Applying Earned Schedule Principles in a Non-EVM Environment
(a.k.a. The "Baseline Execution" Concept)

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Abstract

The application of Earned Schedule (ES) principles has greatly expanded the usefulness of Earned Value Management (EVM) in terms of schedule performance analysis. However, what should be done when a project is not managed with EV? Or what if a project is in a critical stage of execution and a constant watch on schedule performance is needed (in addition to critical path analysis), but fresh EVM data is still almost a month away? This paper will discuss ways to apply Earned Schedule principles on any schedule, regardless of the presence of EVM or resource-loaded activities.

Introduction

Most traditional Earned Value (EV) analysis is centered on the spread of Budgeted Cost of Work Scheduled (BCWS) and Budgeted Cost of Work Performed (BCWP). Both are typically measured in terms of dollars (plotted on the y-axis) and spread along a time-line (plotted on the x-axis) to calculate schedule indices such as Schedule Performance Index (SPI) and Schedule Variance (SV) in terms of dollars (y-axis). The concept of Earned Schedule uses the exact same EV (BCWS/BCWP) plot, but instead uses the x-axis (or time) to measure performance.

In the absence of a resource loaded schedule, the event curve (or, if turned upside down, the event burn-down) is essentially the equivalent of the BCWS/BCWP plot. It uses the exact same time-line, but on the y-axis a simple task count is substituted for dollars. Since an Event Curve is similar to an EV plot, it stands to reason that ES principles can be applied to an Event Curve in the same way it is applied to a BCWS/BCWP plot.

The "Baseline Execution" Concept

Earned Value is a long-standing method to aid in the management of projects. Earned Schedule is a much newer concept that builds on the EV basics. Earned Schedule uses the exact same EV plots of BCWS and BCWP, except instead of measuring budget and performance in terms of cost (y-axis), it measures them in terms of time (x-axis) (*see Exhibit 1*).

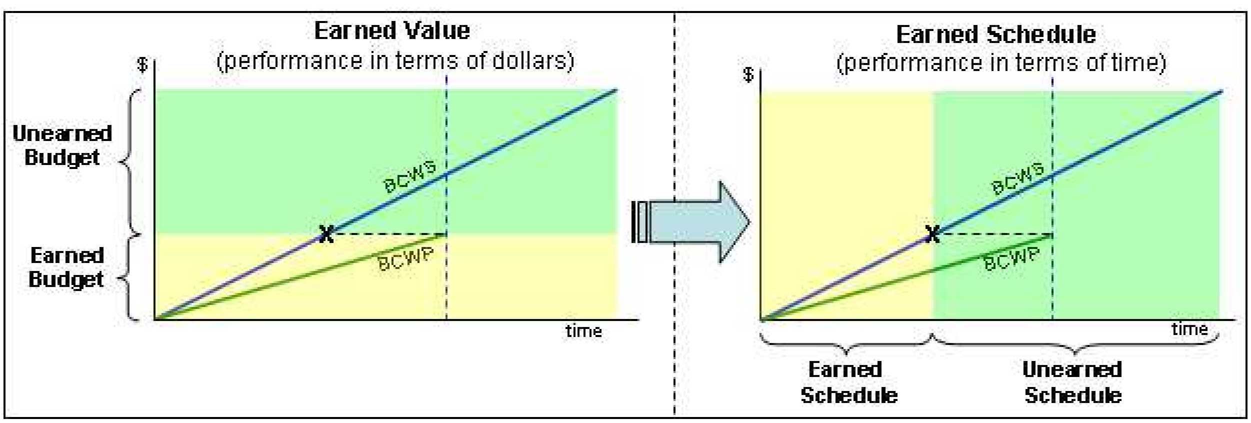

Exhibit 1 - Earned Value versus Earned Schedule

BCWS ~ Planned Completions
Budgeted Cost of Work Scheduled (BCWS) is the planned time-phased spread of dollars (or resource hours). Because activities can be of varying cost/duration/resource distribution, activities within a schedule can affect the total BCWS spread in varying degrees.

The "Planned Completions" plot on an Event Curve treats all activities the same – a long activity affects the total Planned Completions plot in the same way a short one does, and an expensive activity is no more or less influential than a cheaper one. All tasks count as one task, regardless of shape or size.

