A Measure of Time

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August 13, 2009

For on-time delivery, project managers must accurately assess schedule performance. Earned Schedule, a new twist on earned value management, uses quantitative analysis to establish overall progress or lack thereof. Here is a real-world primer, supported by helpful utilities, on Earned Schedule, what it reveals about overall schedule performance, and how specific tasks can affect it.

Vijay was worried about his project. He was two months into a six-month schedule, and a major milestone loomed next week. His boss was demanding daily updates. The vendor kept telling him that everything was fine, but some of the deliverables were overdue. Oddly, others were done early. Vijay studied the schedule, but with dozens of tasks in play, he could not get a fix on how things were going overall. He was not even sure that he was watching the tasks at most risk.

Vijay's situation is a common one for project managers. They need to quickly and accurately assess schedule performance. Experience is a valuable guide, but it has limits: many project managers have not had time to develop their instincts, and even "old hands" can use help on unfamiliar or exceptionally large, complex, or time-critical projects.

Ideally, project managers would have access to a visual representation of schedule performance, making it easy to understand and to communicate. The assessment would be based on best-practice, quantitative grounds, preferably backed-up by solid theory and demonstrated results. Finally, the assessment would highlight the tasks at greatest risk.

As the result of a new twist on an old technique, the ideal is now a reality.

Old Technique, New Twist
Earned Value Management (EVM) is a technique for quantitatively assessing project performance that has been around for decades. Simply put, EVM assigns a value to work that is planned and to work that has been completed. *Planned Value* is the budgeted cost of the work to be performed. *Earned Value* is the budgeted cost of the work times the percent complete. *Cost performance* is measured by comparing earned value and the actual cost of the work performed. *Schedule performance* is measured by comparing earned value and planned value.

Studies have repeatedly shown that EVM accurately assesses project cost performance. It is not, however, as successful in assessing schedule performance. First, **schedule performance is expressed in terms of cost, rather than time, making the measurement less intuitive**. Worse, because schedule performance metrics compare Earned Value and Planned Value, they ultimately break down. At the end of a project, the Earned Value equals the Planned Value, by definition. Consequently, even if a project completes three months late, it shows zero schedule variance (the difference between Planned Value and Earned Value), and it has a perfect schedule performance index (Earned Value divided by Planned Value).

A new twist on EVM has emerged over the past few years, and it resolves these problems. Credit Walt Lipke, retired deputy chief of the software division at Tinker Air Force Base, whose approach utilizes the traditional concepts of Earned Value and Planned Value but relates them directly to time. The idea is simple and elegant. **The amount of _time_ that is earned on a project is measured by correlating Earned Value, Planned Value, and timeline**. The metric is then used to assess schedule performance.

Earned Schedule
The following chart shows how Lipke correlates value and time to measure what Lipke calls Earned Schedule.
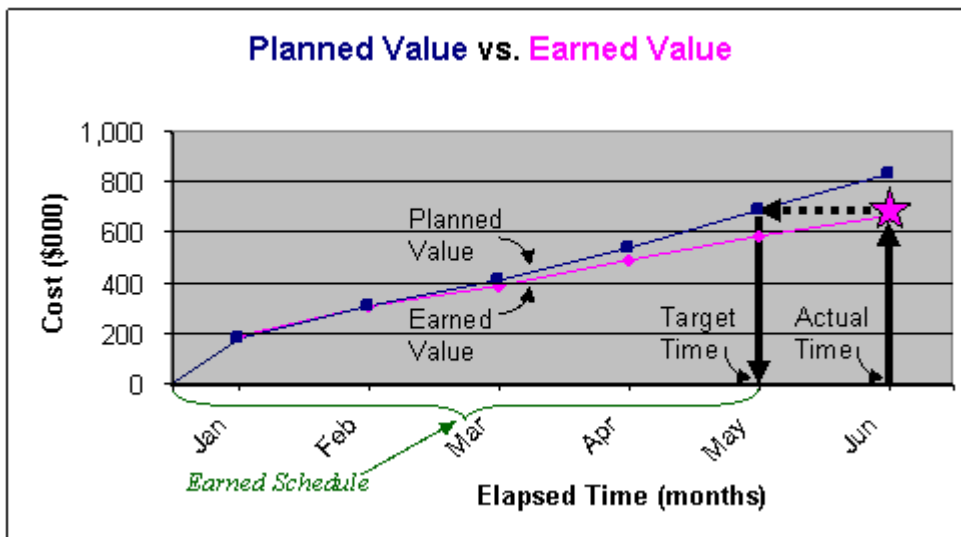

To find the amount of time that has been earned, first determine the value that has been earned at an actual time (the pink star in Figure 1). Next, map that value onto the cumulative planned values for the project. The dotted line in the chart points to the equivalent value on the planned value curve.

