White Paper

A Layman's Guide to Earned Value

If you are a project manager, you should always seek to understand how far along you are in a project. You may have a vague idea, like "we are pretty close to schedule", "we're about half done" or "we're 90% complete." However, it's better to be much more precise than this. If you have a good workplan and you are keeping it up-to-date, you should have a sense for how much work is remaining and what the projected end date is. But are you 50% complete? Or 55% complete? Or 90% complete? It's hard to know for sure.

Enter Earned Value

The earned value metrics were established to remove the guess work from determining where you are at in relation to a baseline. In theory, this concept is very elegant and interesting. Using it allows a project manager to know precisely how far along he or she is, how much work is remaining, what the expected cost and end date will be, and all sorts of other interesting information.

On the other hand, implementing earned value on your project requires a tremendous level of discipline and common processes. In fact, it is hard to apply earned value one project at a time, since no one else would understand what you are doing and why. The calculations behind earned value can seem very complex at first. However, the basic concepts don't have to be intimidating.

Background

Earned value has not been around for hundreds of years. You can actually trace its beginning to the late 1800's and early 1900's, as managers attempted to make the factory floor and the production line as efficient as possible. The drive for efficiency requires a foundation in metrics, and earned value was a way to measure things more precisely.

In the 1960's, the US Department of Defense began to mandate the use of earned value on defense related projects. As you might expect, if the government is contracting out projects worth hundreds of millions, or billions, or dollars, they want project progress updates to consist of more than "we seem to be on target." Earned value calculations can provide a better sense for exactly where the project is against the baseline and provide an early warning if the trends indicate that the project will be overbudget or over its deadline.

The Basic Concepts of Earned Value

Earned value is a way of measuring progress.

In any project, the value to be gained is based on completing the work. From a customer perspective, the business value is achieved when the project is completed. If a project gets canceled 90% through completion, the business value might be zero. However, earned value looks at this differently. With earned value, you are earning the value of the project on an incremental scale as the project is executing. When 50% of the work is completed, you could say that 50% of the value of the project has been realized as well.

The general idea behind earned value is to compare where you actually are against where you planned to be. Let's refine this idea a bit further. If your workplan has 200 activities, it is unlikely that you will work on them sequentially 1, 2, 3, 4, etc. Let's say you are currently working on the activities numbered 49, 87, 88, 100 and 108 in your workplan and that all of the dependent activities in front of them have been completed. Earned value allows you to quantify all of the work that has been accomplished so far on the project. It also allows you to quantify all of the work that should have been done on the project so far. Then, you can compare the work that has been done against the work that should have been done to determine if you are on schedule, ahead of schedule or behind schedule.

Likewise, given where you are today, earned value calculations allow you to determine the total cost of the work done so far, as well as the total cost of all the work you expected to have completed by now. Comparing these two numbers gives you a sense for whether you are trending overbudget, underbudget or on budget.

Utilizing both the schedule and cost metrics gives you more information as well. You may well be spending your budget faster than you anticipated, but what if the reason is because you are ahead of schedule as well? That is, you may be spending more because your team may be getting more work done than planned. That may be fine. Likewise, if your project is behind schedule, but you are also behind in your spending, that may be fine as well. Perhaps you were not able to get the team members allocated as fast as you planned. So, your project is behind schedule, as is your spending rate. If you have a critical end date, this may be a problem. If your end date is a little flexible, you may be fine as long as you don't overspend your budget.

Earned value gives you the information you need to make the right decisions.

Depending on which book you read, there are dozens (maybe hundreds) of earned value calculations. However, most of them involve combining a few basic earned value metrics into various permutations.

There are three metrics that form the building blocks for earned value – budgeted cost of work performed, Actual Cost and budgeted cost of work scheduled. Let's look at each of these in more detail.

Earned Value (EV)

The Earned Value is calculated by adding up the budgeted cost of every activity that has been completed. (Remember, this is not the actual cost of the work activities. This is the budgeted cost.) Look at the following example:

Today's Date: March 31

Completed Activity	A	B	C	D
Target Date	March 10	March 15	March 31	April 5
Budgeted Cost	20	10	15	5
Actual Cost	20	5	20	10

Let's say that we have completed activities A, B, C and D. Can you guess the simple formula for finding the Earned Value? You got it. It's (20 + 10 + 15 + 5), which happens to be the convenient round number of 50.

