Earned Schedule …

an emerging enhancement to EVM

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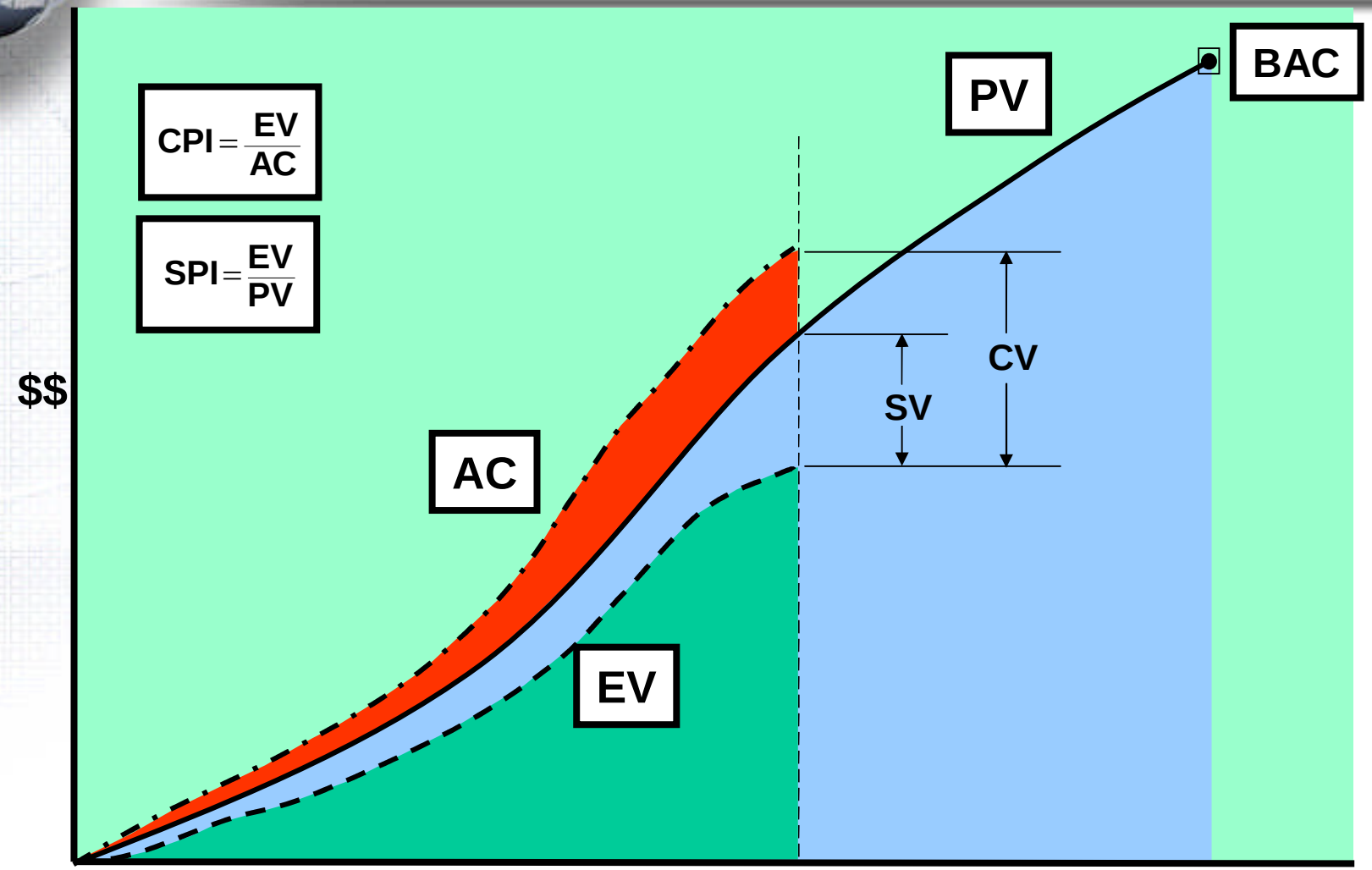
Objective

