Speculations on Project Duration Forecasting

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ABSTRACT – Project duration forecasting has been enhanced with the introduction and application of the techniques derived from Earned Schedule (ES). The computed forecast results from ES have been shown to be better than any other EVM-based method using both real and simulated performance data. However, research has shown that as the topology of the network schedule becomes more parallel, the accuracy of the ES forecast worsens. This paper examines a possible approach for overcoming the dilemma to further improve the effectiveness of ES forecasting.

Introduction

Earned Schedule is a measure of time duration indicating how much of the Earned Value Management performance baseline has been completed. Having the measure, allows for the creation of schedule performance efficiency. The ES schedule performance index, SPI(t) is equal to ES divided by AT, the duration from the project start to the status point [Lipke, 2003]. The concept is illustrated in figure 1 (page 4).

The derived schedule efficiency, SPI(t), is utilized to forecast project duration though the simple formula [Henderson, 2004]:

\[ \text{IEAC}(t) = \frac{\text{PD}}{\text{SPI}(t)} \]

where

- IEAC(t) = Independent Estimate at Completion (time units)
- PD = Planned Duration

The forecasting capability of the formula has been shown to be reasonably good. It has been verified by simulation and application to real project data. A comprehensive examination of the capability of two Earned Value Management (EVM) based methods and ES was made by the research team of Vanhoucke and Vandevoorde, who applied schedule simulation techniques for assessing project duration forecasting performance [Vanhoucke & Vandevoorde, 2007]. The conclusion from their work indicated, “The results …confirm…that the Earned Schedule method outperforms, on average, the other forecasting methods.”

The following year, real data from 16 projects were used for comparing the EVM time conversion forecasting methods to ES [Lipke, 2008]. The comparison was constructed to determine whether the four EVM methods, as an aggregate, produce better forecasts than does ES. The analysis strategy segregated the project data into seven ranges of percent complete in order to isolate possible forecasting characteristics or tendencies among the methods. Conclusively, ES was shown to be the best method of forecasting project duration.

This evidence is compelling for applying ES forecasting when EVM is employed for project control. However, recent research has demonstrated that the topology of the schedule has impact on the “goodness” of the forecast. The ES forecasts are more accurate for schedules which are more serial and less so when parallel [Vanhoucke, 2009].

In turn, this deficiency has lead practitioners and researchers to seek additional techniques for schedule control when schedule topology is predominantly parallel. The approach recently examined combines two techniques, ES forecasting and Schedule Risk Analysis (SRA) [Vanhoucke, 2012]. The combination has shown promise in the testing performed on both simulated and real data. However, it does complicate the analysis and significantly add work to the project control process.

CONTINUED ON PAGE 4
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Possibly, there is a second approach to the analysis and project control dilemma. If the ES deficiency for parallel topology schedules can be overcome, more reliable and significantly improved forecasting can be expected. Achieving this, the project control process discussed previously may be simplified, as well.

The idea for resolving the problem is to apply ES forecasting to the current longest path of the schedule. The remainder of the paper describes the theory and explores its application using notional data.

**Theory**

The fundamental idea for utilizing the longest path (LP) is that the ES forecast is from a schedule topology that is completely serial. As discussed earlier, research has shown the best ES forecast is for a serial schedule. Thus, the ES forecast should be improved if the LP, as it evolves in the project execution, reflects the likely duration outcome.

The concept of the current LP is an extension of the planned critical path (CP). The current LP is the longest duration from among the paths remaining to be executed from the present status point. The longest duration is determined by applying ES forecasting to each remaining serial path. This methodology has been described in the literature for comparison of planned CP performance to the total project [Lipke, 2006]. Fundamentally, the remaining Planned Value (PV) for the serial path examined is used as the Performance Measurement Baseline (PMB). The Earned Value (EV) accrued for the tasks on, say, path m is used with its PMB to calculate the path earned schedule, ESm, and the associated duration forecast.

The longest duration forecast from the remaining executable paths may be longer than the forecast made for the total project (TP). It can be deduced that when LP > TP there must be shorter paths included in the total project. Assuming this is true, it answers a question posed not long after the creation of ES, “Is the duration forecast from ES, the "lower bound"?” From deduction it is apparent, the duration forecast for the total project is always optimistic when the forecast has this relationship, LP > TP.

The theory proposed is the LP forecast at each status point resolves the described limitations of the ES forecasts, thereby providing better and more direct information for project control.
The identification of various executable paths with their associated task aggregated PV and EV is shown in figure 3. The cumulative values, PVc and EVc, are the data used with the special case calculator to compute ES for each of the paths at each status point.

To complete the understanding of figure 3 a brief explanation of the symbol “XX” is needed. When used in the PV row, the XX indicates no work was planned for the period. In the EV row, the interpretation is the execution was delayed for that period. For example, performance was not planned to begin for path 2-4-8-10 until period 3, as shown in the PVp row. For performance path 2-5-9, it is observed that although execution was planned to begin in period 3, it did not commence until period 4. This is shown with XX in the EVp row for periods 1 through 3.

Two paths, 2-5-9 and 6-9 indicate completion two periods past the planned duration of 10 periods. Thus, we know from simple inspection of the figure that execution of the planned CP (1-4-8-10) did not complete the project and that the longest path must have changed during project execution.

Figure 4 contains the computed forecasts for all of the paths and the total project. For the various paths the longest duration forecast for each status period is identified in the chart by the lime color. It is clearly seen that the current LP was identical to the planned CP for only one performance period, period two. Path 7-10 indicated the current LP for periods 4 through 7, while from period 8 through project completion, period 12, the longest duration forecasts were for path 6-9.
Figure 4. Forecast Comparison

Figure 5. Standard Deviation Comparison

Figure 6. Longest Path vs Total Project Forecasts
Results
A significant observation from figure 4 is that for every period the LP forecast is greater than the forecast for the total project. This result supports the expectation postulated earlier in the theory section. Thus it provides credence for the idea that the forecast for the total project is the lower bound; i.e., it is consistently optimistic when LP > TP.

Figure 5 indicates variation from the actual duration using the standard deviation. As shown, excluding periods 2 and 3, the standard deviation for the current LP is fairly constant with respect to the mean value of 0.446. The standard deviation for the total project behaves differently. It is significantly larger than the value for LP and, in general, improves from a beginning value of approximately 1.60 to a project completion value of 1.16. This comparison strongly suggests, forecasting is improved through the use of the current LP.

