work less complex than anticipated • Fewer revisions and rework • Favorable Market Fluctuations in the Cost of Labor or Material • Subcontractor ahead of schedule

Below is a summary of the ACME Home Building project.

as of 1/31	PV	EV	AC	SV	CV	SPI	CPI
Foundation	$15,394	$15,394	$15,850	0	-456	1.00	0.97
Patio	$8,166	$8,166	$7,200	0	966	1.00	1.13
Exterior Walls	$8,748	$6,608	$6,250	-2,140	358	0.76	1.06
Stairway	$5,961	$2,981	$3,100	-2,980	-119	0.50	0.96
Project Total	$38,269	$33,149	$32,400	-5,120	749	0.87	1.02

What conclusions can be inferred as to the cost and schedule performance of this project?

Let's take a look on the next page.

as of 1/31	PV	EV	AC	SV	CV	SPI	CPI
Foundation	$15,394	$15,394	$15,850	0	-456	1.00	0.97
Patio	$8,166	$8,166	$7,200	0	966	1.00	1.13
Exterior Walls	$8,748	$6,608	$6,250	-2,140	358	0.76	1.06
Stairway	$5,961	$2,981	$3,100	-2,980	-119	0.50	0.96
Project Total	$38,269	$33,149	$32,400	-5,120	749	0.87	1.02

The ACME Home Building Project is 13% behind schedule (SPI = .87) but is ahead on cost by 2% (CPI = 1.02). In review of the activities, Installation of the Stairway and Framing the Exterior Walls are the activity causing the project to be behind (SPI = .50 and .76) schedule. On the cost side, the Installation of the Patio is costing less then budgeted (CV =$966) and is the main reason for the project underrunning its budget.

What is the standard reporting variance threshold for a project? Find out on the next page.

The size and complexity of the project determines the reporting needed. Different industries and government agencies will set variance thresholds at different levels, but most set the variance level between + or - 7% to 10%. This means that a SPI or CPI of .90 to 1.1 will require an official variance analysis to explain what is happening on the project. Note that you need to explain positive variances as well as negative variances.

Variance Report for ACME Housing Project

So far we have only looked at how to analyze what has happened on a project (CV,SV, CPI, SPI). Take some time to review the formulas below.

Cost Variance (CV) = EV – AC	**Schedule Variance (SV) = EV – PV**
If the result is POSITIVE→ "Underrun" If the result is NEGATIVE→ "Overrun"	If the result is POSITIVE → "On Schedule" If the result is NEGATIVE → "Behind Schedule"
Cost Variance (CV)% = CV/EV	**Schedule Variance (SV)% = SV/PV**
Tells you what percentage cost varies from what has been earned to date.	Tells you what percentage schedule varies from what has been planned to date.
Cost Performance Index (CPI) = EV/AC	**Schedule Performance Index (SPI) = EV/PV**
If result is less than 1.0, cost is GREATER than budgeted If the result greater than 1.0, cost is LESS than budgeted	If result is less than 1.0, project is "BEHIND" schedule If the result greater than 1.0, project is "AHEAD of schedule

Now it is time to learn how to analyze the future or what is expected to happen on a project given the progress measurements reported to date. Anticipating future progress requires determining when the project will be completed and how much it will cost to complete it.

To complete our analysis, we will look at the Estimate at Completion (EAC) and the Budget at Completion (BAC).

The Estimate at Completion (EAC), which was defined in Module 5, is the actual cost to date plus an objective estimate of costs for remaining authorized work. The objective in preparing an EAC is to provide an accurate projection of cost at the completion of the project.

The Budget at Completion (BAC) is the sum of all budgets allocated to a project scope. The Project BAC must always equal the Project Total PV. If they are not equal, your earned value calculations and analysis will be inaccurate.

The chart on the following page lists the parameters of the BAC and EAC along with the other EVM items we have covered.

