



Earned Schedule ... *an emerging enhancement to EVM*

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**International Metrics Congress
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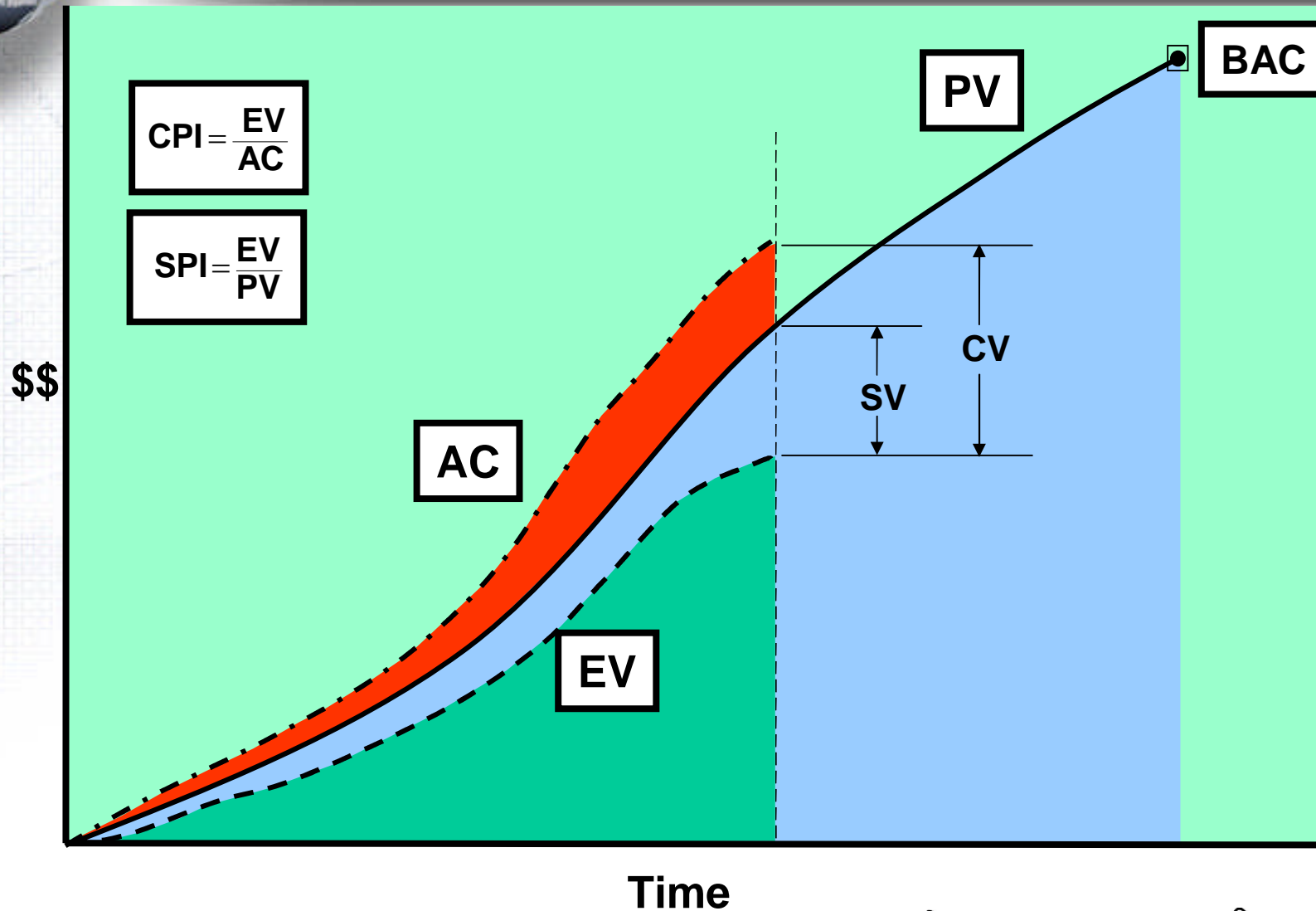


Objective

- Introduce the Earned Schedule Concept
- Develop the Schedule Indicators
- Apply to Project Duration Prediction
- Apply to Schedule Analysis



