EVM = EVM: Earned Value Management Yields Early Visibility & Management Opportunities

presented by

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for

THE SOCIETY OF COST ESTIMATING & ANALYSIS 2004 NATIONAL CONFERENCE & TRAINING WORKSHOP



June 15-18, 2004

Los Angeles, California



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EVM Isn't Just EV

- It is integrated project management
- Specifically, it is predicated on the development of a baseline
- Integrates the technical (scope), cost, and schedule elements of the plan
- Presumes the maintenance of this baseline over the life of the project



Earned Value Management (EVM): Integrated Project Management





EVM: A Vision*

The quality of a management system is determined not by the absence of defects, but by the presence of management value

Gary Christle, The Cost/Schedule Control Systems Criteria (C/SCSC) and Earned Value Management: A Vision, 9/15/94



How Is Value Added?

The management system provides information that is used to make effective management decisions

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Key EVM Data Elements and



- Time
- BCWS Budgeted Cost for Work Scheduled
- BCWP Budgeted Cost for Work Performed
- ACWP Actual Cost of Work Performed
- BAC Budget at Completion

Value

- EAC Estimate at Completion
- ETC Estimate to Completion



Data Analysis





Schedule Performance Index

 $\frac{\text{Work Completed}}{\text{Work Planned}} \text{ or } \frac{\text{BCWP}}{\text{BCWS}} = \text{SPI}$

 $\frac{2100 \text{ Hours BCWP}}{3000 \text{ Hours BCWS}} = .70 \text{ SPI}$

70% Efficiency to Schedule



Cost Performance Index

 $\frac{\text{Work Completed}}{\text{Actual Cost}} \text{ or } \frac{\$ BCWP}{\$ ACWP} = CPI$

 $\frac{\$105.0 \text{ BCWP}}{\$127.4 \text{ ACWP}} = .82 \text{ CPI}$

82% Cost Efficiency

To-Complete Performance Index: Performance Required to Achieve EAC $(TCPI_{EAC})$

$$= \frac{\$300.0 - \$105.0}{\$350.0^* - \$127.4} = .88$$

*Re-estimate of EAC



Performance Factors

Cumulative performance

- Recent experience
- Cost and schedule performance
- Other?

IEAC Based on Performance to Date

$$\begin{array}{rcl} \mathsf{IEAC} = & \mathsf{ACWP} & + & \underline{\mathsf{BAC}} - & \underline{\mathsf{BCWP}} & = & \underline{\mathsf{BAC}} \\ & & \mathsf{CPI} & \mathsf{Cumulative} & & \mathsf{CPI} \end{array}$$

= \$365.2K



EAC Formulae

- M EAC (1) = ACWPc + (BCWR \div CPI6)
 - L EAC (2) = ACWPc + (BCWR ÷ CPI12)

- E M EAC (4) = ACWPc + [BCWR ÷ (CPIc x SPIc)]
- E M L EAC (5) = ACWPc + (BCWR \div CPI3)
 - L EAC (6) = ACWPc + (BCWR \div CPI6)

*E = EARLY M = MID L = LATE

In these formulae:

- EAC is estimated cost at completion.
- ACWPc is actual cost of work performed (cumulative).
- BCWR is budgeted cost of work remaining (equal to BAC BCWP).
- c signifies cumulative.
- Sub numbers (m, 3, 6, 12) refer to months; e.g. CPI6 is the average of six months current period CPIs.
- A bar over CPI (CPI) refers to a CPI based on a sum of BCWPs divided by a sum of ACWPs. CPI3 for example is based on the latest 3 months current BCWPs ÷ 3 months current ACWPs. CPI3 (no bar), on the other hand, is the average of the latest 3 months current CPIs. In general, CPI is a better figure to use than CPI.





EAC Comparisons





\$

Is There More?

- Based on a study done by Michael Popp, there is statistical evidence that program behavior can be counter intuitive
 - The wider range of variation in CPI movement in development contracts versus production ones is not as significant as anticipated
 - There is not a significant difference in behavior of small versus large contracts
 - There is clear evidence that, even as late as 70 80 % complete, cost performance can worsen significantly
 - ▲ Good programs do not improve either "freebies"?

