Earned Schedule in Action

Earned Value Analysis - 11 Conference
London, United Kingdom
12-17 June 2006

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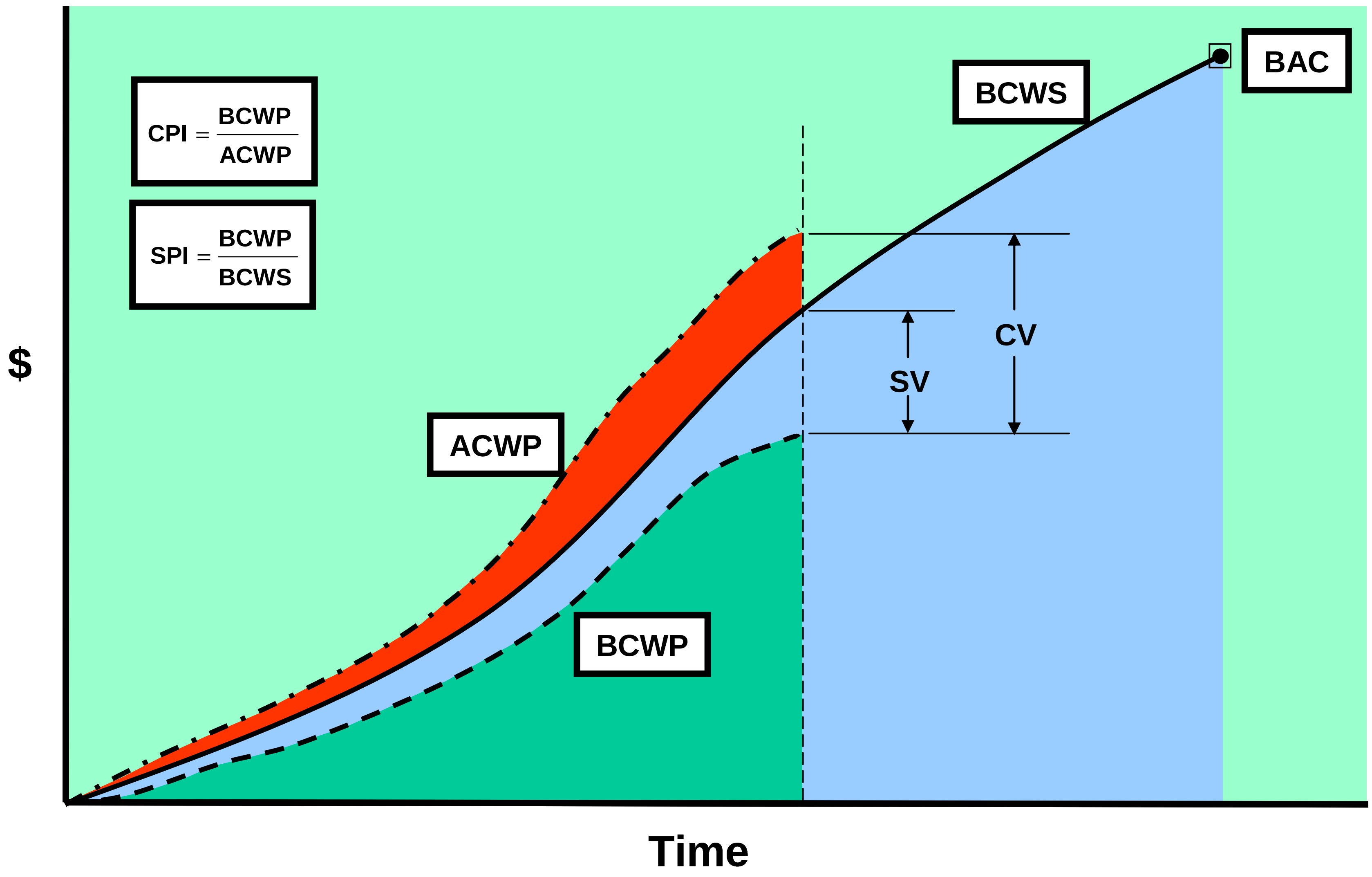
EVM Schedule Indicators