The point where the two values are equal implies the amount of time that has been earned. To quantify it, drop a line from the intersection point to the timeline. This represents the amount of time it took to get to the planned value at the intersection point. Call this the target time.

Now, sum the time segments: count the number of periods between the project start and the target time. The Earned Schedule is the total of those periods. In the chart above, the Earned Schedule is Jan-May, five months.

Practical Application
Applying the theory to Vijay's project, we can clearly see that he is facing a problem. The top line (blue) shows the cumulative amount of time used in the baseline schedule. Plotted against it, the bottom line (pink) shows the amount of time earned each week — the Earned Schedule.
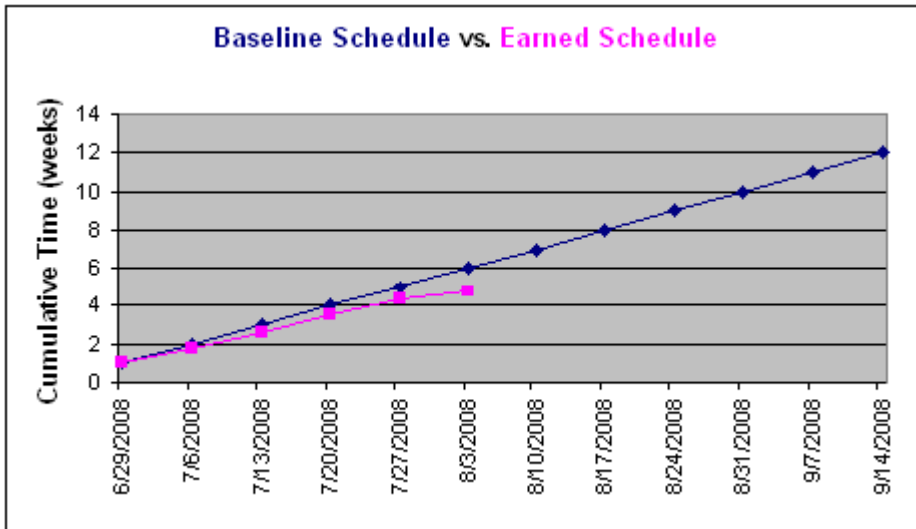
When the earned schedule is tracking below the baseline schedule, it indicates poor schedule performance — the schedule is running late. The wider the gap between the two curves, the worse the performance. The chart shows that there are signs of a gap opening up, but is it serious?

The next chart helps determine how quickly a response is due.
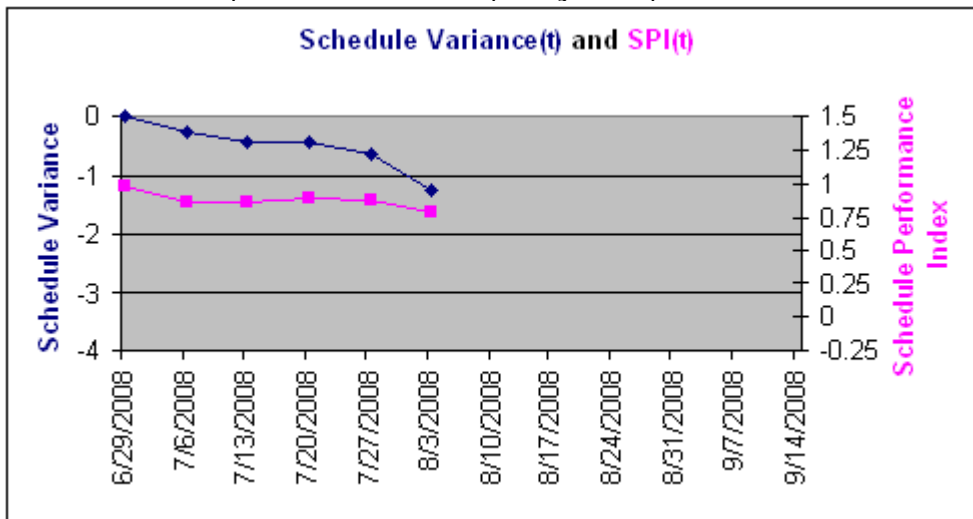
The top line (blue) in the chart shows the amount of variance between the Baseline Schedule and the Earned Schedule. The bottom line (pink) shows the ratio between the two. Reading the left-hand scale, the variance is below zero (not good) and dropping. Reading the right-hand scale, the schedule performance index is below one (also not good) and is dropping. Both confirm that a problem is emerging. Of greater concern, the slope of the lines shows that it has worsened more quickly over the past two weeks. If that trend continues, the problem will soon become unrecoverable.

