Earned Schedule …application to Small Projects

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The Netherlands, November 2012

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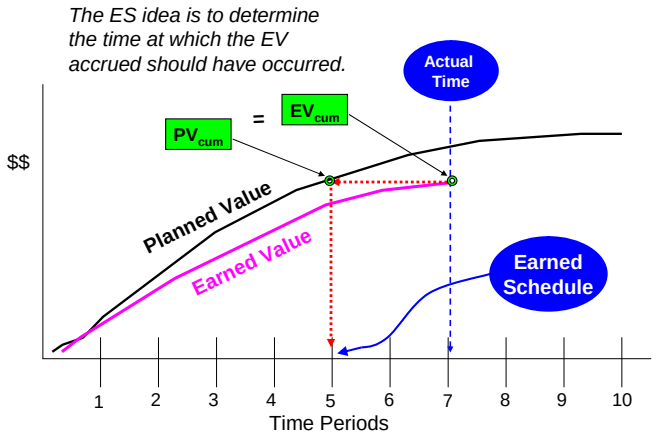

Abstract

Stop work and down time conditions, sometimes occurring for small projects, impact the values computed for Earned Schedule indicators. The distorted values, in turn, have the potential to affect management decisions. To address the problem, a special calculation method for handling these conditions is presented and examined using four sets of notional data. Comparison to the normal ES calculation results indicate significant improvement from using the special calculation method.

Overview

- Introduction
- Down Time & Stop Work
- Schedule Performance Indicators
- Forecasts
- Case Comparisons
- Summary
- Final Comment

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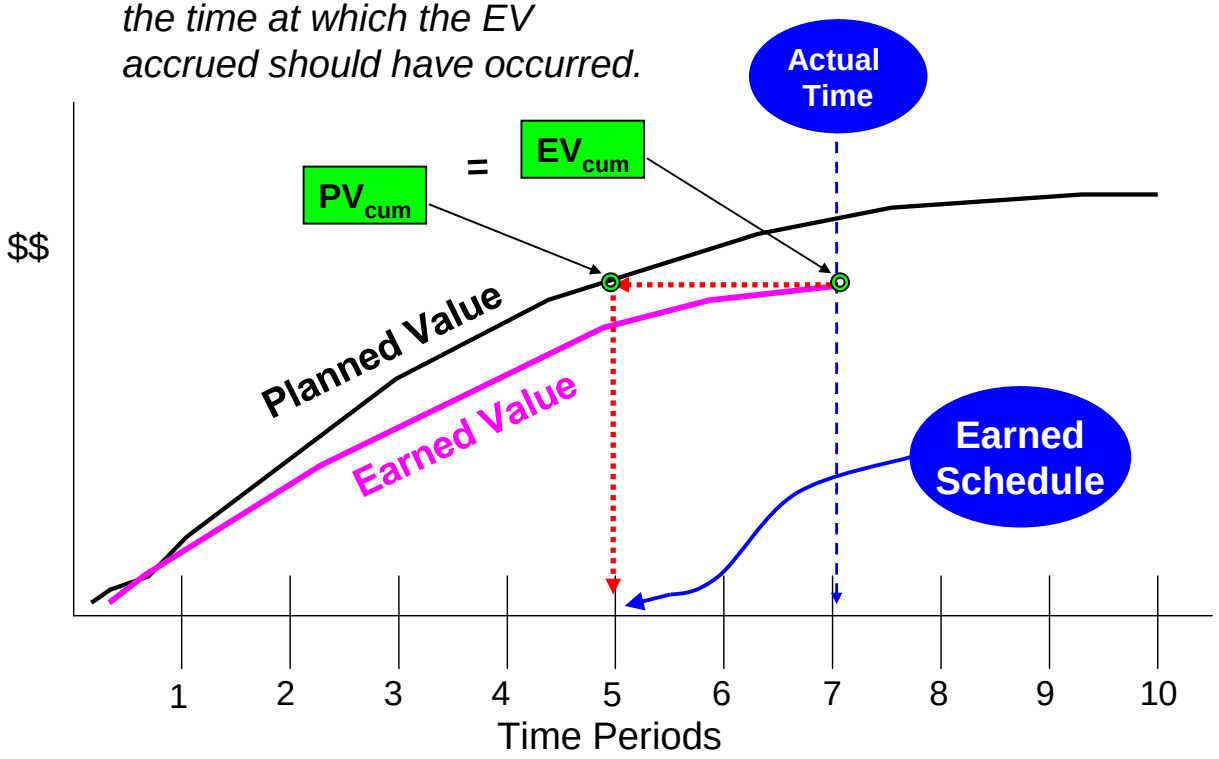
Introduction