EVM Schedule Indicators

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

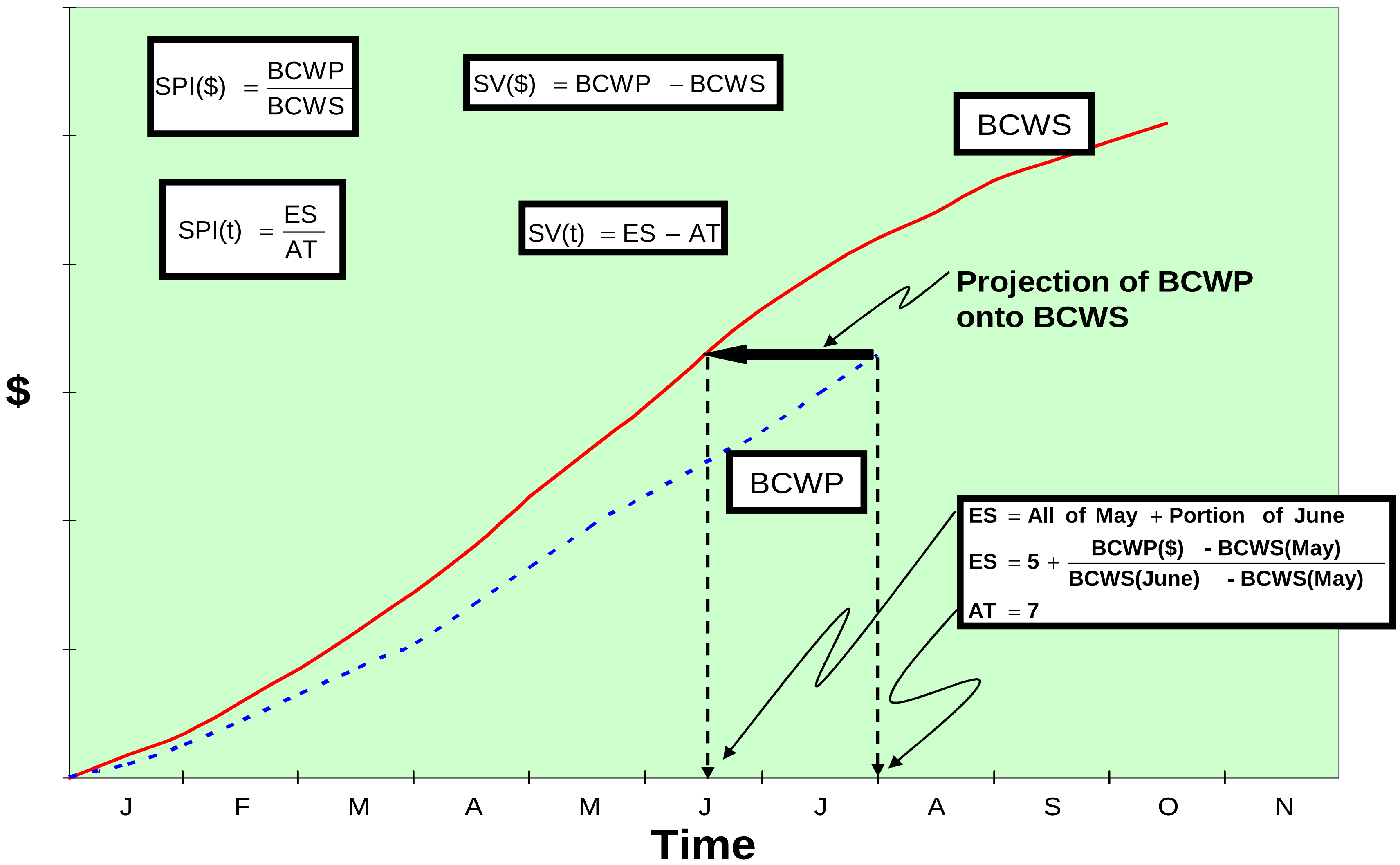
EVM Schedule Indicators

- Why does this happen?
  - SV = BCWP – BCWS
  - SPI = BCWP / BCWS
- At planned completion BCWS = BAC
- At actual completion BCWP = BAC
- When actual completion > planned completion
  - SV = BAC – BAC = $000
  - SPI = BAC / BAC = 1.00

  Regardless of lateness !!

