Earned Schedule Fundamentals - Using EVM data in Units of Time rather than Cost

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* Earned Schedule is trademarked for acknowledgement of source purposes only

BETTER MANAGEMENT - BETTER PROJECTS

Agenda

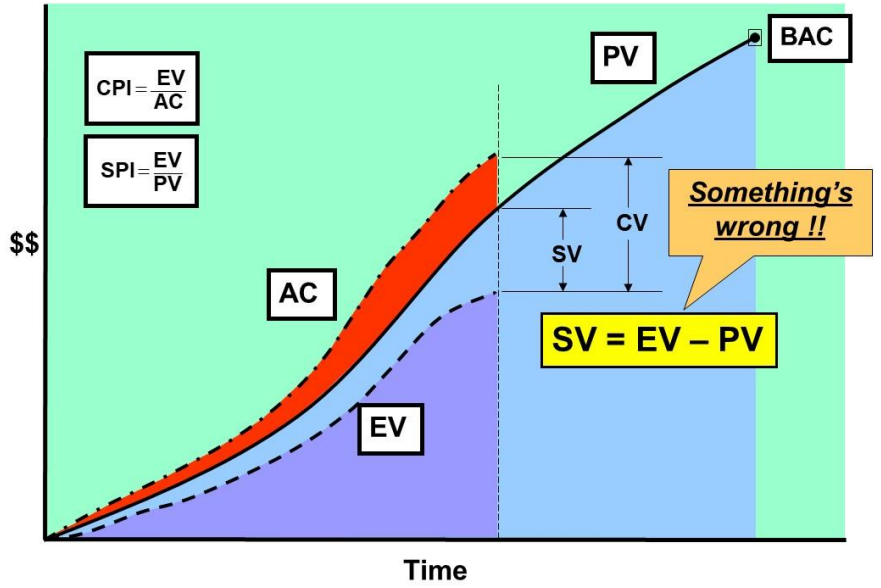
- Issues with EVM Schedule Indicators
- Earned Schedule Concept
- Earned Schedule Key Points
- Earned Schedule TSPI Prediction
- Earned Schedule Forecasting: IEAC (time)
- Earned Schedule Limitations
- Early Empiric Research from 2009 (now replicated many times over)
- Schedule prediction using Earned Schedule TSPI - SPI(t) chart
- Improving schedule performance can improve cost performance
- Earned Schedule Resources
- Questions and Thank you
- **Backup**
  - Earned Schedule Terminology
  - Earned Schedule Formulae
  - ES Computation Example

Issues with EVM Schedule Indicators

- **SV and SPI are measured on value ($) y axis**
  - ***Not*** the time-based X Axis
  - Counterintuitive measures of schedule performance in **$**
  - Difficult to compare and correlate to the network schedule AND report to management
- **SV & SPI behave erratically for late projects**
  - SPI always improves and concludes at 1.00 at end of project
  - SV always improves and concludes at $0 variance at end of project
- **Schedule indicators lose predictive capability**
  - Over final 1/3 of third of the project
  - **Cannot be used as statistical predictors**
  - ***Motivation for Walt Lipke to develop Earned Schedule in 2003***

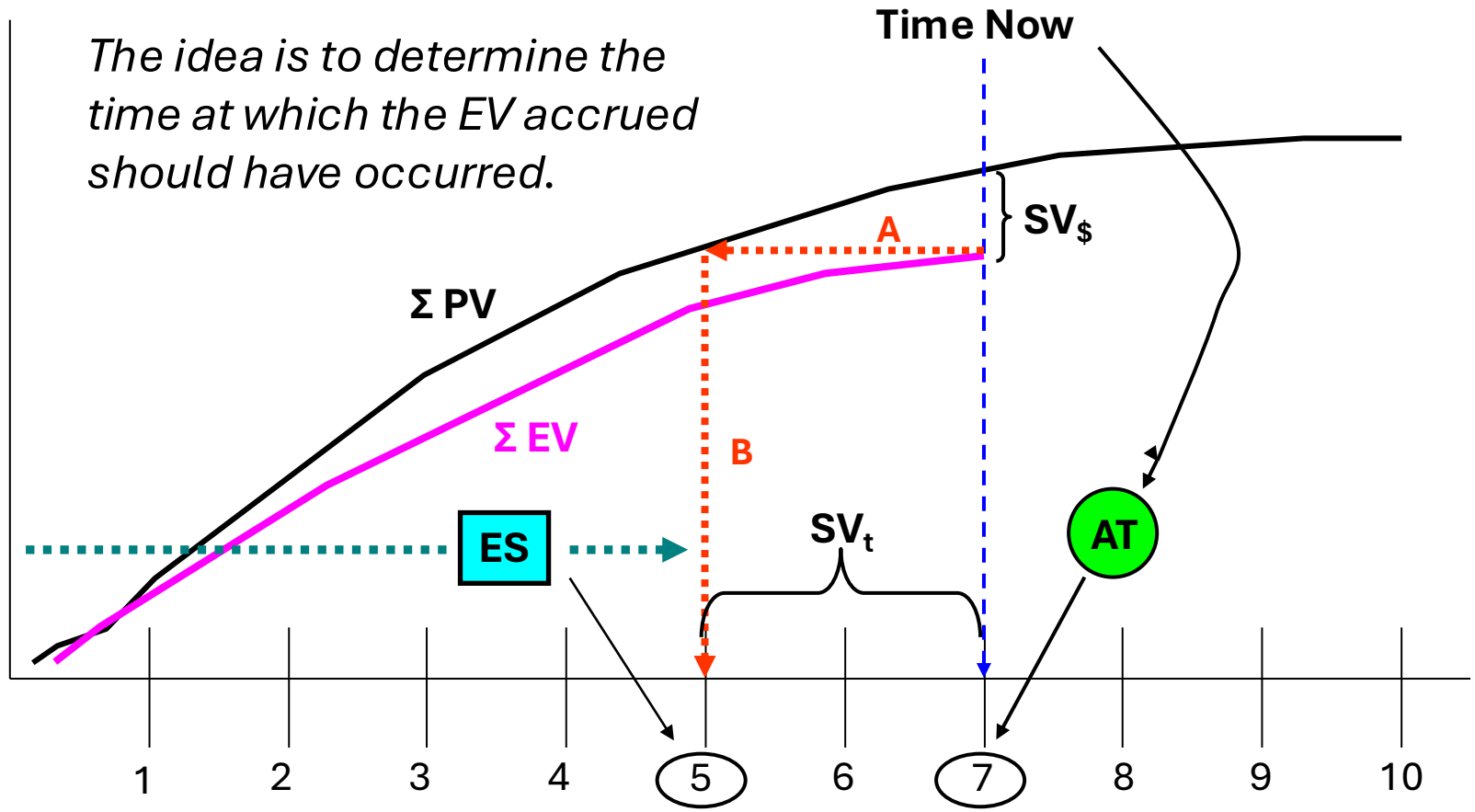
- **Why does this happen?**
  - SV = EV – PV
  - SPI = EV / PV
- At planned completion PV = BAC
- At actual completion EV = BAC
- When actual > planned completion
  - SV = BAC – BAC = $000
  - SPI = BAC / BAC = 1.00