Therefore, if all activities cost exactly $1, and that dollar was scheduled to be earned upon completion of the activity, the shapes of the BCWS line (in an EV plot) and the Planned Completions line (in an Event Curve) would be identical. Since in the real world not all activities are weighted equally, the two lines are similar – but not equal (*see Exhibit 2*).

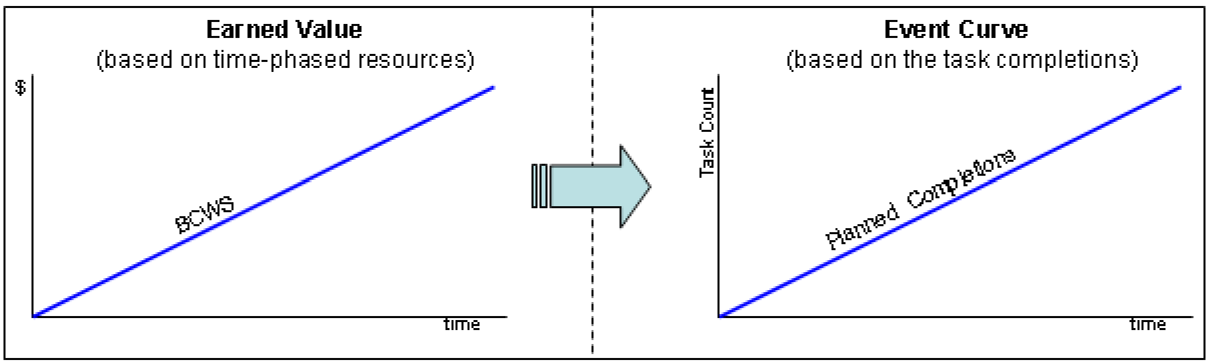

Exhibit 2 – BCWS versus Planned Completions

BCWP ~ Actual Completions
Budgeted Cost of Work Performed (BCWP) is the time-phased spread of dollars (or resource hours) that have been earned to date. Similar to BCWS, the effect an accomplished activity will have on the cumulative BCWP will vary depending on factors such as the total cost, duration, and resource profile of the activity.

The "Actual Completions" plot on an Event Curve treats all activities the same – a long activity affects the total Actual Completions plot in the same way a short does, and an expensive activity is no more or less influential than a cheaper one. Each task will count as one task, regardless of shape or size.

Therefore, if all activities cost exactly $1, and that dollar was earned upon completion of the activity, the shapes of the BCWP line (in an EV plot) and the Actual Completions line (in an Event Curve) would be identical. Since in the real world not all activities are weighted equally, the two lines are similar – but not equal (*see Exhibit 3*).

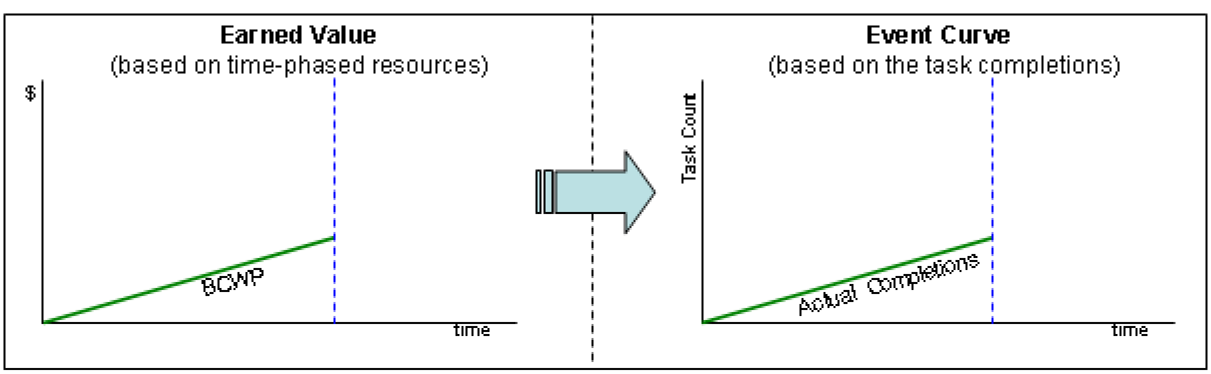

Exhibit 3 – BCWP versus Actual Completions

Originally published as a part of PMICOS 2010 Annual Conference

Earned Schedule Date versus Baseline Execution Date

The Earned Schedule Date (ESD) is the point at which the current level of cumulative earned value should have been earned according to the approved (baseline) plan. This is accomplished by tracing horizontally from the end of the BCWP plot right (if the project is running ahead of plan) or left (if the project is behind) until it intersects with the BCWS plot. From this point, drop straight down to find the date of this intersection (*see Exhibit 4 – left graphic*).