Introduction to Earned Schedule

Earned Schedule Concept



Earned Schedule Metrics

- Required measures
  - Performance Management Baseline (PMB) – the time phased planned values (BCWS) from project start to completion
  - Earned Value (BCWP) – 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 existing EVM data

Earned Schedule Metrics

- ES_{cum} is the:

  Number of completed BCWS time increments BCWP exceeds + the fraction of the incomplete BCWS increment

- $ES_{cum} = C + I$ where:

  C = number of time increments for BCWP ≥ BCWS

  $I = (BCWP – BCWS_C) / (BCWS_{C+1} – BCWS_C)$

- ESperiod(n) = EScum(n) – EScum(n-1) = ΔES_{cum}
- ATcum

  AT = Actual Time (time now)

- ATperiod(n) = ATcum(n) – ATcum(n-1) = ΔAT_{cum}

  ΔAT_{cum} is normally equal to 1

Earned Schedule Indicators

- Schedule Variance: SV(t)
  - Cumulative: $\mathbf{SV(t) = ES_{cum} - AT_{cum}}$
  - Period: $\Delta SV(t) = \Delta\ ES_{cum} - \Delta\ AT_{cum}$
- Schedule Performance Index: SPI(t)
  - Cumulative: $\mathbf{SPI(t) = ES_{cum} / AT_{cum}}$
  - Period: $\Delta SPI(t) = \Delta ES_{cum} / \Delta AT_{cum}$

Earned Schedule Indicators

- What happens to the ES indicators, SV(t) & SPI(t), when the Planned project Duration (PD) is exceeded (BCWS = 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 !!

Earned Schedule Predictors

- 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 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 BCWS calculation reference
  - Provide duration based measures of schedule performance
  - Valid for entire project, including early and late finish
- Facilitates integrated Cost/Schedule Management (using EVM with ES)

Critical Path Study

Critical Path Study Outline

- **The Scheduling Challenge**
- **Case Study Project**
  - The project
  - The EVM, Earned Schedule and Network Schedule approach
- **Earned Schedule vs Critical Path predictors**
- **Real Schedule Management with Earned Schedule**
  - Initial experience and observations
- **Conclusion and Final Thoughts**

The Scheduling Challenge

- **A realistic project schedule is dependent on multiple, often complex factors including accurate:**
  - Estimation of the tasks required,
  - Estimates of the task durations
  - Resources required to complete the identified tasks
- **Identification and modeling of dependencies impacting the execution of the project**
  - Task dependencies (e.g. F-S process flows)
  - “Dependent” Milestones (internal and external)
  - “Other logic”

The Scheduling Challenge

- **From small projects into large projects and programs, scheduling requirements becomes exponentially more complex**
- **Integration**
  - Of schedules between "master" and "subordinate" schedules
  - Often across multiple tiers of
    - Activities and
    - Organisations

    contributing to the overall program of work
- **Essential for producing a useful integrated master schedule**

To further compound schedule complexity

- **Once an initial schedule baseline has been established progress monitoring <u>inevitably</u> results in changes**
  - Task and activity durations change because "actual performance" does not conform to plan
  - Additional unforeseen activities may need to be added
  - Logic changes as a result of corrective actions to contain slippages; and
  - Improved understanding of the work being undertaken
  - Other "planned changes" (Change Requests) also contribute to schedule modifications over time

Wouldn't it be nice ….

- **To be able to explicitly declare "Schedule Reserve" in the project "schedule of record"**
  - Protect committed key milestone delivery dates
- **To have schedule macro level indicators and predictors**
  - Ideally, derived separately from the network schedule!
  - Provides a means for comparison and validation of the measures and predictors provided by the network schedule
  - An independent predictor of project duration would be a particularly useful metric
    - "On time" completion of projects usually considered important
- **Just like EVM practitioners have for cost ….**
  - **The potential offered by Earned Schedule**

Case Study Project

- **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

The EVM and ES Approach

- **Microsoft Project 2002 schedule**
  - Resource loaded for time phased effort and cost estimation
  - Control Account – Work Package views developed in the schedule
  - Actual Costs captured in SAP time recording system
    - Limited (actual) cost – schedule integration
  - Contingency (Management Reserve) managed outside the schedule
- **Top level Planned Values cum “copied and pasted” into Excel EVM and ES template**
  - High level of cost – schedule integration achieved