Note: To generate charts like these for your project, download the **PAW Schedule Performance Analyzer** from the Tools—Decision-Making section. Instructions for its use are embedded in the file.

Immediate action is required, but action on which tasks? Thus far, there is no indication of the tasks that are causing the problem. Their identification requires another twist on the old Earned Value technique.

Vijay could see from his schedule performance charts that a gap had opened between the time planned for the project and the time that had actually been earned on it. The charts also told him that the problem was worsening rapidly. He needed to take immediate action, but he wasn't sure what tasks were causing the problem. Earned Schedule provides an answer by extending concepts associated with schedule performance measurement.

Schedule Efficiency
EVM measures the efficiency of schedule performance — whether the volume of work matches expectations. Think of the fuel efficiency of a car: it is measured by a standard mileage rating, e.g., 17 miles per gallon. If the tire pressure is lower than the recommended level, the gas mileage declines. If the pressure is higher than the recommended level, the mileage is better than the standard.

As with fuel efficiency, schedule performance efficiency can range both above and below the standard. The Schedule Performance Index, for instance, can be below 1, indicating that the schedule efficiency has dropped, or above 1, indicating that productivity is higher than planned. In either case, what is relevant is how much value has been earned versus how much was expected in the same period.

With this information, project managers can readily determine what tasks are late. The project manager simply filters the schedule to display tasks with planned progress but which are still unfinished.

Schedule Adherence
This is not the whole story. It does not tell how well the work is being executed in relation to the plan. Consider the following scenario.

Say that there are three sequential tasks: A, B, and C. Tasks A and B are scheduled to be done this week; task C is not scheduled to start until next week. At the end of the week, suppose that A and (surprisingly) C are done, but B is only half finished. If we assume that each task has one unit of Planned Value, it would appear that we did better than planned. The completion of A and C constitutes 2 full units of value, and B adds another ½ unit, for a total of 2½ units. The plan called for completion of A and B,

totaling 2 units. The Schedule Performance Index would be greater than 1 for this period — an apparently positive outcome.

What is not taken into account is the fact that C depends on B, and we have completed the work out of sequence. Imagine that A = Requirements, B = Design, C = Build. What we have just said is that the construction was completed before the design was finished — a possible, but risky, approach. The sequence in which work is completed is just as important as the total volume of work completed. It needs to be factored into an analysis of the tasks at risk.

Old Technique, Another Twist
Traditional measures of schedule efficiency, such as Earned Value, do not measure how well the schedule as a whole is being followed. Lipke recently extended his theory so that adherence to the schedule can be measured. In doing so, he has made it possible to identify more completely the tasks at risk.

