Making project management indispensable for business results

Earned Schedule …

something new for EVM and schedule analysis

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Importance of Schedule

"We need to maintain our attention on schedule delivery. Data tells us that since July 2003, real cost increase in projects accounted for less than 3 percent of the total cost growth. …*Therefore, our problem is not cost, it is SCHEDULE*."

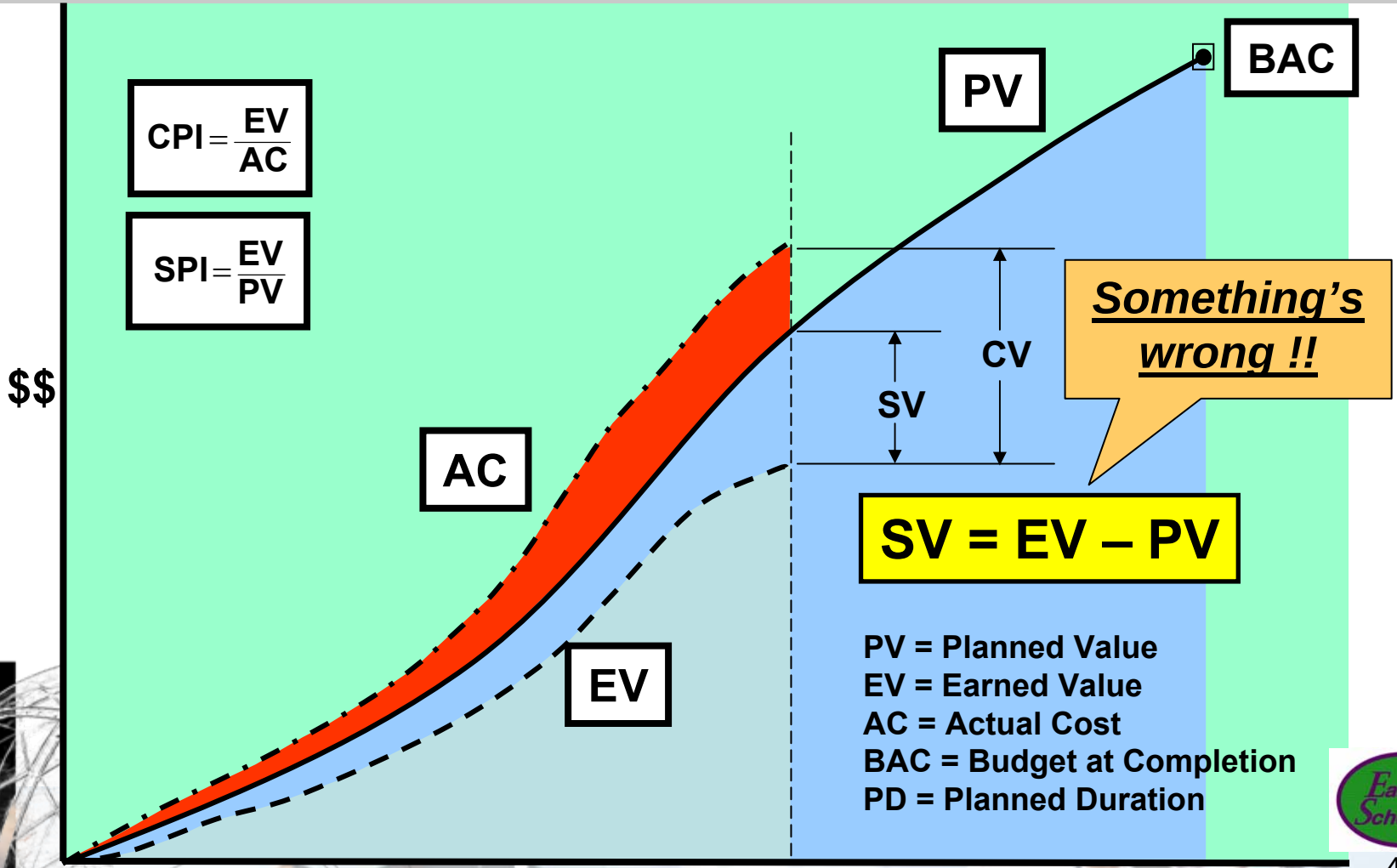
- Dr. Steve Gumley, CEO
  Defence Materiel Organization (Australia)

