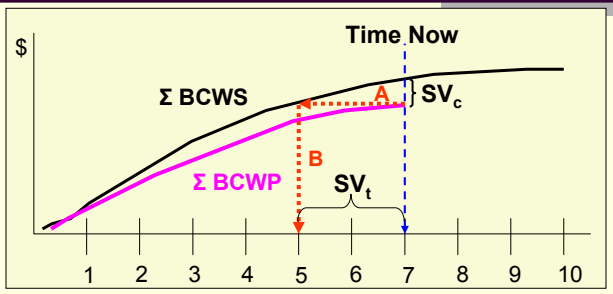
PMI Southeast Regional Conference
June 26 – 28, 2005



New Concept in Earned Value Earned Schedule

Robert Handshuh, CPIM, PMP

Agenda

- Background – Earned Value Anomalies
- What is Earned Schedule
- Sample Calculations
- Example with "Real" Data
- Summary

Emerging EV Theory & Practice

- Earned Value Management (EVM)
  - Formalized about 40 years ago as C/SCSC
  - EVM formulas unchanged in ANSI/EIA 748A
  - Validated over many projects
- Earned Schedule (ES)
  - Proposed in 2003 by Walter Lipke
  - New formulas for Schedule Variance and Schedule Performance Index based on time
  - Validation currently in progress

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Performance Counts !

- Federal Government investments in IT projects in 2004 was $59.4 billion*.
  - Government agencies are making awards based on accountability and past performance (Best value) over lowest bid cost
  - Starting April 2005, DoD Cost or Incentive contracts at or over $20 million require Earned Value Reporting**
    - Some award fees tied to EV metrics
  - Flow down to sub-contractors at $20 million

** Report on Information Technology for the Federal Government, 2002 -2004 OMB*

** Memo from the Under Secretary of Defense, Revision to DoD EV Policy, 7 March 05

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Earned Value Term Decoder (PMBOK to Old C/SCSC)

- PV = BCWS - Planned Value
  - Time Phased Budget to accomplish work planned for that period
- EV = BCWP – Earned Value
  - Calculated value of work of work accomplished in the measured time period
- AC = ACWP – Actual costs
  - "Real" cost charged to the project for the measured time period

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Basic EV Metrics

- CV= Cost Variance - How much was done minus how much was spent (EV-AC)
- SV= Schedule Variance – What got done minus what was planned (EV-PV)
- CPI= Cost Performance Index – How much was done divided by how much was spent (EV / AC) "bang for the buck"
- SPI= Schedule Performance Index – How much was done divided by how much was planned (EV / PV) "Time is money"

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EV Metrics Validated

- The DoD study in 1977 proved with as little as 15% of the program completed, the CPI accurately predicted future cost performance*

  But what about SPI ?
- Studies have shown Schedule Performance Index (SPI) starts losing predictive relevance in the later stages of the program**

* DoD study of 400 programs, CPI did not significantly change after 15% complete, Updated study, included over 700 programs same result by Quentin Fleming 1998

**Professional Management Associates – EAC Calculations to Project Life Cycle

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Quirks of Schedule Variance

- Most people think of schedules in time units.
  - Is the project ahead or behind in days, weeks or months
- Schedule Variance is usually stated in $.
  - A dollar schedule variance is difficult translate to time for many managers.
- Schedule Variance returns to “0” at the end of a project.
  - Perfect performance –It was only ? months late

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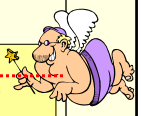
SPI & SV Magical Correction

Month	Σ BCWS	Σ BCWP	SV	SPI
1	100	98	-2	0.98
2	350	325	-25	0.93
3	650	600	-50	0.92
4	1050	960	-90	0.91
5	1500	1360	-140	0.91
6	2000	1830	-170	0.92
7	2500	2260	-240	0.90
8	2950	2665	-285	0.90
9	3350	3075	-275	0.92
10	3650	3350	-300	0.92
11	3900	3575	-325	0.92
12	4000	3725	-275	0.93
13	4000	3800	-200	0.95
14	4000	3875	-125	0.97
15	4000	4000	0	1.00