- ES introduced in 2003

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



Introduction

- ES = C + I

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

  and I = $[(EV - PV_C) / (PV_{C+1} - PV_C)] * 1$ period

- SV(t) = ES – AT

- SPI(t) = ES / AT

- IEAC(t) = PD / SPI(t)

Introduction

- ES has provided analysis and forecasting capability previously not believed possible
  - Reliable indicators
  - Prediction and Forecasting
  - Schedule Adherence
    - Impediments/Constraints
    - Potential rework
    - Forecasting improvement
    - Schedule management indicator
    - Calculation – out of sequence EV accrued & rework forecast

Introduction

- However - conditions occurring for small, short duration, projects can cause error for ES indicators, and forecasts
- Down Time – *periods within the schedule where no work is planned*
- Stop Work – *periods during execution where management has halted performance*

Down Time & Stop Work

Period	1	2	3	4	5	6	7	8	9	10
iEVcum	93	644	975	1275	1739	XX	XX	2292	3331	3869
iPVcum	93	644	1710	2397	3060	3923	4722	5743	7369	9005
Period	11	12	13	14	15	16	17	18	19	20
iEVcum	4612	5527	6575	7991	9193	10831	12946	14295	16051	17808
iPVcum	10850	12218	13921	15417	XX	XX	XX	XX	18170	20022
Period	21	22	23	24	25	26	27	28	29	30
iEVcum	19666	21178	22839	24873	26310	27720	29113	30298	30765	31821
iPVcum	21936	24418	26186	27972	29397	30899	31821			

EV & PV Data with Stop Work & Down Time

- Periods 6 & 7 indicate management imposed a stop work
- Periods 15 -18 show that no work was planned

Note: EV & PV data are preceded by “i.” The i denotes discontinuity; the data are interrupted.

Down Time & Stop Work

- When management imposes a *Stop Work* the opportunity has been removed for accruing EV
  - PV values for periods 6 & 7 are unaffected
- *Down Time* extends the planned period of performance.
  - Management has the prerogative to work, instead.
  - For data shown, work was performed during Down Time
  - If plan had been followed, “XX” would appear for the iEV_{cum} entries

Schedule Performance Indicators

Normal Indicators					Special Indicators				
SPI(t)wk	SPI(t)cum	SV(t)wk	SV(t)cum	Period	iSPI(t)wk	iSPI(t)cum	iSV(t)wk	iSV(t)cum w/o Down time	iSV(t)cum + Down Time
0.4503	0.6084	-0.5497	-1.9578	5	0.4503	0.6084	-0.5497	-1.9578	2.0422
0.0000	0.5070	-1.0000	-2.9578	6	0.0000	0.6084	-1.0000	-2.9578	1.0422
0.0000	0.4346	-1.0000	-3.9578	7	0.0000	0.6084	-1.0000	-3.9578	0.0422

Stop Work Indicators

- $SV(t)_{wk}$ & $iSV(t)_{wk}$ both show -1.0 for *Stop Work* periods
- $SPI(t)_{wk}$ & $iSPI(t)_{wk}$ both equal 0.0
- $SPI(t)_{cum}$ decreases while $iSPI(t)_{cum}$ does not
- $SV(t)_{cum}$ equals $iSV(t)_{cum}$ without *Down Time*
- $iSV(t)_{cum}$ + *Down Time* includes potential to work

