Earned Schedule
...application to Project Management

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Abstract

A review of Earned Schedule, focusing on project management control areas for which the methodology provides an advance in practice.
Overview

- Background
- Review of ES Metric
- Indicators & Terminology
- Forecasting & Prediction
- Project Control
- Schedule Adherence
- Rework
- Application Aids
- Supplemental Remarks
- Summary
Background

“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
Background
ES Metric

The ES idea is to determine the time at which the EV accrued should have occurred.
ES Metric

- ES measure requires the PMB and EV accrued
- Determined from formula, $ES = C + I$

where $C$ is number of periodic time units of the PMB for which $EV \geq PV_C$

and $I = \left( \frac{(EV - PV_C)}{(PV_{C+1} - PV_C)} \right) \times 1$ period

- At completion, just as $EV = BAC$, $ES = PD$
  where $PD = $ Planned Duration
ES Indicators

- The ES measure leads to reliable indicators for the entire duration of the project

\[
SV(t) = ES - AT \\
SPI(t) = \frac{ES}{AT}
\]

\[
SV(t)_n = (ES_n - ES_{n-1}) - 1 \\
SPI(t)_n = \frac{(ES_n - ES_{n-1})}{1}
\]

where AT is the number of status periods
# ES Terminology

<table>
<thead>
<tr>
<th>Metrics</th>
<th>Earned Schedule</th>
<th>ES&lt;sub&gt;cum&lt;/sub&gt;</th>
<th>ES = C + I number of complete periods (C) plus an incomplete portion (I)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual Time</td>
<td>AT&lt;sub&gt;cum&lt;/sub&gt;</td>
<td>AT = number of periods executed</td>
<td></td>
</tr>
<tr>
<td>Indicators</td>
<td>SV(t)</td>
<td>SV(t) = ES – AT</td>
<td></td>
</tr>
<tr>
<td>Schedule Variance</td>
<td>SV(t)%</td>
<td>SV(t)% = (ES – AT) / ES</td>
<td></td>
</tr>
<tr>
<td>Schedule Performance Index</td>
<td>SPI(t)</td>
<td>SPI(t) = ES / AT</td>
<td></td>
</tr>
<tr>
<td>To Complete Schedule Performance Index</td>
<td>TSPI</td>
<td>TSPI = (PD – ES) / (PD – AT)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>TSPI = (PD – ES) / (ED – AT)</td>
<td></td>
</tr>
<tr>
<td>Predictors</td>
<td>IEAC(t)</td>
<td>IEAC(t) = PD / SPI(t)</td>
<td></td>
</tr>
<tr>
<td>Independent Estimate at Completion (time)</td>
<td></td>
<td>IEAC(t) = AT + (PD – ES) / PF(t)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>VAC(t)</td>
<td>VAC(t) = PD - IEAC(t) or EFD</td>
<td></td>
</tr>
</tbody>
</table>
Forecasting

- EVM forecast of final cost: \( \text{IEAC} = \frac{\text{BAC}}{\text{CPI}} \)
- ES forecast of project duration:
  \( \text{IEAC}(t) = \frac{\text{PD}}{\text{SPI}(t)} \)
- Goodness of forecast has been verified by
  - Application
  - Statistical testing
  - Simulation
- Useful to compare forecast from Critical Path EV data to project forecast
Forecasting

- Range of possible outcomes – confidence limits

![Project #1 - Schedule](image)
Prediction

- Calculation of TSPI provides information concerning whether to attempt corrective action or negotiate a change with the customer

<table>
<thead>
<tr>
<th>TSPI Value</th>
<th>Predicted Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 1.00</td>
<td>Achievable</td>
</tr>
<tr>
<td>&gt; 1.10</td>
<td>Not Achievable</td>
</tr>
</tbody>
</table>
Using EVM & ES leads to general strategies

<table>
<thead>
<tr>
<th>CPI(^1)</th>
<th>SPI(t)(^{-1})</th>
<th>Recommended Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green</td>
<td>Green</td>
<td>Reward Employees</td>
</tr>
<tr>
<td>Green</td>
<td>Yellow</td>
<td>Increase Overtime</td>
</tr>
<tr>
<td>Green</td>
<td>Red</td>
<td>Increase Overtime or People</td>
</tr>
<tr>
<td>Yellow</td>
<td>Green</td>
<td>Decrease Overtime</td>
</tr>
<tr>
<td>Yellow</td>
<td>Yellow</td>
<td>Review &amp; Adjust Assignments</td>
</tr>
<tr>
<td>Yellow</td>
<td>Red</td>
<td>Adjust Assignments; Consider Negotiation (Schedule)</td>
</tr>
<tr>
<td>Red</td>
<td>Green</td>
<td>Decrease Overtime or People</td>
</tr>
<tr>
<td>Red</td>
<td>Yellow</td>
<td>Adjust Assignments; Consider Negotiation (Funding)</td>
</tr>
<tr>
<td>Red</td>
<td>Red</td>
<td>Negotiation (Funding/Schedule/Rqmts); Causal Analysis</td>
</tr>
</tbody>
</table>
Project Control