Baseline Schedule: CAP and WP View
(Excluding Risk)

Task Name	Baseline Work	Baseline Cost	Duration	Details	July	August	September
Project: ES Example #1 Inital Baseline Schedule	1,675 hrs	$167,857	87 days	Cost	$74,084	$57,310	
				Cum. Cost	$75,852	$133,162	$133,162
CAP 1 PROJECT MANAGEMENT	297 hrs	$38,610	44 days	Cost	$14,139	$17,680	
				Cum. Cost	$15,907	$33,587	$33,587
CAP 5 BUSINESS REQUIREMENTS	192 hrs	$0	34 days	Cost			
				Cum. Cost	$0	$0	$0
CAP 7 SOLUTION DESIGN	160 hrs	$16,567	9.5 days	Cost	$6,367		
				Cum. Cost	$6,367	$6,367	$6,367
CAP 8 BUILD & UNIT TEST	720 hrs	$77,760	30.25 days	Cost	$45,128	$13,760	
				Cum. Cost	$45,128	$58,888	$58,888
01 Mainframe Stream 1	192 hrs	$24,960	19.38 days	Cost	$12,168		
				Cum. Cost	$12,168	$12,168	$12,168
02 Mainframe Stream 2	64 hrs	$6,400	10 days	Cost	$4,240		
				Cum. Cost	$4,240	$4,240	$4,240
03 Frontend	104 hrs	$10,400	19 days	Cost	$7,920	$1,440	
				Cum. Cost	$7,920	$9,360	$9,360
04 Connect	40 hrs	$4,000	6.25 days	Cost	$4,000		
				Cum. Cost	$4,000	$4,000	$4,000
05 Database	8 hrs	$800	1.25 days	Cost	$800		
				Cum. Cost	$800	$800	$800
06 Middle Tier	208 hrs	$20,800	25 days	Cost	$12,320	$6,880	
				Cum. Cost	$12,320	$19,200	$19,200
07 Reporting	104 hrs	$10,400	21.5 days	Cost	$3,680	$5,440	
				Cum. Cost	$3,680	$9,120	$9,120
CAP 9 SYSTEM TEST	104 hrs	$13,520	29.06 days	Cost	$8,450	$5,070	
				Cum. Cost	$8,450	$13,520	$13,520
CAP 10 UAT	45 hrs	$5,040	3.75 days	Cost		$5,040	
				Cum. Cost		$5,040	$5,040
CAP 11 PRODUCTION IMPLEMENTATION	96 hrs	$10,260	11.81 days	Cost		$10,260	
				Cum. Cost		$10,260	$10,260