Schedule Performance Indicators

Normal Indicators					Special Indicators				
SPI(t)wk	SPI(t)cum	SV(t)wk	SV(t)cum	Period	iSPI(t)wk	iSPI(t)cum	iSV(t)wk	iSV(t)cum w/o Down time	iSV(t)cum + Down Time
0.8685	0.6700	-0.1315	-4.6198	14	0.8685	0.7817	-0.1315	-4.6198	-0.6198
0.7217	0.6735	-0.2783	-4.8981	15	0.7217	0.7771	0.7217	-3.8981	-0.8981
0.8878	0.6869	-0.1122	-5.0103	16	0.8878	0.7850	0.8878	-3.0103	-1.0103
1.4378	0.7310	0.4378	-4.5725	17	1.4378	0.8285	1.4378	-1.5725	-0.5725
0.8225	0.7361	-0.1775	-4.7500	18	0.8225	0.8281	0.8225	-0.7500	-0.7500

Down Time Indicators

- $iSV(t)_{wk} = SV(t)_{wk}$ + Down Time scheduled for the week
- $SPI(t)_{wk}$ equal to $iSPI(t)_{wk}$
- $SPI(t)_{cum}$ less than $iSPI(t)_{cum}$ due to previous Stop Work
- $iSV(t)_{cum}DT = SV(t)_{cum}$ + Total Down Time
- $iSV(t)_{cum}w/oDT = iSV(t)_{cum}DT$ – Down Time Remaining

Schedule Performance Indicators

- Relationship between normal and special schedule performance indicators

  - $iSV(t)_{per} = SV(t)_{per} + DT_{per}$
  - $iSV(t)_{cum}DT = SV(t)_{cum} + DT_{T}$
  - $iSV(t)_{cum}w/oDT = iSV(t)_{cum}DT - DT_{R}$

  - $iSPI(t)_{per} = SPI(t)_{per}$
  - $iSPI(t)_{cum} = SPI(t)_{cum} \bullet (AT / (AT - SW))$

Note: “Normal” refers to the results from the simple ES calculator.

Schedule Performance Indicators

- The key point - when *Stop Work* and *Down Time* conditions occur, the normal indicators do not accurately portray performance and have the potential to cause inappropriate management decisions
- The special indicators provide better management information
- $iSPI(t)_{cum}$ & $iSV(t)_{cum}DT$ indicate the true schedule performance
- $iSV(t)_{cum}w/oDT$ depicts position of the project should *Down Time* be compressed out

Forecasts

- Before proceeding it is worthy to note that ES forecasts using the normal index values will always converge to the actual duration
- Well then …if this is the case …*Why bother?*
- I will show the improvement is significant enough to warrant using the special calculation method
- The idea of the special calculation is fairly simple …but has some complexity

Forecasts

- Simply stated – an initial forecast is made as if interrupting conditions are not present. The interruption effects are then added to this initial forecast as they occur
- The initial forecast is

$$IEAC(t)_{sp1} = (PD - DT_T) / iSPI(t)_{cum}$$

where DT_T = total number of down time periods

- The running total of stop work periods (SW) is added creating a second forecast expression

$$IEAC(t)_{sp2} = (PD - DT_T) / iSPI(t)_{cum} + SW$$

Forecasts

- Next DT_T is added. As down time periods occur they are totaled (DT_L) and subtracted.
- When $IEAC(t)_{sp2} < PD$, the number of down time periods between the forecast and PD are counted (DT_C) and subtracted
- The special forecasting formula becomes

$$IEAC(t)sp = (PD - DT_T) / iSPI(t)_{cum} + SW + DT_T - DT_L - DT_C$$

Forecasts

Period	1	2	3	4	5	6	7	8	9	10
IEAC(t)sp	27.0	27.0	33.9	39.5	41.8	42.8	43.8	41.9	36.3	37.0
IEAC(t)	27.0	27.0	35.1	41.7	44.4	53.3	62.1	56.1	45.7	45.5
Period	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
IEAC(t)sp	36.2	35.5	35.7	35.4	34.6	33.3	30.8	29.8	29.5	29.8
IEAC(t)	43.3	41.6	41.2	40.3	40.1	39.3	36.9	36.7	28.1	28.6
Period	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
IEAC(t)sp	29.6	29.7	29.8	29.7	29.7	29.8	29.6	29.7	30.3	30.0
IEAC(t)	28.6	28.8	29.1	29.1	29.3	29.4	29.4	29.5	30.2	30.0

