


Earned Value

For Project Managers



Topics Covered

- Earned Value Heritage
- Cost Schedule Graphs
- Work Breakdown Structures
- Forming a Project Baseline
- Points of Management Control
- EV Measurement Methods
- Tracking Cumulative CPI and SPI
- “Sample” for Illustration
- Lessons Learned . . .


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Earned Value Heritage . . .


Earned Value was adopted from industrial engineering in factories where planned standards and earned standards were linked primarily to labor hours.

In the mid 1960's the United States Air Force started setting standards to oversee DoD contractor performance. The resulting DoD “Cost/Schedule Control Systems Criteria” (C/SCSC) includes 35 detailed criteria for performance reporting.

The commercial version is commonly known as Earned Value (EV) management and includes 32 of the DoD's 35 C/SCSC criteria. EV is being adopted by an ever increasing number of organizations to improve project performance reporting.

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Information Systems Overview




EV analysis is a performance measurement technique that integrates scope, time, and cost information in a manner that facilitates graphic presentation of schedule and cost performance compared to plan.

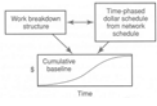
EV reporting is an efficient method of monitoring project progress when sufficient information regarding the project work to be done can be linked to specific scope deliverables and to the organization's resources needed to perform the work.

“Work Packages” with their associated detailed information for planning and tracking are consolidated by period to create a “baseline” schedule that reflects the amount of Earned Value expected to be completed each planning period.

EV can be used to update a project's anticipated cost “Estimate At Completion”.

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Baseline Data Relationships




Earned Value (EV) relies on a well-developed “Work Breakdown Structure” (WBS) and a time-phased schedule of work to be done with realistic cost estimates for each of the “Work Packages” in the project.

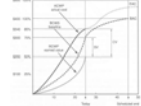
By calculating the cumulative value of all project-related work scheduled to be completed by the end of each period, an “S-curve” can be created to graphically represent the cumulative cost baseline.

As changes to the WBS, Cost estimates, and/or Schedules are approved, the baseline S-curve is updated, and performance is compared to the new baseline.

Actual performance data must be collected periodically to effectively use EV.

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The Cost Schedule Graph




Earned Value (EV) analysis requires familiarity with abbreviations commonly used in measuring performance.

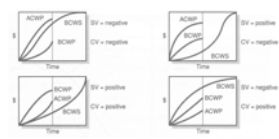
AC = (ACWP) = Actual Cost of Work Performed
 PV = (BCWS) = Budgeted Cost of Work Scheduled
 EV = (BCWP) = Budgeted Cost of Work Performed

BAC = Budget at Completion (approved budget for the project)
 ETC = Estimate To Complete (cost of the remaining work)
 EAC = Estimate At Completion (“updated” estimate of total cost)

CV = Cost Variance = Earned Value minus Actual Cost
 SV = Schedule Variance = Earned Value minus Planned Value


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Earned Value Review Exercise . . .

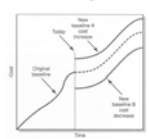


Earned Value (EV) reporting charts facilitate quick assessment of project cost and schedule performance as well as likely outcomes . . .

- Upper-left chart shows a project behind schedule and over its cost budget**
It likely will finish late and cost more than budgeted
- Upper-right chart shows a project ahead of schedule and over its cost budget**
It likely will finish early but cost more than budgeted
- Lower-left chart shows a project ahead of schedule and under its cost budget**
It likely will finish early and cost less than budgeted
- Lower-right chart shows a project behind schedule and under its cost budget**
It likely will finish late but cost less than budgeted

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EV Requires a Project Baseline




Earned Value (EV) management relies on a "Control Account Plan" (CAP) at the most detailed "Work Package" level in order to support integration or roll-up.

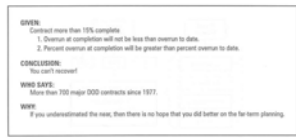
If multiple departments and/or resources are required to complete the work package being monitored, then the CAP must clearly identify how much of the cost for that task is allocated to each departments and/or resource.

We can think of the CAP as a very small project plan with an apportioned Earned Value (budget), Deliverables (scope), and Due Date (schedule).

If the CAP is poorly done, project performance reporting likely will be weak.

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DoD EV "Body of Knowledge"




Given a typical project that is at least one-sixth (17%) complete, a cost overrun to date likely will not be corrected by the time the project is completed.