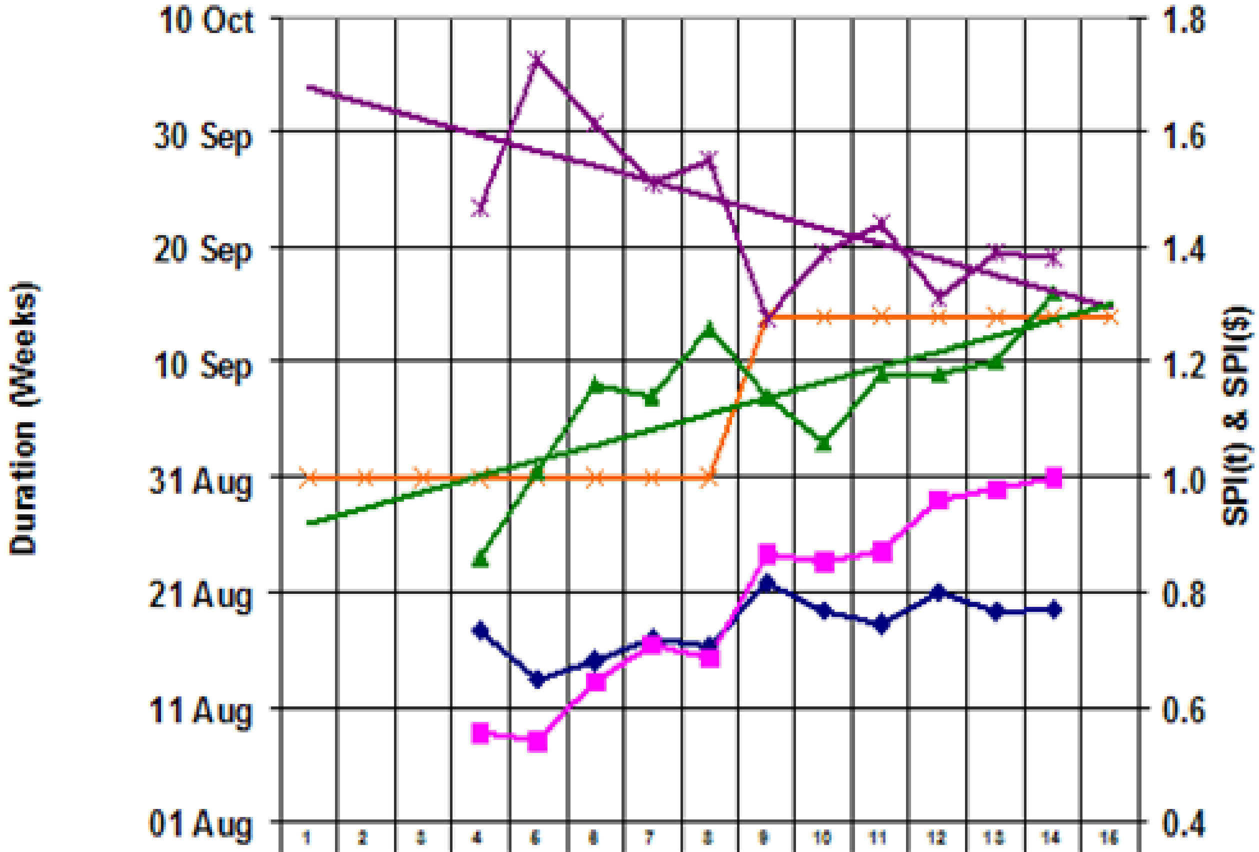
Schedule Management

- **Weekly schedule updates from week 3 focusing on:**
  - Accurate task level percentage work completion updates
  - The project level percentage work completion (cumulative) calculated by Microsoft Project
    - Percentage work complete transferred to the EVM and ES template to derive the progressive Earned Value (cumulative) measures
- **Schedule review focusing on critical path analysis**
  - Schedule updates occurred as needed with
  - Revised estimates of task duration and
  - Changes to network schedule logic

  particularly when needed to facilitate schedule based corrective action
- **Actual costs entered into the EVM template as they became available (~ weekly)**

An Integrated Schedule Analysis Chart

Critical Path, IECD, SPI(t) and SPI($) on one page



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Planned Completion Date	31	31	31	31	31	31	31	31	14	14	14	14	14	14	14
IECD (PD/SPI(t))				23	06 Oct	30	26	27	13	19	21	16	19	19	
Critical Path Completion				24	31	08	07	13	07	03	09	09	10	16	
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				0.56	0.54	0.64	0.71	0.69	0.87	0.86	0.87	0.96	0.98	1.00	

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

Schedule Analysis Result

- **IECD the more credible predictor in <u>this circumstance</u>**
  - Work was not being accomplished at the rate planned
  - No adverse contribution by critical path factors
    - e.g. 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

The IECD vs Critical Path Predictors

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

Further Observations

- **Much has been written about the consequences of not achieving work at the EVM rate planned**
  - At very least, incomplete work needs to be rescheduled …
  - Immediate critical vs non critical path implication requires detailed analysis of the network schedule
  - Sustained improvement in schedule performance is a difficult challenge
    - SPI(t) remained in the .7 to .8 band for the entire project!
    - In spite of the corrective action and recovery effort
  - **Any task delayed eventually becomes critical path if not completed!**
- **SPI(t) a very useful indicator of schedule performance**
  - **Especially later in the project when SPI($) resolving to 1.0**

Questions of Scale

- **We know that ES is scalable as is EVM**
  - Issues of scale did not arise due to small size of the project
- **Detailed analysis of the ES metrics is required**
  - The same as EVM for cost
  - The “masking” or “washout” effect of negative and positive ES variances at the detailed level can be an issue
  - <u>The same as EVM for cost</u>
- **Apply Earned Schedule to the Control Accounts and Work Packages on the critical path**
  - And “near” critical path activities
- **Earned Schedule augments network schedule analysis – it doesn’t replace it**
  - Just as EVM doesn't replace a bottom up ETC and EAC