Figure 6 provides a good visual supporting the improvement in ES forecasting provided by using the current LP. As can be observed, the variation of the LP forecast is reasonably uniform around the actual duration, whereas the total project forecast has much more variation in converging to the actual duration.

As discussed earlier in this section, two of the three statements outlined in the preceding methodology section have been demonstrated. However, the third (LP forecasting removes the effect of parallel schedule topology) has not been shown through the exercise with the notional data; performance was not examined for varying topologies. Even so, logically it is plausible because the LP forecasting is applied to completely serial networks.

Summary and Conclusion
The point of this paper is to demonstrate that ES forecasting is improved by using the current LP. The results from application to the notional data indicate achievement of the objective. Figures 5 and 6 illustrate the improvement theorized, while figure 4 indicates the forecast for the total project may be considered the lower bound when the forecast for LP is the greater of the two.

Although it is more complex than the normal application of ES, the LP methodology is reasonably straightforward. The added complexity is thought to be a good trade-off for gaining the reliable information needed for project control.

A secondary improvement is that the LP forecasting may reduce the effort for the project manager and the EVM analysis staff. The recently proposed combined approach of SRA with ES forecasting is indicated to be labor intensive. The two project control methods appear to require a significant amount of analysis and threshold establishment to successfully apply the combined methodologies.

The results from the notional data example are compelling. However, they are insufficient to say LP forecasting should be adopted and employed without further examination and testing. It is recommended that those with EVM data experiment using the methods described in this paper and report their results. For those researchers that have the capability to create schedules of various topology characteristics and simulate task performance, you are challenged likewise to examine the LP approach to forecasting.

Should LP forecasting become a topic of research and application, it is proposed that the method be referenced as “ES-LP.” The terminology creates common language necessary for understanding.

References:
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Walt Lipke retired in 2005 as deputy chief of the Software Division at Tinker Air Force Base. He has over 35 years of experience in the development, maintenance, and management of software for automated testing of avionics. During his tenure, the division achieved several software process improvement milestones, including the coveted SEI/IEEE award for Software Process Achievement. Mr. Lipke has published several articles and presented at conferences, internationally, on the benefits of software process improvement and the application of earned value management and statistical methods to software projects. He is the creator of the technique Earned Schedule, which extracts schedule information from earned value data. Mr. Lipke is a graduate of the USA DoD course for Program Managers. He is a professional engineer with a master’s degree in physics, and is a member of the physics honor society, Sigma Pi Sigma (ΣΠΣ). Lipke achieved distinguished academic honors with the selection to Phi Kappa Phi (ΦΚΦ). During 2007 Mr. Lipke received the PMI Metrics Specific Interest Group Scholar Award. Also in 2007, he received the PMI Eric Jenett Award for Project Management Excellence for his leadership role and contribution to project management resulting from his creation of the Earned Schedule method. Mr. Lipke was selected for the 2010 Who’s Who in the World.
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Accepted Standards and Emerging Trends in Over Target Baseline (OTB) Contracts

Simon Dekker

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ABSTRACT – Over target baseline (OTB) projects or programs are those that have run significantly over cost and require formal reprogramming – essentially a complete re-planning of the project – in order to help the contractor regain management control over the effort. The OTB process has been well documented and become an established part of earned value management practice. Much of the literature-to-date has focused on OTBs from the contractor perspective, including the steps to take in order to propose and implement an OTB, and the proper channels and occasions for engaging the customer in the process. But effective OTB implementation is a two-way street. The customer also must take an active role in the OTB process, examining variables such as mission need, overall strategic objectives, and prevailing business conditions, when determining if a request for OTB reprogramming should be granted, or if there exist other potential alternatives to pursue. Recent research suggests that OTBs, as currently implemented, have little effect on subsequent project performance, so new questions and criteria for engaging OTBs are now beginning to emerge.

Introduction

There are many reasons why a project may run over budget. Overruns may result from unexpected increases in the cost of the resources that the project consumes – something that has become an increasingly prevalent concern as fuel and commodity costs have shown drastic price spikes in recent years – to poor project performance by the contractor carrying out the work. Often, these cost or schedule overruns can either be made up elsewhere in the project or kept within reasonable and acceptable variances. Occasionally, however, the overruns can become so pervasive that the project has to be rebaselined to a cost exceeding that of the original contract price. This type of intervention is referred to as an over target baseline (OTB), and represents a “fundamental reprogramming” of the contract [1]. In such instances, the contractor submits a proposed OTB to the customer, and if accepted, the project receives an increase in funding sufficient to carry out the remaining work detailed in the original contract. According to the Department of Defense Earned Value Management Implementation Guide, an OTB “increases the performance budget without modifying the work scope or other constraints of the contract [2].” Schedule overruns can be addressed through a process similar to OTB referred to as over target schedule, or OTS. It is very common to have an OTS occur with an OTB.

The purpose of the OTB is to “improve managerial control over the execution of the remaining work in a project [1].” An OTB represents a serious effort to get a program or project back under control when cost overruns have become so significant that there is no way in which the contract budget base (CBB) can cover the remaining work to be done. Although OTBs are carried out routinely in the sphere of government contracting, in many instances, however, the essential thrust of an OTB is misunderstood. An OTB was never intended to simply add dollars to a contract that has experienced significant cost overruns, but instead presents an opportunity and a formal process for re-examining the entire contract and its performance plan. This paper will cover a brief history of OTBs, review some of the salient terms used within the OTB process, summarize the OTB process, and discuss the concerns a project sponsor should attempt to address when an OTB is sanctioned.