Earned Value Basics





EVM Schedule Indicators

- SV & SPI behave erratically for projects behind schedule
 - *SPI improves and equals 1.00 at end of project*
 - *SV improves and concludes at \$0 variance*
- Schedule indicators lose predictive ability over the last third of the project



EVM Schedule Indicators

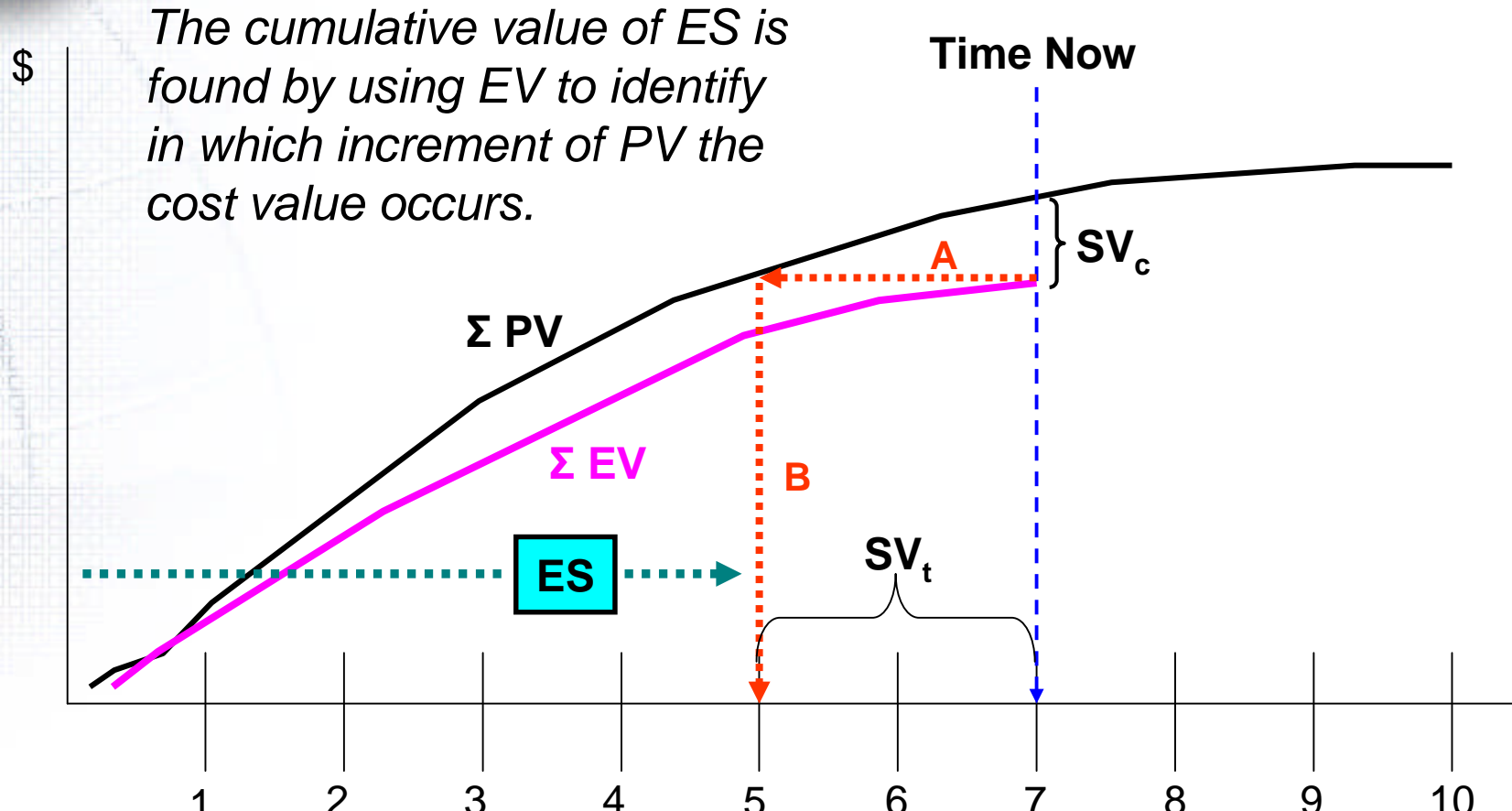
- Why does this happen?
 - $SV = EV - PV$
 - $SPI = EV / PV$
- At planned completion $PV = BAC$
- At actual completion $EV = BAC$
- When actual > planned completion
 - $SV = BAC - BAC = \$000$
 - $SPI = BAC / BAC = 1.00$

Regardless of lateness !!