Quote taken from DMO Bulletin, July 2006, Issue 61, page 3

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

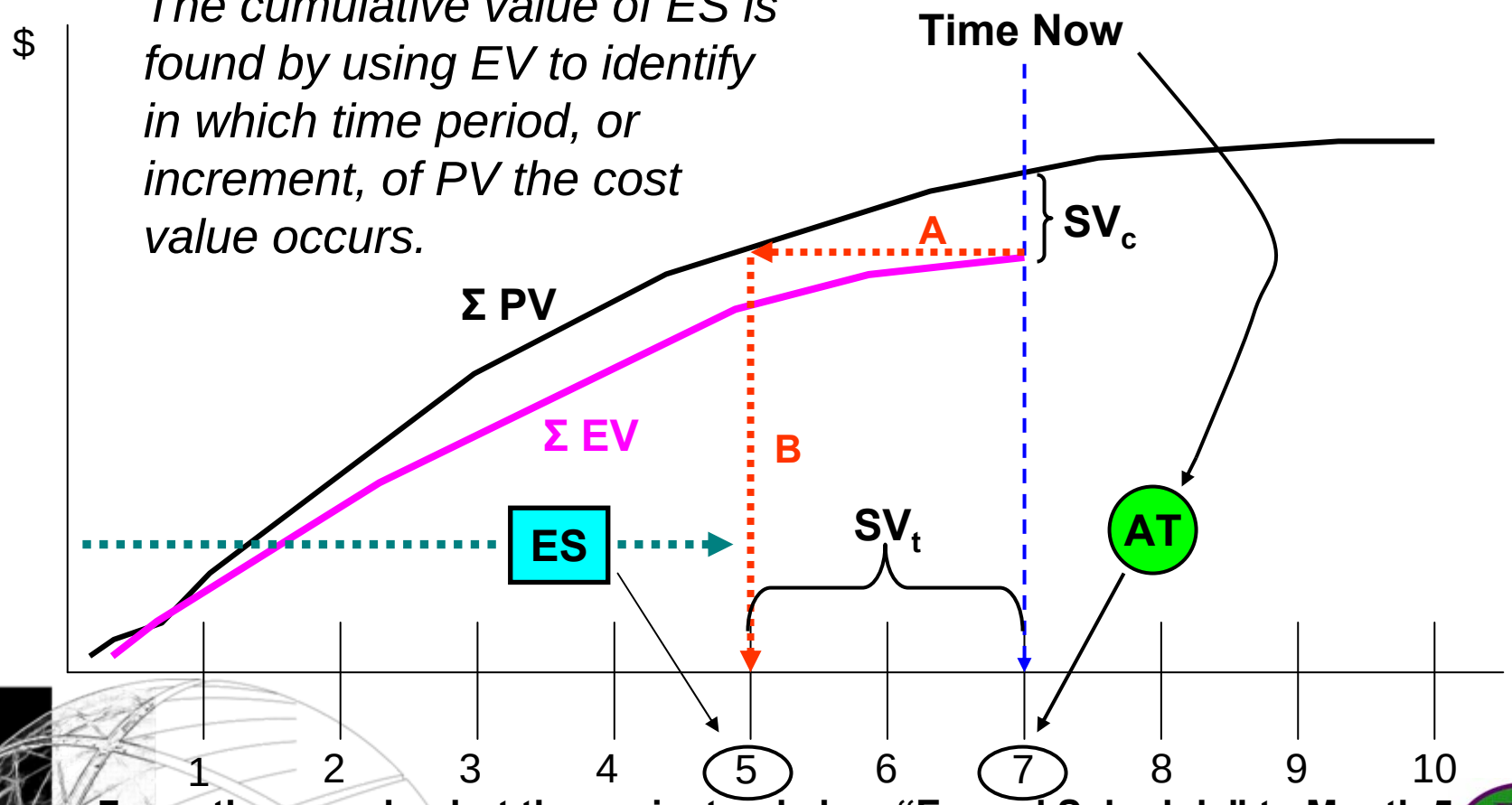
EVM Schedule Indicators

- 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 time period, or 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:

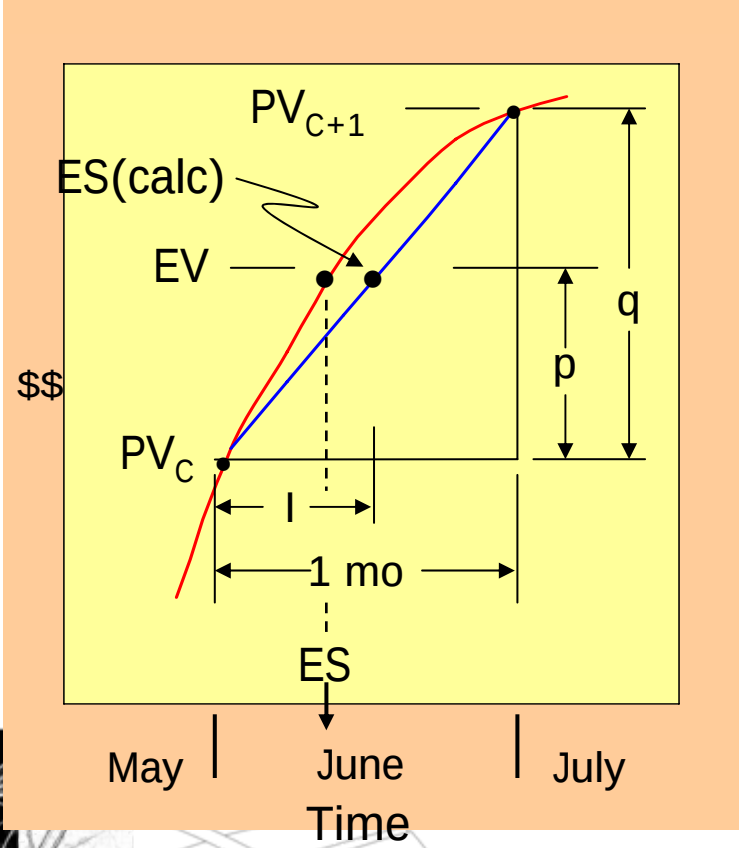
  Number of completed PV time increments EV exceeds + the fraction of the incomplete PV increment