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Clear Concise Communication

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Earned Schedule – It's About Time

- Earned Schedule is done by projecting EV (BCWP) on to PV (BCWS) in time units
  - Better understanding of project status
  - Closer relation to CV and CPI metrics
- Earned Schedule does not return to 0, 1
  - Usable through out project life cycle
  - Historical reference for future projects
  - Predictive capability under academic research*
- Earned Schedule is based on Σ PV and Σ EV
  - EVM data points you are already collecting

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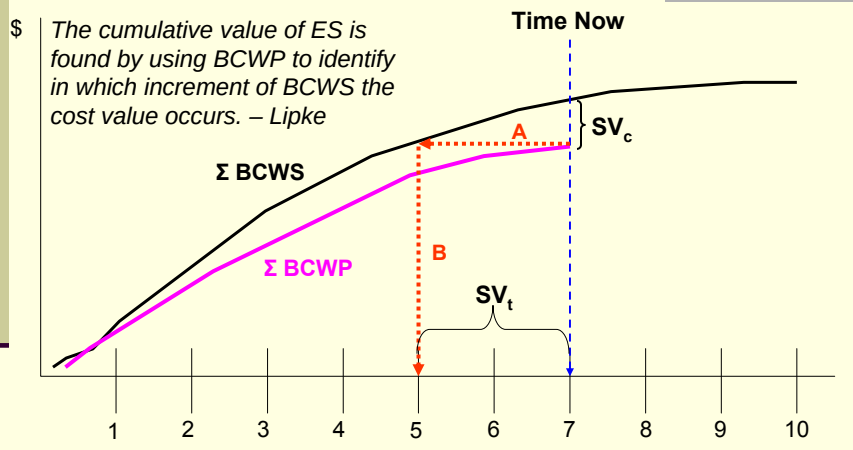
* Kym Henderson - *Earned Schedule in Action*, publication pending in Measurable News

Earned Schedule : How it Works



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? 12

Earned Schedule - The New Math

Earned Schedule Suggested Acronyms*

Earned Schedule = ES	**(Similar to EV on Cost)**
Schedule Variance (time) = SV_t	**(Similar to CV)**
Schedule Performance Index (time) = SPI_t	**(Similar to CPI)**
Actual Time = AT	**(Latest Status Date)**
Earned Value = EV	**(BCWP)**
Planned Value = PV	**(BCWS)**
Planned Duration = PD	**(Project Duration)**
Independent Estimate at Compete (time) = $IEAC_t$	**(Similar to IEAC)**

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* Subject to change as ES is adopted and formalized

Earned Schedule - The New Math

Earned Schedule Formulas

Earned Schedule =
Whole months completed were Σ EV ≥ Σ PV + fractional month completed
= Month (X) + [(Σ BCWPt– Σ BCWSx) ÷ (Σ BCWSy – Σ BCWSx)]
(X = whole month earned; Y = month following X; T = Actual TIme)

Schedule Variance (time) = Earned Schedule - Actual Time
(ES – AT = SV_t)

Schedule Performance Index (time) = Earned Schedule ÷ Actual Time
(ES ÷ AT = SPI_t)

Independent Estimate at Compete (time) =
Planned Duration ÷ Schedule Performance Index (time)
(PD ÷ SPI_t = $IEAC_t$)

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Don't Panic – It's not that hard!