Real Schedule Management with Earned Schedule

- **ES is of considerable benefit in analysing and managing schedule performance**
- **The "time critical" dichotomy of working to "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**

Final Thoughts

- **ES is expected be of considerable value to the schedule management for large scale projects and programs**
  - Exponential increase in the network scheduling complexities which is both
  - Unavoidable and essential on those programs which means
  - **The need and benefits of independent techniques to sanity check schedules of such complexity is much greater**
- ***ES is anticipated to become the "bridge" between EVM and the Network Schedule***

Available Resources

Publications

1. "Schedule is Different," *The Measurable News*, March & Summer 2003 [Walt Lipke]
2. "Earned Schedule: A Breakthrough Extension to Earned Value Theory? A Retrospective Analysis of Real Project Data," *The Measurable News*, Summer 2003 [Kym Henderson]
3. "Further Developments in Earned Schedule," *The Measurable News*, Spring 2004 [Kym Henderson]
4. "Connecting Earned Value to the Schedule," *The Measurable News*, Winter 2004 [Walt Lipke]
5. "Earned Schedule in Action," *The Measurable News*, Spring 2005 [Kym Henderson]
6. "Not Your Father's Earned Value," *Projects A Work*, February 2005 [Ray Stratton]

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Presentations

1. Earned Schedule – An Emerging Practice, 16th IIPM Conference, November 2004 [Walt Lipke, Kym Henderson]
2. Schedule Analysis and Predictive Techniques Using Earned Schedule, 16th IIPM Conference, November 2004 [Walt Lipke, Kym Henderson, Eleanor Haupt]
3. Earned Schedule – an Extension to EVM Theory, EVA-10 Conference (London), May 2005 [Walt Lipke, Kym Henderson]
4. Forecasting Project Schedule Completion by Using Earned Value Metrics, EVM Training at Ghent University (Belgium), January 2005 [Stephan Vandevoorde]

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Presentations

5. New Concept in Earned Value – *Earned Schedule*, PMI Southeast Regional Conference, June 2005 [Robert Handshuh]
6. Forecasting Project Schedule Completion by Using Earned Value Metrics, Early Warning Signals Congress (Belgium), June 2005 [Stephan Vandevoorde, Dr. Mario Vanhoucke]

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Calculator & Analysis Tools

- **Freely provided upon email request**
  - Application assistance if needed
- **Please respect copyright ©**
- **Feedback requested**
  - Improvement / Enhancement suggestions
  - Your assessment of value to Project Managers
  - Disclosure of application and results (with organization permission and/or anonymously)