- 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

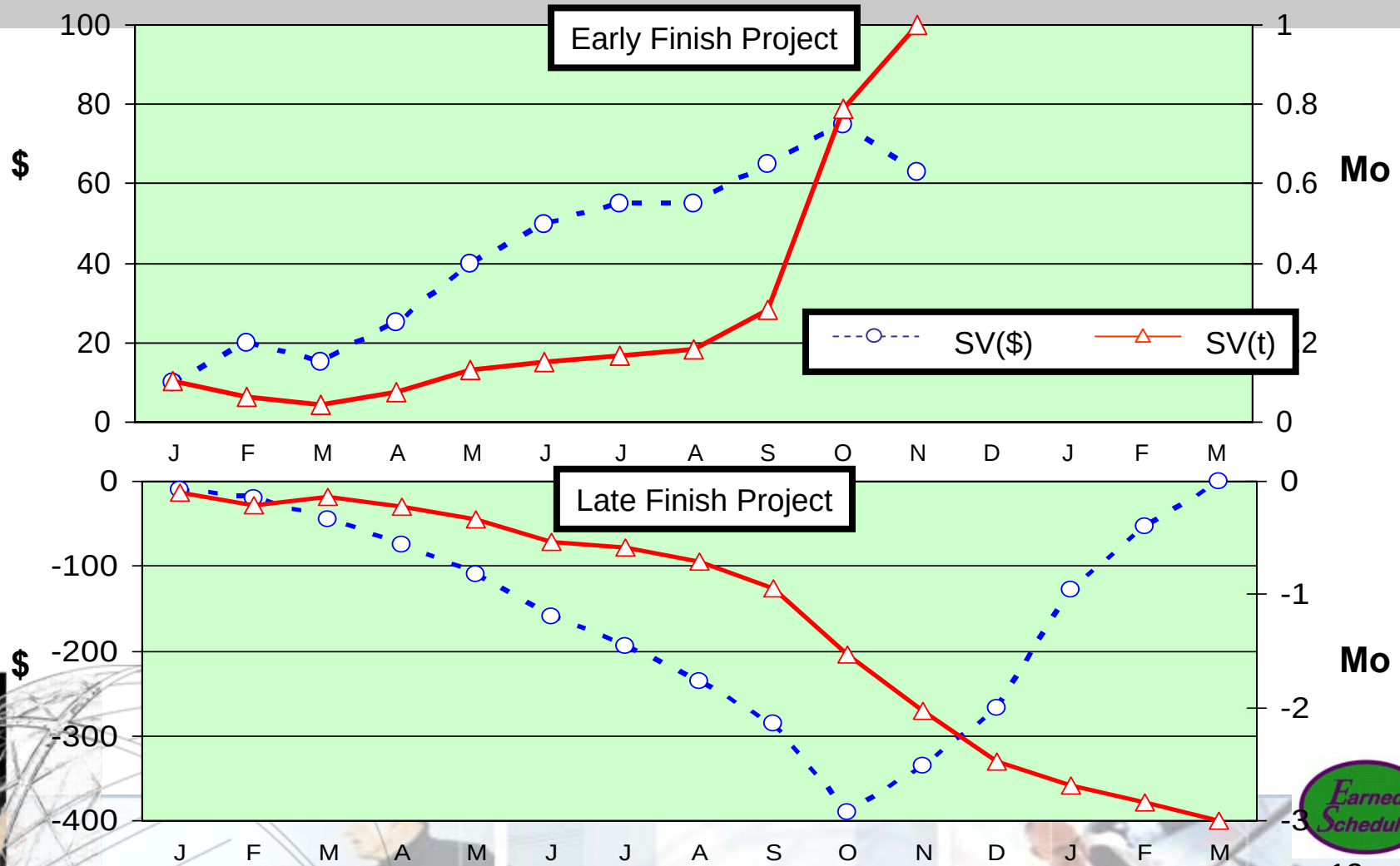
- What happens to the ES indicators, SV(t) & SPI(t), when the planned project duration (PD) is exceeded (PV = BAC)?

