

# **ProjectWorld – Toronto - 2008**

## **Assessing Schedule Performance with Earned Value**

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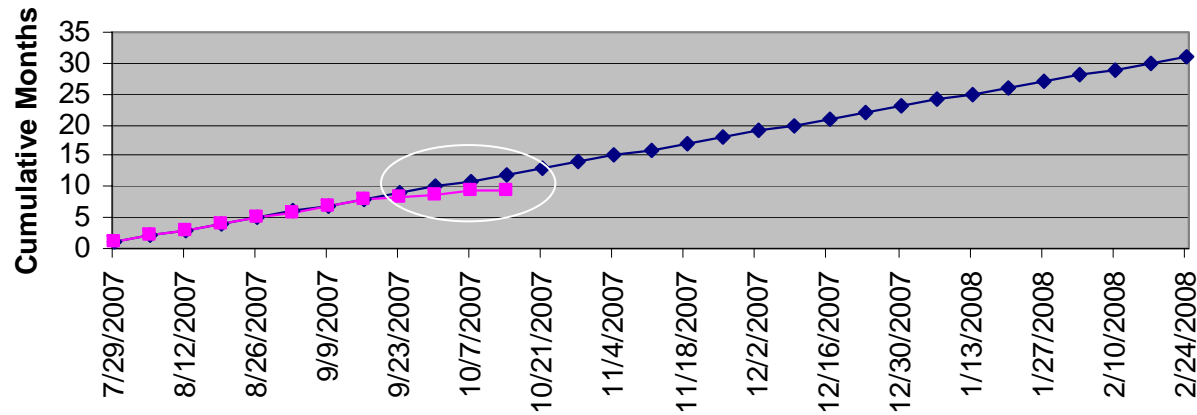
## Learning Objectives

- Acquire practical tools and tips for assessing schedule performance on your project
- Learn about Earned Schedule, a breakthrough approach for assessing schedule performance
- Review the benefits and shortfalls of traditional Earned Value Management



# What's in it for me?

Baseline Schedule vs. Earned Schedule



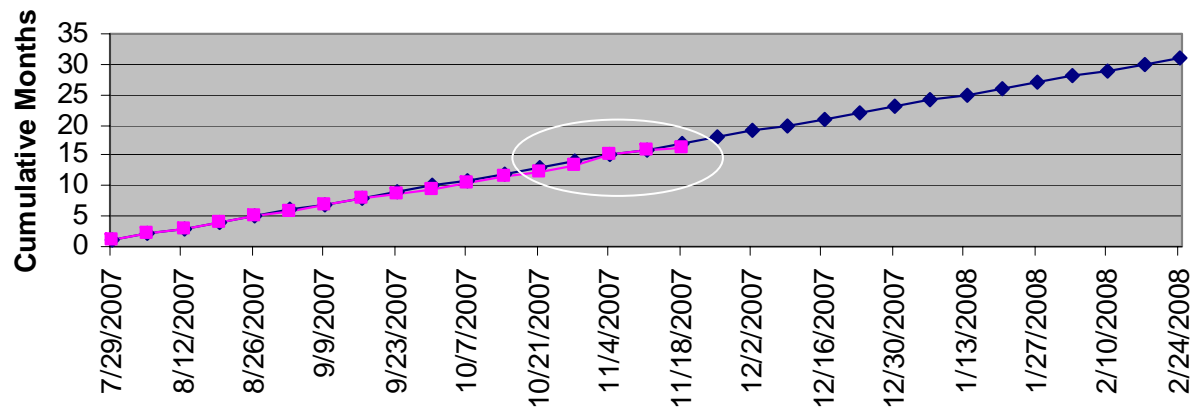
Early Warning

Objectivity

Ease of Use

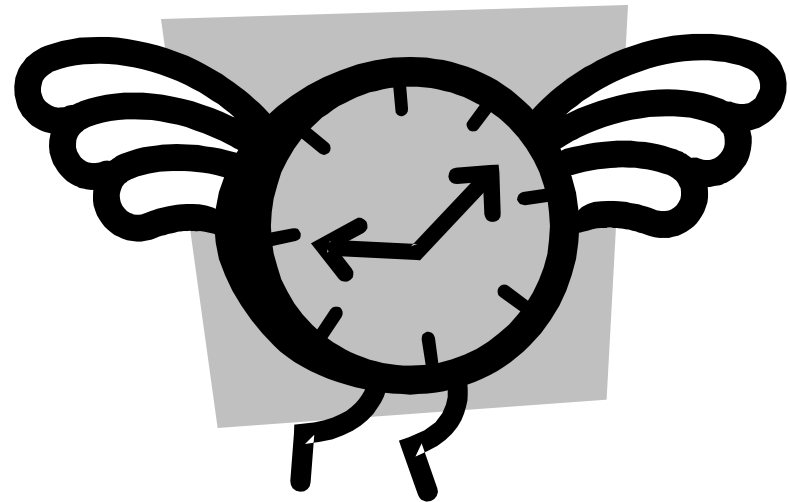
Practicality

Baseline Schedule vs. Earned Schedule



# Introduction

- Quantitative assessment of schedule performance is critical to the success of time-driven projects
- Earned Value Management has historically provided quantitative tools for project performance measurement
- Earned Value Management breaks down for schedule performance
- A recent innovation, Earned Schedule, corrects the problem
- This Track Session is divided into three parts:
  - Background: Earned Value Management
  - Theory: Earned Schedule Breakthrough
  - Practice: How to apply Earned Schedule to your projects