OTB History

Earned value management (EVM) is a project management discipline that “integrates the technical, cost, and schedule parameters of a contract [2].” EVM is standard practice in the defense contracting community, having been used to manage Department of Defense (DoD) acquisitions since the 1960s. Essential to successfully practicing EVM is the development of an “integrated baseline [that] time phas[es] budget resources for defined work.” [2] The term OTB became integrated into the earned value management discourse in the wake of highly publicized overruns on DoD programs such as the Navy A-12 Avenger II stealth aircraft and the Air Force C-17 Globemaster III. In January 1991, then Secretary of Defense Dick Cheney terminated the A-12 program for significant cost and schedule overruns that, by one estimate, threatened to consume 70% of the Navy’s total budget for aircraft [3]. At about the same time, another McDonnell Douglas project, the Air Force C-17 military transport aircraft, incurred significant cost and schedule overruns. In that case, however, after US Congressional intervention the DoD set standards the contractor had to meet to solve cost and schedule overruns, and the program was allowed to continue. [4] As in the case of the C-17, formally reprogramming a contract through an OTB requires that the customer and contractor perform a rigorous cost/benefit analysis and thoroughly examine the remaining work to determine how to establish and move forward with a realistic baseline. As was the case with the A-12 program, if such conditions cannot be created or agreed upon, contract termination is a possible outcome. If this occurs, the customer must absorb the losses already incurred on the project, however painful, in order to save itself from the skyrocketing projected expenses of the project being allowed to move forward. The processes of OTB and OTS have evolved since the early 1990s when the customer and contractor mutually agreed to a condition in which the entire remaining work could no longer be accomplished under the current baseline.

Definitions

The Defense Acquisition University (DAU) includes OTB as part of its Earned Value Management Gold Card [5]. See Figure 1 and Table 1.

Essential to the OTB process is the term “reprogramming.” Reprogramming represents more than simply increasing the budget for the project, but rather it is a fundamental re-assessment of the program or project. An OTB essentially reboots the project, and therefore merits the same careful consideration that launching the project in the first place required. As more research emerges concerning OTBs and their effectiveness,
recommendations have been made that an OTB not be undertaken at all without a comprehensive cost/benefit analysis that examines the project risks afresh [6]. DAU makes a similar recommendation in its Over Target Baseline and Over Target Schedule Handbook [1].

**Terminology and Acronyms**

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Total Allocated Budget (TAB)</td>
<td>Contract cost. At the start of a project, Total Allocated Budget is equal to the negotiated contract cost and contract budget baseline.</td>
</tr>
<tr>
<td>Negotiated Contract Costs (NCC)</td>
<td>Contract price less profit/fees</td>
</tr>
<tr>
<td>Authorized Unpriced Work (AUW)</td>
<td>Work contractually approved, but not yet negotiated/defined</td>
</tr>
<tr>
<td>Contract Budget Base (CBB)</td>
<td>Sum of NCC and AUW</td>
</tr>
<tr>
<td>Over Target Baseline (OTB)</td>
<td>Sum of CBB and recognized overrun</td>
</tr>
<tr>
<td>Profit/Fees</td>
<td>Fixed price contracts include a profit, whereas cost reimbursement contracts include a fee</td>
</tr>
<tr>
<td>Performance Measurement Baseline (PMB)</td>
<td>Contract time-phased budget plan</td>
</tr>
<tr>
<td>Management Reserve (MR)</td>
<td>Budget withheld by PM for unknowns/risk management</td>
</tr>
<tr>
<td>Undistributed Budget (UB)</td>
<td>Broadly defined activities not yet distributed to CAs</td>
</tr>
<tr>
<td>Control Account (CA)</td>
<td>Lowest WBS element assigned to a single focal point to plan and control scope / schedule / budget</td>
</tr>
<tr>
<td>Summary Level Planning Package (SLPP)</td>
<td>Far-term activities not yet defined into CAs</td>
</tr>
<tr>
<td>Work Package (WP)</td>
<td>Near-term, detail-planned activities within a CA</td>
</tr>
<tr>
<td>Planning Package (PP)</td>
<td>Far-term CA activities not yet defined into WPs</td>
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DAU suggests that an OTB may be warranted if the contract’s projected growth exceeds 15% [1]. Projected cost growth represents the difference between estimated costs at completion vs. current actual costs and initial budget at completion vs. budgeted costs of work performed, then divided by the differences between budget at complete and current budgeted costs of work-to-date. Projected cost growth can be expressed in the following equation:

\[
\frac{(EAC - ACWF) - (BAC - BCWF)}{BAC - BCWF} = \text{% Projected Growth}
\]

EAC = estimate at completion, general, projection of total project cost combining previous actual performance and planned future work

ACWP = actual cost of work performed, actual amount spent on work accomplished to-date

BAC = budget at complete, original budgeted cost of total project

BCWP = budgeted cost of work performed, original budgeted cost of work accomplished to-date

**Process**

As previously mentioned, the OTB process has been well established in both the DAU Over Target Baseline and Over Target Schedule Handbook, as well as the DoD EVM Implementation Guide published by DCMA. It has further been defined as “a bottoms-up, collaborative assessment of remaining work that is centered on risk analysis in which cost and schedule variances are typically removed and funding is added in excess of the original contract budget base [6].”

According to these published processes, the OTB is initiated through bottoms-up communication from the contractor to the customer. The contractor will so initiate the process when it “determines that the current baseline does not represent a realistic plan for accomplishing the remaining work and no longer serves as a basis for realistic measurement [2].” This is not to say, however, that the decision to embark on an OTB is a decision that should be made unilaterally by the contractor or contractor project manager (PM). Open communication channels between the two entities are essential to the long-term success of the project. They will be required to shepherd the contract through the OTB process, and to keep it on track once the new baseline that emerges from the OTB reprogramming has been implemented.

The DAU Handbook breaks the OTB process into 10 constituent steps (see figure 2) that begin with the contractor’s decision to pursue formal reprogramming of the contract [1]. This process begins with the contractor because the purpose of an OTB is to help the contractor regain control over and better manage ongoing work. The initial plan, including a statement of remaining scope and an analysis of the potential impact of the OTB on the contract should also be developed at this stage. Several regulations, including DoD 5000.2, ANSI/EIA 748-B, and the Defense Federal Acquisition Regulation Supplement (DFARS) stipulate that the customer must then be notified in writing of the contractor’s intention to pursue an OTB [1].