  They Still Work …Correctly!!

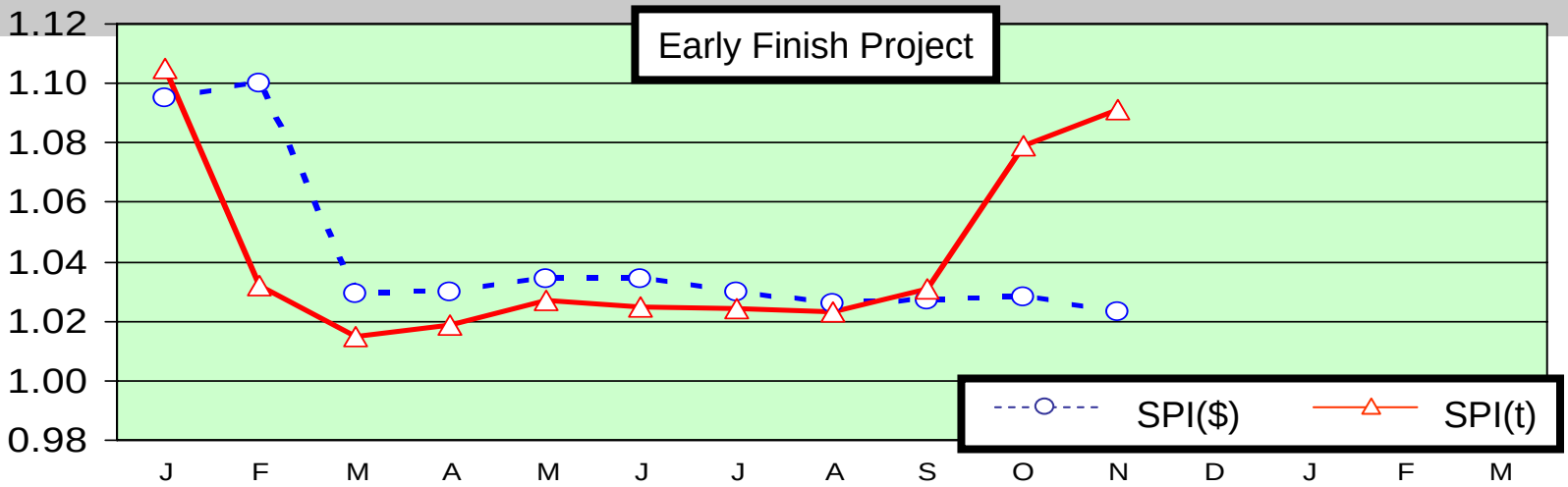
- ES will be ≤ PD, while AT > PD
  - SV(t) will be negative (time behind schedule)
  - SPI(t) will be < 1.00

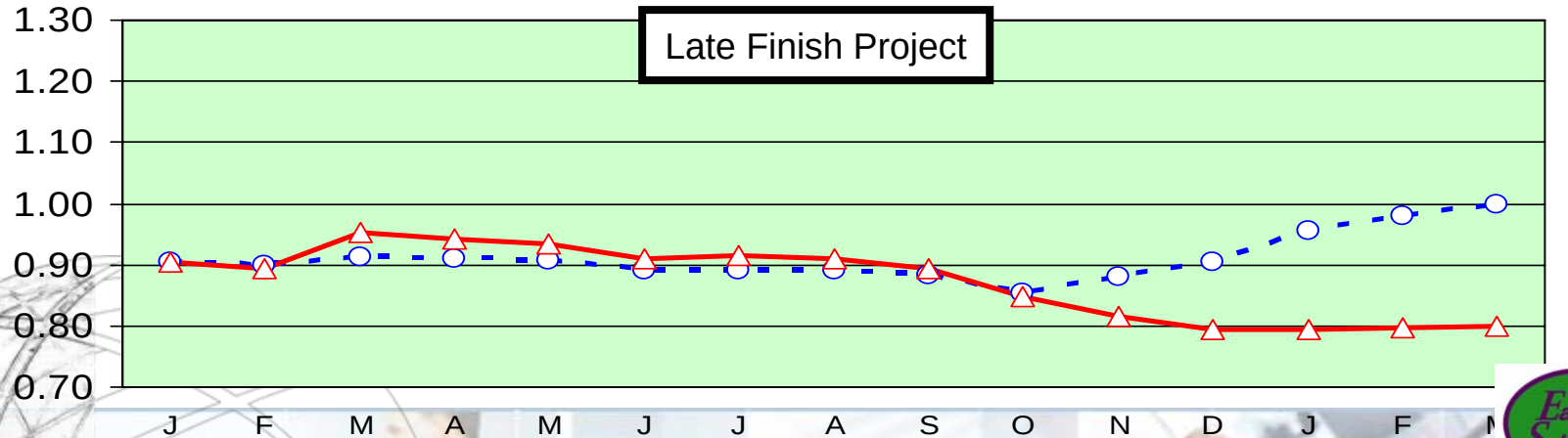
  Reliable Values from Start to Finish !!