Earned Schedule Concept



7 months gone by, but the project only has "Earned Schedule" to Month 5
Which SV "Answers the mail?" \$ behind or 2 months behind schedule?





Earned Schedule Metric

- Required measures
 - **Performance Measurement Baseline (PMB)** – the time phased planned values (PV) from project start to completion
 - **Earned Value (EV)** – the planned value which has been “earned”
 - **Actual Time (AT)** - the actual time duration from the project beginning to the time at which project status is assessed
- All measures available from EVM



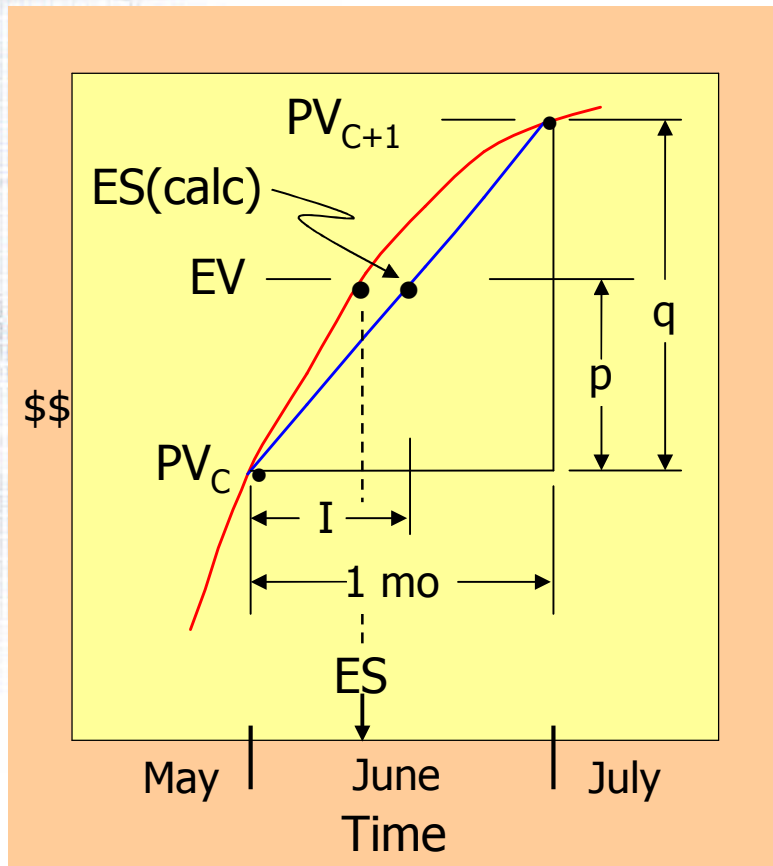


Earned Schedule Calculation

- **ES (cumulative)** is the:
Number of completed PV time increments EV exceeds +
the fraction of the incomplete PV increment
- **ES = C + I** where:
C = number of time increments for $EV \geq PV$
 $I = (EV - PV_C) / (PV_{C+1} - PV_C)$



Interpolation Calculation



$$I / 1 \text{ mo} = p / q$$

$$I = (p / q) * 1 \text{ mo}$$

$$p = EV - PV_C$$

$$q = PV_{C+1} - PV_C$$

$$I = \frac{EV - PV_C}{PV_{C+1} - PV_C} * 1 \text{ mo}$$



Earned Schedule Indicators

- Schedule Variance:

$$SV(t) = ES - AT$$

- Schedule Performance Index:

$$SPI(t) = ES / AT$$

where AT is “Actual Time” – the duration from start to time now

- SV(t) and SPI(t) are time-based (months, weeks ...)





Earned Schedule Indicators

- What happens to the ES indicators, $SV(t)$ & $SPI(t)$, when the planned project duration (PD) is exceeded ($PV = BAC$)?