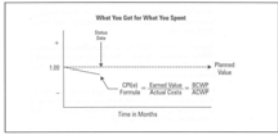
Also, the percent cost overrun when the project is complete likely will be greater than the percent overrun to date.

This assessment is based on results from more than 700 major U.S. Department of Defense contracts since 1977.

It would be imprudent to presume that a project can recover the cumulative net cost overruns incurred by the time we have spend 15% of the project budget.

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Monitoring Cumulative CPI




Because early performance provides a strong indication of how we are likely to perform during the remainder of the project, we periodically compare cumulative Earned Value (EV) to cumulative Actual Costs (AC) for the work completed.


The index used for this comparison is called the Cost Performance Index (CPI)

$$CPI = EV / AC = (BCWP) / (ACWP) = \text{Earned Value divided by Actual Costs}$$

The CPI measures "what we got for what we spent" and can be used to help predict what the "Estimate At Completion" (EAC) or total cost of the project will be when the project is completed.

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WBS for an Energy Project



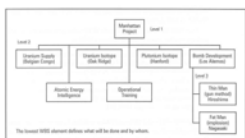
Before we accept this method for calculating an updated Estimate At Completion (EAC), we should review where the information comes from and the logic that will be used in order to ensure that it will provide reasonably accurate estimates.

The top few levels in the Work Breakdown Structure (WBS) typically are defined by the project sponsor who must understand the project deliverables only at the high levels necessary to get support or funding from others.

The next few levels in the WBS typically are defined by the project manager who must understand the relationship among the project deliverables in sufficient detail to communicate effectively with project resources.

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WBS Dictionary to Project SOW



Cost estimates at the Work Package (lowest level) usually come from a "Subject Matter Expert" (SME) and typically are for small enough packages that the errors typically are not very large.

The logical organization of the Work Breakdown Structure (WBS) ensures that the cost estimates are not skipped or double counted during EV "roll-up" processes.

Though the lowest level in the buyer's WBS might have a large amount of work in each element, a supplier's lower level WBS likely would continue to "decompose" those elements much further.

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WBS for a Construction Project

Though we are measuring "overall" performance for the whole project, the whole project is defined in more detail using a "Work Breakdown Structure" (WBS) that "decomposes" the large deliverable into smaller parts that can be more efficiently planned and controlled.

Using WBS logic to consolidate small work package cost estimates reduces error.

A rule of thumb for supplier "Work Package" size is to use 80 hours or 10 days of effort as a maximum limit for each Work Package in a plan when costs are critical.

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Forming a Project Baseline

Defining our SCOPE using a logical "Work Breakdown Structure" (WBS) will tell us WHAT we need to deliver, but not when or how we are to deliver it.

To get from a WBS to a "Project Baseline" we must plan and schedule the work using some easy to update method and then allocate resources to each task.

The assigned resources (costs) are matched to their work in the project schedule to create a time-phased budgets at the "Control Account Plan" (CAP) level.

Consolidating all of the CAPs for each period gives us a total project budget for that period and another point on our "S curve" for performance reporting.

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Points of Management Control

The Control Account Plans (CAPs) are the basis for management control of the work schedules and costs associated with getting that work completed.

We should expect to have for each CAP a single team leader who is responsible for ensuring that the CAP scope is understood, the deliverables are provided on time, and the cost budget is not exceeded for that CAP.

Multiple functions can be included in a CAP provided the CAP stays small enough to easily update its percent complete status at the end of each reporting period.

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EV Measurement Methods

Because management control is maintained through the Control Account Plan (CAP), we must select an appropriate method for measuring its Earned Value.

Some options . . .

- Milestones with Weighted Values - (can be complex to set up)
- Fixed Formula (25/75; 50/50; 75/25; etc.) - (limits over-estimating)
- Percent-Complete Estimates - (common)
- Percent-Complete with Milestone Gates - (limits over-estimating)
- Equivalent Units
- Earned Standards
- Apportioned Relationship to Discrete Work - (i.e. "burden")
- Level of Effort - (not recommended)

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Elements of a Cost Account Plan

Control Account Plan (CAP) effectiveness is determined by its elements . . .