- 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

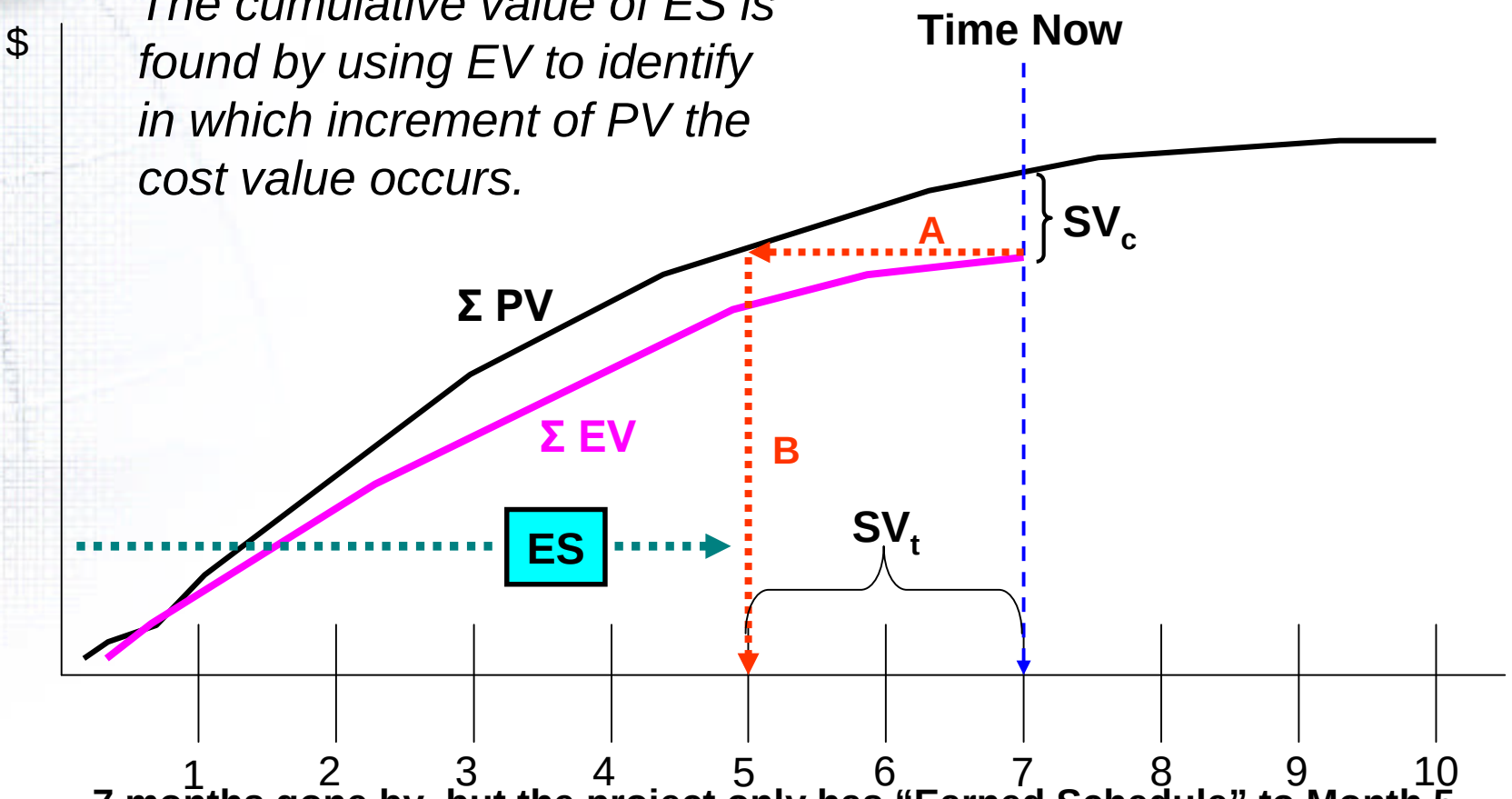
EVM Schedule Indicators

- 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

The cumulative value of ES is found by using EV to identify in which increment of PV the cost value occurs.