In establishing consensus on the remaining scope (see figure 2), OTBs most often seek to provide additional funding for the original, agreed-upon scope of the work to be done, and therefore the DAU observes that contract changes are not traditionally required [1]. Dekker recommends that a complete assessment of all aspects of the project be considered in an OTB process including contractual changes if necessary. In some cases, the review of the existing contract reveals a failure to clearly specify crucial areas of scope or performance. Such an oversight could be the – or one of the – primary factors contributing to poor baseline adherence by the contractor. It is in these cases that customers often decide to edit or amend the contract to be more strict in the future, if an OTB is granted. These restrictions may come in the form of setting
It is important for a customer presented with a request for an OTB to recognize that the existing regulations and protocols on the OTB process are written largely from the contractor’s perspective, and the needs and perspective of the contractor are distinct from those of the customer. The options and chief concerns of a customer facing the prospect of having to allocate millions or potentially billions of dollars to a project or program that has proposed reprogramming through an OTB are addressed only briefly throughout the literature. Those concerns discussed in the existing literature will be enumerated and discussed in the next section of this paper, and other considerations a customer would do well to address will be proposed.

General business conditions prevailing upon the customer come to bear in this decision-making process. There are numerous variables, and DAU provides a detailed list of questions that could be used as a check-off list of concerns [1].

The following concerns categorize the check-off list:

- Once requested by the contractor, should an OTB be granted?
- Should the customer consider other sources? And,
- Should the program or project in fact be terminated?

Regardless of business conditions, however, customers cannot de-emphasize the role of contractor performance-to-date when assessing the relative merits of an OTB. Although given relatively little attention in some of the current literature, an OTB must include an assessment of the contractor’s performance-to-date, with a realistic evaluation of whether or not the project team in place can accomplish the necessary goals even after the OTB. Of the two defense programs cited above – the Navy A-12 and Air Force C-17 – one was ultimately canceled, and the other was threatened with cancelation unless the contractor took positive and concrete steps to rein in cost and schedule overruns. In both cases, these decisions had to be reached after billions of dollars had already been spent investing in these programs. These were painful, high-profile decisions that ultimately rested upon the customer’s evaluation of how the contractor had performed on the contract, and reasonable expectations of how the contractor would manage the project in the future, if allowed to continue.

DAU recommends that customers assess not only the contractor’s performance-to-date, which has resulted in the apparent need for an OTB, but also the contractor’s “system discipline to maintain baseline integrity, as well as compliance with the intent of the industry guidelines and the contractor’s EVM system [1].” System discipline refers to both the quality of the tools the contractor has deployed to track earned value performance, but also the human elements of the entire EVM undertaking. Even if a quality software system is in place, if it is not used consistently in the organization, it cannot produce accurate results. The contractor’s system discipline is perhaps the most crucial evaluation the customer can make at this stage, as even the most carefully thought-out OTB will fail if its execution is poor. Put simply, if there is no reason to believe that the contractor will have any greater control over a new baseline than it has exerted over the existing one, the contractor’s role in the continuation of the project must be addressed. If it no longer makes sense for the customer to move forward with the existing project team, the contract can be canceled, re-bid, or otherwise revisited.

If the customer makes the decision to proceed with an OTB, it must avoid the pitfall of looking only at the changes made by the OTB. Reprogramming a contract offers an opportunity to highlight new interpretations of established procedures and move forward with a clean slate and the added benefit of the hindsight that comes from the past performance of the contract.

**Recent OTB Findings**

The practice of issuing OTBs has undergone close academic scrutiny recently, and new findings offer guidance to customers and contractors facing OTBs.

Regarding the formulation of a new estimate-at-complete (EAC) for contracts in need of reprogramming, Elizabeth Trahan explored the prospect of using nonlinear growth modeling versus traditional earned value management indices to predict final contract costs [7]. In her research, 63-79% of OTB projects examined were able to predict their final contract costs more accurately using these growth models than by using the traditional EVM cost performance index (CPI) or schedule performance index (SPI). Trahan cites numerous examples of traditional EVM metrics failing to accurately estimate project costs. These flawed estimates can lead to poor decision making that ultimately harms project performance. E. Trahan suggests that certain nonlinear regression models, provide “a more accurate EAC to that of the CPI and composite index methods on too high of an organizational cost to bear reprogramming. Additionally, especially in the technology field, where progress takes place at an increasingly rapid pace, market conditions may have evolved to the point where by the time is has been completed a desired product or service will be obsolete, inefficient, or face insurmountable competition from similar offerings that made it to market more quickly.
71% of OTB contracts. This provides a much desired tool for these previously avoided and excluded specifically designated contracts [7].” These models can both be used as predictors for EAC during the OTB process. Subsequent research seeking to apply these models to projects before an OTB is necessary; however, the models developed by Trahan have not been successful in providing an early warning indicator to predict final costs before an OTB condition exists [8].

While the DAU Handbook lists possible benefits of undertaking an OTB [1], the research of D.E. Jack and K.E. Thickstun independently suggest that whatever benefits may be possible from OTBs, they are only rarely realized in actual practice. Thickstun draws the conclusion that the implementation of OTBs in the Department of Defense appears to happen at random, meaning that only a portion of significantly over-budget projects submit to a formal OTBs. This results in significant difficulty in formally quantifying agency-wide cost overruns. She suggests, therefore, that there is no established and quantifiable benefit that can be drawn from the use of OTBs, since there are only limited grounds for any effective comparison [8]. In potentially the most damning assessment of OTB performance, Jack’s research finds that OTBs produce no statistically significant effect on cumulative CPI slope. This means that even after the investment required to institute an OTB, the intervention “does not significantly improve management’s ability to earn cost value [6],” While acknowledging the small data set available to his research inquiry, Jack writes that “OTB does not gain managerial cost control of remaining work with respect to the cumulative CPI slope [6].” As this is the stated purpose of conducting an OTB in the first place, recent research seems to suggest an OTB may not be worth doing, barring extraordinary circumstances revealed by a new and thorough cost/benefit analysis. Jack goes so far as to suggest that the practice for formal OTBs be disallowed, barring significant cost/benefit evidence produced on an individual project basis.

