New Concept in Earned Value
Earned Schedule

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Agenda

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

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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

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

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

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”
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

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
### SPI & SV Magical Correction

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

### Clear Concise Communication

Earned Value, Shmerned Value... When will you be done?!!
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 throughout project life cycle
  - Historical reference for future projects
  - Predictive capability under academic research *
- Earned Schedule is based on $\Sigma$ PV and $\Sigma$ EV
  - EVM data points you are already collecting

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

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Earned Schedule: How it Works

The cumulative value of ES is found by using BCWP to identify in which increment of BCWS the cost value occurs. – Lipke

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 - 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)

* Subject to change as ES is adopted and formalized

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Earned Schedule - The New Math

Earned Schedule Formulas

**Earned Schedule** = Earned Value
= Whole months completed were \(\Sigma EV \geq \Sigma PV + \) fractional month completed
= Month (X) \(+\) \(\left[\frac{\left(\sum BCWP_t - \sum BCWS_x\right)}{\left(\sum BCWS_y - \sum BCWS_x\right)}\right]\)
\(X =\) 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)
\((PD ÷ SPI_t = IEAC_t)\)
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)

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 + (260 ÷ 500) = 6.52
We are in month 7 but only Earned 6.52 months of Schedule
Completing the ES Analysis
(Time Now - Month 7)

- **Schedule Variance (time)** = Earned Schedule - Actual Time
  
  \( \text{ES} - \text{AT} = \text{SV}_t \) = 6.52 – 7 = -0.48 Months Behind

- **Schedule Performance Index (time)** = Earned Schedule ÷ Actual Time
  
  \( \text{ES} ÷ \text{AT} = \text{SPI}_t \) = 6.52 ÷ 7 = 0.93 Earning Schedule at 93% efficiency

- **Independent Time Estimate at Complete** = Planned Duration ÷ Schedule Performance Index (time)
  
  \( \text{PD} ÷ \text{SPI}_t = \text{ITEAC} \) = 12 ÷ 0.93 = 12.90 Time to Complete

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Filling in the rest of the data -

| Month | \( \Sigma \text{BCWS} \) | \( \Sigma \text{BCWP} \) | \( \text{SV}_t \) | \( \text{SPI}_t \) | \( \text{SV}_c \) | \( \text{SPI}_c \) |
|-------|----------------|$\text{BCWP}$|----------------|----------------|----------------|----------------|
| 1     | 100           | 98   | -2            | 0.98           | -0.02          | 0.98           |
| 2     | 350           | 325  | -25           | 0.93           | -0.16          | 0.95           |
| 3     | 650           | 680  | -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     | 2600          | 1830 | -170          | 0.92           | -0.34          | 0.94           |
| 7     | 2500          | 2260 | -240          | 0.90           | -0.48          | 0.93           |
| 8     | 2950          | 2665 | -285          | 0.90           | -0.60          | 0.92           |
| 9     | 3350          | 3075 | -275          | 0.92           | -0.69          | 0.92           |
| 10    | 3650          | 3350 | -300          | 0.92           | -1.00          | 0.90           |
| 11    | 3600          | 3575 | -325          | 0.92           | -1.25          | 0.89           |
| 12    | 4000          | 3725 | -275          | 0.93           | -1.70          | 0.86           |
| 13    | 3800          | 300  | -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           |
ES – EZ Method

Use a spreadsheet

* Copyright Walter Lipke, available on request

SPI\textsubscript{cost} vs. SPI\textsubscript{time} Graphically

80% Complete
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
  - $SPI_t$ and $SPI_c$
  - $IEAC_t$ (PD ÷ $SPI_t$)

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### ES SPI<sub>t</sub> vs. SPI<sub>c</sub> Data Points -