# Earned Value Management Basics

- Earned Value Management is a technique for quantitatively assessing project performance
  - **Planned Value (PV):** value for work that is planned
  - **Earned Value (EV):** value for work that has been completed
- Cost Performance: compare Earned Value and Actual Cost
  - **Cost Variance (CV):** Earned Value minus Actual Cost— $EV - AC$
  - **Cost Performance Index (CPI):** Earned Value divided by Actual Cost— $EV / AC$
- Schedule Performance: compare Earned Value and Planned Value
  - **Schedule Variance (SV):** Earned Value minus Planned Value— $EV - PV$
  - **Schedule Performance Index (SPI):** Earned Value divided by Planned Value— $EV / PV$

## Planned Value

***Budgeted Cost of Work***

## Earned Value

***Budgeted Cost of Work  
\* % Complete***

## Cost Performance

***Overrun:  $CV < 0$ ,  $CPI < 1$   
Under:  $CV > 0$ ,  $CPI > 1$***

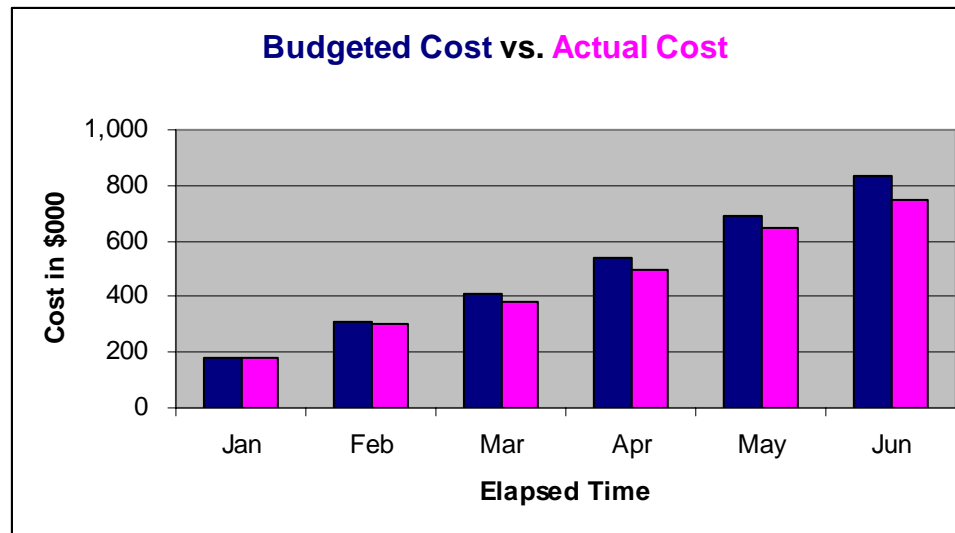
## Schedule Performance

***Behind:  $SV < 0$ ,  $SPI < 1$   
Ahead:  $SV > 0$ ,  $SPI > 1$***



# Common Assessment of Project Performance

- A common method for assessing cost performance is to compare budgeted cost and actual cost

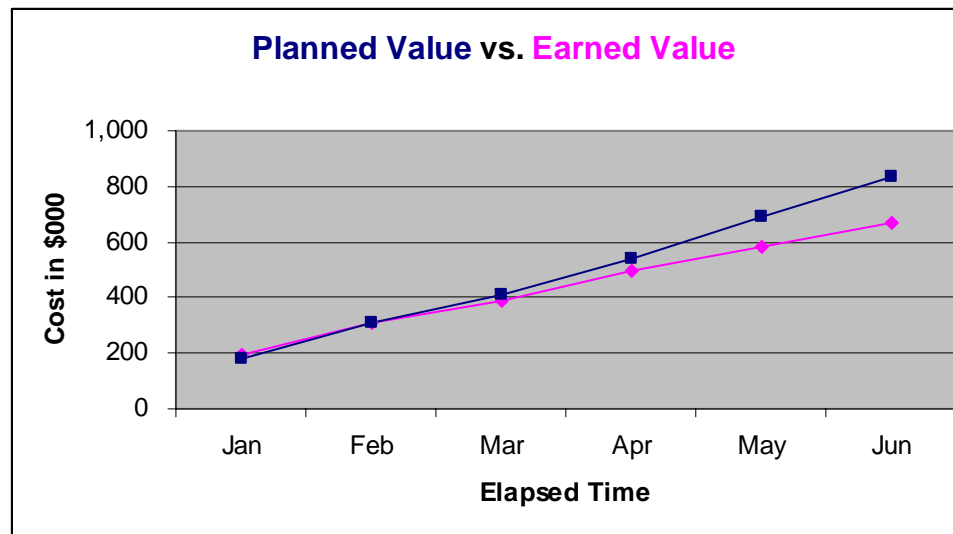


- The chart appears to show that the project cost is tracking slightly below plan
- A reasonable conclusion is that the project's cost performance is acceptable



# Earned Value Management and Project Performance

- The following Earned Value Management chart is based on the same underlying data, but it tells a different story