Earned Schedule =

Whole months completed were Σ EV ≥ Σ PV + fractional month completed

= Month (X) + [(Σ EVt– Σ PVx) ÷ (Σ PVy – Σ PVx)]

X = whole month earned
Y = month following X
T = Actual Time (Time Now)

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Calculating ES -

Extrapolation Between the points

Month (X) + [(Σ EVt– Σ PVx) ÷ (Σ PVy – Σ PVx)]

- Apply EV to PV
- 2260 ≥ 2000 ∴ X = 6
- EVt – PVx =
- (2260 - 2000)
- PVy – PVx =
- (2500 - 2000)
- ES = 6 + (2260 – 2000)÷(2500-2000)
- ES = 6 + (260 ÷ 500) = 6.52
- We are in month 7 but only Earned 6.52 months of Schedule

Month	Σ PV BCWS	Σ EV BCWP
5	1500	1360
6	2000	1830
7	2500	2260
8	2950	2665
9	3350	3075

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Completing the ES Analysis

(Time Now - Month 7)

- **Schedule Variance (time) = Earned Schedule - Actual Time**

(ES – AT = SVt) = 6.52 – 7 = - .48 Months Behind

- **Schedule Performance Index (time) = Earned Schedule ÷ Actual Time**

(ES ÷ AT = SPIt) = 6.52 ÷ 7 = .93 Earning Schedule at 93% efficiency

- **Independent Time Estimate at Compete = Planned Duration ÷ Schedule Performance Index (time)**

(PD ÷ SPIt = ITEAC) = 12 ÷ .93 = 12.90 Time to Complete

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Filling in the rest of the data -

~ 80% Complete (BCWP/BCWS) (EV/PV)

Month	PV Σ BCWS	EV Σ BCWP	SV_c	SPI_c	SV_t	SPI_t
1	100	98	-2	0.98	-0.02	0.98
2	350	325	-25	0.93	-0.10	0.95
3	650	600	-50	0.92	-0.17	0.94
4	1050	960	-90	0.91	-0.23	0.94
5	1500	1360	-140	0.91	-0.31	0.94
6	2000	1830	-170	0.92	-0.34	0.94
7	2500	2260	-240	0.90	-0.48	0.93
8	2950	2665	-285	0.90	-0.63	0.92
9	3350	3075	-275	0.92	-0.69	0.92
10	3650	3350	-300	0.92	-1.00	0.90
11	3900	3575	-325	0.92	-1.25	0.89
12	4000	3725	-275	0.93	-1.70	0.86
13		3800	-200	0.95	-2.40	0.82
14		3875	-125	0.97	-3.10	0.78
15		4000	0	1.00	-3.00	0.80

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ES – EZ Method

- Use a spreadsheet*

EV PV

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	BCWPcum	BCWScum	# Pc=>Sc	Numerator	Denominator	InterpVal	EScum	ESmo	SPI(t)mo	SPI(t)cum	AT	SV(t)mo	SV(t)cum
2	0	0									0		
3	98	100	0	98	100	0.9800	0.9800	0.9800	0.9800	0.9800	1	-0.0200	-0.0200
4	325	350	1	225	250	0.9000	1.9000	0.9200	0.9200	0.9500	2	-0.0800	-0.1000
5	600	650	2	250	300	0.8333	2.8333	0.9333	0.9333	0.9444	3	-0.0667	-0.1667
6	960	1050	3	310	400	0.7750	3.7750	0.9417	0.9417	0.9438	4	-0.0583	-0.2250
7	1360	1500	4	310	450	0.6889	4.6889	0.9139	0.9139	0.9378	5	-0.0861	-0.3111
8	1830	2000	5	330	500	0.6600	5.6600	0.9711	0.9711	0.9433	6	-0.0289	-0.3400
9	2260	2500	6	260	500	0.5200	6.5200	0.8600	0.8600	0.9314	7	-0.1400	-0.4800
10	2665	2950	7	165	450	0.3667	7.3667	0.8467	0.8467	0.9208	8	-0.1533	-0.6333
11	3075	3350	8	125	400	0.3125	8.3125	0.9458	0.9458	0.9236	9	-0.0542	-0.6875
12	3350	3650	9	0	300	0.0000	9.0000	0.6875	0.6875	0.9000	10	-0.3125	-1.0000
13	3575	3900	9	225	300	0.7500	9.7500	0.7500	0.7500	0.8864	11	-0.2500	-1.2500
14	3725	4000	10	75	250	0.3000	10.3000	0.5500	0.5500	0.8583	12	-0.4500	-1.7000
15	3800		10	150	250	0.6000	10.6000	0.3000	0.3000	0.8154	13	-0.7000	-2.4000
16	3875		10	225	250	0.9000	10.9000	0.3000	0.3000	0.7786	14	-0.7000	-3.1000
17	4000		12	0	-4000	0.0000	12.0000	1.1000	1.1000	0.8000	15	0.1000	-3.0000
18			Pc=>Sc	NUM	DENOM	InterpVal	EScum	ESmo	SPI(t)mo	SPI(t)cum	AT	SV(t)mo	SV(t)cum
19			Pc=>Sc	NUM	DENOM	InterpVal	EScum	ESmo	SPI(t)mo	SPI(t)cum	AT	SV(t)mo	SV(t)cum
20			Pc=>Sc	NUM	DENOM	InterpVal	EScum	ESmo	SPI(t)mo	SPI(t)cum	AT	SV(t)mo	SV(t)cum
21			Pc=>Sc	NUM	DENOM	InterpVal	EScum	ESmo	SPI(t)mo	SPI(t)cum	AT	SV(t)mo	SV(t)cum