The corresponding date can be found on an Event Curve by following the same steps. First, trace horizontally from the end of the Actual Completions plot right (if the project is running ahead of plan) or left (if the project is behind) until it intersects with the Planned Completions plot. From this point, drop straight down to find the date of this intersection. This is the Baseline Execution Date (BED), or the point at which we should have finished the number of activities currently completed (*see Exhibit 4 – right graphic*).

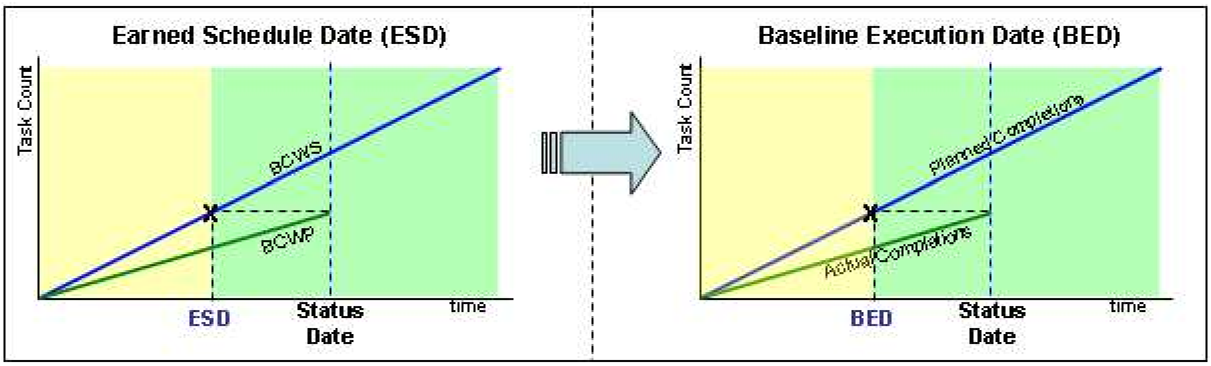

Exhibit 4 – Earned Schedule Date versus Baseline Execution Date

Earned Schedule versus Baseline Executed

Earned Schedule (ES) is the amount of time that it should have taken to earn the current level of BCWP. ES is simply the duration from the planned start of the project through the Earned Schedule Date (*see Exhibit 5 – left graphic*).

Similarly, Baseline Executed (BE) is the amount of time it should have taken to finish the total number of tasks actually completed to date. This is calculated by finding the duration from the beginning of the project, up through the Baseline Execution Date (*see Exhibit 5 – right graphic*). This is the portion of the complete baseline span that has been accomplished to date.