Conclusion
The OTB process has evolved over the past 20 years and is now acceptable under earned value management doctrine. The process is centered around the contractor; however, the customer has the responsibility to review all business and strategic needs supporting a continuance of a major project. When an OTB becomes apparent, the customer should conduct a thorough project audit and review all attributes of a program; a complete cost benefit analysis is required. OTBs are expensive to conduct and must produce a greater sense of controlling scope, schedule and cost. The customer must have faith that the contractor can still perform the work, or that customer must consider alternative approaches if the program outcomes are still in line with corporate objectives. Both the contractor and customer must reevaluate the program and ensure that proper changes have been made in all aspects of the project to ensure expected performance. Recent studies suggest that failure to perform a complete audit increases the likelihood of not discovering opportunities that can mitigate a repeat of past performance. Both the customer and contractor must be prepared to review and change internal processes to prevent a return to the poor performance issues of the past that initially triggered the OTB intervention.

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5. Defense Acquisition University (DAU) 2010, September “DAU EVM ‘Gold Card’
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About the Author
Simon Dekker is CEO and Chairman of Dekker, Ltd., which he founded in 1984. His personal and corporate expertise is grounded in Earned Value Management and Project Management. Dekker, Ltd. is known for its software product Dekker Tracker; and it provides services to private corporations and government entities in program, project, and earned value management computer-based systems, as well as related training.

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Earned Value Management: Adapted for use in Underground Mining Operations

By Ridwan Wibiksana, CCC, PMP

ABSTRACT – The timeline to production is very important in block caving mining for major elements such as draw points, grizzlies and chutes at the extraction level. Readiness of these facilities is the key to commencing ore production flow to meet the planned date. Comprehensive project planning and scheduling, as well as real-time project monitoring, measurement and control are necessary to achieve the project’s targeted completion. Timely and accurate reporting are also required to allow project managers to respond promptly to any problems that will affect project completion.

This paper describes how the earned value management (EVM) method is successfully applied as a tool to generate real project monitoring, measuring and control in an underground mining project.

The author demonstrates the use of Earned Value Management in underground mining operations using the block caving method and concludes that EVM can be applied effectively in this operation.

The Challenge

The Underground Mining Construction Department planned to construct hundreds of draw points, and tens of grizzlies and chutes, with very short construction durations for each activity. In turn, the project management team has to ensure all facilities are delivered on time.

A comprehensive planning and construction schedule is a must. All resource requirements should be identified, such as materials availability, concrete supply, workforce, mobile equipment, support facilities (electricity, ventilation, ground support) and construction method. The project risks in terms of safety, technical and logistics should be clearly identified, assessed, mitigated and responded to throughout the project. However, those efforts are not enough to achieve project success without continuous monitoring, measurement and control of project execution activity to respond promptly to any deviation from the plan, and thence ensure on-time final delivery.

Traditional project monitoring, measurement and control, which only tracks actual progress against the total budget or plan and is reported on a weekly, biweekly or monthly basis, is not suitable for a project with a very short duration. Underground construction projects need accurate and real-time project monitoring, measurement, control, and reporting to allow the project manager to manage the project and to respond promptly to any problems that will affect project completion.

The Initiative:

Earned Value Management (EVM) Implementation

Driven by the requirement for accurate and real-time project monitoring, measurement and control tools, the project management team starts implementing the Earned Value Management (EVM) monitoring and reporting system that can be easily applied by the field project team with minimum effort while providing the needed project information in a timely manner.

Earned Value Management (EVM)

An EVM report provides information related to the project schedule, cost, and performance for the current reporting period and cumulatively, combined with the ability to forecast performance at completion.

The common EVM formulas used:

\[
\text{SPI} = \frac{\text{BCWP}}{\text{BCWS}} \quad (\text{equation 1}) \\
\text{CPI} = \frac{\text{BCWP}}{\text{ACWP}} \quad (\text{equation 2}) \\
\text{BCWP} = \text{Physical \% Complete} \times \text{BAC} \quad (\text{equation 3})
\]

Where:

- SPI = Schedule Performance Index
- CPI = Cost Performance Index
- BCWS = Budget Cost Work Schedule
- ACWP = Actual Cost Work Performed
- BCWP = Budget Cost Work Performed
- BAC = Budget at Completion

The Implementation of EVM using Microsoft Excel® Spreadsheet

The Project Management Team employs a Microsoft Excel spreadsheet since the field project team is familiar with this software and it can be customized to project requirements.

The Underground Construction Department has three types of major routine projects namely: Draw Point, Grizzly and Mechanical Chute. For simplicity, this paper will describe the implementation of EVM on the draw point project only. The same approach can be applied to any of the other underground mining projects.

The default construction schedule uses a 24/7 working calendar that is divided into 3 working shifts, i.e., day shift, swing shift and night shift. This schedule is used to support the operational requirements that also occur in the same timeframe.

Scope Identification

The draw point has design variations depending on the ground condition. These are the Half Draw Point (HDP) for a draw point with a half concrete wall in the panel drift, and the Full Draw Point (FDP) for a draw point with a full concrete wall and roof in the panel drift and draw area. Each design has a work breakdown structure (WBS) and materials list, which varies only in the quantity/volume of concrete required.

The drawpoint WBS is developed in a certain structure, as shown in Figure 1, to allow efficient tracking for a work package that has short duration. Through this approach, we can accurately measure the progress for each DP.
Baseline Estimate

The cost and schedule baseline is the key to project performance measurement, as the performance indicators are compared to the performance measurement baseline. The draw point’s cost baseline is developed using a bottom up estimate which includes direct cost elements of Labor, Material and Equipment. The indirect cost portion is covered in another control account. This separation supports the intent to use EVM at the project level to reflect performance at the field only. Separate project cost control systems which cover the fully loaded cost are generated by the overall project control team.

The draw point typical baseline cost estimate (Table 1) is for illustration only.