Schedule Variance Comparison

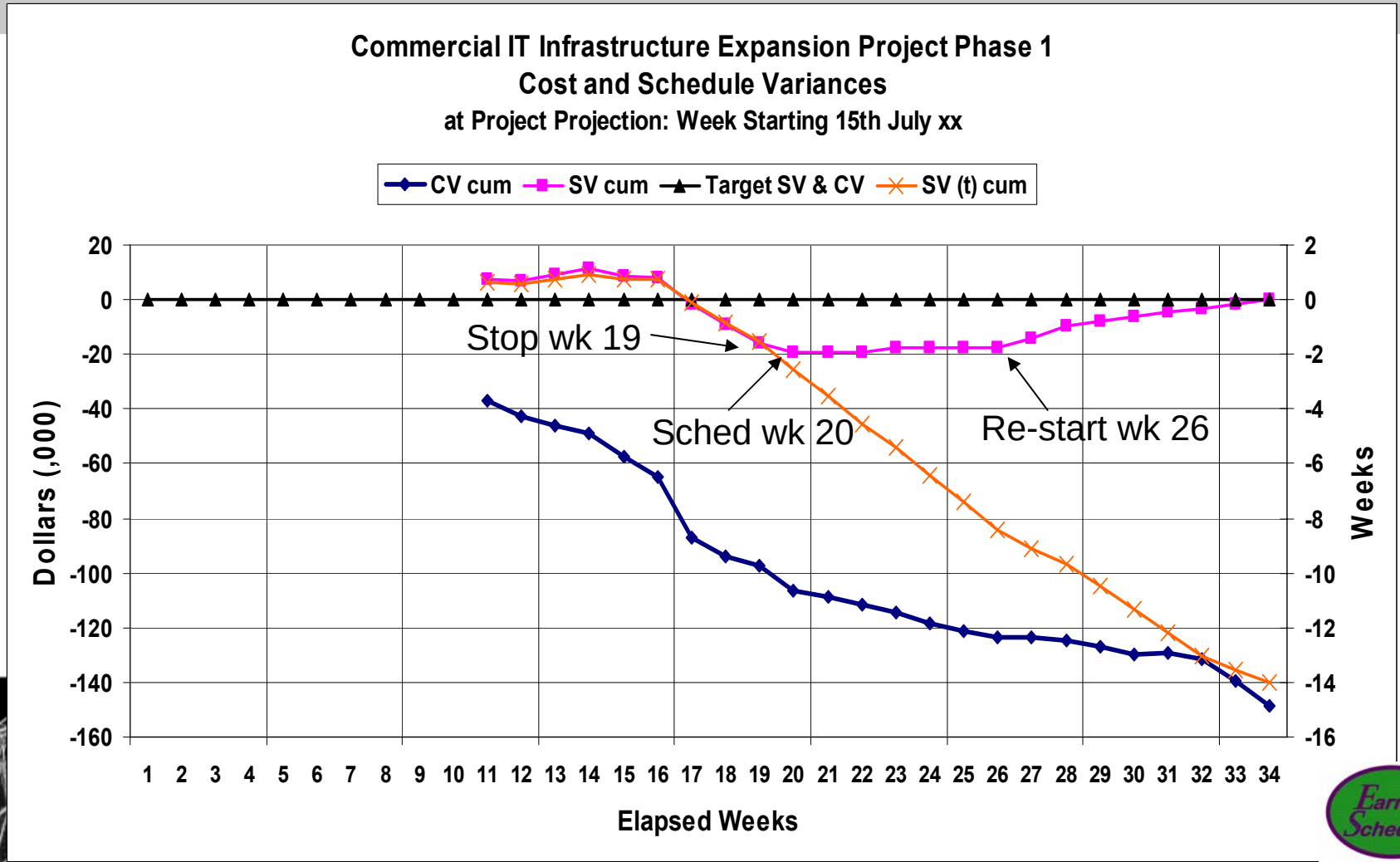


Schedule Index Comparison





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(t)**	**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

- "The results reveal that the earned schedule method outperforms, on the average, all other forecasting methods."