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:

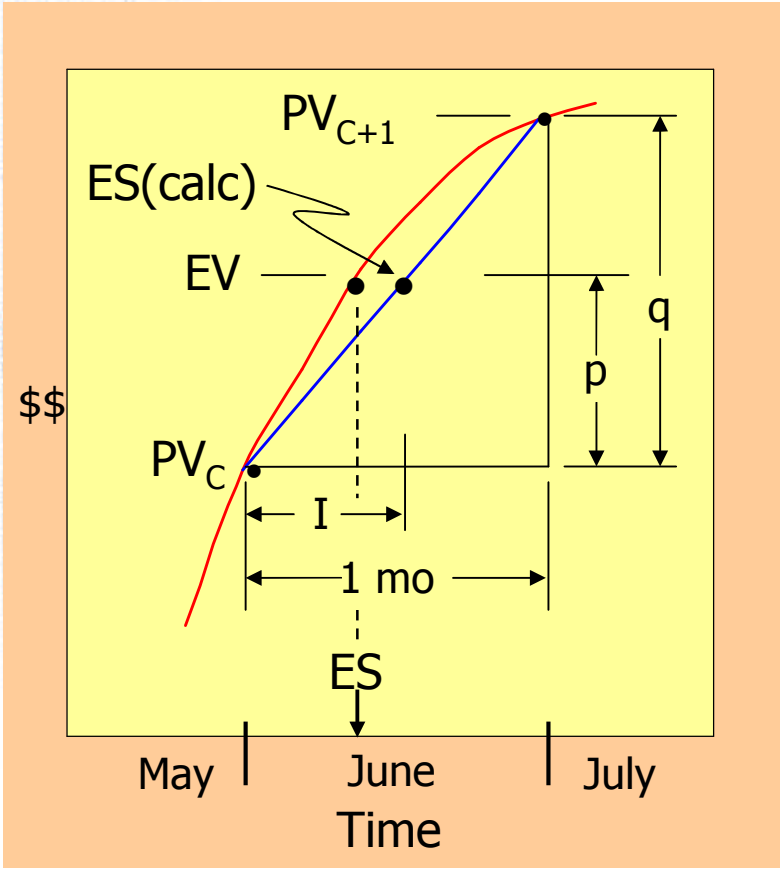
  Number of completed PV time increments EV exceeds + the fraction of the incomplete PV increment

- ES = C + I where:

  C = number of time increments for EV ≥ PV

  $I = (EV - PV_C) / (PV_{C+1} - PV_C)$

Interpolation Calculation



$$I / 1\ mo = p / q$$

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

$$p = EV - PV_C$$

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

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

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

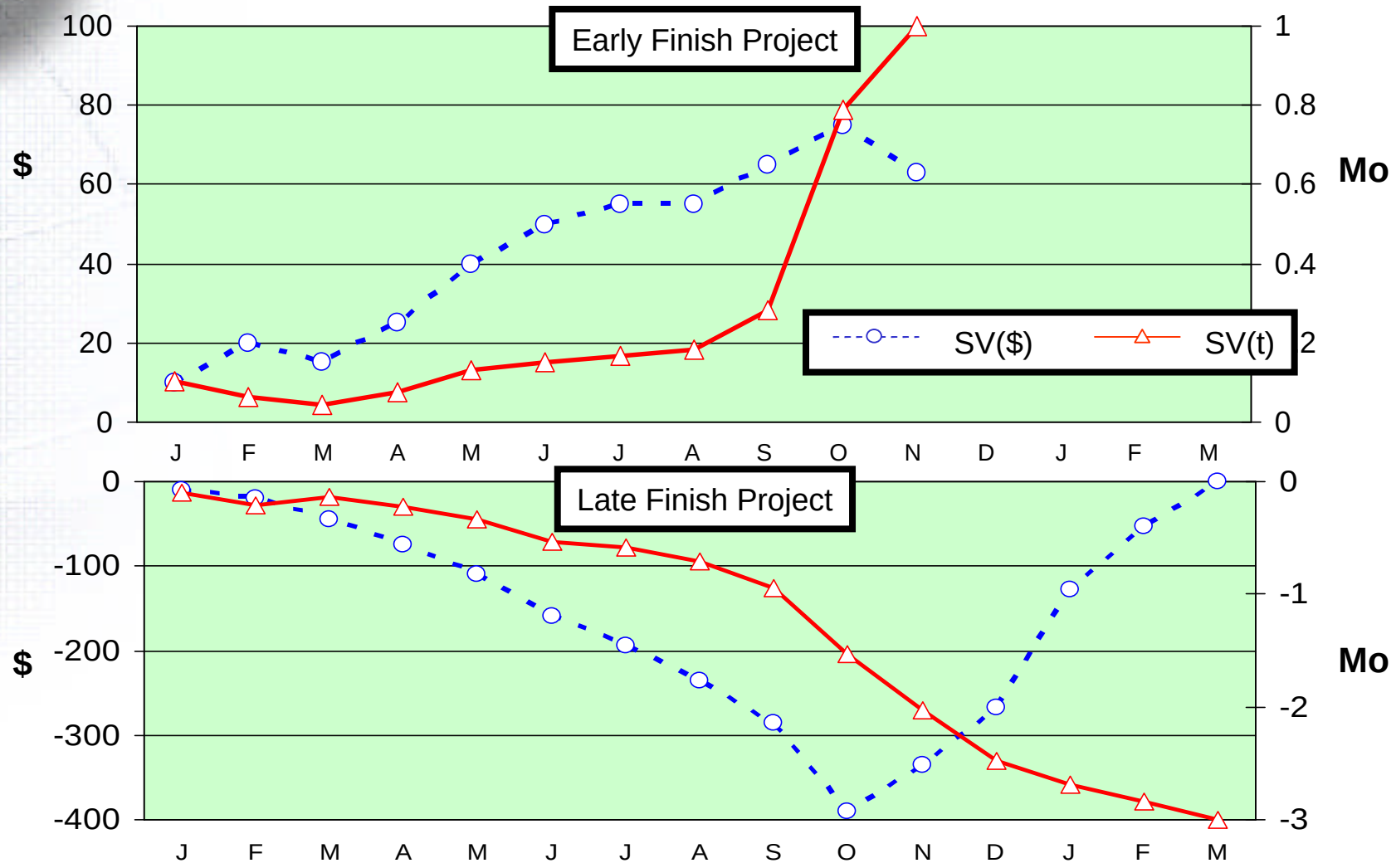
- What happens to the ES indicators, SV(t) & SPI(t), when the planned project duration (PD) is exceeded (PV = BAC)?

They Still Work …Correctly!!