<table>
<thead>
<tr>
<th>WBS</th>
<th>Budget (US$)</th>
<th>Budget Duration (Shift)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Site Preparation</td>
<td>$2,018</td>
<td>$2,018</td>
</tr>
<tr>
<td>2 Lean Concrete</td>
<td>$2,306</td>
<td>$2,306</td>
</tr>
<tr>
<td>3 Embedded Rail</td>
<td>$3,460</td>
<td>$3,460</td>
</tr>
<tr>
<td>4 Concrete Floor</td>
<td>$2,883</td>
<td>$2,883</td>
</tr>
<tr>
<td>5 Anvil Top</td>
<td>$2,595</td>
<td>$2,595</td>
</tr>
<tr>
<td>6 Lintel Set</td>
<td>$2,883</td>
<td>$19,460</td>
</tr>
<tr>
<td>7 Wall &amp; Roof    &amp; $4,901</td>
<td>$8,332</td>
<td></td>
</tr>
<tr>
<td>8 Wall &amp; Roof Concrete</td>
<td>$4,324</td>
<td>$7,784</td>
</tr>
<tr>
<td>9 Stripping &amp; General Clean-Up</td>
<td>$3,460</td>
<td>$6,227</td>
</tr>
<tr>
<td>Total</td>
<td>$28,829</td>
<td>$55,064</td>
</tr>
</tbody>
</table>

Table 1. Draw point typical baseline cost

Project Schedule

Draw Point Construction is one of the projects that run under operation mode. The project produces two types of repetitive deliverables, i.e., Half Draw Point (HDP) and Full Draw Point (FDP). Both types have typical activities as well as sequences.

The monthly target draw point completion is measured by the unit of Half Draw Point Equivalent (HDP Eqv), because HDP is the major type of draw point constructed. The equivalency is calculated based on US$ amount budgeted, in this case 1 HDP = 0.52 FDP.

The draw point project schedule is tied to the targeted draw point completions per month. The number of equivalent draw point targets is equally spread over the shift periods in the month. Because of that, the BCWS on the EVM chart becomes a straight line rather than “S” shaped. The straight line shape for BCWS in this project does not significantly impact execution, but it gives flexibility to the construction crew in accomplishing work at the various project locations assigned for completion each month and to maintain productivity as targeted. This approach also reduces draw point monthly construction project scheduling development efforts.

In this illustrated case, the simulated EV calculation is using the schedule to complete 12 HDPs equivalent (eqv) per month, at certain draw point locations; and to accommodate the opportunity to exceed the monthly target or to adjust if the main target draw point areas have problems. The alternative draw point candidates are also reflected in the monthly plan (See Table 2). In this project the draw point is identified by the draw point location, such as P#1G DP 11 W – HDP. The designation means: P#1G = Panel/Drift/Tunnel number 1G, DP 11 W = Draw point number 11 West, and HDP= Half Draw Point.

Table 2. Sample of Monthly Target Plan

<table>
<thead>
<tr>
<th>Report Period</th>
<th>Shift 50th</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance:</td>
<td>Shift 50th</td>
</tr>
<tr>
<td>Actual achievement</td>
<td>= 5.81 HDPs Eqv</td>
</tr>
<tr>
<td>BCWP</td>
<td>= 5.81 HDPs Eqv x $28,829 = $167,496</td>
</tr>
<tr>
<td>BCWS</td>
<td>= 50 * 0.133 * $28,829 = $191,713</td>
</tr>
<tr>
<td>ACWP</td>
<td>= Calculated at end of the month = N/A</td>
</tr>
<tr>
<td>SPI</td>
<td>= $167,496 / $191,713 = 0.87</td>
</tr>
<tr>
<td>CPI</td>
<td>= Calculated after finance month closing = N/A</td>
</tr>
</tbody>
</table>

Table 3 Draw Point Progress Calculation Sheet
Project Progress Tracking

The goal of this project performance reporting system is timeliness, accuracy, and consistency, so a user friendly measurement and reporting system must be implemented. The project management team has developed a standard Progress Calculation Sheet (See Table 3); and a shift progress measurement check list (See Table 4). For example, Table 4 records the by shift draw point progress, and the field measurement result is uploaded at the end of the shift to the Microsoft Excel application in a shared folder on the server.

The shift crew’s performance is measured using the shift crew’s SPI, because the shift crew ordinarily works at the same location. To avoid any shift performance bias between shift crews, the progress measurement check list has to be signed and accepted by next shift crew’s foreman.

The field project team that is assigned to each shift crew has to complete the shift progress measurement at the end of the shift and input the progress to the Microsoft Excel application to a shared folder in the server. In accordance with the schematic shown in Figure 2, it then allows the project management team to monitor and control progress for every single shift and it provides a project dashboard.

### Table 4 Draw Point Progress Measurement Check List

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>8PM</th>
<th>9PM</th>
<th>10PM</th>
<th>11PM</th>
<th>12PM</th>
<th>1AM</th>
<th>2AM</th>
<th>3AM</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Site Preparations</td>
<td>1%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Complete Roadway</td>
<td>15%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Complete Draw Point</td>
<td>15%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Complete 1st Draw Point</td>
<td>35%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Complete 2nd Draw Point</td>
<td>45%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Complete 3rd Draw Point</td>
<td>65%</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Complete 4th Draw Point</td>
<td>85%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Complete 5th Draw Point</td>
<td>95%</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Completed Field</td>
<td>100%</td>
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<td></td>
<td></td>
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<td>10</td>
<td>Complete Draw Point 1</td>
<td>100%</td>
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<td></td>
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<tr>
<td>11</td>
<td>Complete Draw Point 2</td>
<td>100%</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Complete Draw Point 3</td>
<td>100%</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Complete Draw Point 4</td>
<td>100%</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>14</td>
<td>Complete Draw Point 5</td>
<td>100%</td>
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</tr>
<tr>
<td>15</td>
<td>Complete Draw Point 6</td>
<td>100%</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>16</td>
<td>Complete Draw Point 7</td>
<td>100%</td>
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<td></td>
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<td>17</td>
<td>Complete Draw Point 8</td>
<td>100%</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Complete Draw Point 9</td>
<td>100%</td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Complete Draw Point 10</td>
<td>100%</td>
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</tr>
<tr>
<td>20</td>
<td>Complete Draw Point 11</td>
<td>100%</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Complete Draw Point 12</td>
<td>100%</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Note: Using the function in Microsoft Excel that allows the user to save the excel file to “web page” type, the final report is published to the server each time the user saves the file.

Figure 2. Real-time project reporting system scheme

Project Dashboard The real-time performance dashboard that displays schedule performance is updated every shift (3X/day). This dashboard was developed using Microsoft Excel. The project dashboard does not display the Cost Performance Index (CPI), since ACWP data is only available on a monthly basis.