  Regardless of lateness !!



Earned Schedule Concept

Lipke: 2003 " Schedule is Different"



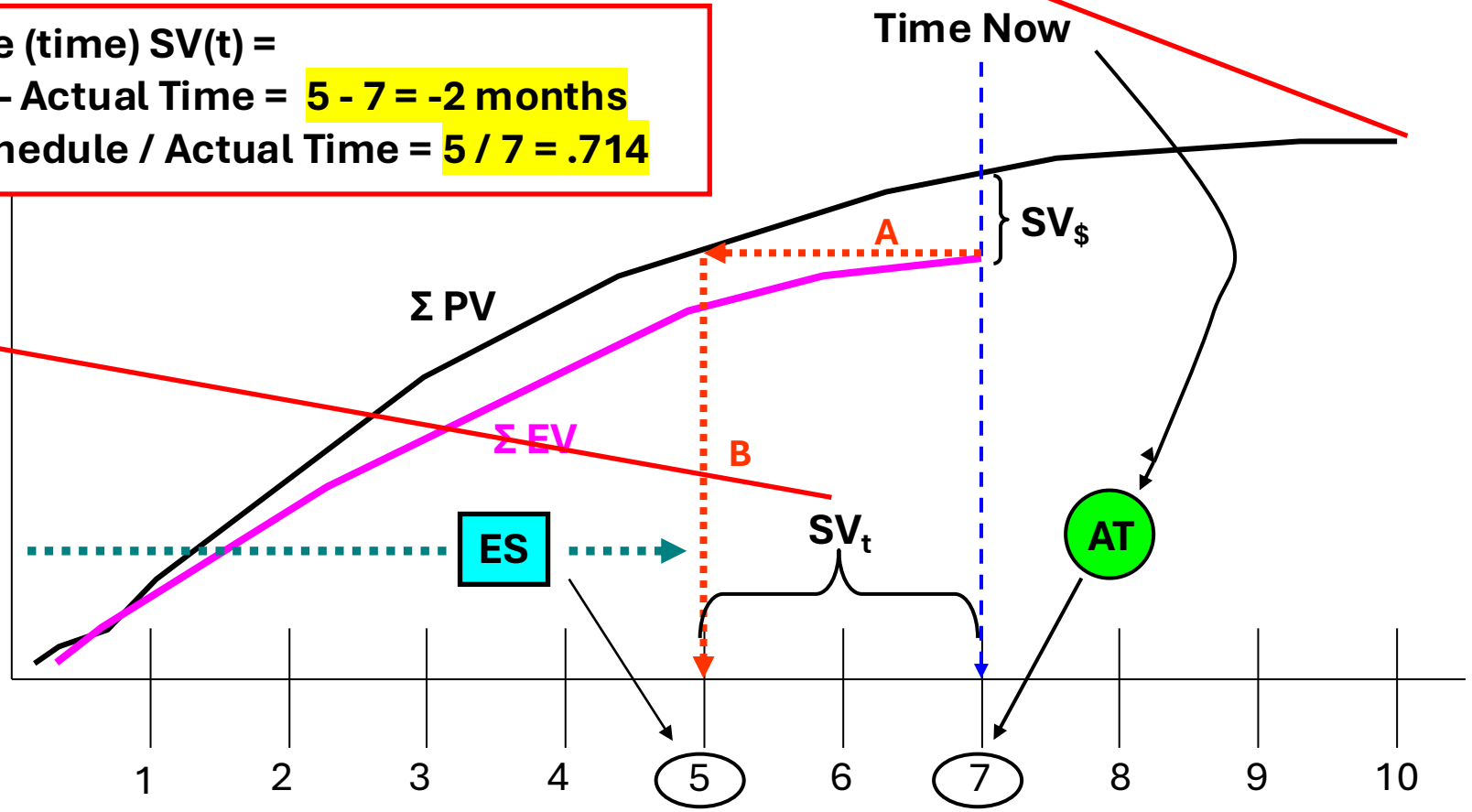
For the above example, ES = 5 months …that is the time associated with the PMB at which PV equals the EV accrued at month 7.