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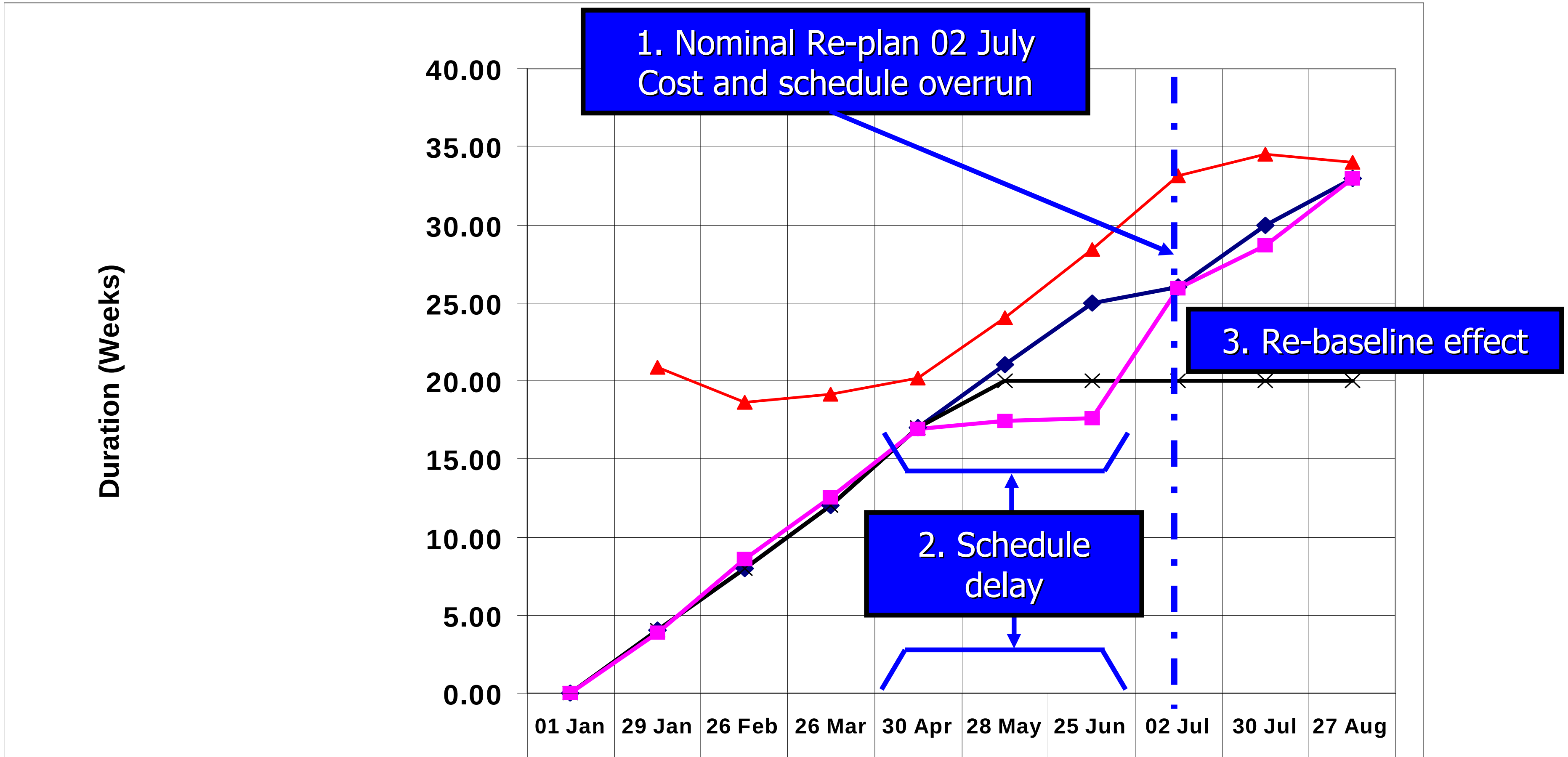
Appendix:
ES and Re-Baselining