You might ask how you calculate an activity if it were in progress. Actually you have some discretion to set the rules up front. One option is to consider the activity as being zero percent completed until it is totally completed and then give 100% of the credit. In other words, when activity B (above) starts, the EV is zero. When activity B ends, the EV is 10.

Another option is to give partial credit. For example, when activity B starts, the EV is zero. When the activity is in progress, you can give 50% credit, or an EV of 5. When the activity ends, you give it the full EV of 10.

Likewise, you can get more precise (say, giving credit in 10% increments), but each level of precision results in more work for marginally more accuracy.

EV is the basic measure of how much value the project has achieved so far. By itself, it does not tell you too much. So, we use it in combination with other calculations to determine your status.

Actual Cost (AC)

To calculate this number, add up the actual cost for all the work that has been completed so far on the project. This could include the internal and external labor costs, as well as invoices paid (or perhaps purchase orders approved). If you have an automated financial system that will crank these numbers out, it is not too hard of a task. If you cannot capture all of the costs automatically, it could be very time consuming. If your project only consists of labor, then the cost and the effort will track along the same lines. If you have a lot of non-labor costs in your budget, then the project costs don't directly tie to the labor used.

Let's look at our example again.

Today's Date: March 31

Completed Activity	A	B	C	D
Target Date	March 10	March 15	March 31	April 5
Budgeted Cost	20	10	15	5
Actual Cost	20	5	20	10

The Actual Cost for activities A through D is (20 + 5 + 20 + 10) or 55. You can see that the actual costs for the work performed are greater than the budgeted costs of the work performed. This could be a problem.

Again, if an activity is in progress, you could use the same options that were discussed in the EV to determine whether to include the actual cost, or some percentage allocation (0 through 100%).

Planned Value (PV)

This is the sum of all the budgeted estimates for all the work that was scheduled to be completed by today (or by any specific date).

Today's Date: March 31

Completed Activity	A	B	C	D
Target Date	March 10	March 15	March 31	April 5
Budgeted Cost	20	10	15	5
Actual Cost	20	5	20	10

Now we have a little more information. Since today's date is March 31, the Planned Value is A + B + C (20 + 10 + 15) or 45. We do not count activity D, since it was not scheduled to be completed by March 31.

Now let's put these fundamental metrics together.

Today's Date: March 31

Completed Activity	A	B	C	D	Remaining Work
Target Date	March 10	March 15	March 31	April 5	July 31
Budgeted Cost	20	10	15	5	500
Actual Cost	20	5	20	10	?

Schedule Variance (SV)

The Schedule Variance (SV) tells you whether you are ahead of schedule or behind schedule, and is calculated as EV - PV. In our example above, the EV is 50 (20 + 10 + 15 + 5) and the PV is 45 (20 + 10 + 15). Note that the difference is activity D. Since work has been completed on this activity, it is included in the EV. However, since it was not scheduled to be completed by March 31, it is not included in the PV.

The Schedule Variance is 5 (50 – 45). If the result is positive, it means that you have performed more work than what was initially scheduled at this point. You are probably ahead of schedule. Likewise, if the SV is negative, the project is probably behind schedule.

Cost Variance (CV)

The Cost Variance gives you a sense for how you are doing against the budget, and is calculated as EV - AC. If the Cost Variance is positive, it means that the budgeted cost to perform the work was more than what was actually spent for the same amount of work. This means that you are fine from a budget perspective. If the CV is negative, you may be overbudget at this point. In our example above, the EV is 50. The AC is 55. Therefore, the Cost Variance is -5 (50 – 55), which implies we are overbudget.

Schedule Performance Index (SPI)

This is a ratio calculated by taking the EV / PV. This shows the relationship between the budgeted cost of the work that was actually performed and the cost of the work that was scheduled to be completed at this same time. It gives the run rate for the project. If the calculation is greater that 1.0, the project is ahead of schedule. In the example above, the SPI is equal to (50 / 45) or 1.11. This implies that your team has completed approximately 11% more work than what was scheduled. If that trend continues, you will end up taking 11% less time to complete the project than what was scheduled.

Cost Performance Index (CPI)

This is the ratio of taking the EV / AC. This shows the relationship between the Earned Value and the actual cost of the work that was performed. It gives the burn rate for the

project. If the calculation is less than 1.0, the project is over budget. In our example, the CPI is (50 / 55) or .91. A CPI of .91 means that for every $91 of budgeted expenses, your project is spending $100 to get the same work done. If that trend continues, you will end up over budget when the project is completed.