Earned Schedule Concept

Lipke: 2003 " Schedule is Different"

Statistically Predicted Project Duration = PD / SPI(t)
= 10/.714 = 14 months

Schedule Variance (time) SV(t) =
Earned Schedule – Actual Time = 5 - 7 = -2 months
SPI(t) = Earned Schedule / Actual Time = 5 / 7 = .714



For the above example, ES = 5 months …that is the time associated with the PMB at which PV equals the EV accrued at month 7.

Earned Schedule Key Points

- Earned Schedule Indicators constructed to behave in an analogous manner to the EVM Cost Indicators, CV, CPI, TCPI
  - Metrics and formulae included in backup
- SV(t) and SPI(t)
  - Not constrained by BAC calculation reference
  - Provide duration-based indicators of schedule performance
  - **Valid for entire project, including early and late finish**
- Facilitates integrated Cost/Schedule Management
  - *using EVM with ES*

Earned Schedule TSPI Prediction (Analogous to TCPI for Cost)

The future efficiency needed to achieved to achieve a target schedule outcome

- **Can the project be completed as planned?**
  - TSPI = Plan Remaining / Time Remaining

    = (PD – ES) / (**PD** – AT)

    where (PD – ES) = PDWR

    PDWR = Planned Duration for Work Remaining
- **….. be completed as estimated?**
  - TSPI = (PD – ES) / (**ED** – AT)

    where ED = Estimated Duration

TSPI Value	Predicted Outcome
≤ 1.00	Achievable
> 1.10	Not Achievable

Earned Schedule Forecasting: IEAC (time)

Analogous to IEAC used to forecast final cost

- Long time goal of EVM …
  Forecasting of total project duration from current 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)
- Independent Estimated Completion Date (IECD)
  - IECD = Start Date + IEAC(t)
  - Enables direct comparison to the critical path completion date

Earned Schedule Limitations

- **Dependent on EVM data**
  - Planned Value and Earned Value
  - Quality of the PMB
  - No additional data collection required if using EVM
- **Earned Schedule predictors assumes historic performance (measured by SPI(t)) will continue to completion**
  - Analysis is needed to confirm whether this is valid
  - *Or substitute a more valid predictor of future schedule performance*
- **Earned Schedule (like EVM) is a "top down" analysis method**
  - Does not directly corelate to critical path
  - However, a PMB for the critical path can be created
  - Earned Schedule analysis can be applied directly to Critical Path
    - *Or any other area of interest in the project*
    - If IEAC (time) total project > IEAC(time) critical path → indicates critical path has changed

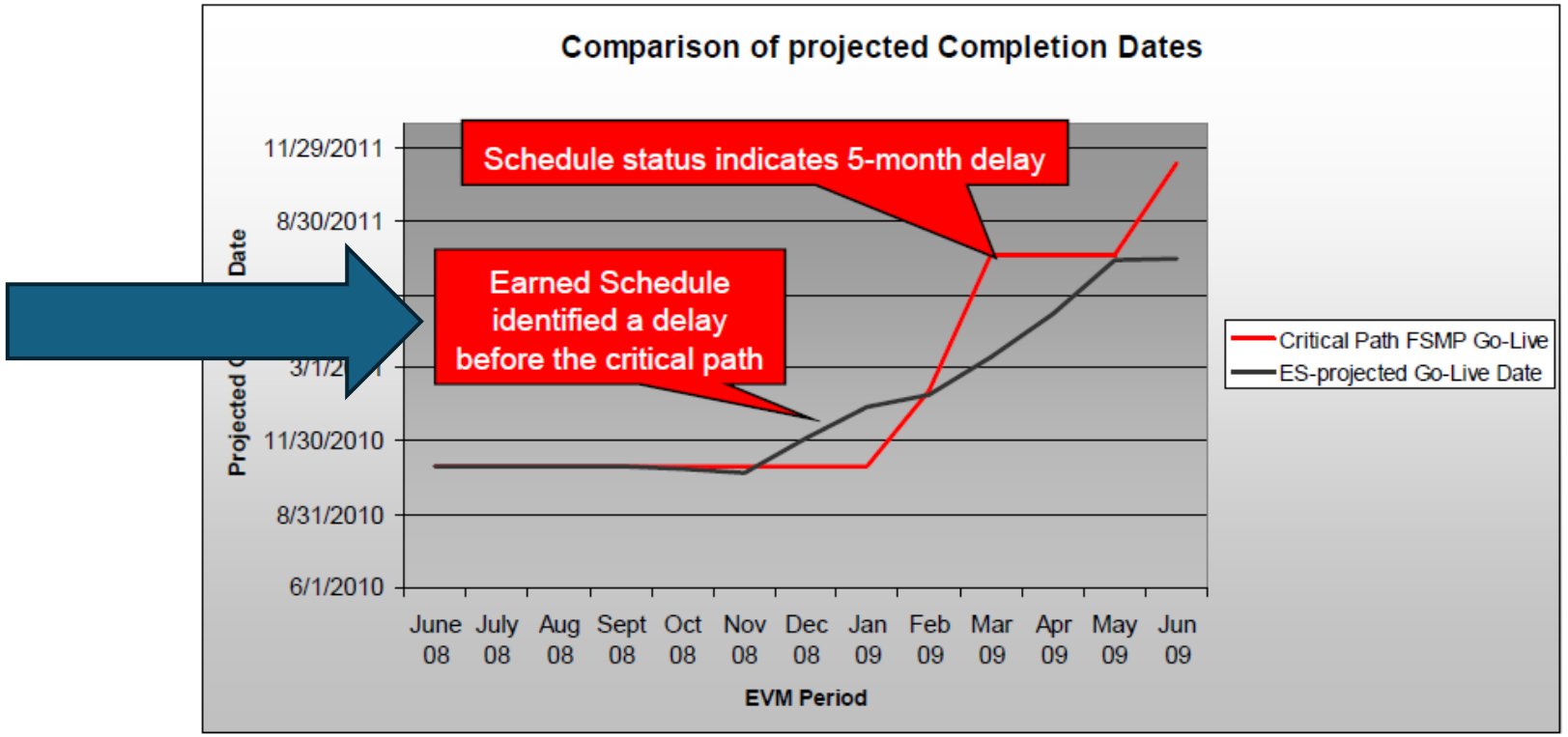
Early Empiric Research from 2009 (now replicated many times over)

