
A Gentle Introduction to Earned Value Management Systems

“Good metrics let us see if we are doing the right things and doing them well.”



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What do Project Managers What to Know?

- ◆ Is the project on schedule?
- ◆ Is the project on budget?
- ◆ Simple project analysis tools can answer these questions using time and cost tracking
- ◆ Earned value asks and answers more important questions:
 - How much of the budget “should have been” spent at this point in the project?
 - How much “value” has the work on the project “earned” so far?

What is Earned Value Analysis?

- ◆ It is a way to measure the amount of work actually performed on a project.
- ◆ It is a way to forecast a project's cost and completion date using historical and statistical projections.
- ◆ It is a way to tell how well a project is “performing” compared to its original plan.
- ◆ Given this information it is a way to forecast how well the project will perform in the future.

Some Introductory Definitions

- ◆ Budgeted Cost of Work Scheduled – “The Plan”
This is the total budgeted cost. It answers the question “*how much do we plan to spend?*” A second question that is answered is “*How much work should be been completed by this date?*”
- ◆ Budgeted Cost of Work Performed – “Earned Value”
This is the cost originally budgeted to accomplish the work that has been completed. It answers the question “*how much work has been actually completed?*”
- ◆ Actual Cost of Work Performed – “The Investment”
The actual cost to accomplish all the work that was performed by a specific date. It answers the question “*how much did we actually spend to deliver the Earned Value?*”

Basic Concepts of Earned Value Management

- ◆ Three dimensions of Earned Value
 - The Plan – Budgeted Cost of Work Scheduled (BCWS)
 - The Performance – Budgeted Cost of Work Performed (BCWP)
 - The costs of Performance – Actual Cost of Work Performed (ACWP)
- ◆ BCWS
 - Authorized work – scheduled tasks
 - Time frame for the work
 - Sum of planned values – baseline plan
- ◆ BCWP – “How much of the planned work was accomplished?”
- ◆ ACWP – the money spent to convert BCWS into BCWP.
- ◆ Cost Variance = $BCWP - ACWP$ (negative CV is “bad”)
- ◆ Schedule Variance = $BCWP - BCWS$ (negative SV is “bad”)

Some More Useful Terms

- ◆ CPI – Cost Performance Index
 - $CPI = BCWP / ACWP$
- ◆ SPI – Schedule Performance Index
 - $SPI = BCWP / BCWS$
- ◆ BAC – Budget at Completion
- ◆ EAC – Estimate at Completion
- ◆ IEAC – Independent Estimate at Completion
 - $IEAC = BAC / CPI$
- ◆ ISAC – Independent Schedule at Completion
 - $ISAC = Schedule / SPI$
- ◆ VAC – Variance at Completion
 - $VAC = BAC - EAC$

A Simple but Edible Example

It's the holidays, it's cookie baking time!



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EVMS of our Holiday Cookie Baking Process

- ◆ Our “Plan”

- 40 cookies per batch
- 5 batches per hour (200 cookies per hour)
- Schedule: 5 hours to make 1,000 cookies
- Budgeted cost per cookie – \$0.05
- Total Budget = \$50.00

- ◆ Analysis after one (1) hour of baking we’ve made ...

- 150 edible cookies – some were burnt, some hit the floor, the kids ate some, and fed some to the dog.
- Actual cost of ingredients after one hour (ACWP) = \$9.00



After One Hour of Making Cookies

- ◆ Simple EVMS

- $BCWS = \$10.00$
- $BCWP = 150 \text{ cookies} \times \$0.05/\text{Cookie} = \$7.50$
- $ACWP = \$9.00$

- ◆ Cost and Schedule Variance

- $SV = BCWP - BCWS = -\$2.50$ (we're behind schedule)
- $CV = BCWP - ACWP = \$7.50 - \$9.00 = -\$1.50$ (we're over budget)
- $SPI = BCWP / BCWS = 0.75$ (we're running at 75% of planned schedule)
- $CPI = BCWP / ACWP = 0.833$ (we're running about 17% over budget)

Forecasting the Cookie Schedule and Budget

- ◆ $IEAC = BAC / CPI = \$50.00 / 0.833 = \60.00
- ◆ $VAC = BAC - IEAC = \$50.00 - \$60.00 = -\$10.00$ (\$10 over)
- ◆ $ISAC = 5 \text{ hours} / SPI = 5 / 0.75 = 6.67 \text{ hours}$
- ◆ It'll take 6 2/3 hours and \$60.00 to make 1,000 edible cookies if the productivity of this cookie project doesn't improve.