Budget at Completion (BAC)

This calculation can be in terms of dollars or hours. It is the Actual Cost (AC) plus the budgeted cost of the remaining work. However, if the Cost Performance Index (CPI) is not 1.0, it means that you are spending at a different rate than your plan, and this needs to be factored in as well. So, the better formula for the Budget at Completion (BAC) is the AC + (Budgeted Cost of Work Remaining / CPI). In other words, if you are running 10% overbudget to get your work done so far, there is no reason to believe the remaining work will not also take 10% more to complete, and your final budget at completion would be 10% over as well.

In our example above, the AC is 55 and the Budgeted Cost of Work Remaining is 500. The estimated budget at completion would be 55 + (500 / .91) or approximately 604.5. Since our total budget is 550, this shows that we will be approximately 10% over budget.

Putting the pieces together in the above example, Earned Value calculations tell us that the project is trending 11% ahead of schedule, but 9% overbudget. In other words we are spending faster than budgeted, but we are also getting more work done. This may not be a problem. If the trend continues, it is likely we will finish ahead of schedule, but close to our budget.

Environmental Complexities of Your Organization

There are a number of environmental factors that must be in place before Earned Value can be implemented. On the project side, the biggest factor to consider is the simple rule of “garbage in – garbage out.”

- **Workplan.** You need a good workplan with good estimates for all of the underlying activities. If you are imprecise with your effort and cost estimates, earned value calculations will not work well for you.
- **Scope change management.** If you create good initial estimates for the work activities, but then you do a poor job of managing scope, the Earned Value calculations are going to go bad in a hurry. On the other hand, the earned value numbers would be showing the effects of taking on more unapproved work and so they would start to raise a problem flag early in the project.
- **Capturing actual effort and cost.** Many project managers build good workplans and manage the workplan based on completing the activities on schedule. Many projects don’t capture the actual effort hours associated with completing each activity. Obviously that is needed for Earned Value calculations to work.

Organizational Factors

It is difficult to implement Earned Value on one individual project if the entire organization is not behind it. First of all, it takes time to capture and calculate Earned Value numbers, and you may find that this extra time is not appreciated by your manager – even if you could show that the extra time invested would ultimately result in a better managed project. Likewise, the resulting Earned Value numbers would be of interest to the project manager, but most other stakeholders in the organization won't have a clue as to what the formulas mean.

From an organizational perspective, the implementation of Earned Value into the organization requires a change in the way people perform their jobs. As such, it needs to be seen as a culture change initiative. First and foremost in a culture change initiative is sponsorship and leadership. You must have a champion who is willing to be the sponsor and who will ensure the proper training, processes and incentives are put into place so that Earned Value concepts are applied consistently across the organization.

The work required to implement earned value also depends on the processes that exist in your organization today. If your organization is not used to creating detailed workplans with accurate effort, cost and duration estimates, it will take some work to build that skill. Likewise, if people aren't used to tracking time and costs on an activity level, it will require major changes to how team members account for and track what they are working on. To implement time reporting may require new tools and processes be established as well.

Weighing the Cost Against the Value

Here is the decision process that you might go through to know if Earned Value should be implemented across the organization.

First, they would look at the effort and cost associated with implementing the concepts successfully. As described earlier, depending on where the organization is today, the cost could be substantial and the timeframe could be quite long.

Second, they need to determine what other core skills will need to be enhanced to make the Earned Value concepts work. For instance, project managers may need to learn better estimating techniques for the calculations to be relevant. They may also need to learn better techniques for building more accurate workplans.

Third, after understanding the effort and cost, you would ask what incremental value would be gained by having more precision on measuring project progress. For instance, if a project manager manages by end date, they should pretty much know whether the project is ahead or behind schedule. So, if the project manager can estimate that a project is three weeks over schedule, is there really much additional value with knowing that the project is trending three weeks and two days over schedule, as shown through Earned Value calculations? Likewise, a project manager may estimate a project is $10,000 overbudget, while the Earned Value calculation might show that the project is trending at $10,615 over budget. In other words, if

the project managers have a decent skill set today, what incremental value will be gained by going to Earned Value?

In some cases, there may well be enough value to go through the pain of the culture change and time tracking. If there is enough benefit, Earned Value is a very good technique for determining where you are at on a project and how much work is remaining.