Booz Allen Hamilton Experience – USA

Un-named US Federal Govt Agency Program Data

Ready for what's next.

Looking Back: Earned Schedule view of The Project (project)



USA IPMC Conference 2009: Michelle Jones et. al.
http://www.evmlibrary.org/library/PS%2023%281%29.pdf

Booz | Allen | Hamilton

Booz Allen Hamilton Experience – USA
National Reconnaissance Office Program Data

Summary of Program Case Studies

Program Case Studies	Insightful	Consistent	Misleading	
Program W - year 6	x			Quantitative measure, supporting controversial ICE
Program W - year 10		x		Consistent with other program metrics
Program X	x			Early warning of schedule problems
Program Y			x	Indicated slip, but extent of slip diluted by LOE in EVM baseline
Program Z	x			Early warning sign of major schedule delay
Additional Earned Schedule Data				
Program M		x		Earned schedule forecasts on-time performance for a program being managed to schedule
Program N		x		Earned schedule consistent with other metrics
Civil IT Project	x			Early warning of a schedule slip
Civil Shipbuilding Program	x			Accurate projection of a 6-month delay in delivery

- **Insightful**: Earned schedule metrics and forecast are a leading indicator of schedule performance or highlight something missed by other analytical techniques
- **Consistent**: Earned schedule metrics and forecast are consistent with the other program data
- **Misleading**: Earned schedule metrics and forecast are inconsistent with other program status indicators

USA IPMC Conference 2010: Lisa Wolf, Michelle Jones
http://www.evmlibrary.org/library/PS%2008v2.pdf

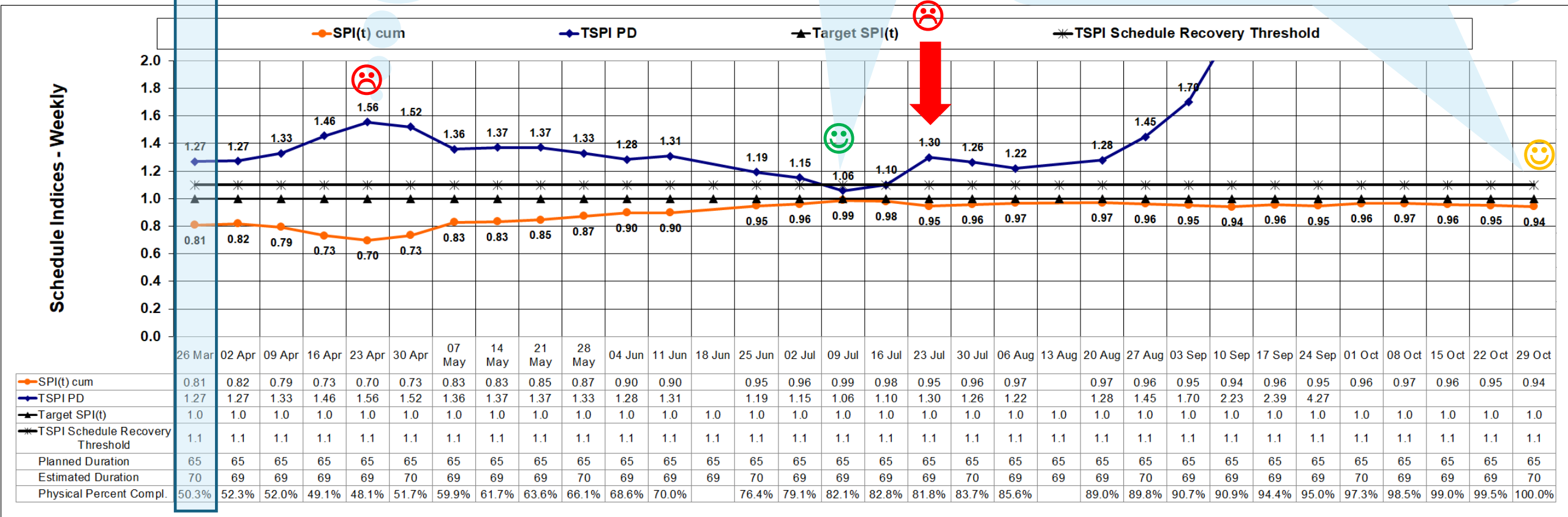
Schedule prediction using Earned Schedule TSPI - SPI(t) chart

1. Re baseline:
Did NOT zero SV

2. WARNING:
Immediate unexpected deteriorating schedule performance

3. Early warning enabled Schedule Performance Improvement
SPI(t) from .70 to .99

4. Schedule performance stabilized, **SPI(t) > .9**
Project delivered final **2.7%** 4 weeks late.
TSPI of 1.3 on 23 July indicated PD unachievable
EXCELLENT RESULT for rebaselined 65-week Planned Duration project