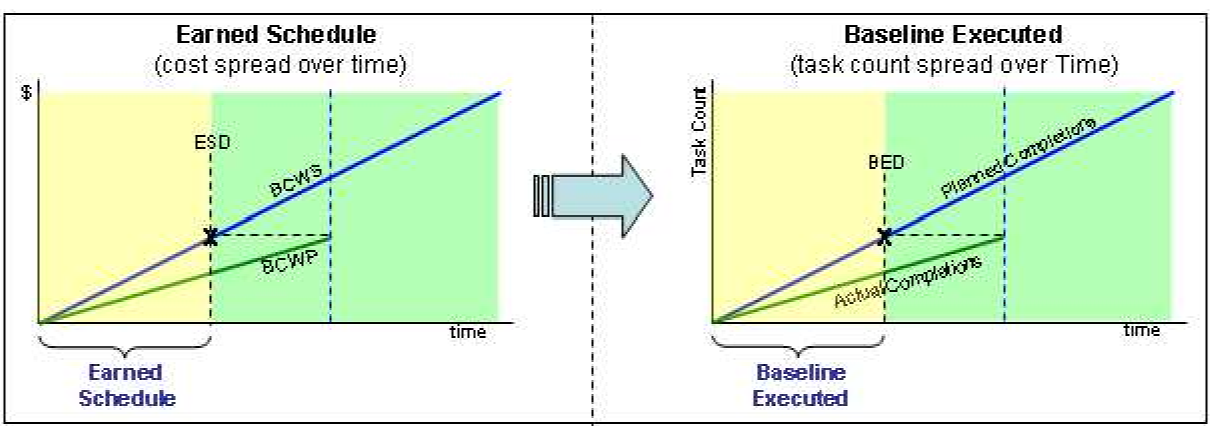

Exhibit 5 – Earned Schedule versus Baseline Executed

Unearned Schedule versus Baseline Unexecuted
Unearned Schedule (or Planned Duration for Work Remaining) is the amount of time that was planned (according to the baseline) to take to go from our current level of BCWP all the way to the project completion. It is simply the duration from the Earned Schedule Date through the end of the BCWS plot (*see Exhibit 6 – left graphic*).

Similarly, Baseline Unexecuted is the amount of time that was planned to take to finish the number of tasks currently remaining open in the project. Similarly, this is the duration from the Baseline Execution Date through the end of the Planned Completions plot on an Event Curve (*see Exhibit 6 – right graphic*).

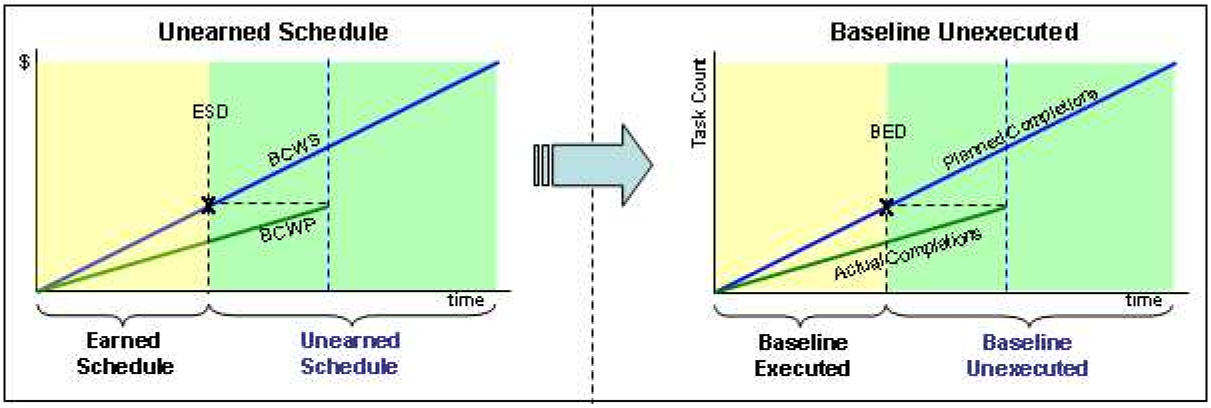

Exhibit 6 – Unearned Schedule versus Baseline Unexecuted

Baseline Execution Indices

Time-Based Baseline Execution Variance – BEV(t)
BEV(t) is similar in function to the time-based Schedule Variance, or SV(t), as calculated using Earned Schedule principles. SV(t) is the duration between the Earned Schedule Date (ESD) and the Status Date (SD) and indicates the average amount of time the project is ahead or behind its original (baseline) plan. Because the ESD on a traditional EV plot is similar in form and function to the Baseline Execution Date (BED), the corresponding schedule variance can be calculated from an Event Curve.

When a project is running exactly to plan, there will be no need to trace left or right from the end of the Actual Completions line to the Planned Completions line because the Actual Completions line is currently tracking precisely on top of the Planned Completions line. As a result, the BED will be the same as the Status Date. However, the more ahead or behind the project becomes, the bigger the delta between those two dates. That delta measured in units of time is referred to as the Baseline Execution Variance, or BEV(t) and is calculated by subtracting the Status Date from the BED (*see Exhibit 7*). This will return the number of (typically working) days between the Status Date and the BED. If this value is positive (meaning the BED is the larger/later date), the project is, on a whole, ahead of plan. If the value is negative (meaning the SD is larger/later), the project is largely behind its plan.

