APPENDIX E

EARNED VALUE TUTORIAL GUIDE

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Appendix E. Earned Value Approach Tutorial

Introduction

The Earned Value Method was first developed over 30 years ago by the United States Department of Defense to reduce risks of project cost growth. The Department of Defense refers to it as the Cost/Schedule Control Systems Criteria. The method is an early warning project management tool that enables Project Managers to identify and control problems before they become formidable. The process does not prevent cost overruns and schedule slippage. It allows the Project Manager to take necessary corrective action to change the trend.

Traditional cost and funding management looks at cost and schedule separately and sometimes makes wrong assumptions from the data. A project may appear to be on schedule and under budget when it is actually over budget and/or behind schedule. The Earned Value method is an enhancement over traditional accounting progress measures. Older methods focus on planned accomplishment (expenditures) and actual costs. Earned Value goes one step further and examines actual accomplishment. Actual accomplishment gives managers greater insight into potential risk areas. It also provides more accurate estimates for projected completion costs. With a clearer picture, managers can create risk mitigation plans based on the actual cost, schedule, and technical progress of the work.

Early warning is important because cost overruns tend not to correct themselves over time. In fact, studies have shown they worsen, if not realized early. Research shows that projects that are over budget when only 15 percent finished usually post overruns at completion. Similarly, research shows that actual completion costs will not improve by more than 10% of the current percentage overrun. The reason cost overruns worsen in most cases is that managers don't know they have a cost overrun early enough in the project. The Earned Value method gives the early indicators that help alleviate this problem – indicators that can be used as early as the 15 to 20 percent point of completion.
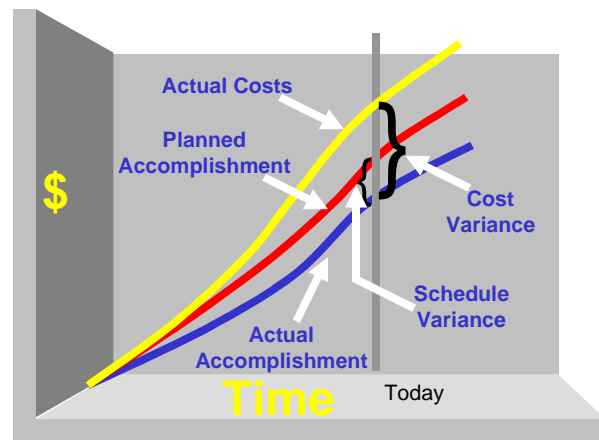
Definition

Earned Value reflects the integration of cost, schedule, and technical work into one common view to establish a project plan. It uses progress against previously defined work plans to forecast such important concerns as estimated completion costs, finish dates, and the effectiveness of corrective action plans. Earned Value is the measurement of what you physically got for what

you actually spent, or the value of work accomplished. "Earned Value" is a term that is often referred to as Budgeted Cost of Work Performed. Simply put, it is a program management technique that uses "work in progress" to indicate what will happen to work in the future.

In a graphical representation of the Earned Value approach, the cumulative Budgeted Cost of Work Scheduled or planned accomplishment is the baseline for the project. The Actual Cost of Work Performed is just the cost as a function of time. The Budgeted Cost of Work Performed or actual accomplishment known as Earned Value is a dollar representation of what it should have cost to do the work already accomplished. From this information, it is easy to calculate the cost variance and the schedule variance of the project at any point in time. It allows us to use cost and schedule together to determine where we are instead of using them separately and missing the total picture. Figure A-3 shows the graphical representation of the data collected using this process.

Figure A-3. Data Needed for Earned Value Determination

Assessing Project Performance

The primary performance measures for the Earned Value method are the Cost Performance Index and the Schedule Performance Index. The Cost Performance Index is the ratio between Earned Value and actual costs while the Scheduled Performance Index is the ratio between Earned Value and planned work (budgeted costs). The formulas are shown below:

Cost Performance Index (CPI) = Earned Value/Actual Cost = BCWP/ACWP

Schedule Performance Index (SPI) = Earned Value/Planned Value = BCWP/BCWS
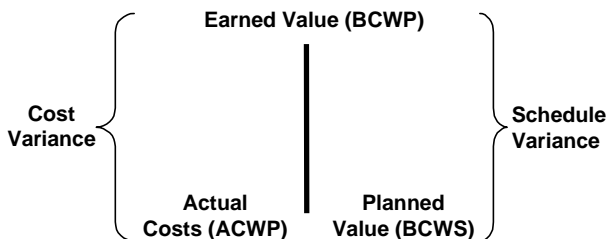
If CPI = 1.0, then performance is on target.

If CPI > 1.0, then performance is exceptional.

If CPI < 1.0, then performance is substandard.

The same is true for Schedule Performance Index. Note that a Cost Performance Index of 0.85 means that for every dollar that was spent, only \$0.85 in physical work was accomplished. A Schedule Performance Index of 0.90 means that for every dollar of physical work the project had planned to accomplish, only \$0.90 was completed.