Stop Work/Down Time Forecast

- Observe the difference for *Stop Work* periods 6 & 7 …how the normal forecast dramatically increases
- For the *Down Time* periods (15-18) …note that the special forecast behaves with less variation through to completion

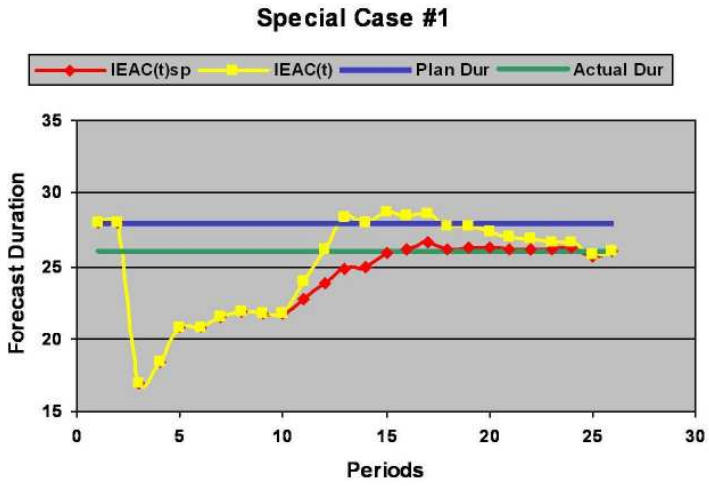
Case Comparisons

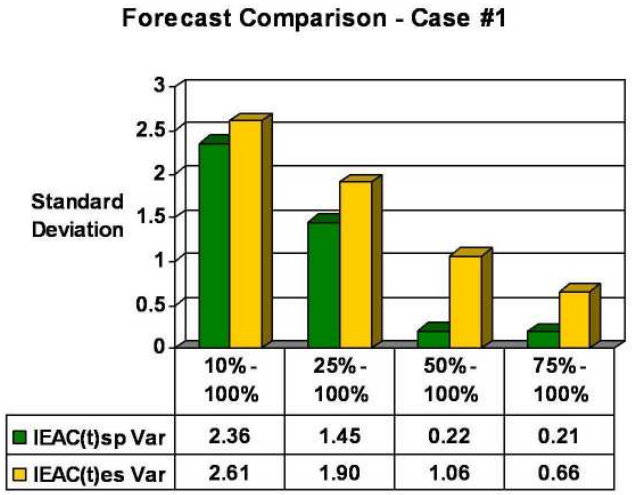
- The normal and special forecasts for four scenarios of *Stop Work* and *Down Time* conditions are compared using a time plot of the forecast values and a column chart of the variation (standard deviation) from actual final duration
  - The time plot of the forecasts provide a visual of the differences
  - The column chart depicts convergence through the use of four performance ranges: 10%-100%, 25%-100%, 50%-100%, 75%-100%

Case Comparisons

- Four performance scenarios compared are
  - Case 1 is an early finish project with a three week stop work condition
  - Case 2 is a late finish with work stopped during four weeks of down time
  - Case 3 is a late finish with work accomplished through four weeks of down time
  - Case 4 is a late finish having two weeks of stop work followed by four weeks of worked down time

