

Predicting Project Completion Date Using Earned Value Management

A New Tradition in EVM Analysis!

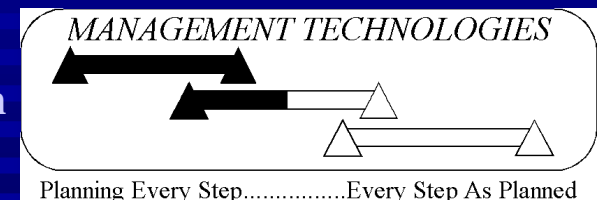
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About Management Technologies

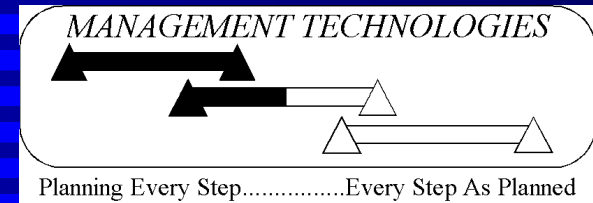
- EVM Training, Process Engineering, Consulting
- ANSI 748 Certification Reviews & Gap Analysis
- EVPrep™ EVP Exam Prep Workshops
- EVPrep™ EVP “*Study Guide*”
- Earned Value Experience™ EVM Workshop
- Earned Value Management Maturity Model®
- EVM Maturity Assessments
- AACEi Approved Education Provider
- PMI Registered Education Provider

Presentation Outline

- Refresher on EVM concepts
- The Problem with SPI
- The Earned Schedule Concept
- Comprehensive Example
- Research Results
- Earned Schedule Maturity
- Conclusions
- References and Contact Information

What Could Be New About EVM?

- In the 1900's.....
 - EVM used in DoD, NASA, DoE, DoT, elsewhere
 - Provided Cost and Schedule Variances (CV, SV)
 - Computed Cost and Schedule Performance Indices (CPI, SPI_{\$})
 - Produced “Estimated Cost at Complete” (EAC)
- 21st Century Improvements to EVM
 - Provides SV in *time* units
 - Computes SPI_t based on *time* units
 - Produces “Estimated Completion *Date*”



•**Refresher on EVM concepts**

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Refresher on Earned Value Concepts

How earned value management is different
from cost reports and schedule updates.

Basic Earned Value Management Concepts

- Work has value equal to its *planned* budget
- Earned value is an “economic value” of all work done to-date, based on planned costs (PV)
- Actual costs (AC) should be close to value of work completed (EV) (stay on budget)
- The earned value should accumulate at the rate planned (stay on schedule)
- EV equals PV at the project end (100% work done)

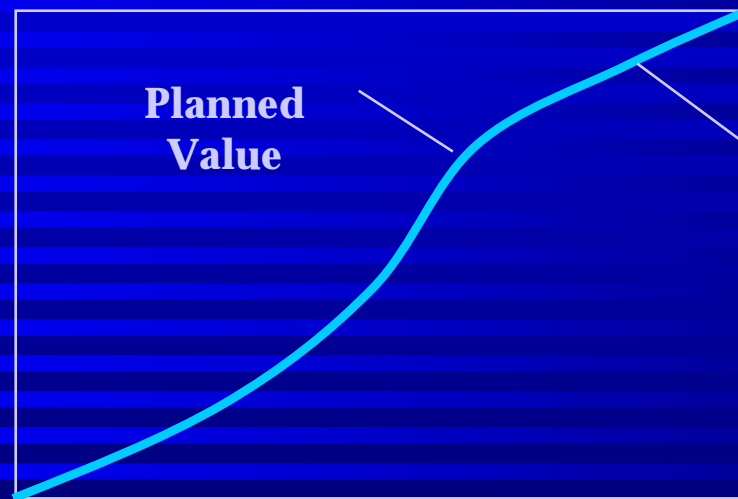
The Four Key Elements of EVM

- Only four terms (three we already have)
- *Planned Value (PV)*
- *Actual Cost (AC)*
- *Earned Value (EV)*
- *Planned Budget (BAC)*

The Planned Value (PV)

- The scheduled (plan) to build value from zero to the total project value
- Previously “budgeted cost of work scheduled” (BCWS)