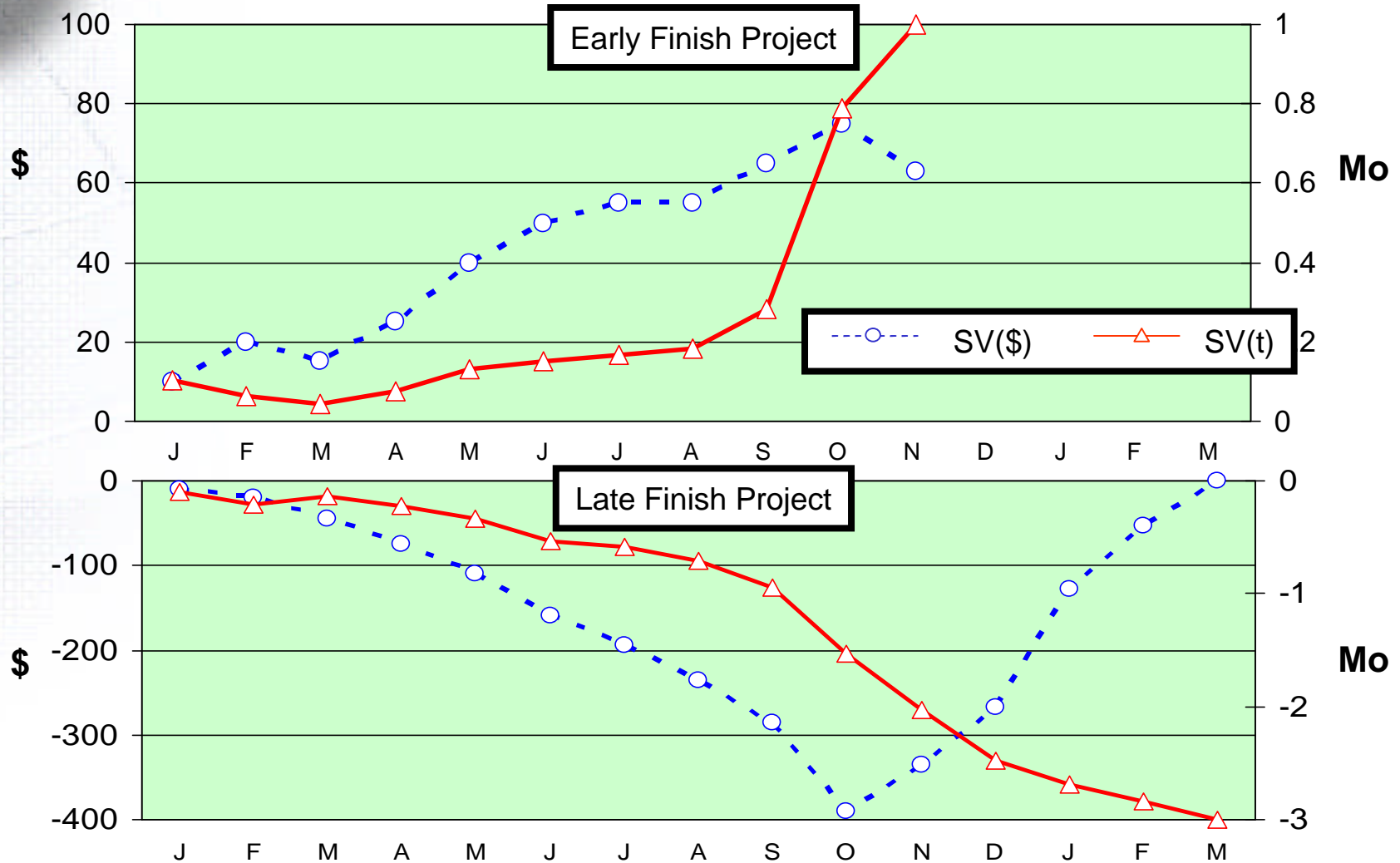
They Still Work ...Correctly!!

- ES will be $\leq PD$, while $AT > PD$
 - $SV(t)$ will be negative (time behind schedule)
 - $SPI(t)$ will be < 1.00

Reliable Values from Start to Finish !!