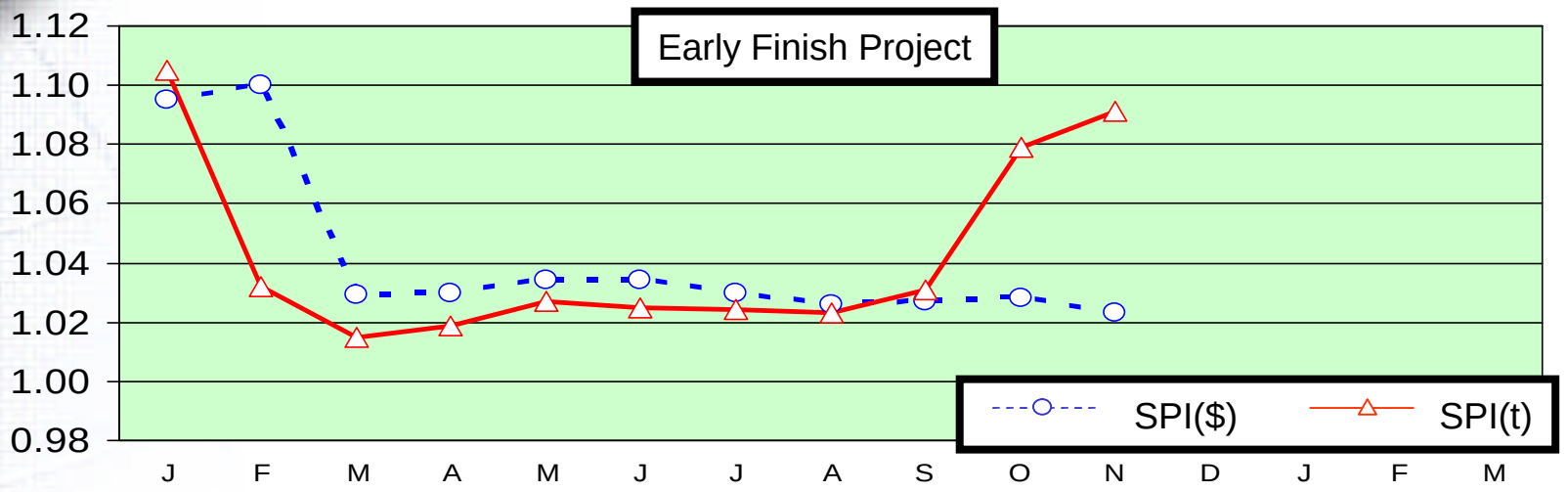
- ES will be ≤ PD, while AT > PD
  - SV(t) will be negative (time behind schedule)
  - SPI(t) will be < 1.00

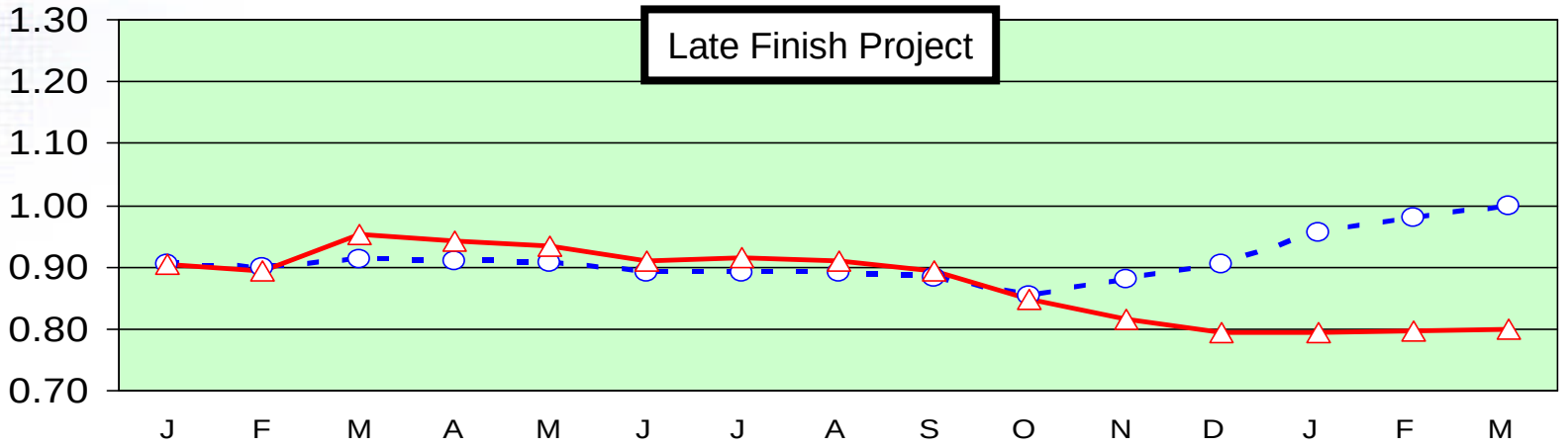
Reliable Values from Start to Finish !!