Case #1 Comparison



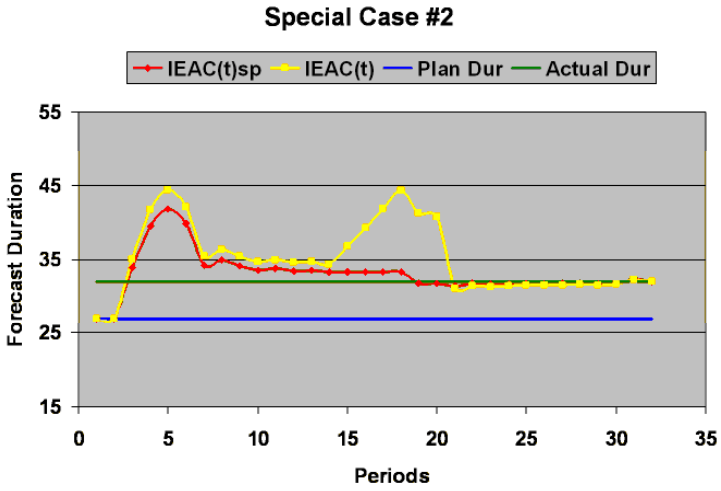


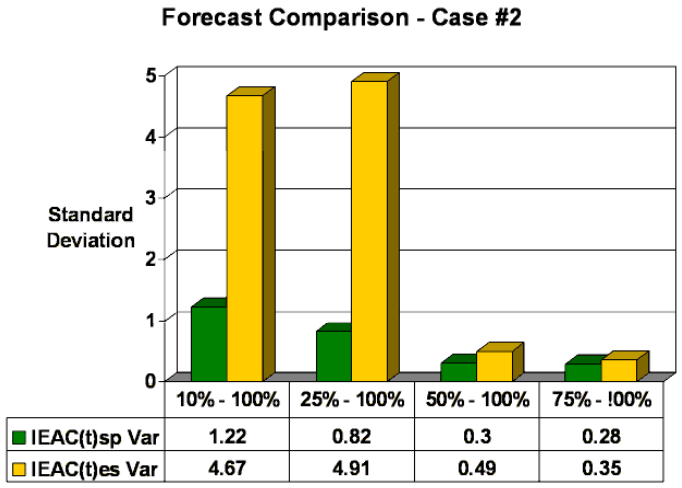
	10% - 100%	25% - 100%	50% - 100%	75% - 100%
IEAC(t)sp Var	2.36	1.45	0.22	0.21
IEAC(t)es Var	2.61	1.90	1.06	0.66

Early Finish – 3 week stop work (11-13)

- The normal forecast overshoots and then converges
- The special forecast converges smoother and sooner

Case #2 Comparison

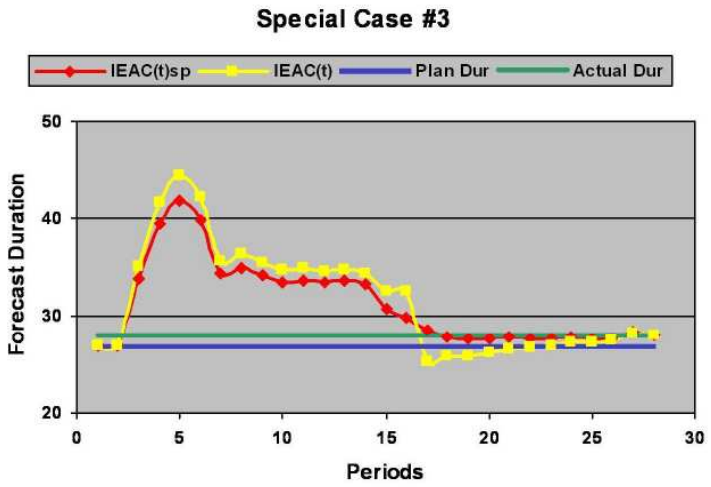


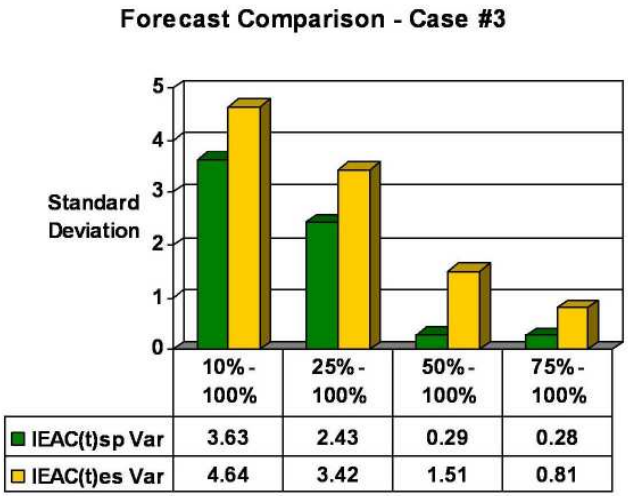


Late Finish – 4 periods of down time (15-18)