	26 Mar	02 Apr	09 Apr	16 Apr	23 Apr	30 Apr	07 May	14 May	21 May	28 May	04 Jun	11 Jun	18 Jun	25 Jun	02 Jul	09 Jul	16 Jul	23 Jul	30 Jul	06 Aug	13 Aug	20 Aug	27 Aug	03 Sep	10 Sep	17 Sep	24 Sep	01 Oct	08 Oct	15 Oct	22 Oct	29 Oct
SPI(t) cum	0.81	0.82	0.79	0.73	0.70	0.73	0.83	0.83	0.85	0.87	0.90	0.90		0.95	0.96	0.99	0.98	0.95	0.96	0.97		0.97	0.96	0.95	0.94	0.96	0.95	0.96	0.97	0.96	0.95	0.94
TSPI PD	1.27	1.27	1.33	1.46	1.56	1.52	1.36	1.37	1.37	1.33	1.28	1.31		1.19	1.15	1.06	1.10	1.30	1.26	1.22		1.28	1.45	1.70	2.23	2.39	4.27					
Target SPI(t)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
TSPI Schedule Recovery Threshold	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Planned Duration	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65
Estimated Duration	70	69	69	69	69	70	69	69	69	70	69	69	69	70	69	69	69	69	70	69	69	69	70	69	69	69	69	70	69	69	69	70
Physical Percent Compl.	50.3%	52.3%	52.0%	49.1%	48.1%	51.7%	59.9%	61.7%	63.6%	66.1%	68.6%	70.0%		76.4%	79.1%	82.1%	82.8%	81.8%	83.7%	85.6%		89.0%	89.8%	90.7%	90.9%	94.4%	95.0%	97.3%	98.5%	99.0%	99.5%	100.0%

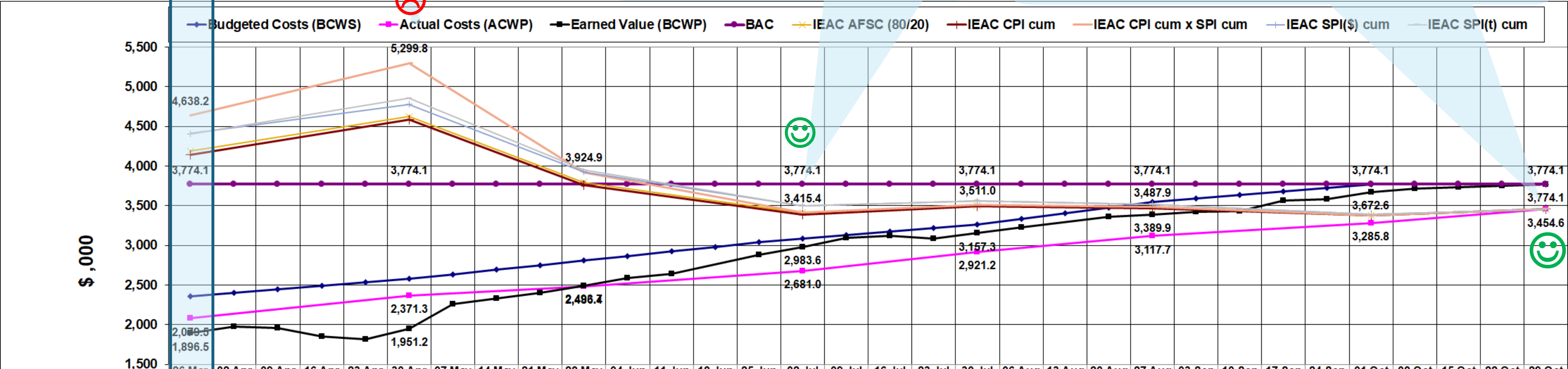
Improving schedule performance can improve cost performance
Cost prediction using Earned Value Cost Independent Estimates at Completion (IEAC) chart

1. Re baseline: Did NOT zero CV

2. WARNING: Immediate unexpected deteriorating cost performance

3. Early warning enabled Cost Performance Improvement IEAC CPI x SPI improved from $5.299 to $3.415 (BAC $3.744)

4. Cost performance stabilized with cost VAC **$3.195** underspent. **$2.164** Risk budget not used. Total underspend **$5.359.** **OUTSTANDING OUTCOME**



	26 Mar	02 Apr	09 Apr	16 Apr	23 Apr	30 Apr	07 May	14 May	21 May	28 May	04 Jun	11 Jun	18 Jun	25 Jun	02 Jul
Budgeted Costs (BCWS)	2,356.8	2,401.3	2,445.8	2,490.3	2,534.8	2,579.3	2,637.0	2,694.6	2,752.2	2,809.9	2,867.5	2,925.1	2,982.8	3,040.4	3,084.9
Actual Costs (ACWP)	2,079.5					2,371.3				2,486.4					2,681.0
Earned Value (BCWP)	1,896.5	1,972.0	1,962.5	1,854.0	1,813.4	1,951.2	2,260.7	2,329.6	2,398.4	2,493.7	2,589.0	2,640.0		2,884.9	2,983.6
BAC	3,774.1	3,774.1	3,774.1	3,774.1	3,774.1	3,774.1	3,774.1	3,774.1	3,774.1	3,774.1	3,774.1	3,774.1	3,774.1	3,774.1	3,774.1
IEAC AFSC (80/20)	4,188.0					4,622.9				3,793.1					3,410.4
IEAC CPI cum	4,138.4					4,586.6				3,763.0					3,391.3
IEAC CPI cum x SPI cum	4,638.2					5,299.8				3,924.9					3,415.4
IEAC SPI($) cum	4,412.9					4,781.0				3,929.1					3,498.3
IEAC SPI(t) cum	4,403.3					4,854.0				3,951.4					3,502.9
Physical Percent Compl.	50.3%	52.3%	52.0%	49.1%	48.1%	51.7%	59.9%	61.7%	63.6%	66.1%	68.6%	70.0%		76.4%	79.1%