Schedule Variance Comparison

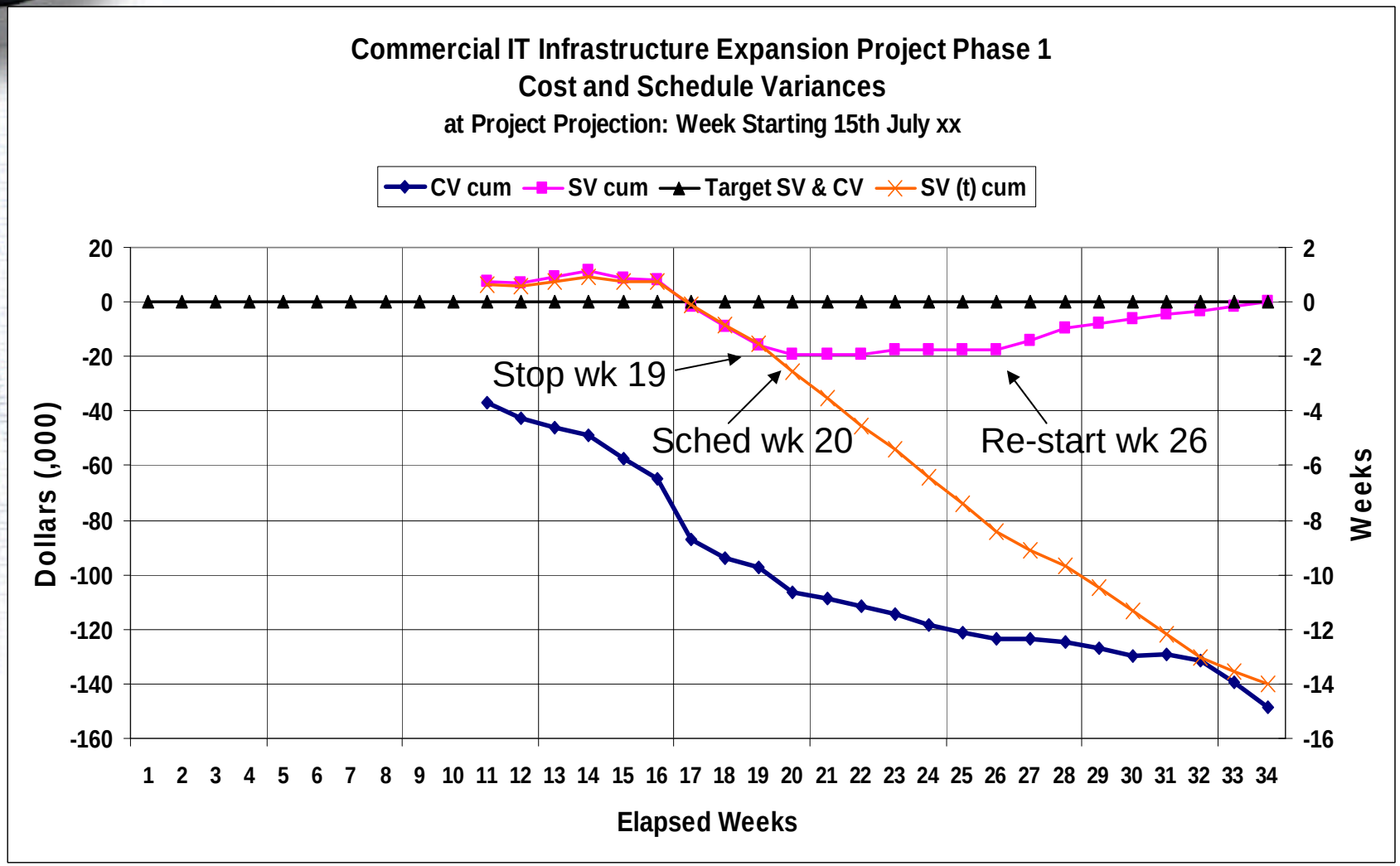


Schedule Index Comparison





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 = Plan Remaining / 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 = 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