Item	Questions
Planned Value (PV)	How much work should be done?
Earned Value (EV)	How much work was done?
Actual Cost (AC)	How much did the work cost?
Budget at Completion (BAC)	What is the total job budgeted to cost?
Estimate at Completion (EAC)	What do we expect the total job to cost?

Another term you may hear is Latest Revised Estimate (LRE). The LRE is equal to the EAC.

Estimate At Completion = Latest Revised Estimate

For the remainder of the Modules, we will refer to Estimate at Completion as "EAC".

The EAC is the best estimate of the total cost at the completion of the project. The EAC is a periodic evaluation of the project status, usually on a monthly basis or when a significant change happens to the project.

EACs are developed with varying degrees of detail and supporting documents. A comprehensive EAC is usually prepared annually or if there are any major changes in the project. The EAC should be reviewed on a monthly basis by the Control Account Manager (CAM) or those responsible. The EAC is developed for projects as well as Control Accounts and Work Packages. There are multiple ways to develop an EAC. The technique selected is based upon the dollar value of the project, the risk, accounting system available and the accuracy of the estimates.

Let's take a look on the following pages at the most frequently used EAC formulas.

The first EAC calculation we will look at is Estimate to Complete:

$$\text{EAC} = \text{Actual Cost (AC)} + \text{Estimate to Complete (ETC)}$$

The Estimate to Complete (ETC) is the estimated cost of completing the authorized remaining work. A detailed ETC will include a description of the work remaining and any revisions to the estimated resources or cost for completing the project. This formula assumes that all remaining work is independent of the burn-rate incurred to date.

Now let's look use the EAC formula for our ACME Home Building project. Take a look on the next page.

Earlier in this module, we determined the actual cost (AC) for January to be $32,400. Now we need to determine the Estimate to Complete (ETC) for all activities. For the two activities that are 100% complete, their actual cost replaces their ETC (see chart below). For the two activities current being worked, we will assume that they will be completed as budgeted even though they have current cost variances (see ETC adjustments below). It will also be assumed that all other activities will have no adjustments to their ETC.

By reviewing the chart to the left you can see that our new Estimate at Completion (EAC) is $164,957.

Now let's look at the same example with some additional changes to the ETC.

	ACTUALS	ETC			EAC
Activity	January	February	March	April	Total
1.1.1.1 Pour foundation	$15,850				$15,850
1.1.1.2 Install Patio	$7,200				$7,200
1.1.1.3 Pour stairway	$3,100	$8,822			$11,922
1.1.2.1 Frame exterior walls	$6,250	$10,271			$16,521
1.1.2.2 Frame interior walls		$11,025			$11,025
1.1.2.3 Install roofing trusse		$15,887			$15,887
1.1.3.1 Install waterlines		$6,194			$6,194
1.1.3.2 Install gas lines		$6,255			$6,255
1.1.3.3 Install B/K fixtures			$6,317		$6,317
1.1.4.1 Install wiring		$18,483			$18,483
1.1.4.2 Install outlets/switches			$9,265		$9,265
1.1.4.3 Install fixtures			$13,969	$4,656	$18,625
1.1.5.1 Install drywall			$6,984		$6,984
1.1.5.2 Install Carpeting			$2,250		$2,250
1.1.5.3 Painting			$6,477		$6,477
1.1.6.1 Install felt		$1,834	$611		$2,445
1.1.6.2 Install shingles			$2,445		$2,445
1.1.6.3 Install vents			$812		$812
	$32,400	$78,771	$49,130	$4,656	$164,957

As the project manager you are reviewing your ETC and you get a call from the carpeting contractor. He tells you that the original budget for installing the carpet ($2,250) is no longer correct because the price of the carpet increased. The project manager asks for a new estimate and the carpeting contractor tells him that it will now cost $3,100. Additionally, your superintendent tells you that the current ETCs for Framing the Exterior Walls and Pour Stairway are good, thus the current cost underrun ($358) for Framing and the cost overrun ($120) for Stairway will be realized at the completion of each activity.

With this information, let's take a look at the EAC.

