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Performance-based EV in Commercial IT Projects

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This article is the third linking earned value management (EVM) to technical performance or quality. It discusses how leading information technology companies in South Korea and India use Performance-Based Earned Value® on fixed-price, commercial projects. Updates to the Department of Defense acquisition reform initiatives regarding technical performance measures and systems engineering are also discussed.

Background

My wife and I were in Seoul during Thanksgiving week, eating kimchee, seafood, and Korean barbecued beef instead of turkey. I had the pleasure of teaching Performance-Based Earned Value® (PBEV) to more than 20 project managers and software engineers at Samsung SDS (SDS). SDS is the largest information technology (IT) company in South Korea, with 17 overseas offices in 10 countries and 10,000 employees. SDS has fixed-price, IT development contracts. It had applied EVM to some of its contracts and was planning to increase its use.

The Samsung Software Academy (SSA) was developing an advanced course for senior project managers (PM). The course consists of five modules, including Leading Complex Projects, Agile PM, Risk Management, Estimation, and EVM. Most of the trainees were project management professionals (PMPs) and had previous, fundamental, EVM training.

The PBEV training was integrated with SDS core training on software requirements and software estimation, based on the books written by Karl Wiegers (2003; 2006) and Steve McConnell (2006). SDS's EVM process is consistent with the *PMI Project Management Body of Knowledge* (PMBOK®) and PMBOK's focus on quality and the *product* scope. SDS does not align its processes with the US EVMS standard or with EVMS guidelines that measure only *work* scope, not product scope.

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Integrating Technical Performance Measures (TPM) and Systems Engineering (SE) with EVM

SDS's EVM training included guidance and examples that were provided in two prior *Measurable News* (MN) articles and an article in *CrossTalk.* This article refers to those examples:

- **MN1** — Fall 2008 *Measurable News*, "Integrating SE with EVM"
- **MN2** — Spring 2008 *Measurable News,* "Integrating Technical Performance with EVM"
- **CT** — May 2006 *CrossTalk*, "Practical Performance-Based EV"

Updates to these articles are near the end of this article under the section head "Updates on DoD Acquisition Reform, TPMs, and SE".

Wiegers: Requirements Baseline

- **Current set of requirements**
  - **Agreed upon**
    - **Reviewed**
    - **Approved**
    - **Committed to a specific product release**
  - **Release could be a**
    - **Delivered product**
    - **Defined interim increment of the product**

Figure 1.

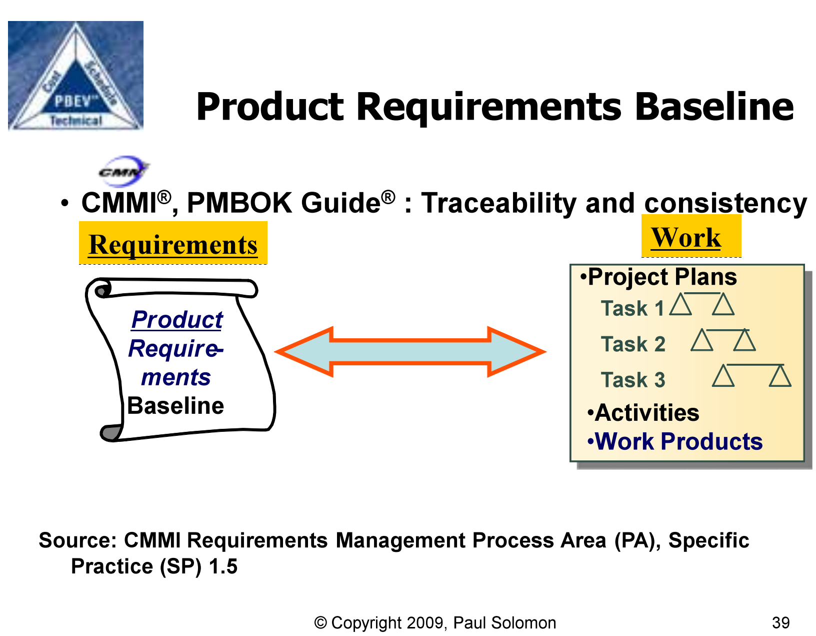

Figure 2.

SDS EV Techniques

The SDS training agenda included techniques and class problems that link EV with technical performance and the product requirements. The techniques illustrated in this article include

- Defining the requirements baseline for each planned product release
- Tracing the requirements baseline to the schedule and work packages
- Tracking status of each requirement
- Monitoring technical performance with meaningful variance analysis
- Accounting for deferred functionality
- Planning and measuring rework
- Making negative adjustments to EV for accurate status
- Determing a realistic estimate at completion (EAC)

Defining Requirements Baseline

Figure 1 provides Wiegers' guidance for establishing the requirements baseline for a product release.

Tracing Requirements Baseline to the Schedule and Work Packages

The SDS training included guidance from the Capability Maturity Model Integrated (CMMI®) for requirements traceability from a requirement to its derived requirements as well as to its allocation to functions, objects, plans, work products, and work packages, as shown in Figure 2.