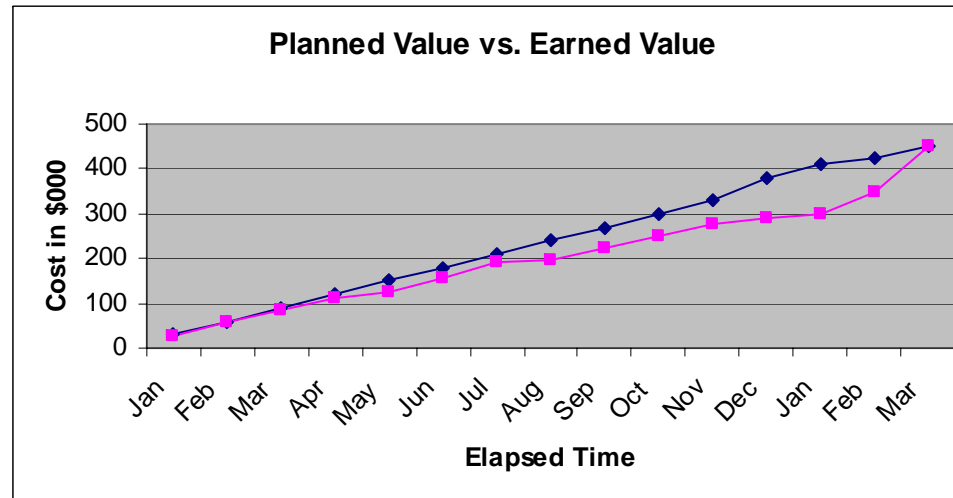


- The Earned Value is tracking below plan, and the gap is widening
- The common view lacks information about how much should have been delivered for the cost expended
- Earned Value Management shows relationship between value and time, plan and result



# Limits of Earned Value Management

- The technique's accuracy in assessing cost performance is proven
- It is less successful for assessing schedule performance
  - Schedule performance is all about *time*
  - But, Earned Value Management is expressed in terms of *cost*—*Planned Value (PV)* and *Earned Value (EV)*



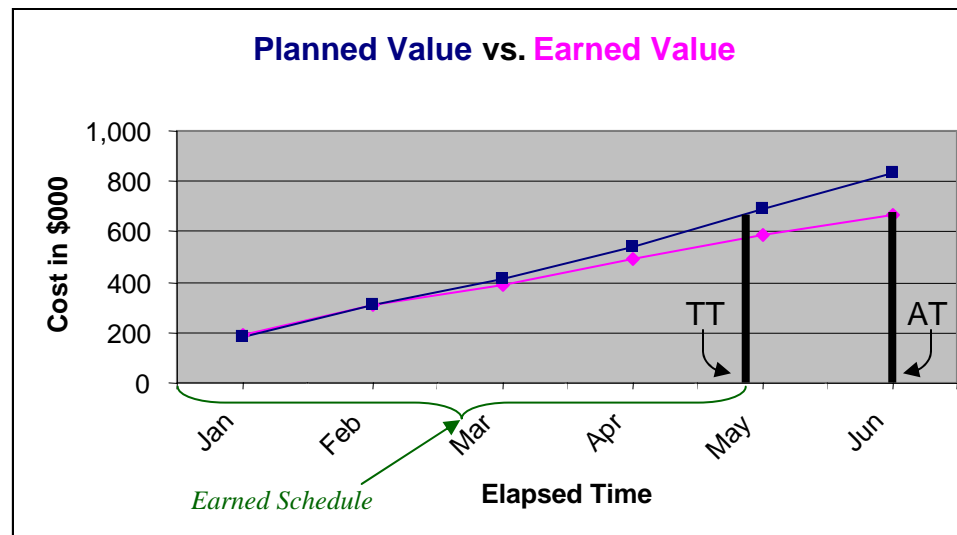
- At the end of the project, what is the relationship between EV and PV?  
 $Variance = EV - PV = ?$   
 $Schedule\ Performance\ Index = EV/PV = ?$
- What if the project's completion date was supposed to be Dec?





# Earned Schedule

- Breakthrough research by Walt Lipke on schedule performance analysis
- Relates Planned Value and Earned Value directly to time

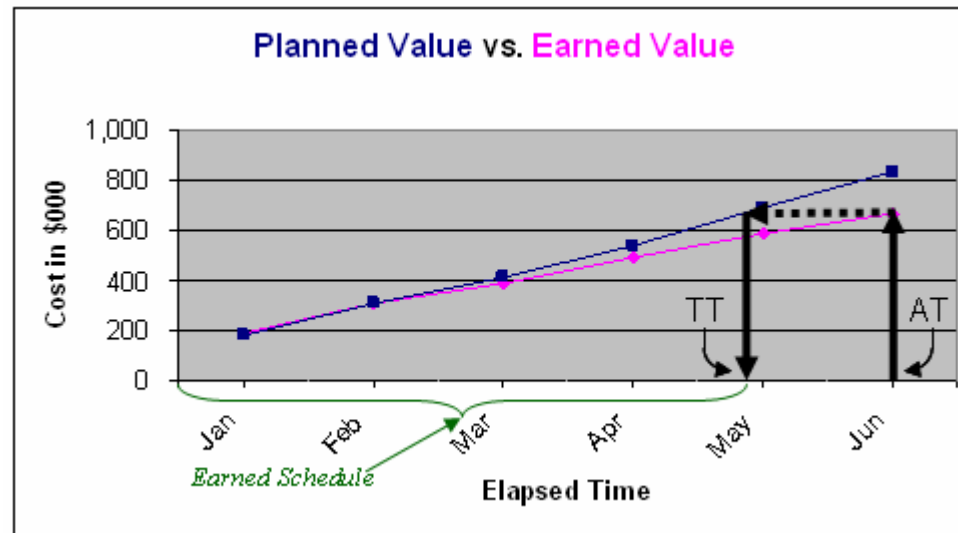


- At the Actual Time (AT), value has been earned
- At the Target Time (TT), that same value *should* have been earned
- The time from the project start to TT is the *Earned Schedule*



# Earned Schedule Calculation

- Find the Earned Value at the Actual Time (AT)
- Map that Earned Value onto the Planned Value curve ( $EV = PV$ )
- Drop a line from the intersection point to the timeline (TT)