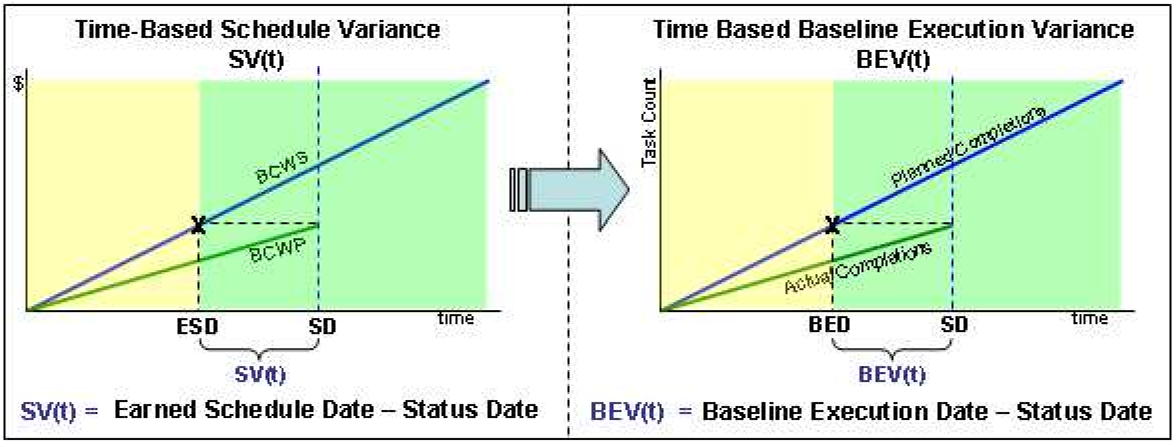

Exhibit 7 – SV(t) versus BEV(t)

Baseline Execution Variance measurements should be used to supplement Critical Path analysis - not replace it. Baseline Variance is a project average and does not necessarily mean one area of a project or another cannot be performing completely contrary to the BEV(t) metric. In fact, because it is unlikely that all areas of a project are performing exactly the same, some areas will be doing better than the current BEV(t), whereas others will be doing worse. For example, a BEV of -35 days, does not in itself mean the project is likely to complete 35 days late, but instead just points out that we should have been at our current level of activity completions 35 days ago.

On the other hand, BEV(t) should not be altogether discounted when it conflicts with critical path analysis results. This is because critical path analysis is largely subjective – estimated future durations, estimated resource availability, estimated logical relationships, etc. BEV(t), on the other hand, is completely objective (presuming accurate status of completed activities). Because of this, if the results of the critical path analysis and the BEV(t) seem too far apart, it may be an indicator that the Critical Path is being calculated based on overly optimistic or pessimistic assessments. Critical path analysis should still be the most reliable source of a project completion forecast, but BEV can be used as a sanity check to help ensure the critical path is within reason.

Time-Based Baseline Execution Index - BEI(t)
SPI(t) is a measure of the time-based efficiency at which a project is being performed, and is calculated by dividing the Earned Schedule by the Actual Time (AT) that has elapsed on the project.

Because Baseline Executed (BE) is similar to Earned Schedule (ES), and the Actual Time will be the same whether you are tracking performance with an EV plot or an Event Curve, the same concept used to calculate SPI(t) can be used to calculate a time-based performance efficiency from an Event Curve. The formula for SPI(t) is ES/AT (*see Exhibit 8 – left graphic*). Simply substituting BE for ES in this equation (BE/AT) yields the formula for BEI(t) (*see Exhibit 8 – right graphic*).