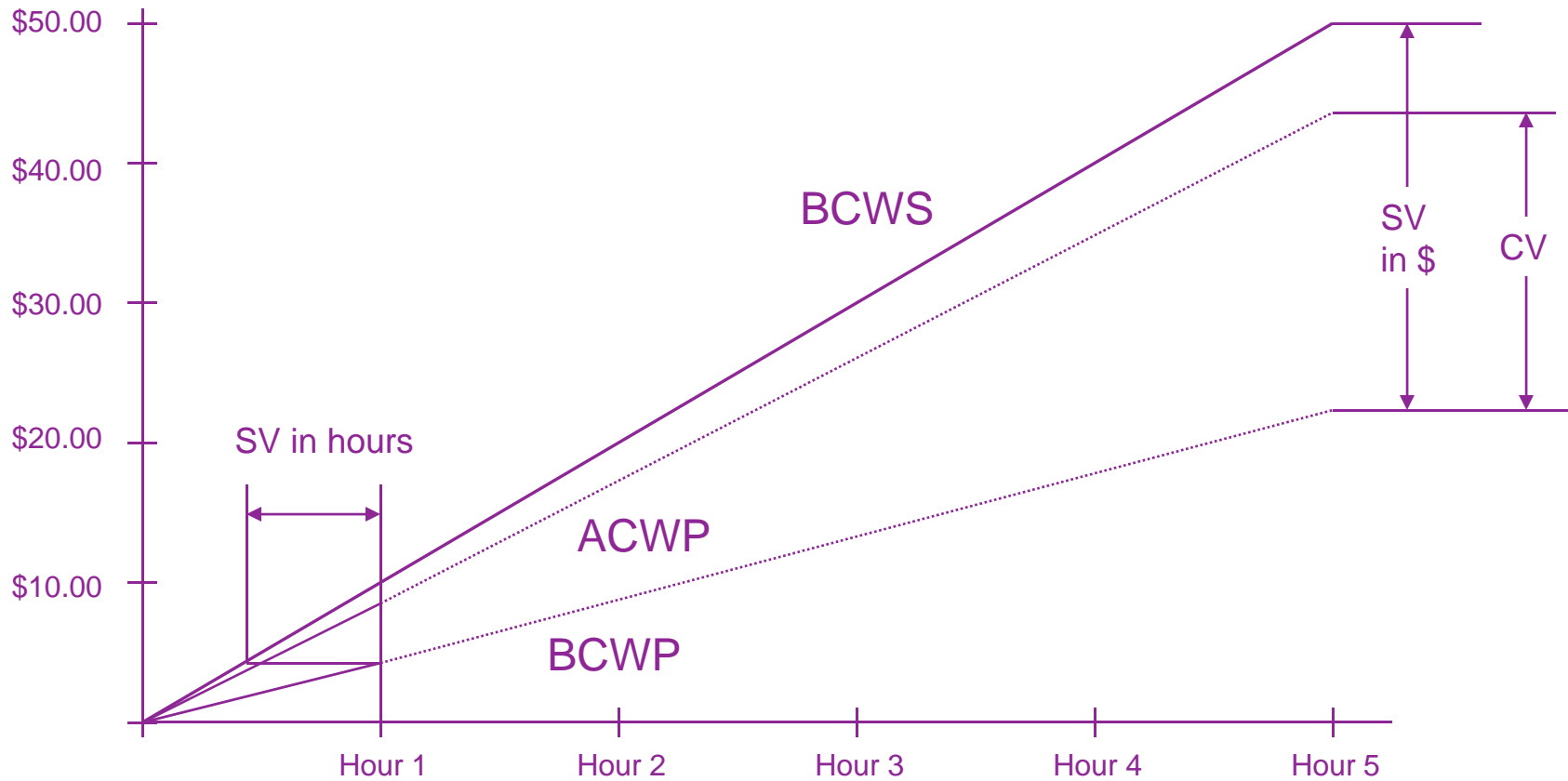
Can we Catch Up?