- The normal forecast has a larger increase for the down time and requires longer to converge to the final duration

Case #3 Comparison

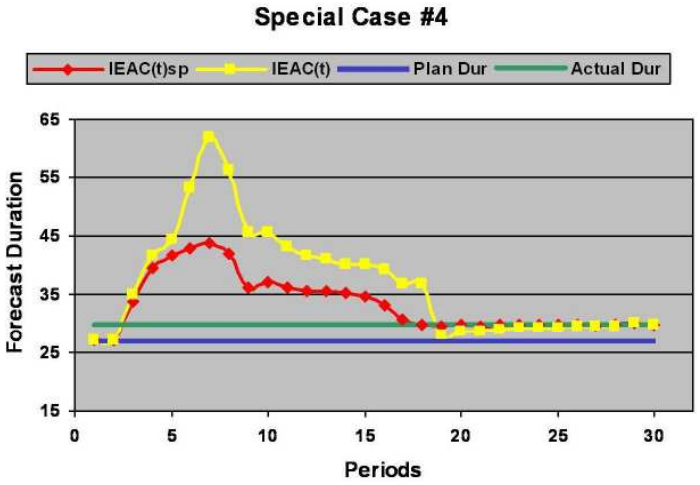


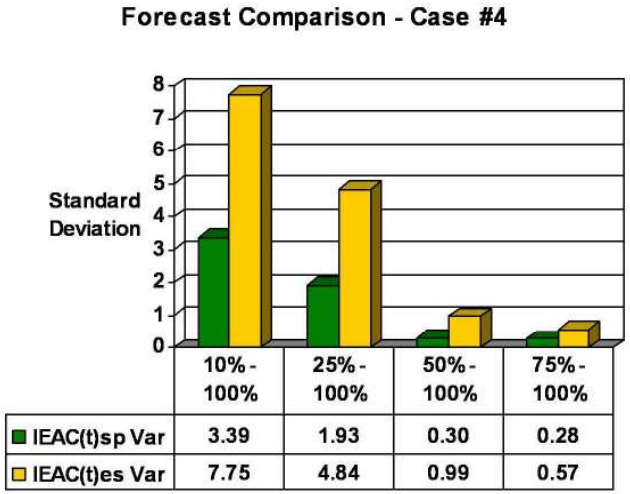


Late Finish – work through 4 periods of down time (15-18)

- The special forecast has less variation and more smoothly converges to the final duration

Case #4 Comparison





	10% - 100%	25% - 100%	50% - 100%	75% - 100%
IEAC(t)sp Var	3.39	1.93	0.30	0.28
IEAC(t)es Var	7.75	4.84	0.99	0.57

Late Finish – 2 period stop work (6-7) and work 4 down time periods (15-18)

- The stop work periods cause more variation for the normal than for the special forecast method
- The special forecast converges much more rapidly

Case Comparisons

- The special case forecasts are more accurate for every set of computed values after the first period
- The column charts clearly indicate better forecasting and convergence for all data ranges
- When interruptions of *Stop Work* and *Down Time* are encountered the special forecasting method can be expected to produce more reliable results

Summary

- Over several years of research and application, ES has shown to be a reliable schedule analysis extension to EVM
- For large projects, *Stop Work* and *Down Time* conditions for small portions of the project may not have much impact on the ES indicators and forecast values
- For small projects, the interrupting conditions will distort ES indicators and forecasts and possibly impact management decisions

Summary

- Special calculation method was created for the conditions of *Down Time* and *Stop Work*
- Comparisons of normal and special method calculations were made for four sets of performance data having DT and SW periods
- For the four performance scenarios, the forecast graphs and column charts clearly indicate the special forecasting method produced better results

Final Comment

- Although the special method calculations are not difficult, they are tedious …and mistake prone
- To facilitate uptake of the special method a calculator *(ES Calculator vs1b (Special Cases))* is freely available from the ES website (www.earnedschedule.com)

References

- "Earned Schedule Application to Small Projects," *PM World Today*, April 2011 (Vol. XIII, Issue IV)
- *Earned Schedule,* Rayleigh, NC, Lulu Publishing 2009
- Earned Schedule Website: www.earnedschedule.com