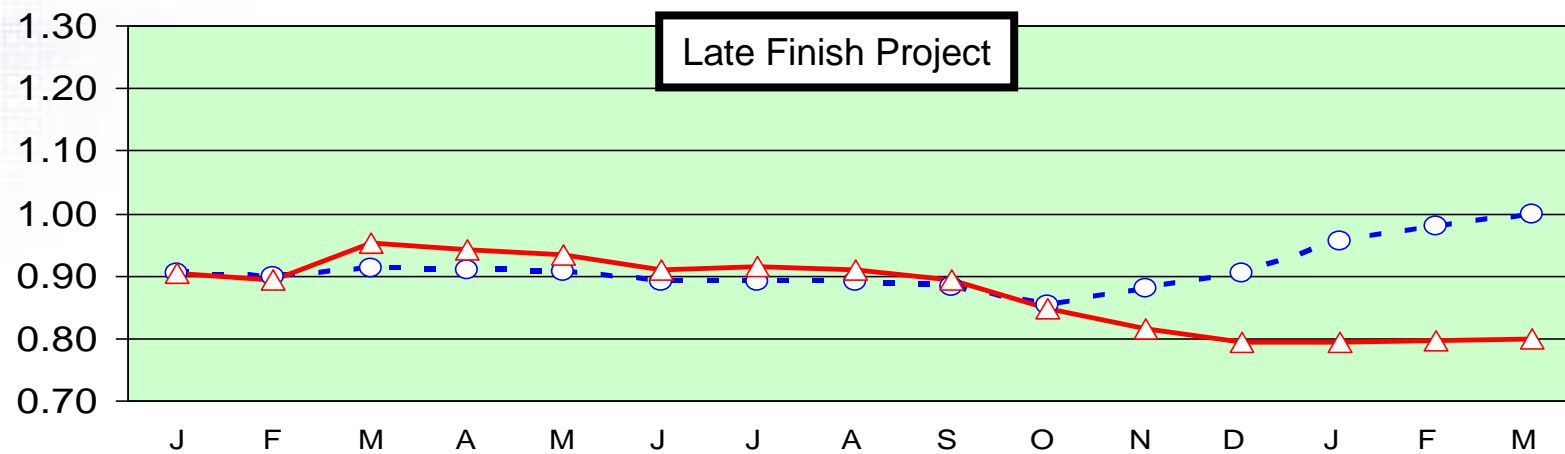
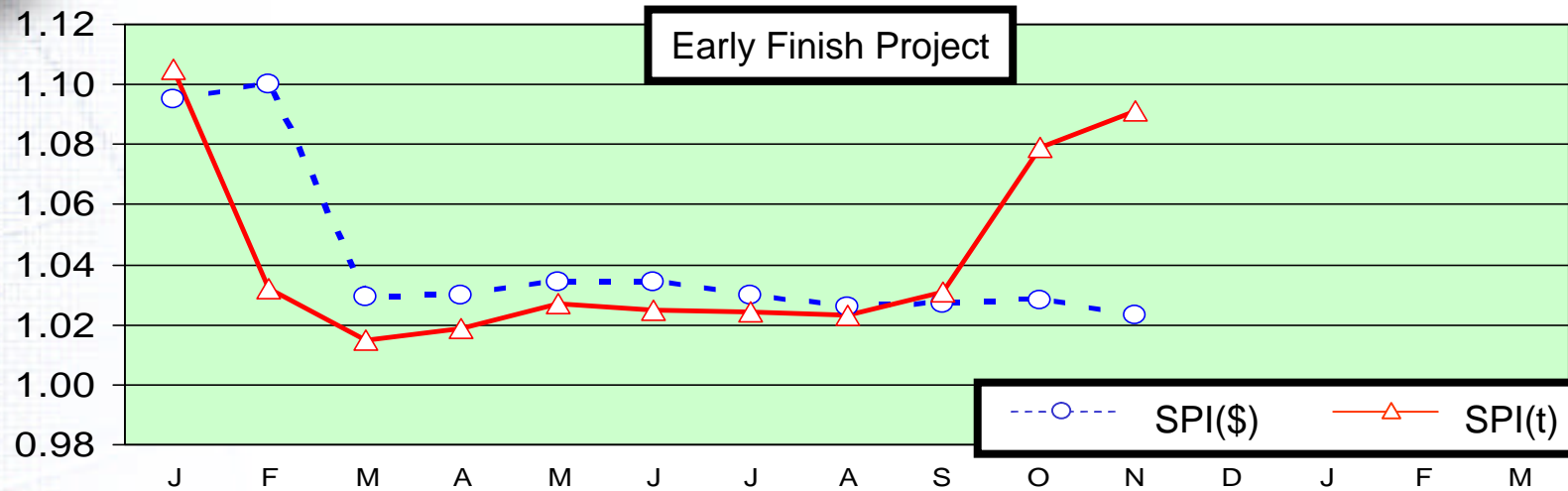