- Improved project recovery tactics

![Diagram showing project control with CPI⁻¹ and SPI⁻¹ axes, colored areas for Green, Yellow, and Red categories, and marked points for strategy and actual values.](Image)
Project Control

- Better project management decisions
Schedule Adherence

- ES facilitates measuring how well project execution follows the plan
Schedule Adherence

- Independent from schedule efficiency (SPI(t))
- Measured as ratio of EV conforming to the PV which should have been earned (P-Factor)
- Allows analysis which identifies tasks having impediments or constraints
- Identifies tasks which are likely to have future rework and enhances forecasting
- Leads to Schedule Adherence Index and improved control
- Facilitates calculation of induced rework
SA - Analysis Example

<table>
<thead>
<tr>
<th>Task</th>
<th>PV</th>
<th>PV@ES</th>
<th>EV@AT</th>
<th>EV - PV</th>
<th>I/C or R</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>12</td>
<td>9</td>
<td>5</td>
<td>-4</td>
<td>I/C</td>
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<tr>
<td>3</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>0</td>
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</tr>
<tr>
<td>4</td>
<td>5</td>
<td>5</td>
<td>3</td>
<td>-2</td>
<td>I/C</td>
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<tr>
<td>5</td>
<td>5</td>
<td>2</td>
<td>5</td>
<td>+3</td>
<td>R</td>
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<tr>
<td>6</td>
<td>8</td>
<td>4</td>
<td>3</td>
<td>-1</td>
<td>I/C</td>
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<tr>
<td>7</td>
<td>7</td>
<td>0</td>
<td>1</td>
<td>+1</td>
<td>R</td>
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<tr>
<td>8</td>
<td>5</td>
<td>0</td>
<td>3</td>
<td>+3</td>
<td>R</td>
</tr>
<tr>
<td>Total</td>
<td>62</td>
<td>40</td>
<td>40</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>
SA - Enhanced Forecasting

Example Data

Predicted Duration

Fraction Complete

Good Prediction Area

Reverse Data

Predicted Duration

Fraction Complete

Good Prediction Area
Rework

- Schedule Adherence Index
  \[ SAI = \frac{R}{(BAC - EV)} \]
  where \( R = f(P, EV, BAC) \)
- SAI is useful for detecting trends …thus a management tool for gauging actions taken
  - SAI increasing with EV \( \Rightarrow \) SA worsening
  - SAI decreasing with EV \( \Rightarrow \) SA improving
- Allows for calculation of out of sequence EV
- Facilitates forecast of project rework cost
Rework

- Ability to determine amount of out of sequence EV and forecast rework cost heightens management attention to schedule execution
- Increases ability of oversight functions to identify EV “gaming”
- Improved schedule adherence hypothesized to improve both cost and schedule performance efficiencies
Rework - Real Example

- BAC ≈ $2.5 million, P = 0.930 ⇒ 0.995
- CPI ≈ 1.05, SPI(t) ≈ 0.98
- EV(r) ≈ $80K, Rework Forecast < $40K
Application Aids

- Calculation of ES, indicators, and forecast – available from ES website (es calculator page) and several EVM tools
- Small Projects (Down Time & Stop Work) – ES website
- Range of possible outcomes (confidence limits) – ES website
- Schedule Adherence (P-Factor) – ES website, Project Flight Deck, and ProTrack
- Out of Sequence EV & Rework – ES website
Summary

- Managing schedule may be more difficult than cost and has more repercussions
- ES is derived from the PMB and EV accrued
- ES makes possible – reliable schedule performance indicators, forecasting, prediction
- Amplifies ability to control project using EVM & ES
- Facilitates identifying process logjams and assess & minimize rework
- Application aids are available and coming
Supplemental Remarks

- Data for analysis comes from EVM …no new data is required
- Provides top down approach to assessing schedule performance
- Equally usable for re-planned projects, and small projects having stop work and down-time conditions
Supplemental Remarks

- ES methodology is growing
  - ES website is receiving ≅ 40K hits per month
  - Project management and EVM books now include ES
  - Included in university coursework & research
  - Evidence of use is global
  - Usage is occurring in several industries
  - Included in PMI® EVM Practice Standard (Oct 2011)
Supplemental Remarks

- ES has had its share of detractors ... and proponents, as well
- British philosopher, John Stuart Mill, once made this observation that new ideas pass through three phases of denial:
  - **First** – They are wrong
  - **Second** – They are against religion
  - **Third** – They are old news, trivial, common sense, and we all would have thought of them if we had had the time, money, and interest
References

- Earned Schedule Website: www.earnedschedule.com