There are other factors that can be used to assess the performance of projects. These measures include Cost Variance, Schedule Variance, Percent Variance, Variance at Completion, and To Complete Performance Index. In many cases, the Cost and Schedule Variances are more meaningful to upper management who may not fully understand the indices. Definitions of terms and calculations are shown in Attachment 8.1. An illustration of cost and schedule variance is seen in Figure A-4 and in the following illustration.

Estimating Future Cost and Completion Dates

Because we have cost and schedule indices, we can then estimate the approximate cost at completion of the project and the time that it will take to complete it. For cost, we can calculate the Estimate at Completion within a given range of values. The calculations are as follows:

Estimate at Completion (EAC) $_{min}$ = (BAC – BCWP) + ACWP

Estimate at Completion (EAC) $_{max}$ = ((BAC – BCWP) / (CPI x SPI)) + ACWP

(Note that there are a number of different Estimates at Completion equations that can be used. See Attachment 8.1 for further explanation.)

The estimated time to complete the project can also be calculated by taking the projects planned completion in months and dividing it by the Scheduled Performance Index. Therefore:

Estimated Time to Complete (ETC) = Planned Completion / SPI

Monitoring Performance

Performance must be monitored at the lowest level of the Work Breakdown Structure where distinct work packages are created, budgeted, and scheduled. This gives the greatest confidence in determining specific deliverables and the ability to estimate the Earned Value for work performed. However, the final indices and measures are reported overall as a roll-up of the Work Breakdown Structure tasks.

The schedule of tasks and a method for measuring the use of resources are needed in order to calculate Earned Value. The metrics used can vary and should be determined based on availability of data, type of project task, and appropriateness. The various types of metrics include:

1. Weighted Milestones

Weighted milestones work well for work packages that are three or more months in length. Each milestone is given a budget value that will be earned on completion of the event. Thus, the total work package budget is divided up based on a weighted value assigned to each milestone, as shown in the following table.

	Item	Jan	Feb	Mar	Apr	May	Jun	BAC
Weighted Milestones	Planned	30	70	70	30	30		230
	Earned							
	Actual							

This method is a preferred one used in performance measurement, but it is also the most difficult to plan and administer. Why? Because it requires a close working relationship between the work package managers, scheduling people, and resource estimating people in order to establish meaningful milestones.

2. Fixed Formula by Task: 0/100; 25/75; 50/50

This method is perhaps the best one when applied to short-span work packages whose duration is only one, two, or possibly even three months. For instance, 0/100 method is best applied to those work packages that start and end within one accounting month. Nothing is earned when the task begins, but 100 percent of the budget is earned when completed.

Similarly, the 50/50 technique is used for work packages whose duration usually spans two accounting months. Fifty percent of the planned value is earned when the task starts and the balance is earned when it ends.

Cost account managers may use other variations of this method to set in advance the percentage values they wish to use, e.g., 25/75, 20/80, etc.

3. Percent Complete

Typically this method relies strictly on one's "subjective" estimate of the percentage of work completed and is provided by the individual in charge of the work package. However, written guidelines have been used to assist in assigning a percent complete value based on completed work, e.g., drawings issued, lines of software code tested, parts received, etc.

The percent complete method is the easiest to administer, but is most subject to individual bias and optimistic figures. One technique used to address the optimism factor is to set a maximum ceiling amount for any work package until it is 100 percent complete. For example, with an 80 percent ceiling, a work package may only earn up to 80 percent of the manager's estimate until the task is 100 percent complete.

Subjective estimates only work well if checks and balances exist to challenge poor or overly optimistic estimates.

4. Equivalent Completed Units

This approach places a planned value for each unit completed and is used for managing repetitive-type work. For instance, a project's goal is to construct ten homes valued at $100,000 per unit. Costs for each site excavation and unit foundation are estimated to be ten percent of each house. At the end of the first month, the project completed excavation and unit foundations for all ten homes. Therefore, the Earned Value for the first month would be $100,000, or the equivalent of one home.

Typically laboratory projects are not repetitive enough for this approach to be useful.

5. Level of Effort … NOT Recommended!

Level of effort activities are those driven by time vs. task (e.g., procurement, contract administration, budgeting, etc.). The principal problem with level of effort activities is that whatever is authorized as the planned value actually becomes the Earned Value regardless of what actual work takes place. In other words, Earned Value always matches planned value. The use of level of effort methods is not recommended.

In short, one or more of the first three methods should be when figuring Earned Value for discrete work packages.

Limitations on Earned Value Method

Earned Value measurement works well with direct labor and corresponding indirect labor rates applied to direct labor costs. However, with materials, subcontracts, and other direct costs whose charges may take time to arrive, the problem arises with the early or delayed recording of actual costs. This will obviously affect the Earned Value performance being measured! Some care is required to compare comparable costs; the results will not be comparable if there is a significant difference between project reporting times and financial accounting times.

References

American Graduate University, (1999), Performance Measurement and Analysis (Performance Measurement Using Earned Value Concepts); Technical Program Management Course.

CMS Information Services, Inc. (March 1999), Web Page

Hess, Michael M. (September 1998). Earned Value Project Management: What is it? And how can we effectively use it? White Paper, Sandia National Laboratories

Kerzner, Harold. (1998), Project Management: A Systems Approach to Planning, Scheduling, and Controlling.

Figure A-4. Performance Metrics