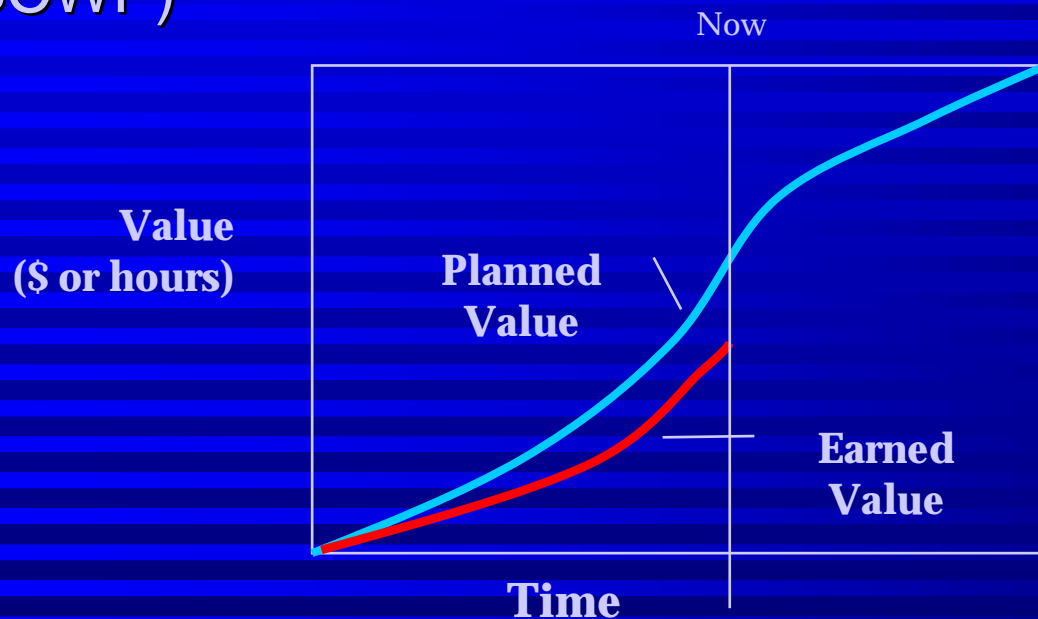
Value
(\$ or hours)



*Performance
Measurement
Baseline (PMB)*

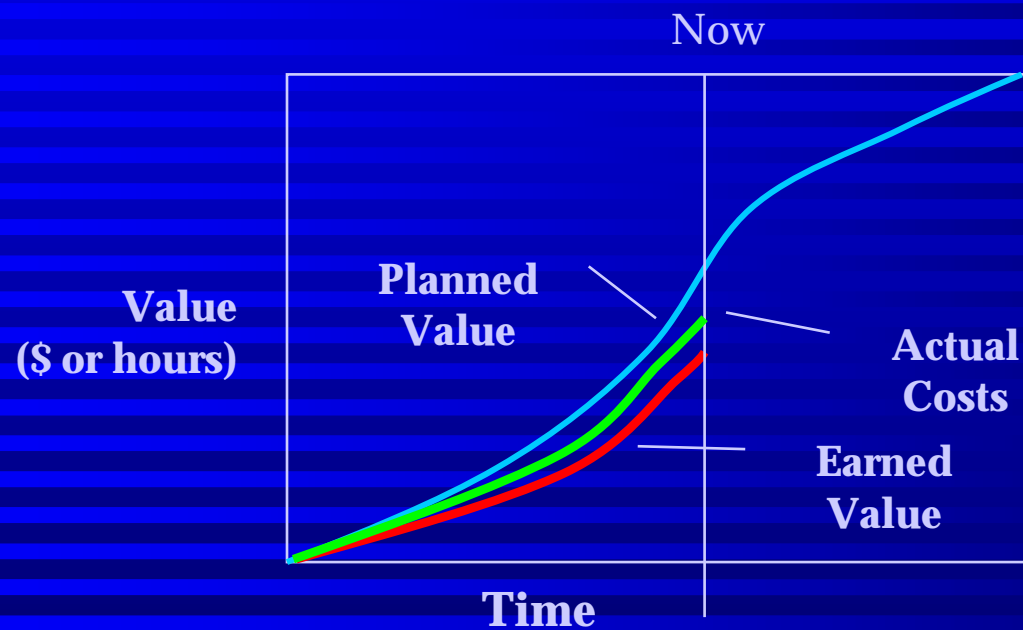
The Earned Value (EV)

- The value gained as project work is completed
- Previously “budgeted cost of work performed” (BCWP)



The Actual Cost (AC)