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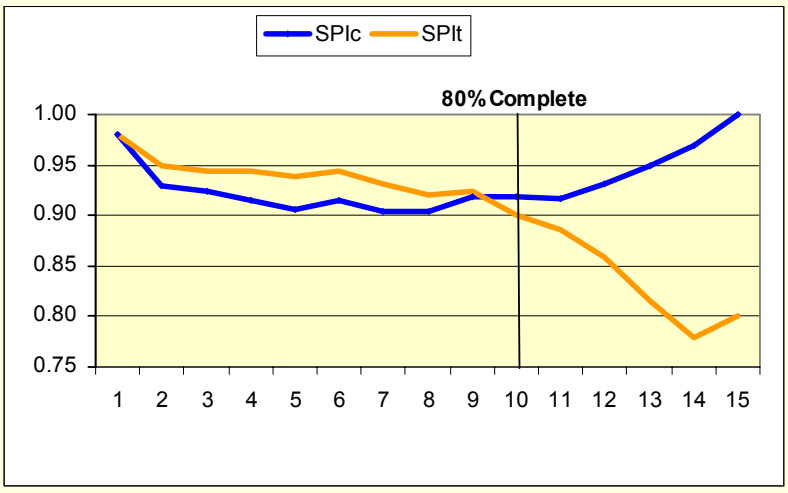
SPI_{cost} vs. SPI_{time} Graphically

ES



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ES in the "Real World"

- The Project
  - Reporting 99.4% complete as of March 05
- ~ $260 million dollar contract
  - 48 month duration
  - Planned End Date - Dec 2004
  - Latest Estimated Completion - Jun 05 (6 month Slip)
- Earned Schedule Calculations
  - Data points for the last 30 months
  - SPI_c and SPI_t
  - $IEAC_t$ (PD ÷ SPI_t)

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ES SPI_t vs. SPI_c Data Points -

	$ (000) EV BCWP	$ (000) PV BCWS	SPIc	ES SPIt		$ (000) EV BCWP	$ (000) PV BCWS	SPIc	ES SPIt
Oct	164,896	165,414	0.997	0.997	Jan	228,286	232,694	0.981	0.941
Nov	168,947	170,660	0.990	0.837	Feb	232,817	237,042	0.982	0.943
Dec	173,707	176,668	0.983	0.836	Mar	235,663	240,954	0.978	0.927
Jan	178,598	180,870	0.987	0.865	Apr	239,247	243,624	0.982	0.924
Feb	184,218	185,877	0.991	0.934	May	243,273	247,773	0.982	0.943
Mar	191,101	192,368	0.993	0.967	Jun	246,576	251,672	0.980	0.939
Apr	194,757	196,833	0.989	0.934	Jul	247,303	252,259	0.980	0.904
May	198,408	201,535	0.984	0.917	Aug	249,118	253,751	0.982	0.885
Jun	199,829	204,005	0.980	0.849	Sep	251,389	255,260	0.985	0.872
Jul	203,592	207,465	0.981	0.883	Oct	252,851	257,345	0.983	0.896
Aug	209,892	213,705	0.982	0.944	Nov	253,921	257,971	0.984	0.889
Sep	212,133	216,215	0.981	0.896	Dec	254,751	258,190	0.987	0.876
Oct	215,916	220,276	0.980	0.914	Jan	255,071	258,209	0.988	0.853
Nov	220,156	224,560	0.980	0.926	Feb	256,467	258,241	0.993	0.848
Dec	224,038	228,038	0.982	0.925	Mar	256,816	258,305	0.994	0.825