EAC = Actual Cost (AC) + New Estimate to Complete

The new ETC total is $133,166 ($78,533 + $49,980 + $4,656)
The new EAC total is $165,569 ($32,400 (AC) + $133,172 (ETC)).

When using this formula to calculate EAC, you can also include expert opinion, project and industry trends and other forms of objective analysis.

	ACTUALS	ETC			EAC
Activity	January	February	March	April	Total
1.1.1.1 Pour foundation	$15,850				$15,850
1.1.1.2 Install Patio	$7,200				$7,200
1.1.1.3 Pour stairway	$3,100	$8,942			$12,042
1.1.2.1 Frame exterior walls	$6,250	$9,913			$16,163
1.1.2.2 Frame interior walls		$11,025			$11,025
1.1.2.3 Install roofing trusse		$15,887			$15,887
1.1.3.1 Install waterlines		$6,194			$6,194
1.1.3.2 Install gas lines		$6,255			$6,255
1.1.3.3 Install B/K fixtures			$6,317		$6,317
1.1.4.1 Install wiring		$18,483			$18,483
1.1.4.2 Install outlets/switches			$9,265		$9,265
1.1.4.3 Install fixtures			$13,969	$4,656	$18,625
1.1.5.1 Install drywall			$6,984		$6,984
1.1.5.2 Install Carpeting			$3,100		$3,100
1.1.5.3 Painting			$6,477		$6,477
1.1.6.1 Install felt		$1,834	$611		$2,445
1.1.6.2 Install shingles			$2,445		$2,445
1.1.6.3 Install vents			$812		$812
	$32,400	$78,533	$49,980	$4,656	$165,569

Now that we have the EAC, what does it tell us?

As mentioned earlier, EAC is the best estimate of the total cost at the completion of the project. It is also used to determine the Variance at Completion (VAC) for the project. The VAC is calculated as follows:

VAC = BAC – EAC

If the result is POSITIVE, project is projecting an "Underrun"

If the result is NEGATIVE, project is projecting an "Overrun"

Now let's determine the VAC for our project as shown on the next page.

The VAC for our project is determined as follows:

$$\text{BAC} \quad - \quad \text{EAC} \quad = \quad \text{VAC}$$
$$\$165{,}467 \quad - \quad \$165{,}569 \quad = \quad -\$102$$

In other words, the project is now forecasted to overrun by $102 using this form of EAC. Remember, this is only one method of forecasting the performance of the project. Several other methods can be used. Let's consider those on the following pages.

As you examine the remaining Estimate at Completion (EAC) formulas, keep in mind that they are subjective analyses. These calculations use performance-to-date data to help calculate the EAC. Sometimes these forms of EAC Calculations are called Independent Estimate at Completion (IEAC).

The second EAC formula is as follows:

$$\text{EAC} = \text{AC/EV} \times \text{BAC}$$

This calculation uses the Actual cost, Earned value and Budget at Completion for the project.

This formula is the easiest to use, but it assumes that the "burn-rate" will be the same for the remainder of the project.

Let's use our ACME Home Building project to calculate the EAC using this formula. Take a look on the next page.

EAC = AC/EV x BAC
EAC = $32,400/$33,149 x $165,467
EAC = .98 x $165,467
EAC = $162,158

VAC = BAC – EAC
VAC = $165,467 - $162,158
VAC = 3,309

Using this EAC calculation, our project is projected to underrun by $3,309.

Now let's look at the next EAC formula on the next page.

as of 1/31	PV	EV	AC	BAC
Foundation	$15,394	$15,394	$15,850	$15,394
Patio	$8,166	$8,166	$7,200	$8,166
Frame exterior Walls	$8,748	$6,608	$6,250	$16,521
Stairway	$5,961	$2,981	$3,100	$11,922
Frame interior walls	$0	$0	$0	$11,025
Install roofing trusse	$0	$0	$0	$15,887
Install waterlines	$0	$0	$0	$6,194
Install gas lines	$0	$0	$0	$6,255
Install B/K fixtures	$0	$0	$0	$6,317
Install wiring	$0	$0	$0	$18,483
Install outlets/switches	$0	$0	$0	$9,265
Install fixtures	$0	$0	$0	$18,625
Install felt	$0	$0	$0	$2,445
Install shingles	$0	$0	$0	$2,445
Install vents	$0	$0	$0	$815
Install drywall	$0	$0	$0	$6,984
Painting	$0	$0	$0	$6,477
Install Carpeting	$0	$0	$0	$2,250
	$38,269	$33,149	$32,400	$165,467