<table>
<thead>
<tr>
<th>Month</th>
<th>BCWP</th>
<th>BCWS</th>
<th>$SPI_c$</th>
<th>$SPI_t$</th>
<th>ESP</th>
<th>EV</th>
<th>PV</th>
<th>$SPI_t$</th>
<th>$SPI_c$</th>
<th>ESP</th>
<th>EV</th>
<th>PV</th>
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<tbody>
<tr>
<td>Oct</td>
<td>164,896</td>
<td>165,414</td>
<td>0.997</td>
<td>0.967</td>
<td>228,286</td>
<td>232,694</td>
<td>0.981</td>
<td>0.941</td>
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<tr>
<td>Nov</td>
<td>168,947</td>
<td>170,660</td>
<td>0.990</td>
<td>0.837</td>
<td>232,817</td>
<td>237,042</td>
<td>0.982</td>
<td>0.943</td>
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<td></td>
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<tr>
<td>Dec</td>
<td>173,707</td>
<td>176,668</td>
<td>0.983</td>
<td>0.836</td>
<td>235,663</td>
<td>240,954</td>
<td>0.978</td>
<td>0.927</td>
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<tr>
<td>Jan</td>
<td>178,598</td>
<td>180,870</td>
<td>0.987</td>
<td>0.865</td>
<td>239,247</td>
<td>243,624</td>
<td>0.982</td>
<td>0.924</td>
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<tr>
<td>Feb</td>
<td>184,218</td>
<td>185,877</td>
<td>0.991</td>
<td>0.934</td>
<td>243,273</td>
<td>247,773</td>
<td>0.982</td>
<td>0.943</td>
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<tr>
<td>Mar</td>
<td>191,101</td>
<td>192,368</td>
<td>0.993</td>
<td>0.967</td>
<td>246,576</td>
<td>251,672</td>
<td>0.988</td>
<td>0.939</td>
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<tr>
<td>Apr</td>
<td>194,757</td>
<td>196,833</td>
<td>0.989</td>
<td>0.934</td>
<td>247,303</td>
<td>252,259</td>
<td>0.980</td>
<td>0.904</td>
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<tr>
<td>May</td>
<td>198,408</td>
<td>201,535</td>
<td>0.984</td>
<td>0.917</td>
<td>249,118</td>
<td>253,751</td>
<td>0.982</td>
<td>0.885</td>
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<tr>
<td>Jun</td>
<td>199,829</td>
<td>204,005</td>
<td>0.980</td>
<td>0.849</td>
<td>251,389</td>
<td>255,260</td>
<td>0.985</td>
<td>0.872</td>
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</tr>
<tr>
<td>Jul</td>
<td>203,592</td>
<td>207,465</td>
<td>0.981</td>
<td>0.883</td>
<td>252,851</td>
<td>257,345</td>
<td>0.983</td>
<td>0.896</td>
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<tr>
<td>Aug</td>
<td>209,892</td>
<td>213,705</td>
<td>0.982</td>
<td>0.944</td>
<td>253,921</td>
<td>257,971</td>
<td>0.984</td>
<td>0.889</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sep</td>
<td>212,133</td>
<td>216,215</td>
<td>0.981</td>
<td>0.896</td>
<td>254,751</td>
<td>258,190</td>
<td>0.987</td>
<td>0.876</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>Oct</td>
<td>215,916</td>
<td>220,376</td>
<td>0.980</td>
<td>0.914</td>
<td>255,271</td>
<td>258,209</td>
<td>0.988</td>
<td>0.853</td>
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<tr>
<td>Nov</td>
<td>220,156</td>
<td>224,960</td>
<td>0.980</td>
<td>0.926</td>
<td>256,467</td>
<td>258,241</td>
<td>0.993</td>
<td>0.848</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Dec</td>
<td>224,038</td>
<td>228,038</td>
<td>0.982</td>
<td>0.925</td>
<td>258,816</td>
<td>258,305</td>
<td>0.994</td>
<td>0.825</td>
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</tbody>
</table>
ES SPIc vs. SPIt Tracking

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

Example-

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

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.

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

IEAC_t = PD ÷ SPI_t

48 ÷ SPI_t
ES for Schedule Completion
Independent Time Estimate At Complete (ITEAC)

IEACT = (PD ÷ SPIt)

ECD = 48 ECD = 54

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
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

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
Learn More? Recommended Reading