Tracking Status of Each Requirement

Wiegers advises that the status of each functional requirement be planned and tracked, as discussed in Figure 3.

An example of tracking requirements status using the requirements traceability matrix (RTM) is provided in CT, Example 3. A time-phased schedule for the planned completion of tasks (such as validating the requirement, completing the test procedure, and verifying that the requirement has been met) is the basis for the Performance Measurement Baseline (PMB). The status of each requirement in the RTM is the basis for EV.

Wiegers: Track Requirements Status

- **Tracking the status of each functional requirement provides an accurate gauge of project progress**
- **Track status against definition of what complete means for the product iteration**
  - **Example: Implement only part of a use case in this release**

Figure 3.

PMBOK: Technical Performance Measurements

8.3.5.4 Work Performance Measurements
Used to produce project activity metrics

- **Evaluate actual progress as compared to planned progress**
- **Include, but are not limited to:**
  - **Planned vs. actual *technical performance***
  - **Planned vs. actual schedule performance, and**
  - **Planned vs. actual cost performance**

Figure 4.

PMBOK: Technical Performance Measurements

11.6.2.4 Technical Performance Measurement

- **Compares technical accomplishments…to.. project management plan's schedule of *technical* achievement**
- **Requires definition of *objective quantifia*ble measures of *technical performance* which can be used to compare actual results against targets.**
- **Might include weight, transaction times, number of delivered defects, storage capacity etc.**
- **Deviation, such as demonstrating more or less functionality than planned at a milestone…forecast degree of success in achieving the project's scope.**

Figure 5.

Measuring Technical Performance

An IT system normally includes physical, technical performance requirements in addition to functional software requirements. Examples of TPMs are response time or data throughput. Consequently, a software component may have met the software functional requirements during software integration tests but may require rework of both the requirements and the code to resolve a technical performance issue at a higher system or sub-system level. When system requirements are decomposed into functional requirements for both the software and hardware subsystems, the completion criteria for software work packages should depend on meeting the work breakdown structure (WBS) level requirements that include the hardware requirements. EV should not be reported as 100% complete until all requirements (software functionality and TPMs) are met.

PMBOK guidance on measuring technical performance is shown in Figures 4 and 5.

The SDS training included two examples of linking EV to both the software functionality and physical TPMs. One example is similar to Example 1 in MN1. EV depends on completion of the enabling work products and drawings and meeting TPM requirements for weight and diameter. The corresponding SDS example used the SDS's most common base measure of EV, the number of screens, as enabling work products and had two TPMs throughput and response time.

The second example was similar to Example 2 of the MN2, "TPM at a Higher WBS Level than Work Package." In this case, EV depends on meeting TPM objectives at both the component and system WBS levels.

Accounting for Deferred Functionality

The SDS training included examples and problems to account for deferred functionality. Guidance is shown in Figure 6. More detailed guidance is provided in the MN2 issue on page 21.

Planning and Measuring Rework

The SDS training included the Naval Air Systems Command guidance for rework is shown in Figure 7. More detailed guidance is provided in MN2 on page 21.

Internal Replanning of Deferred Functionality

If build is released short of planned functionality:

- **Take partial EV and leave work package open**

  or
- **Take partial EV and close work package**
  - **Transfer deferred scope and budget to first month of work package for next incremental build**
    - **EV mirrors technical performance**
    - **Schedule variance retained**
  - **Disclose shortfall and slips on higher schedules**

Figure 6.

NAVAIR: Rework

- **It is unreasonable to assume that there will be no defects detected in any of the requirements, design or code.**
- **Time and effort for rework is usually based on the developer's estimate of the number of defects likely to occur and the average amount of time required to correct such defects.**
  - **If such rework phases are not planned for, it can cause severe problems to EV system when it is attempted to determine how to implement it at the spur of a moment.**

Figure 7.

Making Negative Adjustments to EV for Accurate Status

When cumulative EV becomes inaccurate or misleading, it is appropriate to make negative adjustments. Conditions for negative EV are shown in Figure 8. An example of taking negative when a work package failed to meet a TPM objective is provided in MN1, Example 1, Table 10.

An example of negative EV technique is called Critical-to-Quality (CTQ). Mr. L. Kompella of Wipro Technologies, a large IT company in India, teaches that the traditional EV does not capture the quality of the deliverable. With the CTQ approach, EV is adjusted downward when a TPM or software quality metric deviates from the norm (Solomon and Young, 2007).

Determing a Realistic EAC

Guidance and class problems for realistic EACs were based on Wiegers' and McConnell's books, as shown in Figures 9 through 12.

Updates on DoD Acquisition Reform, TPMs and SE

There have been several changes in DoD EVM guidance and acquisition reform since publication of the prior articles. First, the *Defense Acquisition Program Support Methodology (DAPS) V2.0* states that "EVMS has no provision to measure quality." DAPS provides guidance to use TPMs to determine whether percent completion metrics accurately reflect quantitative technical progress and quality toward meeting key performance parameters (KPP) and critical technical parameters (CTP). DAPS also includes components that provide a flow down from KPPs to TPMs to EVM. DAPS guidance is shown in Figure 11.