Mario Vanhoucke & Stephan Vandevoorde
"A Simulation and Evaluation of Earned Value Metrics to Forecast Project Duration"
Journal of the Operational Research Society (September 2006)

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

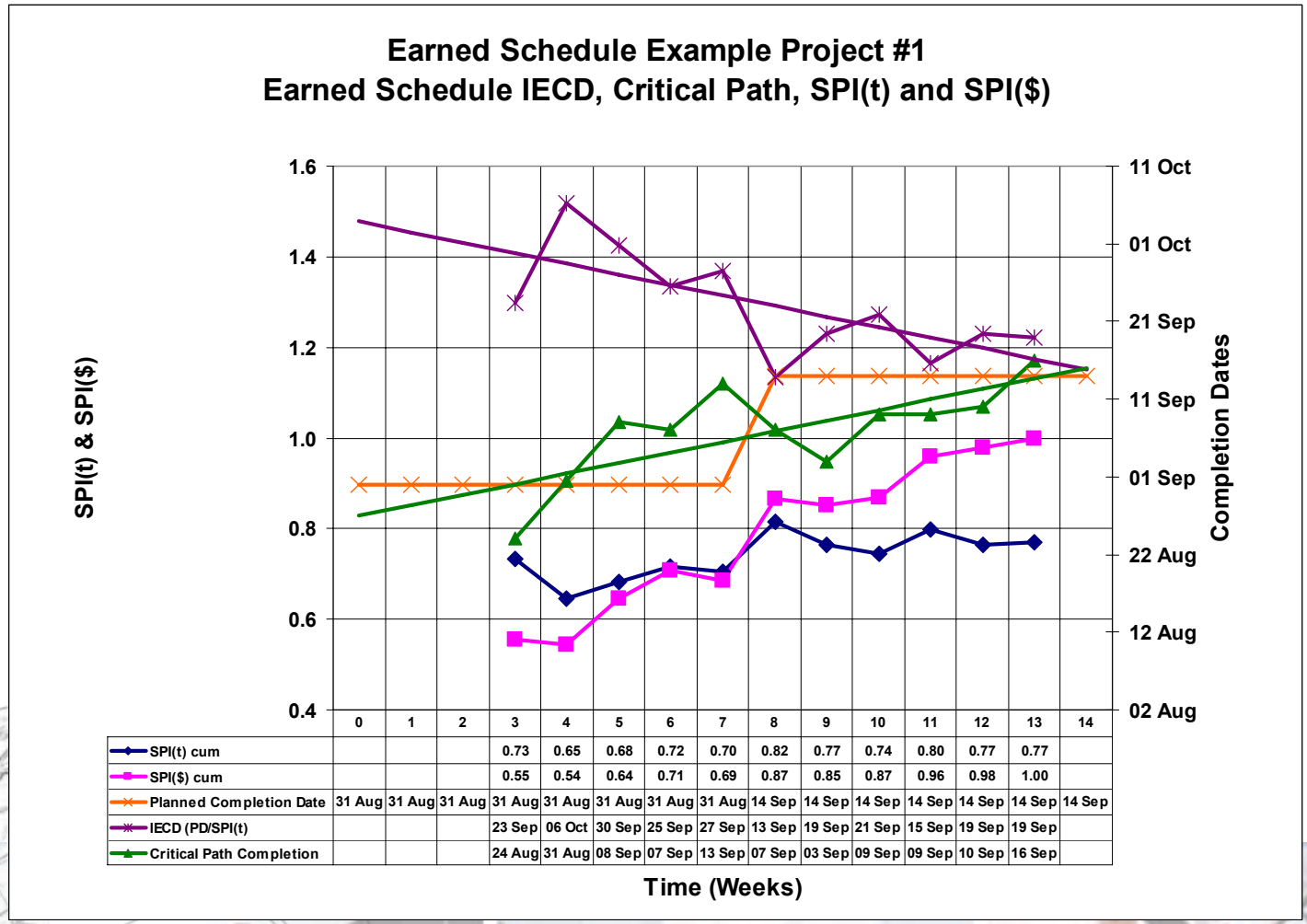
Critical Path Case Study

- Commercial sector software development and enhancement project
  - Small scale: 10 week Planned Duration
  - Time critical: Needed to support launch of revenue generating marketing campaign
  - Cost budget: 100% labour costs
- Mixture of:
  - 3 tier client server development
    - Mainframe, Middleware, Workstation
  - 2 tier client server development
    - Mainframe to Workstation direct

Case Study Schedule Analysis

- Initial expectation
  - The critical path predicted completion date would be more pessimistic than the IECD
- In fact
  - The ES IECD trend line depicted a “late finish” project with improving schedule performance
  - The critical path predicted completion dates showed an “early finish project” with deteriorating schedule performance
- Became the “critical question” in Week 8
  - ES IECD improvement trend reversed
  - Continued deterioration in the critical path predicted completion dates