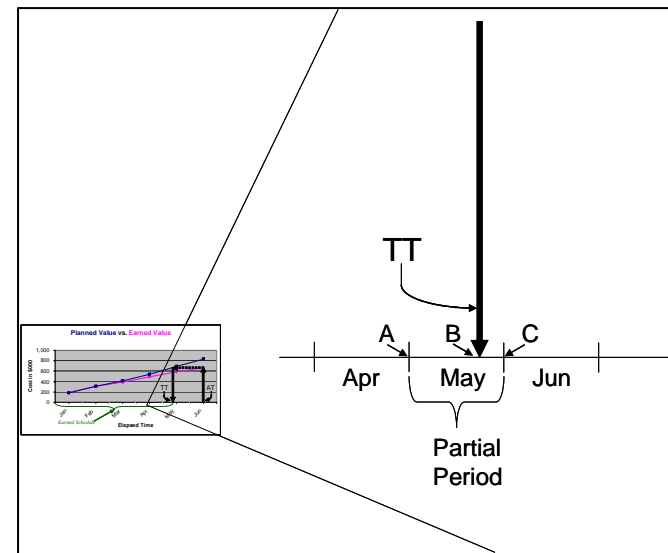


- Earned Schedule = the sum of the time segments
  - Count the number of full periods
  - Calculate the amount of time earned in the partial period



# Partial Period Calculation

- The partial period is represented by a fraction:  
*The time between A and B / the time between A and C*
- Calculate the amount of time earned by using either:
  - Interpolation from the values on the Planned Value curve, or
  - Computation based on the daily totals for Planned Value and Earned Value
- Details of the partial period calculations are covered in the Appendix
- The Earned Schedule equals the number of full periods plus the earned time in the partial period



# Earned Schedule Formulas

- Earned Schedule supports a wide range of formulas
- To distinguish them from the traditional Earned Value Management assessment formulas, the suffix “(t)” is appended
  - **Schedule Variance (t):** Earned Schedule minus Actual Time
  - **Schedule Performance Index (t):** Earned Schedule divided by Actual Time
- The variance and index values act in the same way as traditional Earned Value Management
- Unlike traditional Earned Value Management, Earned Schedule supports prediction of project duration and end date
  - **Estimated Duration (t):** Planned Duration divided by Schedule Performance Index (t)
  - **Projected End Date:** Project Start Date plus Estimated Duration (t)

## Schedule Assessment

$$ES - AT = SV(t)$$

$$ES / AT = SPI(t)$$

## Ahead of Schedule

$$SV(t) > 0$$

$$SPI(t) > 1$$

## Behind Schedule

$$SV(t) < 0$$

$$SPI(t) < 1$$

## Schedule Prediction

$$PD / SPI(t) = ED(t)$$

$$Start + ED(t) = End Date$$



# Implementing Earned Schedule

- The pre-requisites for implementing Earned Schedule do not vary significantly from standard project management practices
- The challenge for Project Managers is to consistently exercise the practices
- There are two sets of pre-requisites:
  - One for generating the data
  - The other for performing the calculations
- Once the pre-requisites are met, the results require interpretation—some tips and techniques are provided for doing this
- Manual calculation of Earned Schedule is possible, but onerous
  - For most projects, tool support is required
  - Common tools such as Microsoft Excel™ and Microsoft Project™ are used here for illustration purposes



# Generating the Data

- Maintain the Schedule
  - Do you ensure that new tasks are incorporated into your schedule in a timely way?
  - Are you rigorous in tracking work that is done and that remains?
  - Do you regularly re-vamp your schedule so that it reflects reality?
- Set a Baseline
  - The system needs a basis for measurement—the baseline provides it
  - Overcoming the psychological hurdle of setting the baseline
    - Baseline selected tasks
    - Use a private baseline
    - Re-set the baseline (note: affects Earned Schedule)
- Enter Resources and Rates
  - Tools use resources and their costs to calculate Planned Value and Earned Value
  - Rates do *not* have to be exact—even nominal rates generate meaningful results



# Manually Performing the Calculations

- Scheduling tools generally provide a function for extracting time-phased data (e.g., the “Analyze Timescaled Data in Excel” wizard)
- The data can then be put into the spreadsheet accompanying this presentation to perform the Earned Schedule calculations