The third EAC formula is as follows:

$$EAC = BAC/CPI$$

This calculation uses the Budget at Completion (BAC) and the Cost Performance (CPI) Index to calculate EAC.

This formula is also easy to use and assumes that the "burn-rate" remains constant for the remainder of the project.

This formula is derived from the previous formula and thus should result in the same EAC figure. Note that with this formula you need additional information than the previous formula.

Let's use our ACME Home Building project and calculate the EAC using this formula. Take a look on the next page.

Calculating Estimate at Completion

EAC = BAC/CPI
EAC = $165,467/1.02
EAC = $162,222

as of 1/31	PV	EV	AC	SV	CV	SPI	CPI
Foundation	$15,394	$15,394	$15,850	0	-456	1.00	0.97
Patio	$8,166	$8,166	$7,200	0	966	1.00	1.13
Exterior Walls	$8,748	$6,608	$6,250	-2,140	358	0.76	1.06
Stairway	$5,961	$2,981	$3,100	-2,980	-119	0.50	0.96
Project Total	$38,269	$33,149	$32,400	-5,120	749	0.87	1.02

VAC = BAC – EAC
VAC = $165,467 - $162,222
VAC = 3,245

Using this EAC calculation, our project is projected to underrun by $3,245.

Why is this answer different then the previous calculation when it was mentioned that the two formulas are derived from each other?

Rounding to the second decimal is the reason for the $64 difference.

as of 1/31	PV	EV	AC	BAC
Foundation	$15,394	$15,394	$15,850	$15,394
Patio	$8,166	$8,166	$7,200	$8,166
Frame exterior Walls	$8,748	$6,608	$6,250	$16,521
Stairway	$5,961	$2,981	$3,100	$11,922
Frame interior walls	$0	$0	$0	$11,025
Install roofing trusse	$0	$0	$0	$15,887
Install waterlines	$0	$0	$0	$6,194
Install gas lines	$0	$0	$0	$6,255
Install B/K fixtures	$0	$0	$0	$6,317
Install wiring	$0	$0	$0	$18,483
Install outlets/switches	$0	$0	$0	$9,265
Install fixtures	$0	$0	$0	$18,625
Install felt	$0	$0	$0	$2,445
Install shingles	$0	$0	$0	$2,445
Install vents	$0	$0	$0	$815
Install drywall	$0	$0	$0	$6,984
Painting	$0	$0	$0	$6,477
Install Carpeting	$0	$0	$0	$2,250
	$38,269	$33,149	$32,400	$165,467

The fourth EAC formula is as follows:

$$\text{EAC} = \text{AC/EV} \times [\text{Work Completed and in Progress}] + [\text{Cost of work not yet begun}]$$

This calculation uses the Actual cost, Earned value, the value of work completed and in process and the cost of work not yet begun.

This formula assumes that the work not yet begun will be completed as planned.

Let's use our ACME Home Building project and calculate the EAC using this formula. Take a look on the next page.

Calculating Estimate at Completion

$$EAC = AC/EV \times [\text{Work Completed and in Progress}] + [\text{Cost of work not yet begun}]$$

You need the chart to the right to determine the first part of the formula (actual cost and earned value).

AC/EV = $32,400/$33,149
AC/EV = .98

To obtain the remaining two parts, you will also need to use the chart, but some calculations will be needed.