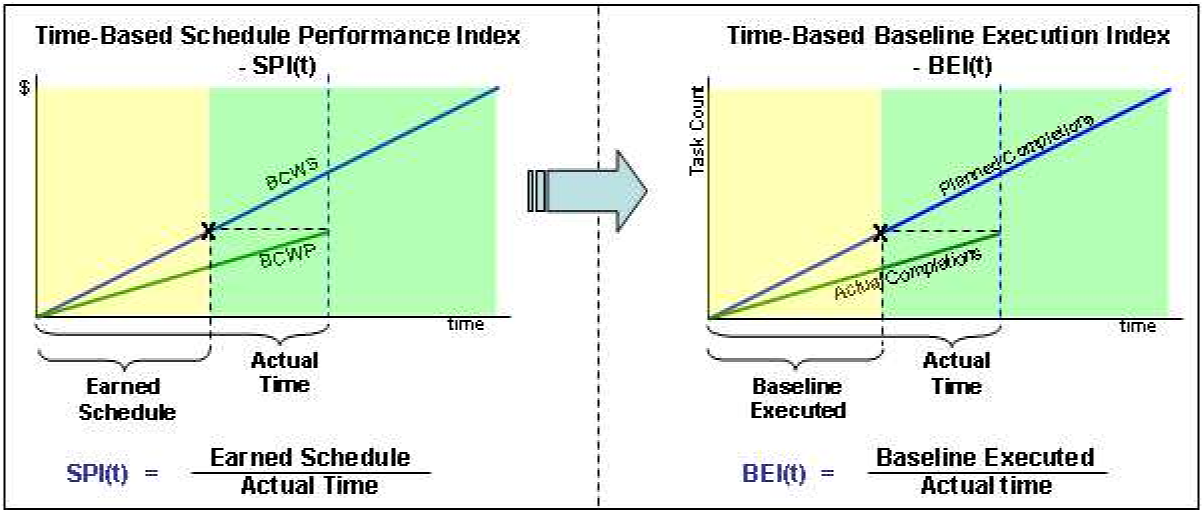

Exhibit 8 – SPI(t) versus BEI(t)

As previously discussed, when a project is performing (on average) to its plan, the Status Date and the Baseline Execution Date will be the same. Likewise, the Baseline Executed duration and the Actual Time for the project will be the same. The resulting BEI(t) for a project currently on track is 1.0. If more activities have been completed than originally planned, the Baseline Executed span will be longer than the Actual Time causing the BEI(t) to rise above 1.0 (or better than planned performance), while completing fewer activities than planned will shorten the Baseline Executed Span resulting in a ratio below 1.0 (or poorer than planned performance).

Time-Based To-Complete Baseline Execution Index - TBEI(t)
TSPI(t) is a measure of the time-based efficiency at which a project will need to be performed to achieve its projected Estimated completion Date (ECD). It is calculated by dividing the Unearned Schedule (US) by the Remaining Time (RT) to project completion.

Because Baseline Unexecuted (BU) is similar to Unearned Schedule (US), and the Remaining Time will be the same whether you are tracking performance with an EV plot or an Event Curve, the same concept used to calculate TSPI(t) can be used to calculate a time-based "to-go" performance efficiency from an Event Curve. The formula for TSPI(t) is US/RT (or Plan Remaining / Time Remaining) (see figure 9a). Simply substituting BU for US in this equation (BU/RT) yields the formula for BEI(t) (see figure 9b).

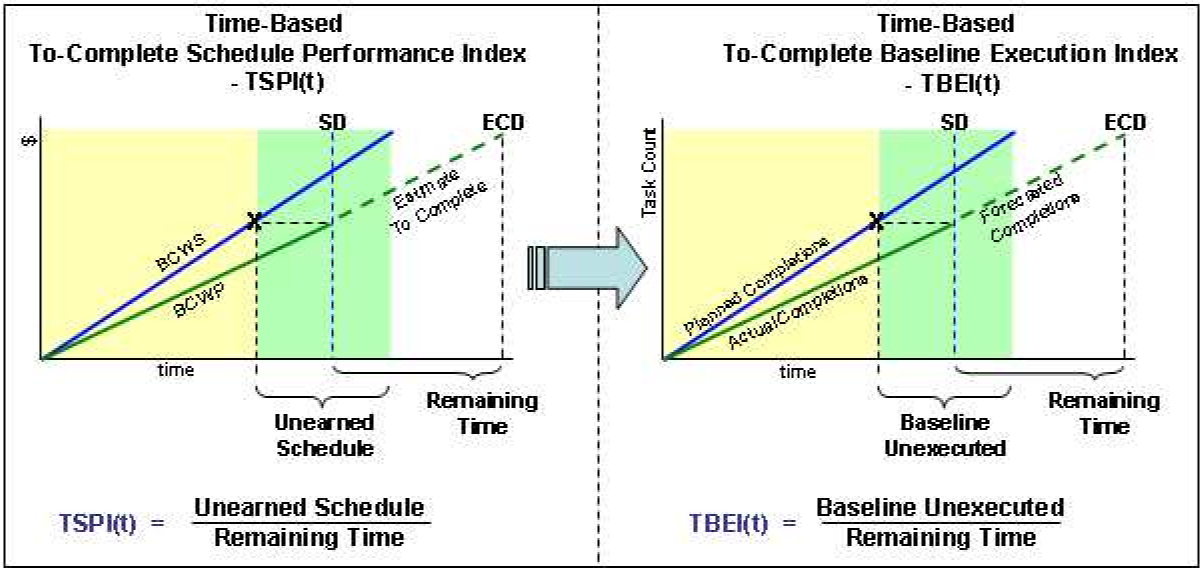

Exhibit 9 – TSPI(t) versus TBEI(t)