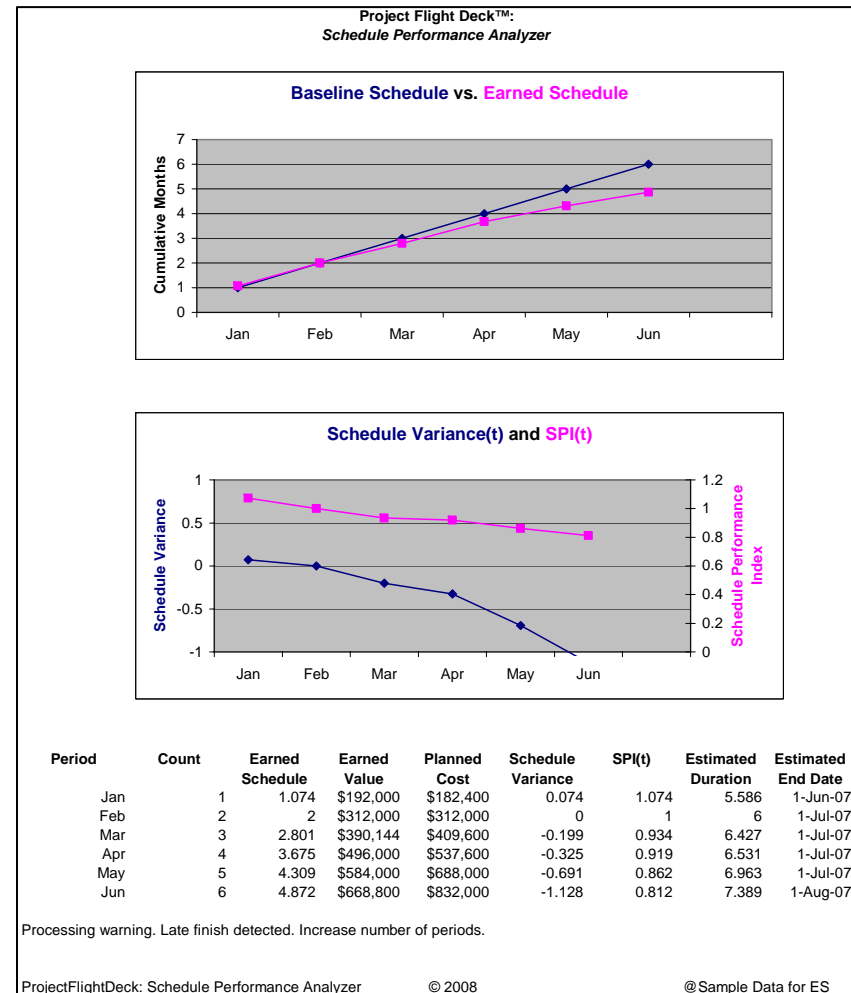
Project Flight Deck™ ES Calculator											
	Period	Planned Value	Earned Value			Period Count	Earned Schedule	Schedule Variance	Schedule Performance Index	Estimated Duration	Estimated Completion Date
Enter values in bold:	Jan	\$182,400	\$192,000		Calculated Values:	1	1.074	0.074	1.074	5.586	1-Jun-07
	Feb	\$312,000	\$312,000			2	2	0.000	1.000	6.00	30-Jun-07
	Mar	\$409,600	\$390,144			3	2.801	-0.199	0.934	6.43	30-Jun-07
	Apr	\$537,600	\$496,000			4	3.675	-0.325	0.919	6.53	30-Jun-07
	May	\$688,000	\$584,000			5	4.309	-0.691	0.862	6.96	30-Jun-07
	Jun	\$832,000	\$668,800			6	4.872	-1.128	0.812	7.39	1-Aug-07

- Extract the Period name, Planned Value, and Earned Value for each time period
- Paste them into the respective columns
- Execute the macro



# Automatically Performing the Calculations

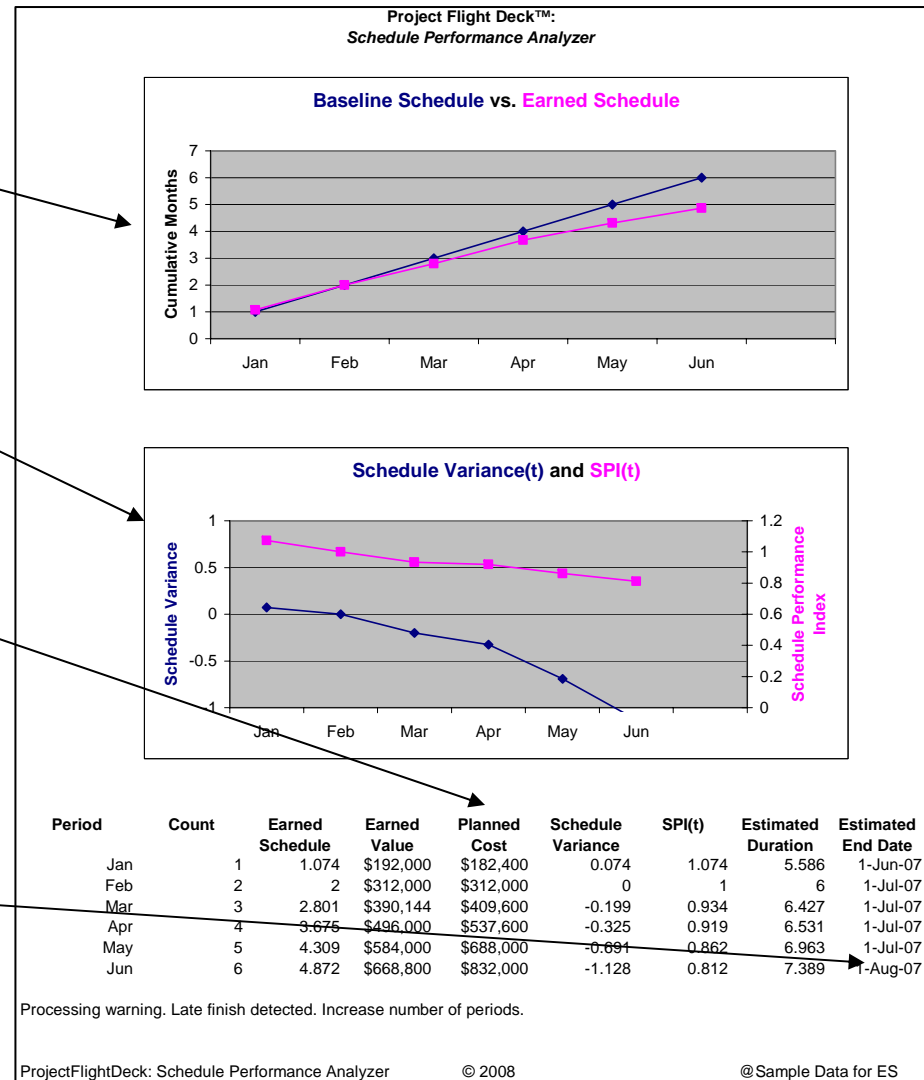
- Commercial plug-ins are available for standard scheduling tools like Microsoft Project™
- The plug-in performs the following functions:
  - Extracts the required data from MS Project
  - Calculates the Earned Schedule values
  - Analyzes the results
  - Dynamically creates an Excel file to hold the output
- The charts make it easy to identify trends
- The numerical results support detailed analysis
- The warning message high-lights risks