Integrated Schedule Analysis



	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
SPI(t) cum				0.73	0.65	0.68	0.72	0.70	0.82	0.77	0.74	0.80	0.77	0.77	
SPI($) cum				0.55	0.54	0.64	0.71	0.69	0.87	0.85	0.87	0.96	0.98	1.00	
Planned Completion Date	31 Aug	31 Aug	31 Aug	31 Aug	31 Aug	31 Aug	31 Aug	31 Aug	14 Sep	14 Sep	14 Sep	14 Sep	14 Sep	14 Sep	14 Sep
IECD (PD/SPI(t)				23 Sep	06 Oct	30 Sep	25 Sep	27 Sep	13 Sep	19 Sep	21 Sep	15 Sep	19 Sep	19 Sep	
Critical Path Completion				24 Aug	31 Aug	08 Sep	07 Sep	13 Sep	07 Sep	03 Sep	09 Sep	09 Sep	10 Sep	16 Sep	

Schedule Analysis Result

- IECD the more credible predictor in this circumstance
  - Work was not being accomplished at the rate planned
  - No adverse contribution by critical path factors
    - Externally imposed delays caused by “dependent milestone”
- Two weeks schedule delay communicated to management
  - Very late delay of schedule slippage a very sensitive issue
- Corrective action was immediately implemented
  - Resulted in two weeks progress in one week based on IECD improvement in week 9
  - Project substantively delivered to the revised delivery date

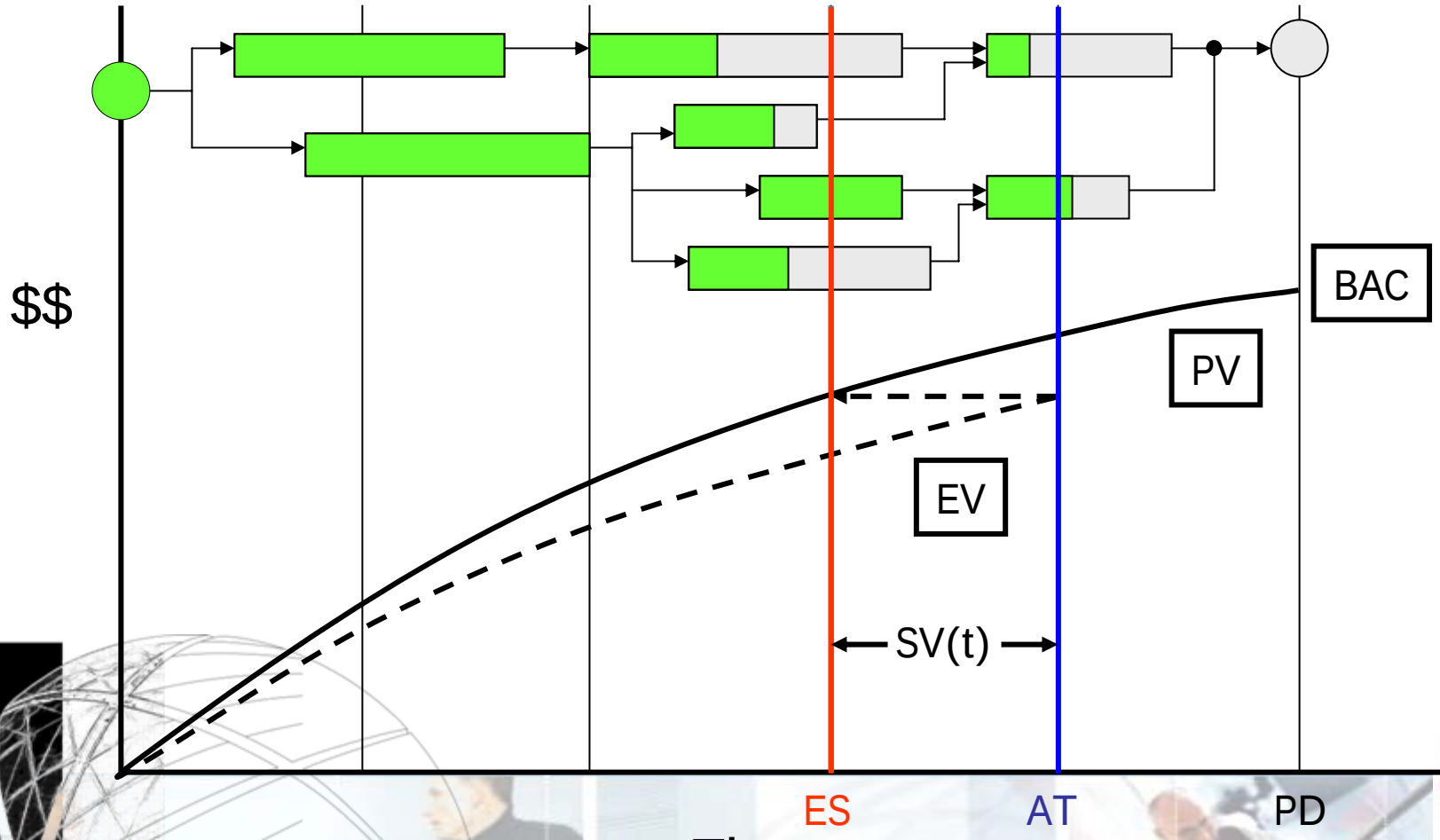
IECD vs Critical Path Predictors

- Network schedule updates do not usually factor past (critical path) task performance into the future
  - Generally concentrate on the current time window
    - Task updates
    - Corrective action to try and contain slippages
  - Critical path predicted completion date is not usually calibrated by past actual schedule performance
- The ES IECD
  - Does not directly take into account critical path information – for this study
  - BUT does calibrate the prediction based on historic schedule performance as reflected in the SPI(t)