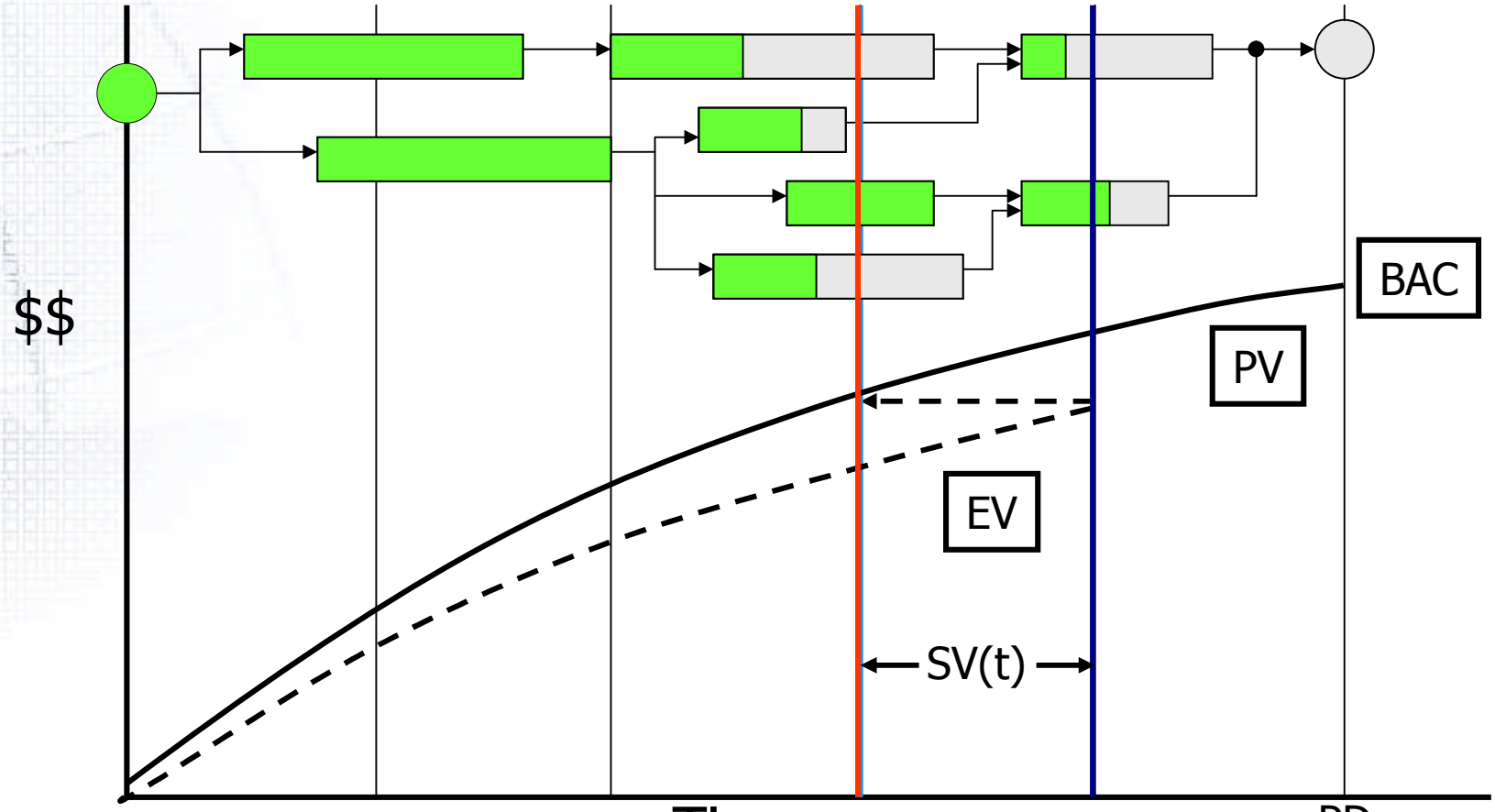
  – **A significant advance in practice**

- *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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