- ◆ TCPI = “To Complete” Performance Index
 - $TCPI_{EAC} = (BAC - BCWP_{CUM}) / (EAC - ACWP_{CUM})$
 - EAC = the amount we estimate we will spend in the end
- ◆ The numerator (Budget at Completion – BCWP) is how much work is left
- ◆ The dominator (EAC – ACWP) is how much we have left to spend
- ◆ If $EAC = IEAC$, then $TCPI = CPI$
 - *“If we don’t change our performance, IEAC is the correct estimate of the final cost.”*

Our “Catch Up” Plan

- ◆ We want to finish this little baking exercise with a \$50.00 budget.
 - $TCPI = (\text{Budget} - BCWP) / (EAC - ACWP)$
 - $TCPI = (50.00 - 7.50) / (50.00 - 9.00) = 42.50 / 41.00 = 1.036$
- ◆ We must perform at 103.6% of the originally planned performance in order to maintain the budget goal

A Simple EVMS Chart



Putting This Simple Concept into Practice

EVMS can be deployed in many ways. A straight forward way is to “micro-schedule” the work activities.



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Micro–Schedule

- ◆ Micro–scheduling does NOT mean micro–managing.
- ◆ It means planning at a sufficient level of detail to identify useful tasks that can be measured in days (3 to 5) or at most a week.
- ◆ Micro–schedule consists of:
 - Objective completion criteria – so we know when we are done.
 - “Budgets” and “Values” – usually representing person days and some “measurable” value to the customer in terms of dollars.
 - Planned Completion Dates – so we know when to expect these tasks to be done.

Some Fundamental Concepts of EVMS

- ◆ Never relate what was planned to be spent (BCWS) to the actual amount spent (ACWP).
 - This tells us nothing of value
 - It can even warp our thinking into attempting to under-spend our allowed amount to report favorable numbers.
- ◆ Cost Performance (CV) must focus on what has been accomplished (BCWP) versus what was invested to accomplish that work (ACWP)

A Framework for Deploying EVMS

Let's do it the “standard” way with a twist of
“agility” and “common sense.”†

† Common sense has the very curious property of being more correct retrospectively than prospectively, it seems to me that one of the principal criteria to be applied to successful projects is that its results are almost always obvious retrospectively; unfortunately, they seldom are successful prospectively. Common sense provides a kind of ultimate validation after the work after the project has completed its work; it seldom anticipates what the work is going to discover. Russel Lincoln Ackoff, *The Art of Problem Solving*, 1978



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ANSI/EIA–748A–2002 and Success Criteria of Earned Value Management

- ◆ The EIA 748A–2002 specification calls out 35 performance criteria required for compliance.
- ◆ These criteria are too complex for our “agile” environment.
- ◆ There are 10 key criteria that can be deployed here.

10 Criteria for Successful EVMS

- ◆ Define authorized work elements
- ◆ Identify project organizational structure
- ◆ Provide integrated planning, scheduling, budgeting, work authorization, and cost accumulation processes
- ◆ Schedule the authorized work in a sequential manner that identifies the the significant task dependencies
- ◆ Identify physical products and organizations
- ◆ Establish and maintain time–phased budget baseline
- ◆ Record direct costs consistently in a formal manner
- ◆ Periodically generate project metrics
- ◆ Develop revised cost estimates–at–completion based on performance to date.
- ◆ Incorporate authorized changes in a timely manner.

Define Authorized Work Elements

- ◆ Create a Work Breakdown Structure (WBS) for all activities at the micro–schedule level
- ◆ The scope of the entire project must be defined in order to measure performance.
 - This is a problem for agile methods, since scope evolves as the project evolves
 - Schedule major iterations on 2 to 3 week boundaries
 - Generate “macro” estimates of future work and “micro” estimates of the current iteration's work
- ◆ Defined project objectives, deliverables, and key milestones are based primarily on experience.