Schedule Management with ES

- The “time critical” dichotomy of reporting “optimistic” predicted task completions and setting and reporting realistic completion dates was avoided
  - ES metrics provided an independent means of sanity checking the critical path predicted completion date
  - Prior to communicating overall schedule status to management
- ES focused much more attention onto the network schedule than using EVM alone

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

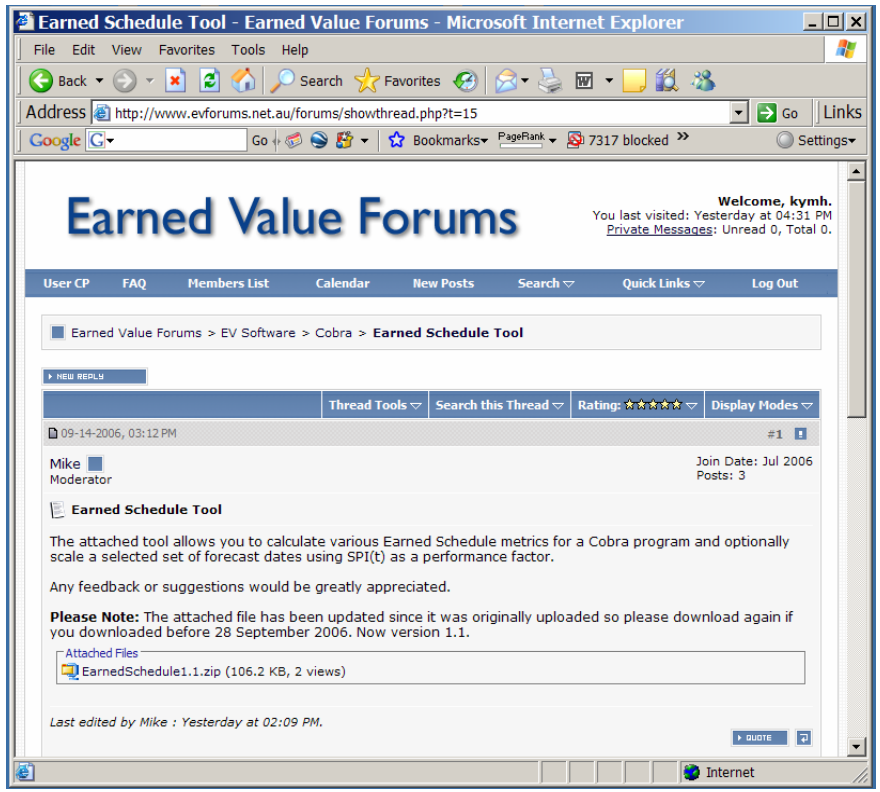
- EVM instruction including ES
  - Performance Management Associates, Management Technologies, George Washington University, University of Florida …
- Boeing, Lockheed Martin, US State Department, Secretary of the Air Force
- Several Countries - Australia, Belgium, United Kingdom, USA ….(Spain, Brazil, Serbia, Sweden, Canada, India, …)
- Applications across weapons programs, construction, software development, …
- Range of project size from very small and short to extremely large and long duration

Current Usage & Recognition

- Inclusion of Emerging Practice Insert into PMI - EVM Practice Standard (2004)
- Described and included in *The Earned Value Management Maturity Model* by Ray Stratton
- Earned Schedule macro for MS Project 2003
  - Created by Diego Navarro
    dnavarro@armell.com
  - Spanish version
    http://www.armell.com/excel/earned_schedule_es.zip
  - English version being tested

Current Usage & Recognition

- Freely available add on tool for the Deltek Cobra product
- Requires registration to Earned Value Forums
- Contact:
  Mike Boulton
  WST Pacific
  mboulton@wstpacific.com.au
  +61 8 8150 5500



http://www.evforums.net.au/forums/showthread.php?t=15

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

Available Resources

- PMI-Sydney http://sydney.pmichapters-australia.org.au/
  - Repository for ES Papers and Presentations
- Earned Schedule Website

  http://www.earnedschedule.com/
  - Established February 2006
  - Contains News, Papers, Presentations, ES Terminology, ES Calculators
  - Identifies Contacts to assist with application
- Wikipedia now references Earned Schedule

  http://en.wikipedia.org/wiki/Earned_Schedule

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