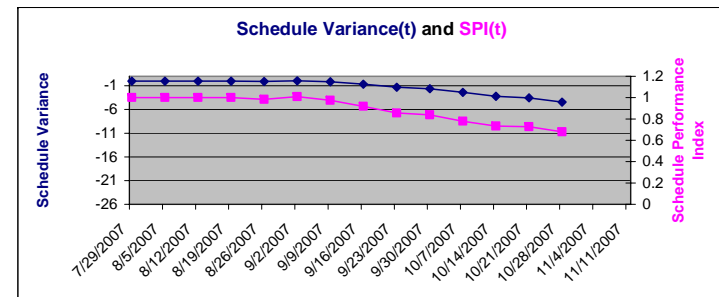
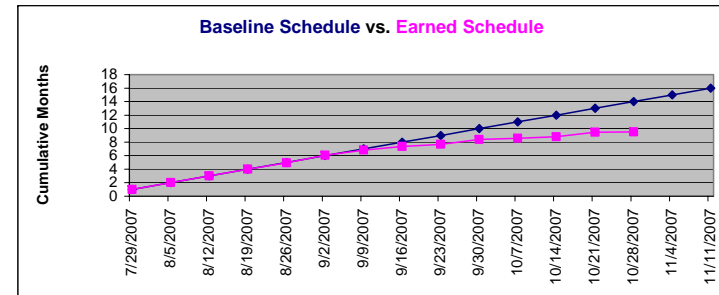
# Interpreting the Results

- Rule of Thumb #1: Mind the Gap
  - The gap between the baseline schedule and the earned schedule indicates whether there is an issue
  - The variance and index analysis portray the trend
  - Experienced users focus on the numbers, in particular, on the Schedule Performance Index, i.e., the SPI(t)
  - The estimated end date is a conservative forecast



# Interpreting the Results

- Rule of Thumb #2: Three in a Row
  - For many projects, monthly resolution is insufficient; weekly time increments are required
  - In such cases, three successive SPI(t) values below expectation signal a trend
  - Expectations vary with projects, but, generally,  $SPI(t) < .8$  are cause for concern
  - An end date that exceeds the target by more than two weeks is worrisome



Period	Count	Earned Schedule	Earned Value	Planned Value	Schedule Variance	SPI(t)	Estimated Duration	Estimated End Date
29-Jul-07	1	1	\$2,400.00	\$2,400.00	0	1	36	6-Apr-08
5-Aug-07	2	2	\$8,800.00	\$8,800.00	0	1	36	6-Apr-08
12-Aug-07	3	3	\$16,800.00	\$16,800.00	0	1	36	6-Apr-08
19-Aug-07	4	4	\$32,800.00	\$32,800.00	0	1	36	6-Apr-08
26-Aug-07	5	4.917	\$64,355.50	\$67,200.00	-0.083	0.983	36.605	10-Apr-08
2-Sep-07	6	6.06	\$123,200.00	\$118,800.00	0.06	1.01	35.644	4-Apr-08
9-Sep-07	7	6.831	\$179,733.30	\$192,133.30	-0.169	0.976	36.891	12-Apr-08
16-Sep-07	8	7.356	\$210,480.00	\$243,733.30	-0.644	0.919	39.154	28-Apr-08
23-Sep-07	9	7.696	\$228,063.30	\$283,333.30	-1.304	0.855	42.098	19-May-08
30-Sep-07	10	8.394	\$259,348.30	\$329,066.70	-1.606	0.839	42.886	24-May-08
7-Oct-07	11	8.58	\$266,685.70	\$362,133.30	-2.42	0.78	46.156	16-Jun-08
14-Oct-07	12	8.797	\$275,302.80	\$400,533.30	-3.203	0.733	49.106	7-Jul-08
21-Oct-07	13	9.464	\$304,560.00	\$432,800.00	-3.536	0.728	49.45	9-Jul-08
28-Oct-07	14	9.534	\$307,760.00	\$450,933.30	-4.466	0.681	52.863	2-Aug-08
4-Nov-07	15			\$472,533.30				
11-Nov-07	16			\$491,333.30				
31-Mar-08	36			\$680,000.00				

Processing warning. Late finish detected. Increase number of periods.



# Interpreting the Results

- Rule of Thumb #3: Impact of Re-baselining

- Re-baselining the whole schedule has significant impact on metrics

- Best practice is to selectively re-baseline tasks, e.g., re-baseline new tasks as they are added, rather than re-baselining all tasks in the project

## Before:

Period	Count	Earned Schedule	Earned Value	Planned Value	Schedule Variance	SPI(t)	Estimated Duration	Estimated End Date
29-Jul-07	1	0.556	\$3,200.00	\$5,760.00	-0.444	0.556	55.8	22-Aug-08
5-Aug-07	2	1.889	\$26,240.00	\$28,800.00	-0.111	0.944	32.824	14-Mar-08
12-Aug-07	3	2.953	\$81,080.00	\$83,640.00	-0.047	0.984	31.49	5-Mar-08
19-Aug-07	4	3.934	\$120,080.00	\$122,640.00	-0.066	0.984	31.517	5-Mar-08
26-Aug-07	5	4.952	\$183,643.50	\$186,696.00	-0.048	0.99	31.298	4-Mar-08
2-Sep-07	6	5.888	\$228,664.20	\$233,952.00	-0.112	0.981	31.589	6-Mar-08
9-Sep-07	7	6.81	\$284,592.10	\$296,464.00	-0.19	0.973	31.865	8-Mar-08
16-Sep-07	8	7.527	\$328,422.30	\$357,052.00	-0.473	0.941	32.946	15-Mar-08
23-Sep-07	9	7.642	\$335,372.30	\$410,512.00	-1.358	0.849	36.508	9-Apr-08