Figure 3. Sample of Project Dashboard
As alluded to previously, the Underground Construction Department employs this EVM method not only for draw point projects but also for other projects. Accordingly, the combined project dashboard can display the overall underground construction project performance status. The dashboard (Figure 3) has some important gauges to measure the project’s health and shift crew’s performance such as:

- **Project Level - SPI**
- **Shift Crew – SPI**
- **Project Physical % Complete**
- **Schedule alert indicator (on schedule, ahead, or target)**

**Data Interpretation** From Figure 3, the charts and indicators could be interpreted as follows:

1. SPI chart of Draw Point Project (1), starting in the 3rd week the schedule performance goes down because the priority changed and resources were allocated to other Project (3), but then target could recover by the 4th week.
2. SPI chart of HALO#4 Project (2), schedule performance goes down starting 2nd week because the priority changed and resources were allocated to other Project (3).
3. SPI chart of Other Project (3) got additional resources from Draw Point (1) and HALO#4 (2) project due to priority changed, the performance is goes higher than original target.
4. SPI chart of the overall construction (4), reflects rolling up off all construction projects, and it was on track at 1st and 2nd week, but then goes lower than the target.
5. The chart no 1, 2 and 3 could also be used as tools to balance the resources among the projects, re-allocate one to another to optimize the overall construction progress.
6. Project Health (Original Cost Based) (5), it is a numerical indicator which displays the Project’s SPI, schedule variance in work shift period and physical % complete and provides schedule remarks such as “in trouble”, “ahead”, and “on target” if it meets with certain SPI criteria.
7. Chart project % complete (6) shows the Month To Date (MTD) project % complete.
8. Budget vs Earned Value (7), the Total here means MTD Earned Value, Total planned is Monthly Budget, in this dashboard BCWP=$696,317 and BCWS=$780,590 with zero (0) shift to go, it means that this period is the end of month, and the SPI = BCWP/BCWS = <1 (behind schedule).
9. Project Health (Update Cost Based), is used, when during project execution, the scope changes or any unpredictable situations occur which require changes in budget. In this dashboard there were changes in other project scope. This is important to recognize actual team efforts and their performance, and should be compared with the actual scope undertaken.

**The Financial Benefit**
The main goal of the underground construction project is to support the mining operation. Time to production is critical, because the construction project directly affects ore production. Failing to deliver the project on time will cause losing the production opportunity and create potential delay cost.

**The Non-Financial Benefit**
This system allows the project team at all levels to see the value of their work thru the earned value report. It increases awareness concerning the project cost as well as building pride in the work accomplished. It also creates a healthy competitiveness among the shift crews to achieve the best work value and to foster accountability. This system has been created to provide real-time project status. The problems that occur can be identified in a very short time. Lastly, it enables the project manager to respond to and resolve problems promptly, thereby reducing the risk of delay in solving problems.

Our EVM-based reporting has proven reliable and has been in use since 2004 through the present day. For over eight years the Underground Construction Department has successfully used this management and reporting system as a powerful tool for managing project performance.

With simple and user friendly methods, it has reduced the effort required for scheduling, budgeting and reporting while increasing report accuracy.

**Conclusion**
Block Caving is one of the methods that is used in Underground Mining. It is a concatenated process of several activities that have dependency on each other such as Mine Planning and Engineering, Mine Development, Underground Construction, and Production and Ore Flow.

The timeline to production is very important as it directly affects ore production output. The primary facilities of block caving mining such as Draw Point, Grizzly and Chute are the major projects for underground construction supporting ore production.

Comprehensive planning and scheduling of underground construction activity is a must. However, it is not enough. Controlling and monitoring the planning, aligning the planning with the operation process, and performing “real-time” project measurement and monitoring are required for operational projects. The Earned Value Management (EVM) approach, combined with a simple and user friendly computer application is the solution for accurate and “real-time” project monitoring, measurement and control of underground construction projects. EVM with a “real-time” project dashboard has proven to improve the facility time to production line, build project team awareness of project cost, build pride in the work, create healthy competitiveness among the shift crews, and foster accountability.

**References**

**About the Author**
Ridwan Wibikasana, CCC, PMP is a project management practitioner, with nearly 17 years of extensive experience in project management, material management, project controls, planner, scheduler, budget and cost control in construction projects for infrastructures, municipalities, open pit and underground mining facilities and offshore oil and gas. He is a co-author of the Max Wideman’s translated English to Bahasa Indonesia, Project Management Dictionary, 2006 Edition. He has worked for Freeport McMoran Indonesia, the Copper and Gold Mining in Papua Indonesia, as Project and Cost Control Superintendent for about 15 years until he join with Pertamina Hulu Energi Offshore North West Java (PHE ONWJ), the Indonesia Oil and Gas Company in Jakarta Indonesia as Budget and Cost Control Team Leader. Ridwan can be contacted at ridwan.wibikasana@pertamina.com.
Customize your Independent Estimate at Completion (IEAC) Formula

Bill Mendelsohn

We all understand the value of having multiple IEACs to validate a project’s LRE. For one, a range of estimates is always preferable to a point estimate. Additionally, as DOD practitioners know, this is a requirement for the header of Format 1 of the Contract Performance Report, now described in data item DI-MGMT-81861. Having a variety of IEACs in our portfolio also contributes to more robust Monte Carlo modeling.

As a refresher, IEACs typically consist of taking BCWR or Work Remaining, dividing it by an efficiency factor and adding it to ACWP. The most basic IEAC is ACWP + BCWR / CPI which can be mathematically simplified to BAC / CPI. This IEAC does an excellent job passing the common sense test. CPI is a meaningful metric on its own. A CPI of .90 means we’re providing 90 cents of value for every dollar we spend. This IEAC is also easily explainable, “Boss, if we continue to perform at our current cost efficiency our IEAC will be $2M over our reported LRE”.