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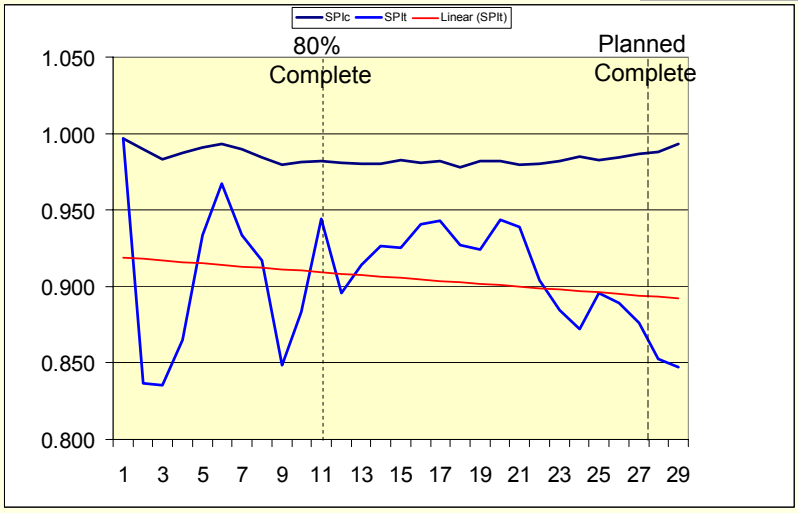
ES SPI_c vs. SPI_t Tracking



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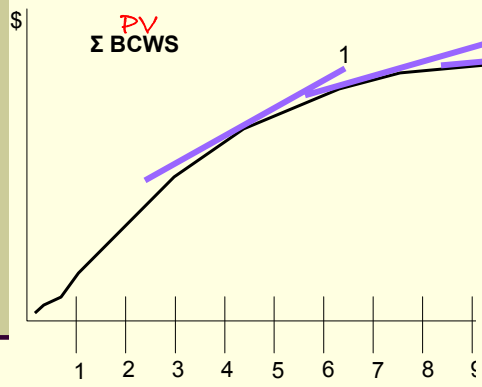
SPIc Historical Smoothing



Slope of the curve is Diminishing. PV is less while time is constant

Even at perfect SPIc (1.0) each monthly gain is a smaller and smaller fraction of total budget

More dramatic effect on large dollar programs

Historical Smoothing of SPIc

	Monthly PV	Σ PV	% of Σ PV
43	$2,084,662	$257,345,102	0.810%
44	$625,995	$257,971,057	0.243%
45	$219,179	$258,190,236	0.085%
46	$18,540	$258,208,776	0.007%
47	$32,594	$258,241,370	0.013%
48	$63,948	$258,305,318	0.025%

Example-

If the project had EV of $231,610,592 in month 43 then SPIc = 0.90

If NOTHING was done for the next 6 months SPIc would still equal 0.90

Σ SPIc is mathematically smoothed by history. Once 80% complete, monthly gains only have marginal effect on SPIc. Smoothing effect is increased by lower monthly budgets typically established in the final phase program

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ES Independent Time Estimate At Complete (time) ($IEAC_t$)