## After:

Period	Count	Earned Schedule	Earned Value	Planned Value	Schedule Variance	SPI(t)	Estimated Duration	Estimated End Date
29-Jul-07	1	1	\$3,200.00	\$3,200.00	0	1	31	2-Mar-08
5-Aug-07	2	2	\$26,240.00	\$26,240.00	0	1	31	2-Mar-08
12-Aug-07	3	3	\$81,080.00	\$81,080.00	0	1	31	2-Mar-08
19-Aug-07	4	4	\$120,080.00	\$120,080.00	0	1	31	2-Mar-08
26-Aug-07	5	4.99	\$183,469.50	\$184,136.00	-0.01	0.998	31.065	2-Mar-08
2-Sep-07	6	5.942	\$228,664.20	\$231,392.00	-0.058	0.99	31.301	4-Mar-08
9-Sep-07	7	6.851	\$284,592.10	\$293,904.00	-0.149	0.979	31.674	6-Mar-08
16-Sep-07	8	7.642	\$332,800.10	\$354,492.00	-0.358	0.955	32.452	12-Mar-08
23-Sep-07	9	8.175	\$363,866.90	\$407,952.00	-0.825	0.908	34.127	23-Mar-08
30-Sep-07	10	8.395	\$375,616.50	\$448,872.00	-1.605	0.84	36.926	12-Apr-08



# Observations

- Earned Schedule makes a material difference in the management of project schedules
  - Quantitative assessment
  - Solid theoretical basis
  - Easy to use
- Virtually no incremental effort required for Project Managers already exercising disciplined project management practices
  - Take schedule seriously
  - Set the baseline
  - Enter resources and rates
- Tool support is required in practice
  - Scheduling tool must generate Planned Value and Earned Value
  - Scheduling tool should support export to a file
  - Full automation increases efficiency



## Future Direction

- Task Level Analysis
  - Earned Schedule provides early warning of overall schedule performance problems
  - Project Manager must investigate schedule to identify the specific tasks that are at risk
  - “P-Factor analysis” takes the technique to the next level
    - Builds on theoretical foundation of Earned Schedule
    - Supports systematic identification of tasks at risk
    - Identifies tasks that are impeded and tasks that require re-work
    - Practical application to schedule management requires automated support
    - Methodology extensions and supporting tools are currently available

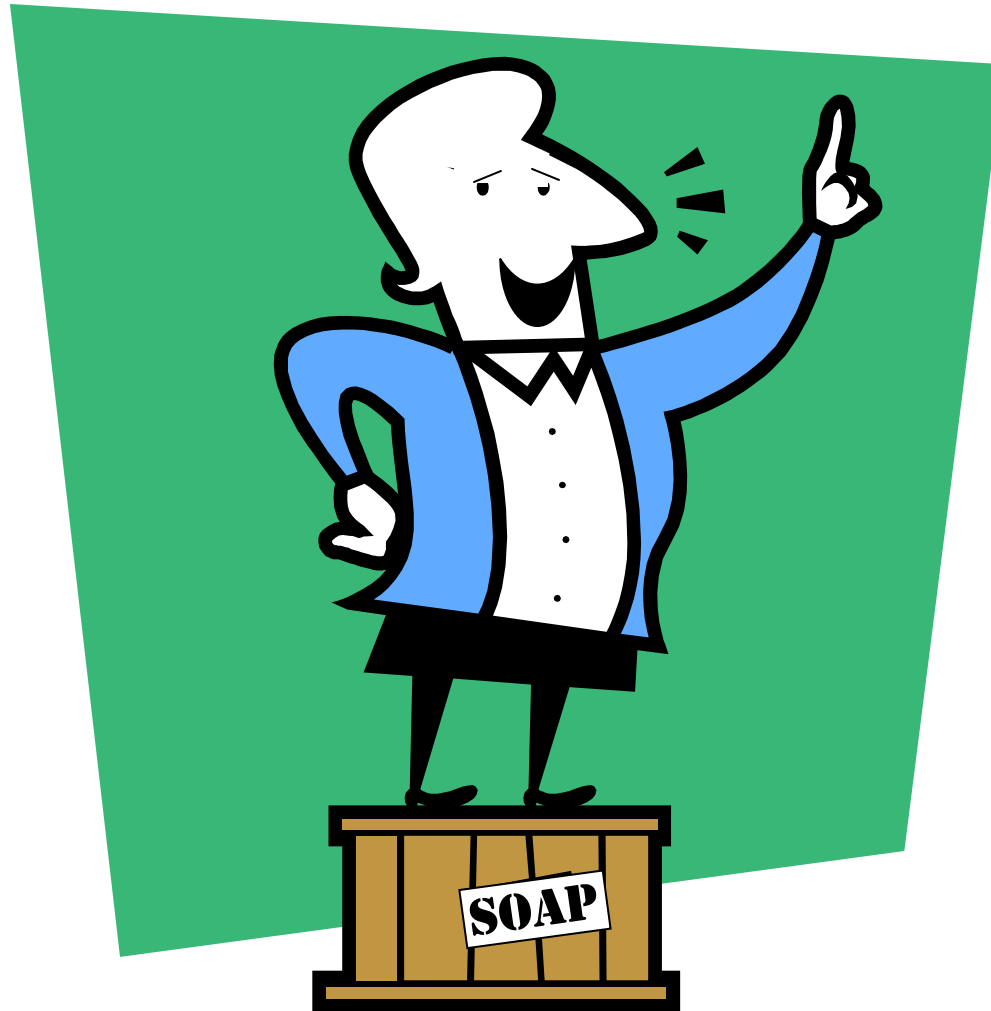


## Learning Objectives

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- Review the benefits and shortfalls of traditional Earned Value Management