The well-known deficiency with this simple IEAC is that it assumes that we’ll continue operating at the same efficiency, when studies show that overruns tend to get worse. Thus we use a series of efficiency factors relying on composites typically involving SPI. Examples are CPI x SPI or .5CPI + .5SPI and countless variations. The studies by David Christensen previously cited in The Measurable News and elsewhere have found the ideal IEAC may depend on which phase a project is in. His papers detail the reasons for this, but for our purposes we accept that there is value in having multiple IEACs to provide range estimates and comparison points. These composite efficiency factors are useful, but meaningless. As many Earned Schedule (ES) enthusiasts will tell you, SPI is already close to meaningless, but by the time you start multiplying SPI by CPI and weighting it the results are beyond meaningless. However, anything that offers a more accurate IEAC is useful. Still not convinced? I bet if you look at your worst programs where the LRE kept growing and growing and simply took ACWP + BCWR / CPI and added .95 to the denominator for ACWP + BCWR / CPI x SPI you’d arrive at a more accurate IEAC than the standard formulas provided.

Why .95? I pulled it out of the air to illustrate that there’s nothing magical about efficiency factors using weighted CPI and SPI. Is .75CPI + .25SPI somehow meaningful or more pure because the weights add to 1.0, even if multiplying by some made up factor like .95 is more accurate? Where estimates are concerned, I’ll trade purity for accuracy any day.

I’m not advocating we all start adding .95 to our existing efficiency factors. What I’m driving at is identifying a new efficiency factor, let’s call it e, to add to our IEAC portfolio. Here’s how I calculated the e for a selected a group of like projects. First, I only selected projects with suspect or optimistic LREs. I selected products where the Variance at Completion (VAC) was more optimistic (higher) than the cumulative Cost Variance (CV). I call this the Keenu metric and we’re interested in negative Keenus because that is where the project is projecting to improve the existing overrun, which rarely happens. For example, you have a program where you project a VAC of -$2.5M and a cumulative CV of -$4.0M. Our Keenu in this example is -$1.5M = -$4M – (-$2.5M) ; a negative Keenu is an indicator you may have an overly optimistic LRE. The LRE is stating that not only are we not going to maintain this same level of inefficiency, somehow we’re going to get more efficient in the future. I don’t typically perform IEAC analyses on programs with a good Keenu. Why bother? We have better uses for our time than fixing the unbroken.

Next, I took the standard IEAC composite formula of ACWP + BCWR / (CPI x SPI) to solve for e. First I added e, ACWP + BCWR / (CPI x SPI x e). This is the formula we’ll use to calculate IEACE after we determine our e constant. To do this, we solve for e where e = BCWRold / (CPIold x SPIold x ETCfinal) on a selection of projects that are now complete. For the variables labeled ‘old’, go back to some point in time of the closed projects and plug in the numbers at that point in time. I used data from when the sample programs were around 50% complete. The ETCfinal will be the real or final LRE of the closed project minus the ACWP of the point in time you chose. This will give the ETC that the program would have used if they had a crystal ball (and were honest).

Let’s say you look at a project that finished with a VAC of -$75M and LRE of $550M. You want to know what e would have predicted that a year ago. The numbers from a year ago were:

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\begin{align*}
CV &= -$50M, VAC = -$30M, Keenu = -$20M, CPI=.85, SPI = .83 \\
ACWP &= $340M, BCWR = $135M, ETCfinal &= $210M (or final LRE of $550M minus 1 year ago ACWP of $340M).
\end{align*}
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e = BCWR / (CPI x SPI x ETC) or 0.91 = $135M / (0.85 x 0.83 x $210)
\]

Our e would be .91, so to demonstrate this e would have provided the crystal ball perfect IEAC if we used it a year ago we just plug it back in ACWP + BCWR / (CPI x SPI x e) or $340M + $135M / (.85 x .83 x .91) = IEAC = $550M (rounded).

I then applied this to my portfolio to arrive at an average e constant to apply to future projects with bad Keenu metrics. Statistically, this IEACE formula had a higher Pearson’s correlation when compared to 4 other traditional IEAC types for the same projects. The difference wasn’t statistically significant from the other IEACs, but that’s OK. I’m not recommending abandoning any of the existing IEAC, just adding one to our IEAC portfolio.

Given that the purpose of the IEAC efficiency factor is to come up with the most accurate estimate, isn’t a good efficiency factor more important than pretending that some composite like .70CPI12 months + .30SPI3 months means something? I encourage you to calculate the e on your programs and test the theory.

About the Author
Bill is currently the Director of Earned Value and Project Management at ITT Exelis, Mission Systems, 655 Space Center Drive, Colorado Springs, Colorado. During his career, he has worked in project and program management, EVM compliance, procurement, subcontracts, budget analysis, pricing, and program control. He has used EVM from the perspectives of analysis, administration, control account manager, and ensuring compliance. Bill earned a Master's in Contract Management, and obtained certifications as a PMI PMP, an AACE EVP, and a Lean Six sigma Black Belt.
Howard Dean
Featured Speaker EVM World 2013

Howard Dean is best known as a political figure, but he has had a varied career which has encompassed a wide spectrum of interests and activities, namely:

- CNBC Contributor
- Founder, Democracy for America
- Chairman, Democratic National Committee, 2005-2009
- Architect of the 50-State Strategy for Political Fundraising
- 2004 Candidate for the Democratic Nomination for President
- Governor of Vermont, 1991-2003
- Practicing Physician

Currently, Mr. Dean is engaged in the private sector as an independent consultant, focusing on the areas of health care, early childhood development, alternative energy, and the expansion of grassroots politics around the world.

Mr. Dean began his career in public service in 1982 when he transitioned from a full-time practicing physician to an elected representative in Vermont. After election as Lieutenant Governor of Vermont in 1991, he became Governor in the same year due to the untimely death of the sitting Governor. He was subsequently elected to five consecutive terms, the second longest tenure as Governor in Vermont history. During this time, he also served as chairman of the National Governors’ Association, the Democratic Governors’ Association, and the New England Governors’ Conference.

In 2005, Mr. Dean attained the position of chairman of the Democratic National Committee. In this capacity, he implemented an effective fundraising strategy, known as the “50 State Strategy”, which employed the internet as a tool to reach out to donors. As a result, Mr. Dean was credited with helping the Democratic Party to make significant gains in 2006 and 2008.

Before entering politics, Mr. Dean graduated from Yale University with a B.A. in Political Science in 1971, and he received his medical degree from the Albert Einstein College of Medicine in New York City in 1978. Upon completing his residency at the Medical Center Hospital of Vermont, he practiced internal medicine in Shelburne, Vermont.

He is married to Dr. Judy Steinberg and they have two children, Anne and Paul.
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