Unlike a BEI(t) of 1.0, a TBEI(t) of 1.0 does not mean that the project is currently on track. Instead, all it means is that amount of time originally planned to complete the open activities (Baseline Unexecuted) is equal to the forecasted remaining duration of the project (Remaining Time). If the Baseline Unexecuted is longer than the Remaining Time, it indicates the project needs to be executed at a more efficient pace than originally set, whereas if the Baseline Unexecuted is less than the Remaining Time, the project is projected to operate less efficiently than the baseline rate.

In addition to calculating the efficiency needed to achieve the currently forecasted project completion date, the efficiency needed to achieve the baseline project completion date can also be easily calculated. This is accomplished by substituting the Remaining Time to the baseline completion (as opposed to the Remaining Time to the forecasted project completion) into the TBEI(t) formula.

BEI(t) versus TBEI(t)

Although there may have been good or poor efficiency demonstrated on a given project, there is no “wrong” calculated value for BEI(t). For example, a BEI(t) of 0.75 is considered to be poor performance, but 0.75 is an accurate (or “right”) calculation assuming the IMS has been properly constructed and maintained.

Similarly, there is no “wrong” value for TBEI(t). However, there is a difference between the BEI(t) and TBEI(t) calculations. BEI(t) is a ratio of two completely objective inputs: Baseline Executed and Actual Duration. They are objective because they have already occurred and can be measured with certainty. TBEI(t) is not a completely objective measurement. This is because the duration forecasted to complete the project (or Remaining Time) is based on subjective assessments of how long tasks are expected to take to accomplish. So while there is no “wrong” value for TBEI(t), if the projected efficiency, or TBEI(t), is not similar to the demonstrated efficiency, or BEI(t), the TBEI(t) value becomes “suspicious”. The bigger the delta between the past and future efficiency calculations, the larger the suspicion becomes. When this type of difference occurs, additional investigation is generally needed to see if there is some valid reason for the shift in efficiency (such as hiring additional labor or buying a new tool to expedite operations), or if the subjective nature of downstream forecasting (estimating the project’s Remaining Time) has caused the TBEI(t) calculation to be overly optimistic or pessimistic (*see Exhibit 10*).

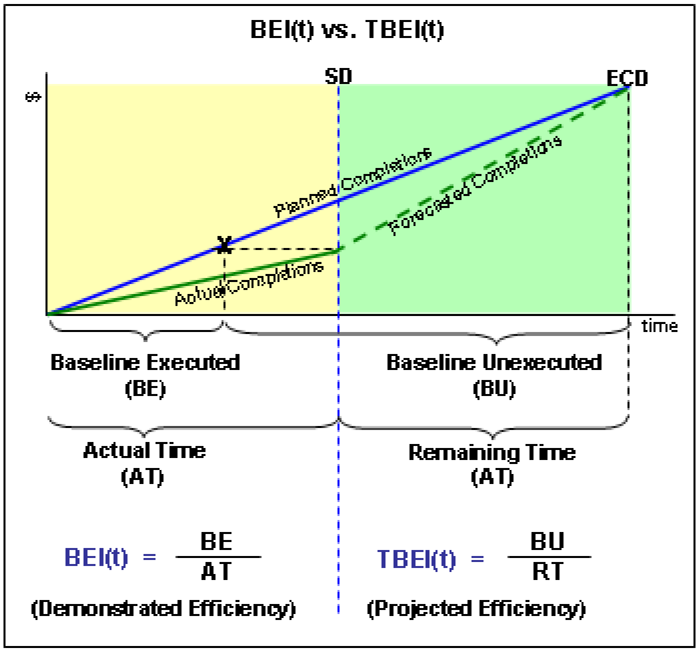

Exhibit 10 – BEI(t) versus TBEI(t)

Advantages and Disadvantages of the Baseline Execution Concept

Baseline Execution versus Earned Schedule

Clearly, resource loading a schedule will provide many more avenues for analysis than a schedule alone. While the Planned Completions and Actual Completions lines on an Event Curve may be similar to the BCWP and BCWS spreads on an EV plot, the BCWS and BCWP spreads will provide a more precise representation of the planned effort and accomplishments because of the individualized weighting of every activity in the IMS. The Event Curve will be more crude because long tasks are weighted the same as short tasks, and complex effort will count the same as simple activities. Because of the increased fidelity of the BCWS and BCWP spreads, all of the resulting Earned schedule measures will tend to be more accurate than their Baseline Executed counterparts.