Let's take a look on the next page at the final two part of this formula.

as of 1/31	PV	EV	AC	BAC
Foundation	$15,394	$15,394	$15,850	$15,394
Patio	$8,166	$8,166	$7,200	$8,166
Frame exterior Walls	$8,748	$6,608	$6,250	$16,521
Stairway	$5,961	$2,981	$3,100	$11,922
Frame interior walls	$0	$0	$0	$11,025
Install roofing trusse	$0	$0	$0	$15,887
Install waterlines	$0	$0	$0	$6,194
Install gas lines	$0	$0	$0	$6,255
Install B/K fixtures	$0	$0	$0	$6,317
Install wiring	$0	$0	$0	$18,483
Install outlets/switches	$0	$0	$0	$9,265
Install fixtures	$0	$0	$0	$18,625
Install felt	$0	$0	$0	$2,445
Install shingles	$0	$0	$0	$2,445
Install vents	$0	$0	$0	$815
Install drywall	$0	$0	$0	$6,984
Painting	$0	$0	$0	$6,477
Install Carpeting	$0	$0	$0	$2,250
	$38,269	$33,149	$32,400	$165,467

$$\text{EAC} = \text{AC/EV} \times \begin{bmatrix} \text{Work Completed} \\ \text{and in Progress} \end{bmatrix} + [\text{Cost of work not yet begun}]$$

The project has 4 activities that are completed and in progress (Foundation, Patio, Frame exterior walls and stairway). The value of these activities is obtained by using the BAC column. The total for Work Completed and in Progress is $52,003.

The final part is the cost of work not yet begun. The value for this section is the sum of the activities not yet begun. The total Cost of work not yet begun is $113,464.

Now let's calculate our EAC. Check it out on the next page.

as of 1/31	PV	EV	AC	BAC
Foundation	$15,394	$15,394	$15,850	$15,394
Patio	$8,166	$8,166	$7,200	$8,166
Frame exterior Walls	$8,748	$6,608	$6,250	$16,521
Stairway	$5,961	$2,981	$3,100	$11,922
Frame interior walls	$0	$0	$0	$11,025
Install roofing trusse	$0	$0	$0	$15,887
Install waterlines	$0	$0	$0	$6,194
Install gas lines	$0	$0	$0	$6,255
Install B/K fixtures	$0	$0	$0	$6,317
Install wiring	$0	$0	$0	$18,483
Install outlets/switches	$0	$0	$0	$9,265
Install fixtures	$0	$0	$0	$18,625
Install felt	$0	$0	$0	$2,445
Install shingles	$0	$0	$0	$2,445
Install vents	$0	$0	$0	$815
Install drywall	$0	$0	$0	$6,984
Painting	$0	$0	$0	$6,477
Install Carpeting	$0	$0	$0	$2,250
	$38,269	$33,149	$32,400	$165,467

$$EAC = AC/EV \times \begin{bmatrix} \text{Work Completed} \\ \text{and in Progress} \end{bmatrix} + [\text{Cost of work not yet begun}]$$

EAC = (.98 x $52,003) + $113,464

EAC = $164,427

Now let's calculate the Variance at Completion (VAC).

VAC = BAC – EAC

VAC = $165,467 - $164,427

VAC = 1,040

Using this EAC calculation, our project is projected to underrun by $1,040.

Now let's look on the next page at our final EAC formula.

The final EAC formula is as follows:

$$EAC = AC + [1/CPI (BAC-EV)]$$

This calculation uses the Actual Cost (AC) Budget at Completion (BAC), Earned Value (EV) and the Cost Performance (CPI) Index to calculate EAC.

This formula is a very subjective way of calculating EAC.

Let's use our ACME Home Building project and calculate the EAC using this formula. Check it out on the next page.