## Concluding Comments



# Appendix



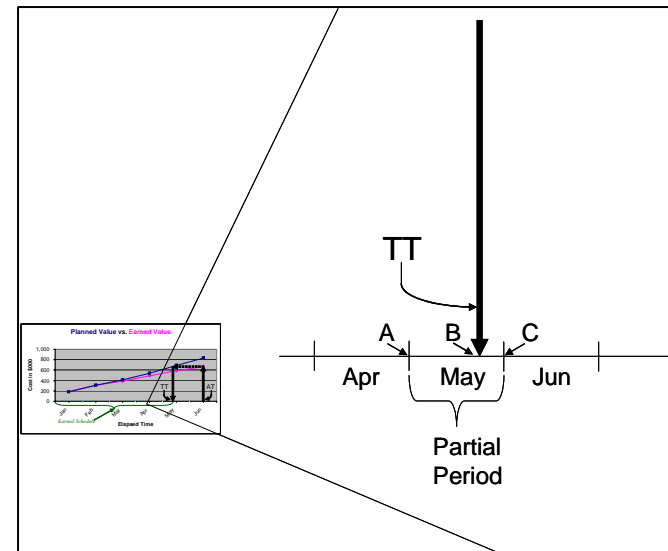


# Partial Period Calculation

- The only part of the technique that requires elaboration
- The partial period is represented by a fraction:

$$B - A / C - A$$

- The values on the curves are cumulative
  - The denominator is the cumulative value at C minus the cumulative value at A
  - The numerator is the cumulative value at B minus the cumulative value at A
- The start of the partial period is known
- The end of the partial period is known
- The Target Time is not known and cannot be directly calculated



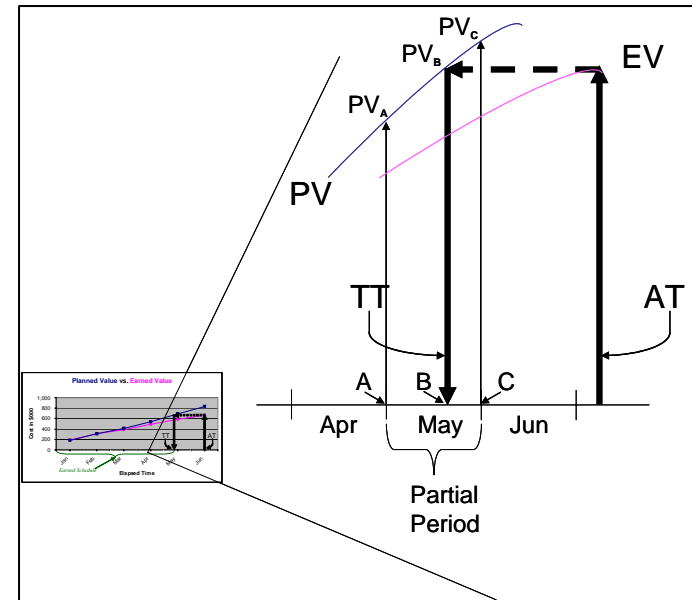
# Interpolation

- The value of the partial period is estimated (interpolated) using known values from the Planned Value curve
- The equation is

$$PV_B - PV_A / PV_C - PV_A$$

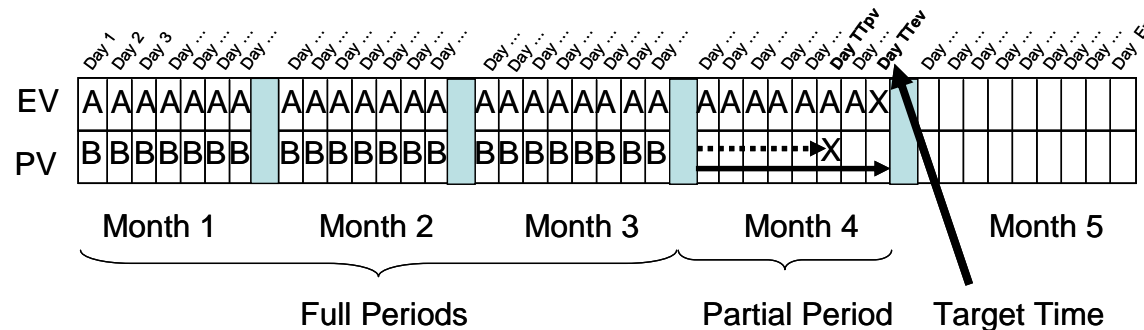
- The denominator is the Planned Value at the period end minus Planned Value at the period start
- The numerator is the Planned Value at the Target Time minus the Planned Value at the period start
- The Planned Value at the Target Time is the same as the Earned Value at the Actual Time; so,

$$EV_{AT} - PV_A / PV_C - PV_A$$



# Computational Method

- An alternative method for calculating the partial period has evolved from the computational implementation of the technique
- Some scheduling tools calculate and store Planned Value and Earned Value for each task for each time period (e.g., by day)
- The values can be used to determine the fractional amount



- Get the Earned Value (X) for the Target Time
- Compare it to the Planned Value for each day
- Determine the exact day when the Planned Value hits X (dotted line)
- Count the number of days in the partial period to get to X
- Count the total days in the partial period (solid line)
- The former over the latter is the fractional amount of Earned Schedule