Identify Project Organizational Structure

- ◆ Identify the structure of the functional organizations performing the work
- ◆ Define all organizational elements responsible for delivering value
- ◆ Identify who is doing what and what value they are delivering
- ◆ Assign all tasks to specific named resources
- ◆ Identify the major milestones and those responsible for meeting the commitments represented by these milestone

Provide Integrated Planning, Scheduling, Budgeting, Work Authorization, and Cost Accumulation Processes

- ◆ Provide integration of the firms:
 - Planning,
 - Scheduling,
 - Budgeting,
 - Work Authorization
 - Cost accumulation
- ◆ Project management process should be integrated with the WBS and the functional organization.

Schedule the Authorized Work in a Sequential Manner That Identifies the the Significant Task Dependencies

- ◆ Describe the work sequence
- ◆ Identify significant dependencies required to meet the requirements
- ◆ Identify which tasks are impending the process of other tasks
- ◆ Create a “master schedule” for larger projects to connect the subordinate projects

Identify Physical Products and Organizations

- ◆ All project must be able to identify and measure physical performance
- ◆ Define metrics which convert to “planned values” into “earned values”
- ◆ Project must specify:
 - Physical Products,
 - Deliverables,
 - Outputs,
 - Metrics,
 - Milestones
 - Technical performance indicators

Establish & Maintain Time-Phased Budget Baseline

- ◆ Establish initial budgets on internal management estimates and external negotiated targets
- ◆ Budget for long-term efforts must be held at higher levels of the organization
- ◆ Time-phase budget is required to measure performance
 - Staff
 - ODCs

Record Direct Cost Consistency in a Formal System

- ◆ “Applied Direct Costs” is the preferred method of accounting for the accrual of “value”
- ◆ Isolate Level of Effort costs in a separate WBS element

Periodically Generate Project Metrics

- ◆ The amount of planned versus budgets earned for the work accomplished
- ◆ The amount of budget earned versus the actual direct costs for the same work
 - This is the “cost variance”
- ◆ This differentiates EVMS from other “actual versus budget” cost analysis
 - Weekly measures are now the “norm”
 - Comparisons need to be detailed enough to provide intervention opportunities

Develop Revised Cost Estimates—at–Completion (EAC) Based on Performance to Date

- ◆ Compare this information with the performance measure baseline to identify variances at completion

Incorporate Authorized Changes in a Timely Manner

- ◆ All changes must be addressed as they effect budget and schedule
- ◆ Base changes on the estimated amount and assignment to functional organizations needs to be recorded as well
- ◆ All approved changes must be incorporated into the project baseline

Ten Benefits of EVMS

1. It is a single management control system to provide reliable and consistent data on project performance.
2. It integrates work, schedule, and cost using a work breakdown structure.
3. The associated database of completed projects is useful for comparative analysis.
4. The cumulative cost performance index (CPI) provides an early warning signal.
5. The schedule performance index provides an early warning signal.
6. The CPI is a predictor for the final cost of the project.
7. It uses an index-based method to forecast the final cost of the project.
8. The “to-complete” performance index allows evaluation of the forecasted final cost.
9. The periodic (e.g., weekly or monthly) CPI is a benchmark.
10. The management by exception principle can reduce information overload.

What's Next

Now that we have some tools that can be used to “manage” our efforts, what can we do with them in order for them – and us – to “earn our value?”



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Deployment Plan

- ◆ Identify critical projects in both applications and infrastructure
- ◆ Baseline these projects
- ◆ Track the actual costs using time recording, Work Authorization and a project management system
- ◆ Report CV, SV, BCWP (Value) for the projects on weekly basis.
- ◆ Use this information to “manage” our efforts in a predictive manner.
- ◆ In the past we were “driving in the rearview mirror”
 - It can be done, but it’s real sporty
- ◆ Let’s drive by looking out the front wind shield instead.
 - The scenery is better, and we end up with less road kill.

Some More Details We'll Need Along the Way

- ◆ Planning, budgeting, and scheduling
 - Scheduling
 - Cost account baseline
 - Budgets
 - Management reserve
 - Undistributed budget
 - Overhead budget
 - Project target cost
- ◆ Accounting
 - Direct costs
 - Indirect costs
 - Material costs
 - Summarization
- ◆ Analysis and management
 - Cost variance
 - Schedule variance
 - Variance analysis
 - Reporting
 - Estimates at completion
 - Indirect cost analysis
 - Management action
- ◆ Revisions and Data Maintenance
 - Authorized changes
 - Unauthorized changes
 - Budget reconciliation