- Statement of Work - (keep it short & simple)
- Schedule - (earliest start, scheduled start, scheduled end, latest end)
- Budget - (unit of measure usually is dollars)
- Responsible Person - (the Team leader)
- Responsible Department - (typically an executive level)
- Type of Effort - (recurring or nonrecurring)
- Division into Discrete Work Packages - (one for each resource)
- Method used to Measure EV - (Milestone, formula, % complete, etc.)

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A "Sample" Cost Account Plan

A typical CAP has multiple "Work Packages" . . .

Each "Work Package" has its own EV measurement method
 Note milestone gates limit percent completion estimates for WP #4
 The total CAP Earned Value can be calculated by a "roll-up"
 A weighted average % complete for the CAP can be calculated

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Tracking Cumulative CPI and SPI

When we add all of the Earned Value (EV) to date and compare it to the Planned Value (PV) in the schedule to date and the Actual Costs (AC) incurred to date, we get some useful indicators for predicting project outcomes. Index ≥ 1.0 is good.

Schedule Performance Index = Earned Value / Planned Value
SPI = EV / PV or BCWP / BCWS

Cost Performance Index = Earned Value / Actual Costs
CPI = EV / AC or BCWP / ACWP

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Cost and Schedule Variances

When we add all of the Earned Value (EV) to date and compare it to the Planned Value (PV) in the schedule to date and the Actual Costs (AC) incurred to date, we get some unit measures of past performance. A "positive" variance is good.

Schedule Variance = Earned Value minus Planned Value
SV = EV - PV or BCWP - BCWS

Cost Variance = Earned Value minus Actual Costs
CV = EV - AC or BCWP - ACWP

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Adjustments May Be Needed

We may need to adjust the reported Actual Cost (AC) numbers before we do the calculations because sometimes the reported numbers are for activities that do not exactly match the scope of the activities being measured.

Reduce "Actual Costs" for:
 Advance payments made without work performed
 Materials held in inventory with no work performed

Increase "Actual Costs" for:
 Supplier holdbacks for work performed
 Supplier work performed without payments made
 Lagging invoices for work already performed

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Cumulative CPI "Rule of Thumb"

If the project is at least one-sixth (17%) complete, we can prudently presume that the cumulative CPI will not improve before the end of the project.

Therefore, the updated "Estimate At Completion" (EAC) likely will be no less than the original "Budget at Completion" (BAC) divided by the CPI

EAC = AC + [Remaining Work (BAC - EV)] / CPI
 simplified as **EAC = BAC / CPI**

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Cumulative SPI "Rule of Thumb"

If the project is at least one-sixth (17%) complete, we can prudently presume that the cumulative SPI will not improve before the end of the project.

The likely total project duration likely will increase (decrease) in proportion to the inverse of the Schedule Performance Index (SPI) to date. For example:

If the SPI = 0.80 and the original project duration was 24 months, then the new expected duration would be
24 months / 0.80 = 30 months [6.0 months late]

Note: we are already 2.5 months late with only 40% of the work done.

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Baseline Scope Changes

Baseline EV profiles can change as a result of approved changes to scope, cost estimates, and/or schedules.

When then happens, we will see a shift in the baseline "S curve" as indicated in the figure above.

We would expect the project manager's focus to be on ensuring that there is a good understanding of the remaining work, and the project team's performance would be measured against the new S curve.

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A "Sample" for Illustration . . .

Project Charter:

Total budget = \$100,000
 Ten months of level effort to complete the project
 Deliverable is 20 identical units

Status after five months:

Spent to date = \$52,000
 Units produced = 10 complete plus 3 partial units

Questions:

How are we doing? That depends on the status of the 3 partial units.
 Are we ahead or behind schedule? That depends . . .
 Are we "over" or "under" budget? That depends . . .
 When are we likely to finish? That depends . . .
 What is our likely total cost? That depends . . .

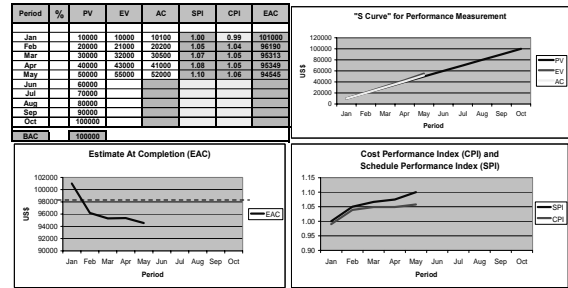
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Tabular and Graphic Reports



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Wrap Up . . .

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