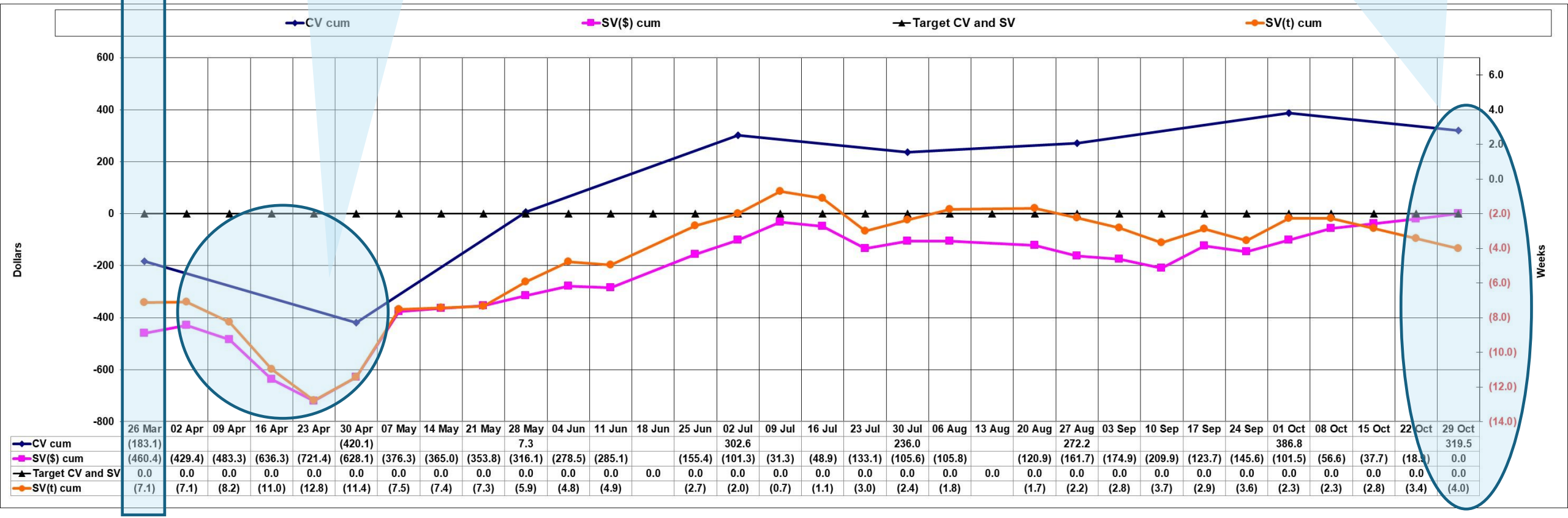
	09 Jul	16 Jul	23 Jul	30 Jul	06 Aug	13 Aug	20 Aug	27 Aug	03 Sep	10 Sep	17 Sep	24 Sep	01 Oct	08 Oct	15 Oct	22 Oct	29 Oct
Budgeted Costs (BCWS)	3,129.4	3,173.9	3,218.4	3,262.9	3,335.1	3,407.2	3,479.4	3,551.6	3,596.1	3,640.6	3,685.1	3,729.6	3,774.1	3,774.1	3,774.1	3,774.1	3,774.1
Actual Costs (ACWP)				2,921.2				3,117.7					3,285.8				3,454.6
Earned Value (BCWP)	3,098.1	3,124.9	3,085.3	3,157.3	3,229.2		3,358.5	3,389.9	3,421.2	3,430.6	3,561.4	3,584.0	3,672.6	3,717.5	3,736.3	3,755.2	3,774.1
BAC	3,774.1	3,774.1	3,774.1	3,774.1	3,774.1	3,774.1	3,774.1	3,774.1	3,774.1	3,774.1	3,774.1	3,774.1	3,774.1	3,774.1	3,774.1	3,774.1	3,774.1
IEAC AFSC (80/20)				3,504.2				3,479.9					3,379.0				3,454.6
IEAC CPI cum				3,491.9				3,471.1					3,376.6				3,454.6
IEAC CPI cum x SPI cum				3,511.0				3,487.9					3,379.1				3,454.6
IEAC SPI($) cum				3,558.7				3,520.3					3,390.1				3,454.6
IEAC SPI(t) cum				3,565.4				3,516.8					3,391.0				3,454.6
Physical Percent Compl.	82.1%	82.8%	81.8%	83.7%	85.6%		89.0%	89.8%	90.7%	90.9%	94.4%	95.0%	97.3%	98.5%	99.0%	99.5%	100.0%