Schedule Variance Comparison



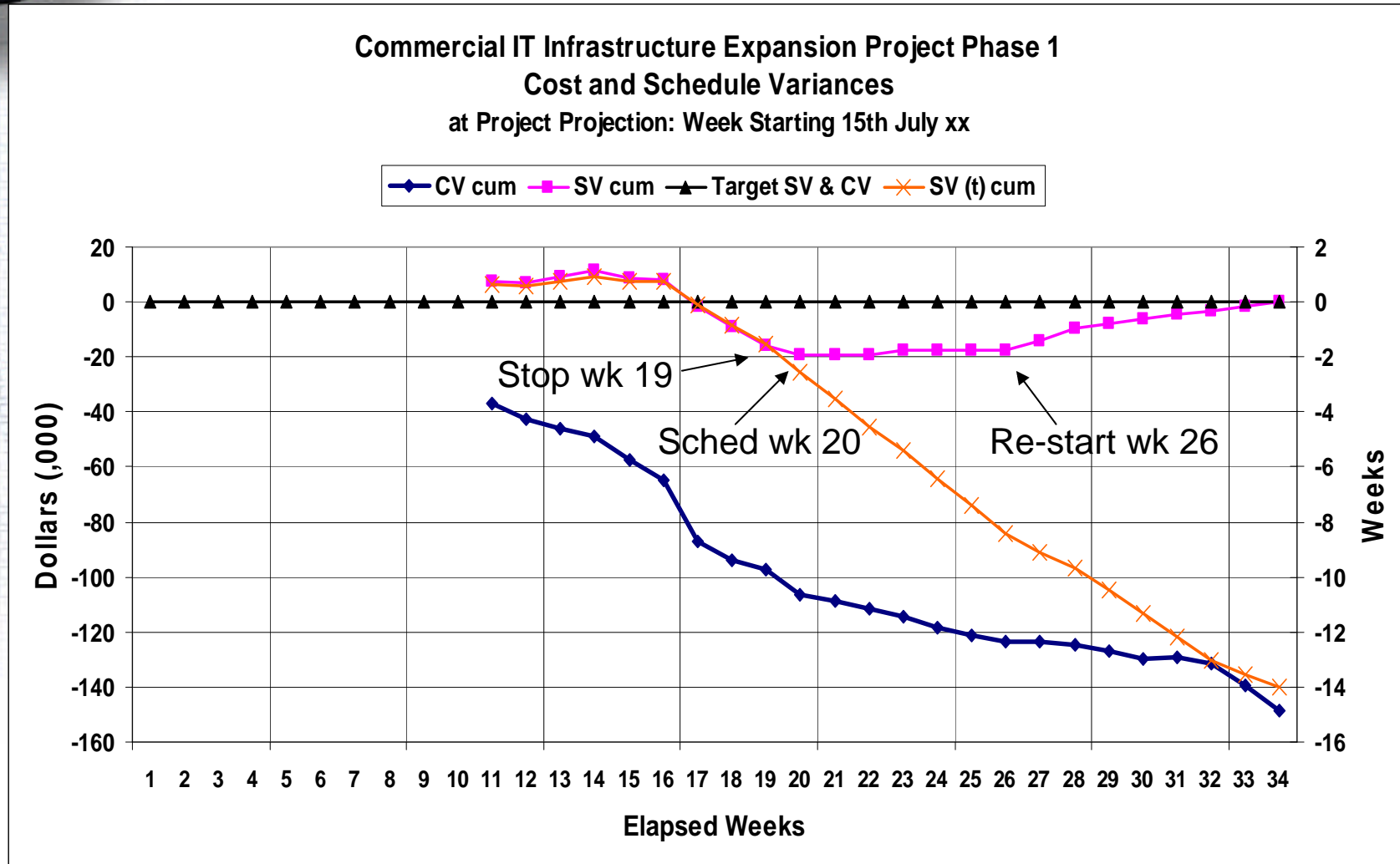


Schedule Index Comparison





Late Finish Project





Earned Schedule – Key Points

- ES Indicators constructed to behave in an analogous manner to the EVM Cost Indicators, CV and CPI
- SV(t) and SPI(t)
 - Not constrained by PV calculation reference
 - Provide duration based measures of schedule performance
 - Valid for entire project, including early and late finish
- Facilitates integrated Cost/Schedule project management
(using EVM with ES)