Second, the *Defense Acquisition Guidebook* (DAG) includes new guidance for integrating TPMs with EVM and the IMS, including contractual TPM reporting. Per DAG, a contractor must now have a TPM plan, defined in terms of expected performance at specific points in the program as defined in the WBS and IMS, the methods of measurement at those points, and the variation limits for corrective action. DAG also includes expanded responsibility for SE to integrate the technical scope of effort in the WBS, the corresponding event-driven program implementation in the IMS and EVM.

Third, in responding to the Weapons System Acquisition Reform Act, DoD submitted a Report to Congress on the quality of EVM implementation. It stated the following regarding technical performance:

1. The EV process is reliable and accurate only if:
   - TPMs are identified and associated with completion of appropriate work packages.
   - Quality of work must be verified.
   - Criteria must be defined clearly and unambiguously.
2. If good TPMs are not used, programs could report 100% of EV even though behind

- **If change in valued milestones or # of units, reported performance data is no longer valid:**
  - **Previous progress, as % complete, is no longer accurate**
  - **CPI, based on old EV, is not current or accurate**
  - **EAC, based on old CPI, is not current or accurate**
  - **Estimated completion date may change**
- **If reported EV of work package for enabling work products (drawings, software units) does not meet Functionality/Quality completion criteria:**
  - **Same invalid performance data as above**
- **Take negative EV to correct cumulative EV**

Figure 8. Conditions for negative EV.

Wiegers: What to Count to Estimate Size of Remaining Work

- **Testable requirements**
- **Function points and feature points**
- **Number, type, and complexity of graphical user Interfaces (GUI)**
- **Estimated lines of code (LOC) needed to implement specific requirements**

Figure 9.

Wiegers: Size Measures for Remaining Product Features or Use Cases

Use correlations between past size and effort to estimate the future effort to fully implement and verify each feature or use case:

- **Size measures:**
  - **Number of lines of code**
  - **Function points**
  - **Object classes**
  - **GUI elements**

Figure 10.

McConnell: Tip 31: Look for something you can count that is a meaningful measure of the scope of work in your environment

- **Code already written**
- **Defects reported**
- **Classes**
- **Tasks**
- **All the detailed items you were counting earlier**
- **Look for something that will be a strong indicator of the SW's size such as Function Points (FP)**

Figure 11.

McConnell: Tip 32: Collect historical data that allows you to compute an estimate from a count

- **Average (Avg) hours (hrs) per requirement for**
  - **Development**
  - **Independent testing**
  - **Documentation**
- **Avg hrs per feature for development or testing**
- **Avg development/test/documentation effort per FP**
- **Avg LOC in target language per FP**

Figure 12.

schedule validating requirements, completing the preliminary design, and meeting weight targets.

3. The PM should ensure that the EVM process measures the quality and technical maturity of technical work products, instead of the quantity of work performed.

DoD guides are applicable to only DoD acquisition officials, not to contractors. There are no regulatory requirements for contractors to utilize the guidance in DAPS or DAG. Of greater concern, neither the federal acquisition regulations nor the EVMS Standard require linkage of EVM to TPMs, as discussed in MN1 and MN2.

Regarding SE, the DoD Report stated that the EV process is reliable and accurate only if:

- Augmented with a rigorous SE process
- SE products are costed and included in EVM tracking

The DoD guides, DoD Report, and links to the articles are at www.PB-EV.com within the "Advanced EV:PBEV" tab.

Conclusion

World class, international, commercial IT companies selectively use EVM on their fixed-price contracts. They do so effectively and efficiently. Their EVM techniques are primarily based on selecting the most effective software metrics as base measures of EV and on PMBOK's focus on the product baseline or quality. For EV, they measure both the quantity of work completed and the quality of the evolving work product. They use TPMs or the percentage of requirements that were met. EV is truly tied to technical performance.

In contrast, U.S. defense contractors use EVM processes based on the EVMS standard and its limited focus on the quantity of work performed, not quality of the evolving system. Defense contractors and their customers should consider adopting some of the best practices of commercial IT companies. These practices can transform EVM into a more effective project management tool.

References

Solomon, P. and R. Young. 2007. *Performance-Based Earned Value®*. Hoboken NJ: John Wiley & Sons/ IEEE Computer Society.

McConnell, S. 2006. *Software Estimation: Demystifying the Black Art.* Redmond, WA: Microsoft Press.

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Wiegers, K.E. 2006. *More About Software Requirements*. Redmond, WA: Microsoft Press.

Additional references and pertinent extracts of the cited guidance are provided at www.PB-EV.com.

About the Author

Paul Solomon, PMP is the co-author of the book

Performance-Based Earned Value® and is president of the consulting firm with that name. He is internationally recognized as a leader, teacher, and consultant on EVM. He has published many articles on EVM, systems engineering, software metrics, and risk management. Most are available at www.PB-EV.com.