EAC = AC + [1/CPI (BAC-EV)]
EAC = $32,400 + [1/1.02 ($165,467 – $33,149)]
EAC = $32,400 + [.98 ($132,319)
EAC = $32,400 + $129,726
EAC = $162,073

VAC = BAC – EAC
VAC = $165,467 - $162,073
VAC = 3,394

Using this EAC calculation, our project is projected to underrun by $3,394.

as of 1/31	PV	EV	AC	BAC
Foundation	$15,394	$15,394	$15,850	$15,394
Patio	$8,166	$8,166	$7,200	$8,166
Frame exterior Walls	$8,748	$6,608	$6,250	$16,521
Stairway	$5,961	$2,981	$3,100	$11,922
Frame interior walls	$0	$0	$0	$11,025
Install roofing trusse	$0	$0	$0	$15,887
Install waterlines	$0	$0	$0	$6,194
Install gas lines	$0	$0	$0	$6,255
Install B/K fixtures	$0	$0	$0	$6,317
Install wiring	$0	$0	$0	$18,483
Install outlets/switches	$0	$0	$0	$9,265
Install fixtures	$0	$0	$0	$18,625
Install felt	$0	$0	$0	$2,445
Install shingles	$0	$0	$0	$2,445
Install vents	$0	$0	$0	$815
Install drywall	$0	$0	$0	$6,984
Painting	$0	$0	$0	$6,477
Install Carpeting	$0	$0	$0	$2,250
	$38,269	$33,149	$32,400	$165,467

as of 1/31	PV	EV	AC	SV	CV	SPI	CPI
Foundation	$15,394	$15,394	$15,850	0	-456	1.00	0.97
Patio	$8,166	$8,166	$7,200	0	966	1.00	1.13
Exterior Walls	$8,748	$6,608	$6,250	-2,140	358	0.76	1.06
Stairway	$5,961	$2,981	$3,100	-2,980	-119	0.50	0.96
Project Total	$38,269	$33,149	$32,400	-5,120	749	0.87	1.02

The outcomes of the various methods for computing EAC are shown in the table below:

EAC Formula	EAC	VAC
EAC = AC + ETC	$165,569	-$102
EAC = AC/EV x BAC	$162,158	$3,309
EAC = BAC/CPI	$162,222	$3,245
EAC = AC/EV x ([Work Completed and in Progress] + [Cost of work not yet begun])	$164,427	$1,040
EAC = AC + [1/CPI (BAC-EV)]	$162,073	$3,394

In reviewing the EAC formulas, be aware that the formula you use impacts your project's EAC. Though all the EAC calculations are correct, choosing the appropriate formula for your project is important. The EAC formula you choose should be determined by the specifics of the project.

If you need to review these techniques, please pay close attention to the assumptions of each.

At this point, you have covered all of the content in Module 6. Take some time now to review the major items:

- Performance measurement defines how success or failure is determined on a project. In the case of Earned Value Management, performance measurements focus on cost and schedule management.

- Earned value performance measurements look at the project cost and schedule performance by analyzing the cost and schedule variance along with cost and schedule efficiency.
    - **Cost Variance (CV)** is the difference between the earned value of work performed and the actual cost. CV tells you the earned value of work performed less actual cost.
    - **Schedule Variance (SV)** is the difference between the earned value of work performed and the work scheduled. SV tells you the value of work performed less value of work scheduled.
    - **Cost Performance Index (CPI)** is a measure of Cost Efficiency. The CPI measures the value of work performed against the actual cost.
    - **Schedule Performance Index (SPI)** is a measure of Schedule Efficiency. The SPI measures the value of work performed against the work scheduled.

- The **Estimate at Completion (EAC)** is the actual cost to date plus an objective estimate of costs for remaining authorized work. The objective in preparing an EAC is to provide an accurate projection of cost at the completion of the project.

- There are multiple methods for determining EAC. Each project needs to be evaluated to determine which EAC formula best fits the project's size and complexity.

At this point we have examined the basic metrics and performance measures used in EVMS. In the next module you will examine the concepts of Integrated Baseline Review (IBR), Rebaselining, and Change Control.

If you have a firm grasp of the concepts covered in this module, feel free to progress to the next module. Otherwise, review this module to ensure you have a solid understanding of the basics metrics and performance measures used in EVMS.

This concludes Module 6.