ES	ITEAC	ES	ITEAC
SPIt	PD / SPIt	SPIt	PD / SPIt
0.997	48.15079	0.941	51.01883
0.837	57.36599	0.943	50.90999
0.836	57.43557	0.927	51.78973
0.865	55.50248	0.924	51.92542
0.934	51.40657	0.943	50.87834
0.967	49.61406	0.939	51.13767
0.934	51.41506	0.904	53.10076
0.917	52.352	0.885	54.26405
0.849	56.56541	0.872	55.0474
0.883	54.34294	0.896	53.57912
0.944	50.82327	0.889	53.99639
0.896	53.59098	0.876	54.76977
0.914	52.52138	0.853	56.29378
0.926	51.81007	0.848	56.63395
0.925	51.88011	0.825	58.19056

$$IEAC_t = PD \div SPI_t$$

$$48 \div SPI_t$$

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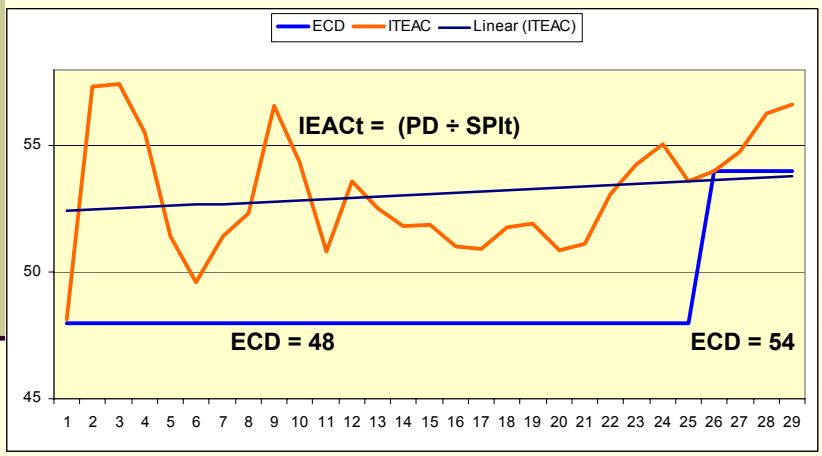
ES for Schedule Completion

Independent Time Estimate At Complete (ITEAC)



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Observation - ES Volatility

- ES is based on incremental gains against PV
  - Observing “true” gains will lead to more volatility of data points on month to month analysis
  - May require several months data to establish actual trend
  - Trend lines may be used to smooth data
  - Check and balance for current metrics

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ES Summary -

- New & Emerging Concept
  - Gain Consensus on Terms / Acronyms
  - Academic Research and Additional Proof of Concept
    - Air Force Institute of Technology Grad Thesis
    - Kym Henderson, PMI Sydney AU (Preliminary Studies)
    - ES Concept evaluation in Belgium & England
- ES requires a firm baseline / sound EVM practices – will not cure -
  - Baseline of the month club
  - PMF (Performance Measurement Flexline)
  - EV "Gamming" Non Critical Completions; Front Loading

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ES Summary

- Moving Forward
  - Adoption of ES in EVM and PM Practice
  - Education and Training
  - Incorporation of ES formulas in EVM / PM software
  - PMI PMBOK inclusion
  - Used in conjunction with current validated metrics for project measurement and analysis
- Bottom Line –
  - A better way to analyze schedule performance
  - Significant advance in Earned Value theory & practice

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Learn More ? Recommended Reading

- Lipke, Walt, Schedule is Different, Measurable News, College of Performance Management, March 2003 (reprinted Summer 2003)
  - http://www.pmi-cpm.org/public/downloads/measnews/MN2003_march/0303.lipke.pdf
- Henderson, Kym, Earned Schedule: A Breakthrough Extension to Earned Value Theory? A Retrospective Analysis of Real Project Data, Measurable News, College of Performance Management, Summer 2003
  - http://www.pmi-cpm.org/public/downloads/measnews/MNsu03earnedschedule.pdf
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  - http://sydney.pmichapters-australia.org.au/programs/customer/v_filedown.asp?P=31&FID=712686688&FRF=n&

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