Case Study Conclusion (Cost and Schedule Variances Chart) – Final Point

1. Re baseline:
Did NOT zero CV

2. WITHOUT THE EVM AND EARNED SCHEDULE PROJECT PERFORMANCE EARLY WARNINGS HERE

3. THE PROJECT COST AND SCHEDULE OUTCOMES ACHIEVED AT COMPLETION WOULD NOT HAVE OCCURRED.



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CV cum	(183.1)					(420.1)				7.3					302.6				236.0				272.2					386.8				319.5
SV($) cum	(460.4)	(429.4)	(483.3)	(636.3)	(721.4)	(628.1)	(376.3)	(365.0)	(353.8)	(316.1)	(278.5)	(285.1)		(155.4)	(101.3)	(31.3)	(48.9)	(133.1)	(105.6)	(105.8)		(120.9)	(161.7)	(174.9)	(209.9)	(123.7)	(145.6)	(101.5)	(56.6)	(37.7)	(18.3)	0.0
Target CV and SV	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SV(t) cum	(7.1)	(7.1)	(8.2)	(11.0)	(12.8)	(11.4)	(7.5)	(7.4)	(7.3)	(5.9)	(4.8)	(4.9)		(2.7)	(2.0)	(0.7)	(1.1)	(3.0)	(2.4)	(1.8)		(1.7)	(2.2)	(2.8)	(3.7)	(2.9)	(3.6)	(2.3)	(2.3)	(2.8)	(3.4)	(4.0)

Earned Schedule Resources

- Earned Schedule website www.earnedschedule.com
  - Public domain repository of freely available Earned Schedule information
    - Papers and Presentations
    - **Calculators**
    - Books (including translations)
    - News
- **Free Earned Schedule Masterclass** https://pgcs.org.au/es-mc-registration/
- ISO 21508:2026 Edition 2: ISO 21508:2026 - Project, programme and portfolio management — Earned value management
- ISO 21512:2024: ISO 21512:2024 - Project, programme and portfolio management — Earned value management implementation guidance
- AS 4817:2019: Earned value management in project and programme management (ISO 21508:2018, MOD) AS 4817:2019 | Standards Australia Store
  - *Pending modified adoption of ISO 21508:2026 Edition 2*