Formulae from the Popp Study

 Further statistical analysis yielded formulae that can be used to calculate what the CPI will be upon completion of the contract

Development

CPI_{100%Cmplt} = 0.438+0.057(BCWP/BAC)+(0.497 x CPI_{CUM}) ▲ Production

CPI_{100%Cmplt} = 0.383+0.066(BCWP/BAC)+(0.622 x CPI_{CUM})

- Keep in mind that these formulae are based on data for completed contracts
 - The character of changes from now to the end can and will affect future efficiencies
 - e.g. Can you say "get well" change?

OTHER CONSIDERATIONS: Do You Have Enough People Given Your Performance ?



 When you assess your CPI in terms of hours, how do the authorized resources for remaining work compare with

Planned Resources *

CPI

 Is your estimate to complete (ETC) in your EVMS consistent with this?

*Budgeted Resources for remaining work



EVMS VARIANCES



Time

What Does \$875,000 Behind Schedule Mean?!

- Well, it depends.
- It definitely means you haven't completed as much work as you had planned to by now.
- One approach to translating an earned value schedule variance into a time oriented one is

Months Ahead or Behind =

SV Avg. Monthly BCWS *

*The average BCWS may be calculated using the total contract months to date or a selected number of recent months



Per Average BCWS, \$875K = How Many Months



 Inception to Date Average Monthly BCWS

 $\frac{875.2}{404.9} = 2.16$ months behind

Most Recent 3 Months

 $\frac{875.2}{594.7}$ = 1.47 months behind

Most Recent Month

 $\frac{875.2}{728.4} = 1.20$ months behind



However

- Depending on which activities are behind schedule per the plan, you may or may not be behind schedule.
- Whatever the situation is, if \$875K represents a significant variance as a percentage, you need to look at your physical schedules NOW.



And, The Schedule Says

🔜 Gantt View													×
			FY 2002										
Activity Name	Activity Code	Activity Description	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	
XP7110	1.1	Design and Development of kinematic m	7			e e						1	≜
XP7121	1.2.1	Circuit board fabrication layout				Û							
XP7122	1.2.2	Circuit board assembly			-	Û							
XP7124	1.2.4	Mezzanine PC board development and fab			ŤΞ			ů î					
XP7125	1.2.5	Signal patch design and development			0	û						5	
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- Here is a partial screen capture of all the activities associated with our WBS element that are late.
- Activities XP7121, XP7122, XP7124, and XP7125 are late and are all contributing to the -\$875K SV
- But only activities XP7121, XP7122, and XP7125 are on the critical path. Regardless of the \$ value of our SV, these are significant, because they put the project end date is in jeopardy.

TRAKKER Example from Dekker, Ltd.



🎟 Gantt View																
			FY 2002			r			1					FY 2003		F.
Activity Name	Activity Code	Activity Description	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	
XP7110	1.1	Design and Development of kinematic m	*				_									-
XP7120	1.2	Circuit board fabrication and development	·	0				<u>.</u>								
XP7121	1.2.1	Circuit board fabrication layout			U	û										
XP7122	1.2.2	Circuit board assembly			U r	<u>ن</u>				<u>-</u>						
XP7123	1.2.3	Circuit board quality check				12	<u>6</u>	т С								
XP7124	1.2.4	Mezzanine PC board development and fab			"æ			ů Cr								
XP7125	1.2.5	Signal patch design and development			U	<u>ن</u>										
XP7130	1.3	HV patch panel design and development							0	û						
XP7131	1.3.1	Patch panel completion											1	1		
XP7140	1.4	DCS Module development and fabrication												1 CŽ	- 1	
	1		•													

- Here a filter is applied identifying one or more of the following conditions:
 - The activity is forecasted to complete more than 30 days late.
 - There have been 3 slips of the execution schedule in the last 4 months.
 - The activity has negative float
- Thus, while Activity XP7124 is not on the critical path, it is still a worry
- AND, how about those unstarted activities (e.g. XP7123, et al)
 - Notice that most of these are in other legs of the WBS, but there is some dependency between the work in branch 1.2 and them

TRAKKER Example from Dekker, Ltd.