Where Baseline Execution measurements may have the advantage is in the ease implementation and timeliness of use. First, an Event Curve is less involved to create than an EV plot. This is because no resource estimate loading is required. All an Event Curve needs to perform its basic function is 2 dates from each activity in the IMS: 1) Baseline Finish and 2) Actual or Forecasted Finish. Whether the IMS is resource loaded directly (within the scheduling tool), indirectly (in another tool separate from the IMS), or not at all, every IMS (that has been baselined and statused to date) is capable of producing an Event Curve.

Second, an Event Curve is more independent than an EV plot. BCWS and BCWP calculations are oftentimes tied to the accounting cycle. When this is the case, the EV plot will not change throughout the length of the period. So if the accounting cycle is monthly, it may be that decisions are being made based on EV data 3 or 4 weeks old at times. An Event Curve will generally not need to be dependent on the accounting cycle. This is because there is never a need to wait for accounting functions such as the rating of hours or the calculation of Earned Value. All that is required to produce a fresh Event Curve is to status the IMS through a later date. Because of this, a metric like BEI(t) could potentially be recalculated every day, while an updated SPI(t) value may be a few weeks away.

Baseline Execution versus Traditional Event Curves

The primary disadvantage of the Baseline Execution concept is not so much a true disadvantage as it is a potential for misinterpretation. Because variance is measured against the x-axis (or time), it can be an easy (but generally false) assumption that the project will complete ahead or behind by the amount of that variance. Like most EV and ES indices (such as SV, SV(t), SPI, SPI(t), etc), the Baseline Execution calculations are averages. Therefore, if the project is behind by 20 days as calculated by BEV(t), it does not necessarily mean the project is likely to finish 20 late to its baseline. Likewise, if the project is performing better than planned as a whole (BEI(t) > 1.0), it does not always indicate the project is likely to finish ahead of schedule. Following the Baseline Execution principles (or EV principles, or ES principles) should not be a substitute for sound critical path analysis. This is because while the BE indices are averages, the critical path is made up of the specific activities driving the project completion.

Traditional Event Curve indices are measured against the y-axis (or task count). Since at project completion the Planned Completions count will always equal the actual Completion count, measures such as BEI become less accurate (and useful) as a project nears completion. Baseline Execution indices are measured against the x-axis (or time). Since the Planned Completions and Actual Completions are never compelled to finish at the same point in time, metrics base on time/duration will hold their value throughout the life of the project. So if a project completes in an actual duration that was 110% of the original baseline duration that project will complete with a BEI(t) of .91 (accurately showing poor schedule performance) while the BEI will be 1.0 (giving the misleading appearance of on-track performance).

Using traditional Event Curve methods, calculating the efficiency needed to complete the project per the estimated completion date as forecasted within the IMS is not mathematically possible. This is because the traditional method of analyzing Event Curve variance is based on task count only (from the y-axis). TBEI(t) however, measures variance against the x-axis (or time). This will cause the calculated TBEI(t) ratio to fall or rise if the project completion slips or is forecasted earlier.

In Conclusion

In the presence of a resource loaded IMS and tools capable of easily and accurately generating basic calculations such as BCWS and BCWP spreads, using Earned Schedule principles would generally be the most desirable method of supplementing traditional Earned Value Management. If however, the schedule is not resource loaded, the tracking tools are too rudimentary or cumbersome to easily produce BCWS and BCWP spreads, or fresh data is needed more frequently than the accounting cycle will allow, implementing a standard deck of Baseline Execution metrics may be the best solution available. Because the concept of Baseline Execution follows the basic construct of Earned Schedule (only without the requirement for resources or EV), it could also be considered "Earned Schedule Lite".