ES and Re-Baselining

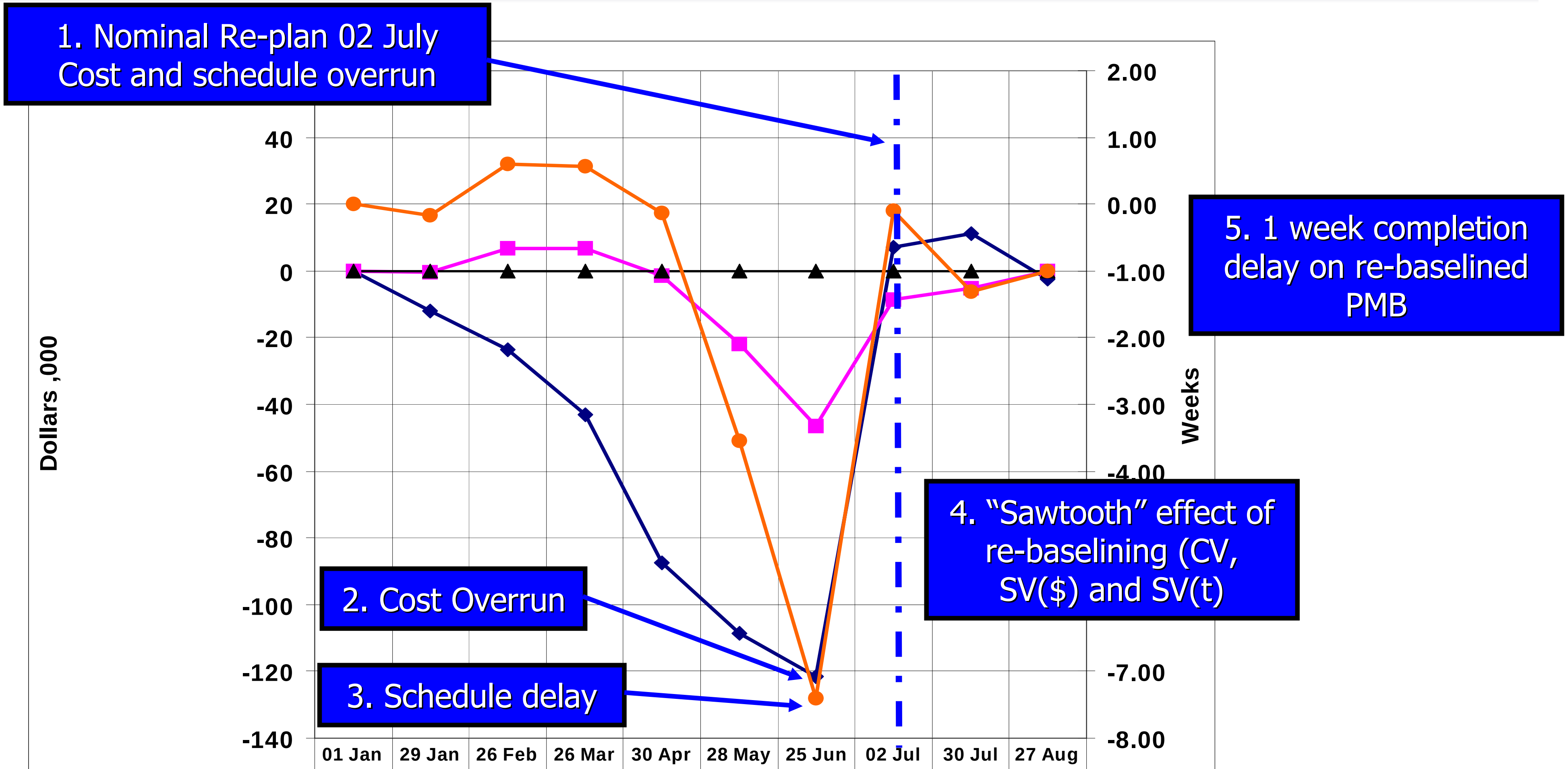
- **ES indicators are affected by re-baselining**
  - Behaviour of SV(t) and SPI(t) is analogous to CV and CPI
    - See examples
- **PMB change affects schedule prediction similarly to cost**
- **Earned Schedule brings attention to the potential schedule impact of a declared “cost only” change**

Earned Schedule – Re-Baseline Example
Real project data – <u>nominal</u> re-baseline



	01 Jan	29 Jan	26 Feb	26 Mar	30 Apr	28 May	25 Jun	02 Jul	30 Jul	27 Aug
Actual Time (weeks)	0.00	4.00	8.00	12.00	17.00	21.00	25.00	26.00	30.00	34.00
Planned Schedule ReBline #1	0.00	4.00	8.00	12.00	17.00	21.00	25.00	26.00	30.00	33.00
Planned Schedule cum CBB	0.00	4.00	8.00	12.00	17.00	20.00	20.00	20.00	20.00	20.00
Earned Schedule cum	0.00	3.84	8.60	12.56	16.87	17.45	17.59	25.91	28.70	33.00
IEAC(t) SPI(t)		20.85	18.60	19.11	20.15	24.07	28.42	33.12	34.50	34.00

Earned Schedule – Re-Baseline Example
CV, SV($) and SV(t)



	01 Jan	29 Jan	26 Feb	26 Mar	30 Apr	28 May	25 Jun	02 Jul	30 Jul	27 Aug
Actual Time (weeks)	0.00	4.00	8.00	12.00	17.00	21.00	25.00	26.00	30.00	34.00
CV cum	0.00	(12.14)	(23.70)	(42.92)	(87.31)	(108.61)	(121.43)	6.96	11.09	(2.30)
SV($) cum	0.00	(0.41)	6.65	6.73	(1.42)	(22.07)	(46.48)	(8.60)	(5.22)	0.00
Target CV and SV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SV(t) cum	0.00	(0.16)	0.60	0.56	(0.13)	(3.55)	(7.41)	(0.09)	(1.30)	(1.00)