Another chart, adapted from Lipke, helps to visualize the situation.
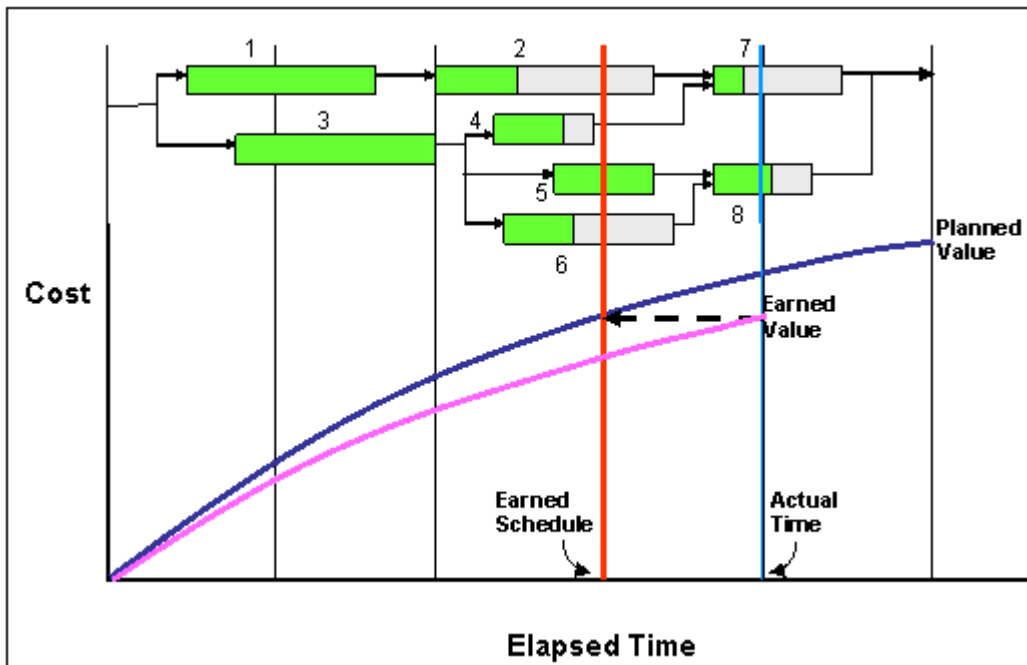
The bottom part of the chart has curves like those in Figure 1. A network diagram has been superimposed on the top of the chart to show the connection between the scheduled tasks and the planned and earned values. As value is earned on tasks, the bars on the chart are filled in.

If the schedule were being executed according to plan, tasks 1-6, and only those tasks, would be shaded up to the Earned Schedule line — that would show all and only the value planned up to that point had been earned. The schedule alignment would be perfect, and like the wheel alignment on a car, it could not be any better than fully aligned — schedule adherence measurements cannot range above the limit.

What is shown is more typical: the tasks are in various stages of progress. Tasks with earned value to the left of the Earned Schedule line are tracking toward expectations, even if they are not complete. Tasks with earned value to the right of the line are being done early. Either way, they are out of alignment.

Tasks that run behind are at risk because they indicate some kind of impediment or constraint. For example, a resource may lack the necessary training or tools to keep pace with the timeline.

Tasks that run ahead may well be subject to re-work, as they are proceeding with incomplete information. For example, a resource has forged ahead thinking that he can fill in missing information on his own.

Whether they are behind or ahead, tasks not adhering to the schedule should be examined.

Practical Application
In large schedules, a chart like the one above is impractical. With dozens of tasks in play, the network diagram would be confusing. A project manager such as Vijay needs to focus on the tasks that do not have the amount of value that they should have. A table like the one below, again adapted from Lipke, is a more effective representation.

Task	PV	PV@ES	EV@AT	EV-PV	I/C or R
1	10	10	10	0	OK
2	12	9	5	-4	Behind
3	10	10	10	0	OK
4	5	5	3	-2	Behind
5	5	2	5	3	Ahead
6	8	4	3	-1	Behind
7	7	0	1	1	Ahead
8	5	0	3	3	Ahead
Total	62	40	40	0	

The first column contains the planned value for each task. The second column indicates the value planned as of the Earned Schedule time. The third column displays the value earned by the actual time. Three tasks, 2, 4, and 6, are behind, as indicated by the negative differences in the Earned Value – Planned Value (EV – PV) column. Something is blocking progress. Three other tasks, 5, 7, and 8, are ahead, as indicated by the positive differences. Re-work is likely. The remaining tasks are progressing according to schedule.

Note: To generate a table like the one above for your project, download the **PAW Task Performance Analyzer** from the Tools/Decision Making section. Instructions for its use are embedded in the file.

As Vijay analyzes schedule performance, he must attend to both the amount of work that is being completed and the sequence in which it is being done. Consequently, he must examine tasks that are simply late versus the actual time and tasks that are not adhering to the schedule, whether their completion is lagging or early versus the earned schedule time.

Vijay's project was a real one, as was his problem. He used the charts above and the full table listing the tasks at risk to detect the problem, identify its seriousness, and take action on specific tasks. Within three weeks, the schedule was back on track, and the project finished on time.

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