Questions and Thank you

Backup

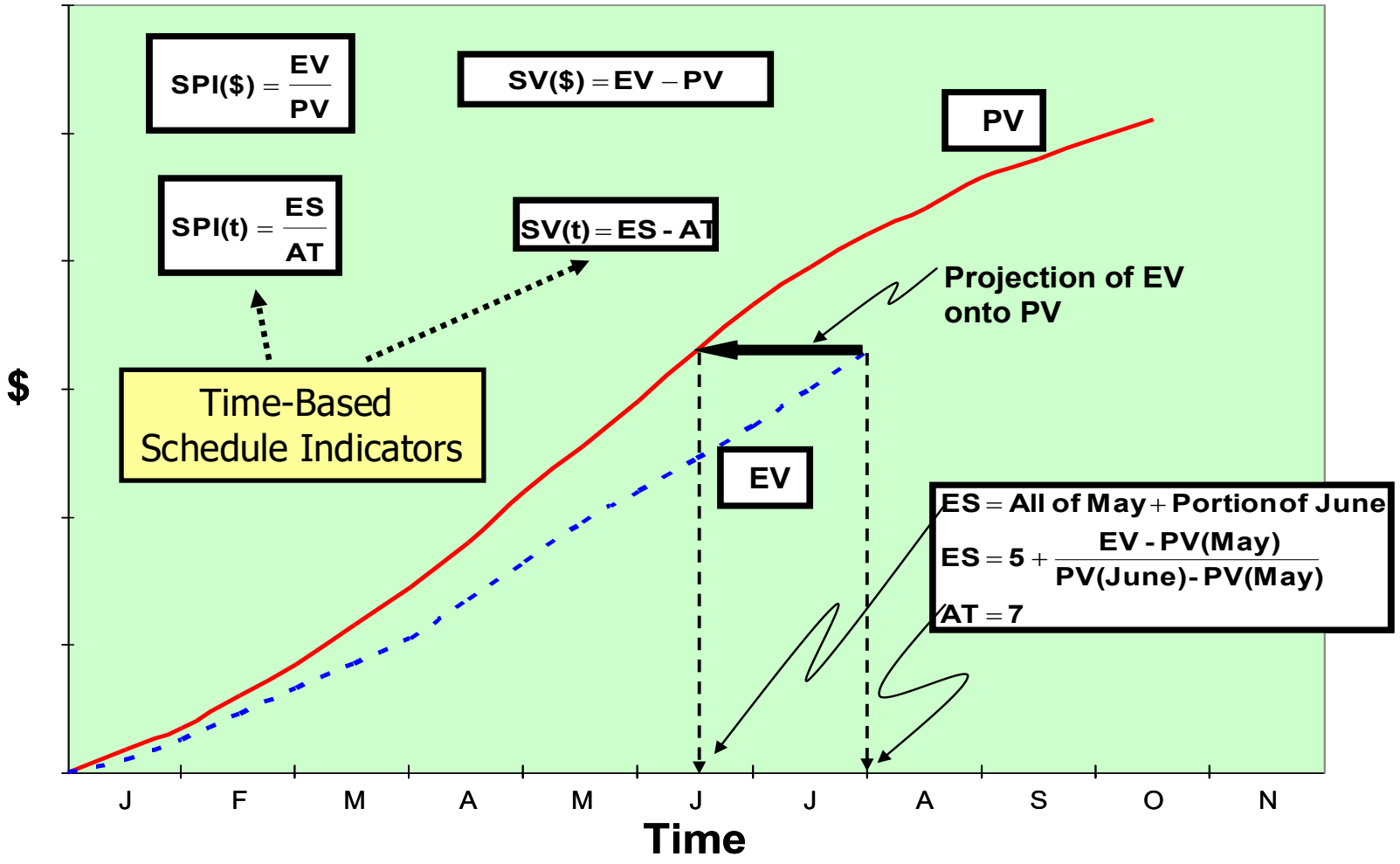
Earned Schedule Terminology

	EVM	Earned Schedule
Status	Earned Value (EV)	Earned Schedule (ES)
	Actual Costs (AC)	Actual Time (AT)
	SV	SV(t)
	SPI	SPI(t)
Future Work	Budgeted Cost for Work Remaining (BCWR)	Planned Duration for Work Remaining (PDWR)
	Estimate to Complete (ETC)	Estimate to Complete (time) ETC(t)
Prediction	Variance at Completion (VAC)	Variance at Completion (time) VAC(t)
	Estimate at Completion (EAC) (supplier)	Estimate at Completion (time) EAC(t) (supplier)
	Independent EAC (IEAC) (customer)	Independent EAC (time) IEAC(t) (customer)
	To Complete Performance Index (TCPI)	To Complete Schedule Performance Index (TSPI)

Earned Schedule Formulae

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
		SV(t)%	SV(t)% = (ES – AT) / ES
	Schedule Performance Index	SPI(t)	SPI(t) = ES / AT
	To Complete Schedule Performance Index	TSPI	TSPI = (PD – ES) / (PD – AT)
			TSPI = (PD – ES) / (ED – AT)
Predictors	Independent Estimate at Completion (time)	IEAC(t)	IEAC(t) = PD / SPI(t)
			IEAC(t) = AT + (PD – ES) / PF(t)
	Variance at Completion	VAC(t)	VAC(t) = PD - IEAC(t) or ED

ES Computation Example



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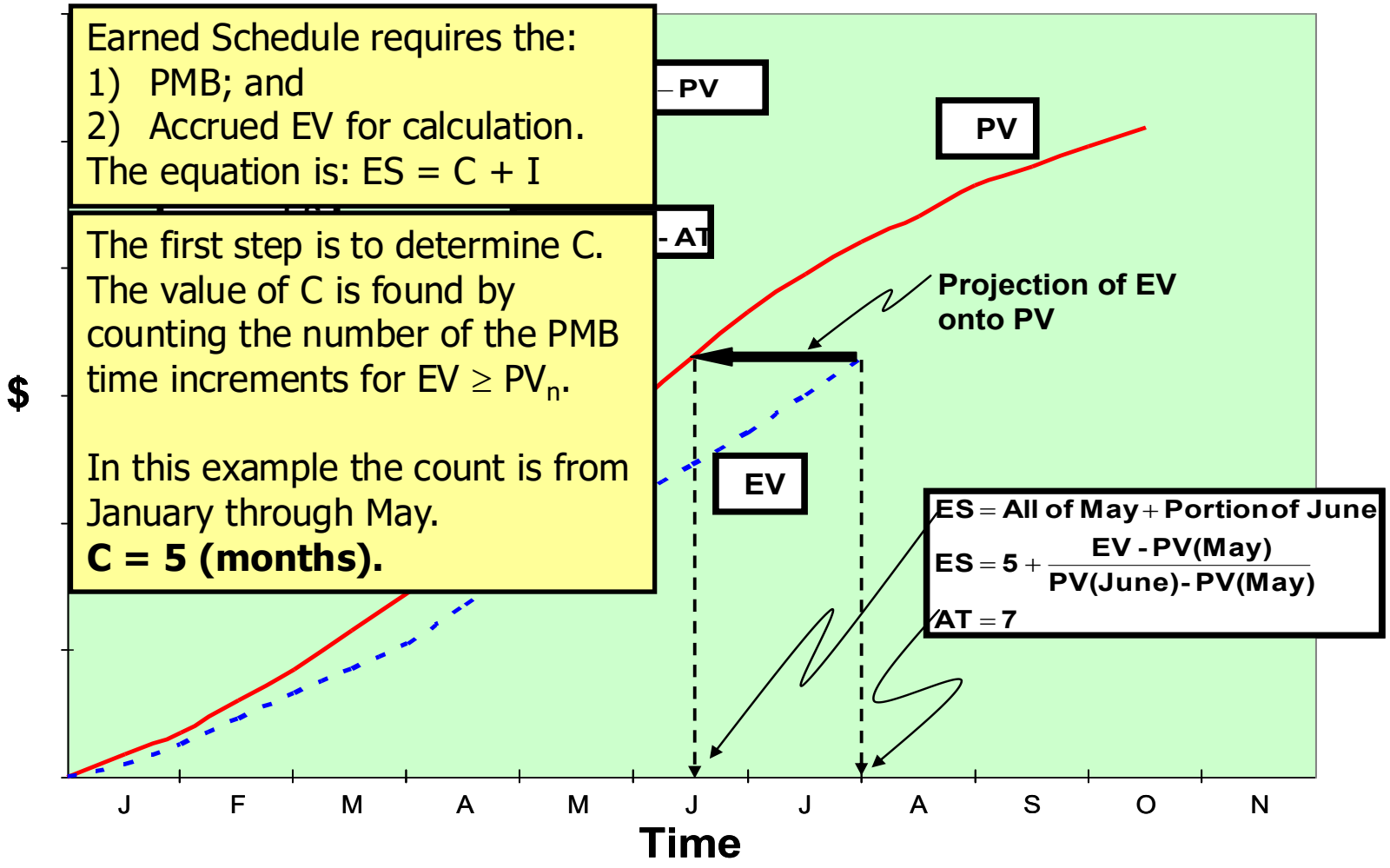

ES Computation Example