Schedule Prediction

- Can the project be completed as planned?
 - $TSPi = \text{Plan Remaining} / \text{Time Remaining}$
 $= (PD - ES) / (PD - AT)$
where PD is the planned duration (time at BAC)
(PD - ES) = PDWR
PDWR = Planned Duration for Work Remaining
- ...completed as estimated?
 - $TSPi = (PD - ES) / (ED - AT)$
where ED = Estimated Duration

TSPi Value	Predicted Outcome
≤ 1.00	Achievable
> 1.10	Not Achievable



Schedule Forecasting

- Long time goal of EVM ... *Prediction of total project duration from present schedule status*
- Independent Estimate at Completion (time)
 - $IEAC(t) = PD / SPI(t)$
 - $IEAC(t) = AT + (PD - ES) / PF(t)$
where $PF(t)$ is the Performance Factor (time)
 - Analogous to IEAC used to predict final cost
- Independent Estimated Completion Date (IECD)
 - $IECD = \text{Start Date} + IEAC(t)$



Earned Schedule Terminology

Metrics	Earned Schedule	ES_{cum}	$ES = C + I$ number of complete periods (C) plus an incomplete portion (I)
	Actual Time	AT_{cum}	AT = number of periods executed
Indicators	Schedule Variance	$SV(t)$	$SV(t) = ES - AT$
	Schedule Performance Index	$SPI(t)$	$SPI(t) = ES / AT$
	To Complete Schedule Performance Index	$TSPI$	$TSPI(t) = (PD - ES) / (PD - AT)$
$TSPI(t) = (PD - ES) / (ED - AT)$			
Predictors	Independent Estimate at Completion (time)	$IEAC(t)$	$IEAC(t) = PD / SPI(t)$
			$IEAC(t) = AT + (PD - ES) / PF(t)$



Independent Confirmation

- SPI(t) & SV(t) do portray the real schedule performance
- At early & middle project stages pre-ES & ES forecasts of project duration produce similar results
- At late project stage ES forecasts outperform all pre-ES forecasts
- The use of the SPI(t) in conjunction with the TSPI(t) has been demonstrated to be useful for managing the schedule

Stephan Vandevoorde – Fabricom Airport Systems, Belgium





Schedule Analysis with EVM?

- Most practitioners analyze schedule from the bottom up using the network schedule, independent from EVM
 -“It is the only way possible.”
 - Analysis of the Schedule is overwhelming
 - Critical Path is used to shorten analysis
 - (CP is longest path of the schedule)
- Duration prediction using Earned Schedule provides a macro-method similar to the method for estimating Cost
 - **A significant advance in practice**
- *But, there's more that ES facilitates*