FOOD FOR THOUGHT: Schedule Variance Categories

"Problem"

Critical tasks that did not start on time

- "Late with Float"
 - Tasks that did not start on time but are not critical
- "Purposely Delayed"
 - Tasks delayed due to work-around
- "Early"
 - Tasks begun ahead of planned start
- "Anomalies/Errors"

There are tools that automatically provide this information; Dekker TRAKKER from prior slides is one of these.



Schedule Variance Example

Schedule variance 3500 - 4000 = (500)

Problem- 100Late with float- 300Purposely delayed- 200Early+ 100

- 500

The Schedule Performance Index (SPI)

- Let's pause and talk about another EVMS concept
- The SPI is a measure of how efficient we have been in accomplishing our work relative to our plan for its accomplishment
- As a reminder, it is calculated per the formula

 $SPI = \frac{BCWP}{BCWS}$



Are Your SPI and Your Schedule Data in Agreement

 It is possible to confirm that the schedule performance data are consistent with the SPI by use of one of these two formulas.

Critical Path Length (CPL) + Float
CPLOrProject Length ± Time Ahead or Behind
Project Length

 Significant differences between the SPI and either of these calculations should be assessed.



Earned Schedule and SPI_{Time}

- The last slide brings up a point not unlike that of Walt Lipke and Kym Henderson
- They have espoused a theory documented in a presentation called, "Earned Schedule" The Concept, Initial Evaluation and Potential Benefits
- Their position is that the traditional EVM schedule variance and SPI are limited in value, because as a program approaches completion, the SV and SPI march inexorably toward 0 and 1.0, respectively
 - ▲ Even if the program finishes late or early

EVMS VARIANCES



ES Calculation

The Earned Schedule (ES) is the combination of

- all full time periods (7 months here) up to the point where today's BCWP intersects the BCWS curve
- Plus any fraction of a time period (the portion of October here) associated with the intersection
- In our case, the fraction of October would be arrived at by the following calculation

BCWP_{JAN CUM} – BCWS_{SEP CUM} BCWS_{OCT ONLY}

▲ This is similar to our earlier calculations



ES Calculation (cont'd)

Thus, in our case, if the cumulative BCWP through January were \$55K, the cumulative BCWS through September were \$50K and the BCWS for the month of October had been \$7.5K our earned schedule would be

$$\mathsf{ES} = 7 + \frac{\$55,000 - \$50,000}{\$7,500} = 7.67 \text{months}$$

Given that time now is the end of January (our project's 10th month), we have a schedule variance (SV_t)

$$SV_t = BCWP_t - BCWS_t = 7.67 - 10.0 = -3.33$$
 Months



Earned Schedule SPI?

 Since we can calculate ES and we know where we are in the project, we can calculate a time oriented SPI analogy

SPI
$$_{t} = \frac{\text{Earned Schedule}}{\text{Actual Duration}} = \frac{7.67}{10.0} = 0.767$$

Per the earlier figures, the traditional SPI is

$$\mathsf{SPI} = \frac{\mathsf{BCWP}}{\mathsf{BCWS}} = \frac{55,000}{72,500} = 0.759$$

- Yes, these are close, but look at the next slide
 - ▲ The data are for two actual projects, not our example
 - Notice the correlation between the two until later
 - In the later stages the difference between the time-based SPI and the traditional one, becomes apparent.



This slide is used with the permission of Walter Lipke and Kym Henderson

ES Observations

- This concept may have better predictive utility for late finish programs, however
- The concept developers say that more research is needed, including
 - More project data for retrospective analysis, especially for large scale projects
 - Data from Earned Schedule "early adopters"
- Finally, there is no substitute for analysis of the integrated project schedule

So, what can we conclude from all of this?

- EVM isn't a panacea (hmmm, let me think about some of those DOD and DOE programs)
- EVM isn't always applicable, and where it is
- It isn't simple to implement, BUT
- It is a tool that can provide added value to the project team by
 - ▲ offering earlier visibility into project issues, which
 - leads to the opportunity to shift the direction of undesirable trends earlier and therefore
 - increases the likelihood of project success

Thank you.

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