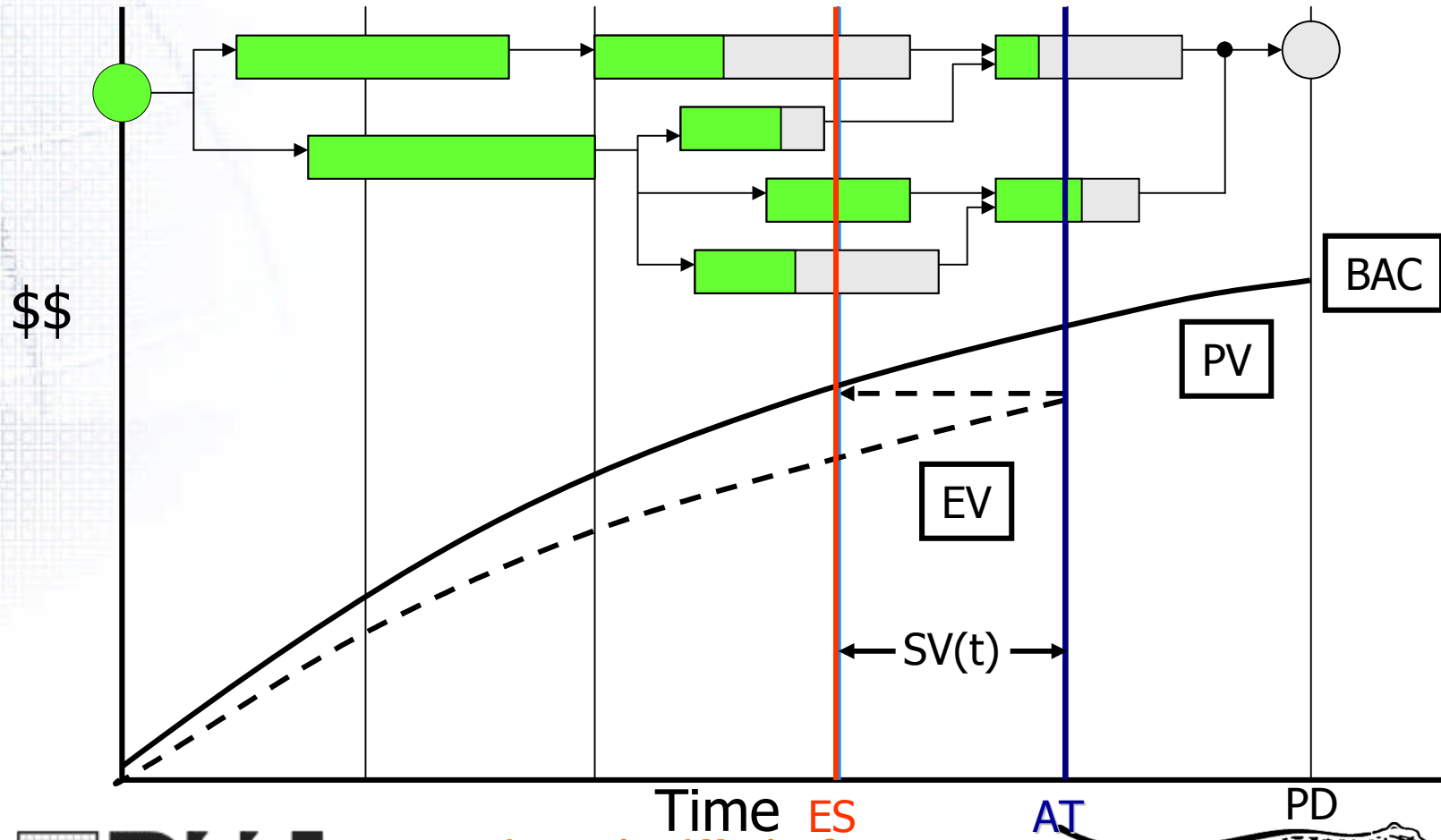


Facilitates Drill-Down Analysis

- ES can be applied to any level of the WBS, to include task groupings, such as the Critical Path (CP)
 - Requires creating PMB for the area of interest
 - EV for the area of interest is used to determine its ES
- Enables comparison of forecasts, total project (TP) to CP
 - Desired result: forecasts are equal
 - When TP forecast > CP forecast, CP has changed
 - When CP > TP, possibility of future problems



ES Bridges EVM to the Schedule





How Can This Be Used?

- Tasks behind – possibility of impediments or constraints can be identified
- Tasks ahead – a likelihood of future rework can be identified
- The identification is independent from schedule efficiency
- The identification can be automated

PMs can now have a schedule analysis tool connected to the EVM Data!!



Current Usage & Recognition

- EVM Instructors
 - Performance Management Associates, Management Technologies, George Washington University, University of Florida ...
- Boeing Dreamliner®, Lockheed Martin, US State Department, Secretary of the Air Force
- Several Countries - Australia, Belgium, United Kingdom, USA(Japan, Switzerland, Sweden, Spain, Brazil, India, ...)
- Applications across weapons programs, construction, software development, ...
- Range of project size from very small and short to extremely large and long duration
- Inclusion of Emerging Practice Insert into PMI - EVM Practice Standard (2004)





Summary

- Derived from EVM data ... only
- Provides time-based schedule indicators
- Indicators do not fail for late finish projects
- Application is scalable up/down, just as is EVM
- Schedule prediction is better than any other EVM method presently used
- Application is growing in both small and large projects
- Practice recognized as “Emerging Practice”
- Facilitates bridging EVM analysis to include the Schedule



Thank You!



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