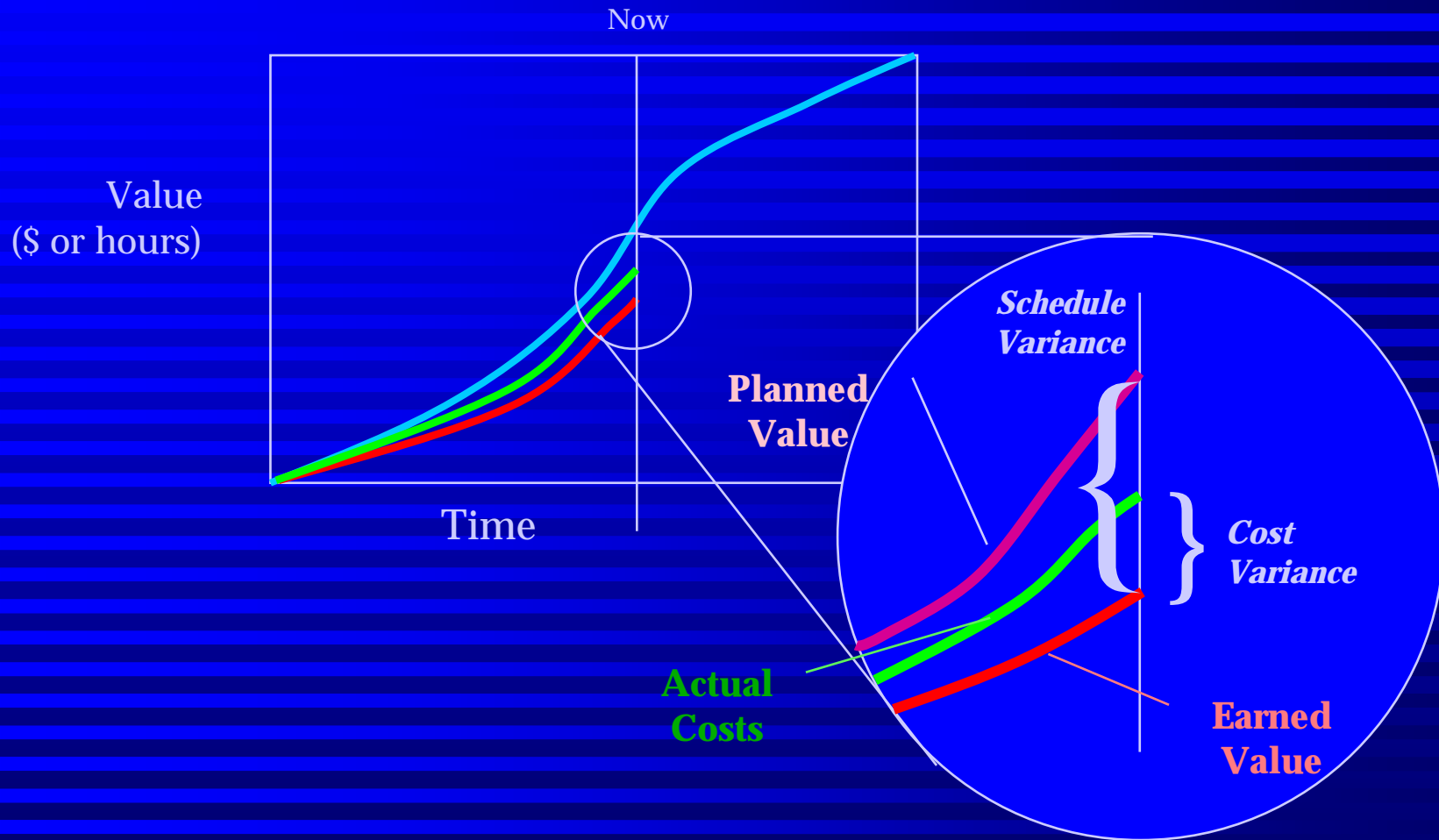
- The cost of the completed work
- Previously “actual cost of work performed” (ACWP)



Evaluating Project Performance

- Data collection process
 - 1. What was supposed to be accomplished (PV)
 - 2. What was accomplished (EV)
 - 3. What did the accomplishment cost (AC)
- Schedule information: compare what should be done with what was done
- Cost information: compare if the completed work cost what it should

Analyzing Variances From the Plan



Cost Performance Index (CPI)

- “Did the progress we made cost what it should?”
- $CPI = EV/AC$
- Greater than 1.0 is good, less than 1.0 is bad
- Example

(this is not good)

$$CPI = \frac{EV}{AC} = \frac{WORK_DONE}{COST_OF_WORK_DONE} = \frac{1000hrs}{1500hrs} = 0.66$$

Schedule Performance Index (SPI)

- “Did a month’s of schedule produce a month of progress?”
- $SPI = EV/PV$
- Greater than 1.0 is good, less than 1.0 is bad
- Example

(this is good)

$$SPI_s = \frac{EV}{PV} = \frac{WORK_DONE}{WORK_PLANNED} = \frac{1200\text{ hrs}}{1000\text{ hrs}} = 1.2$$

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The Problem with SPI

We've been using SPI for 30+ Years,
What could be wrong with it?

What is the Final Value of SPI?

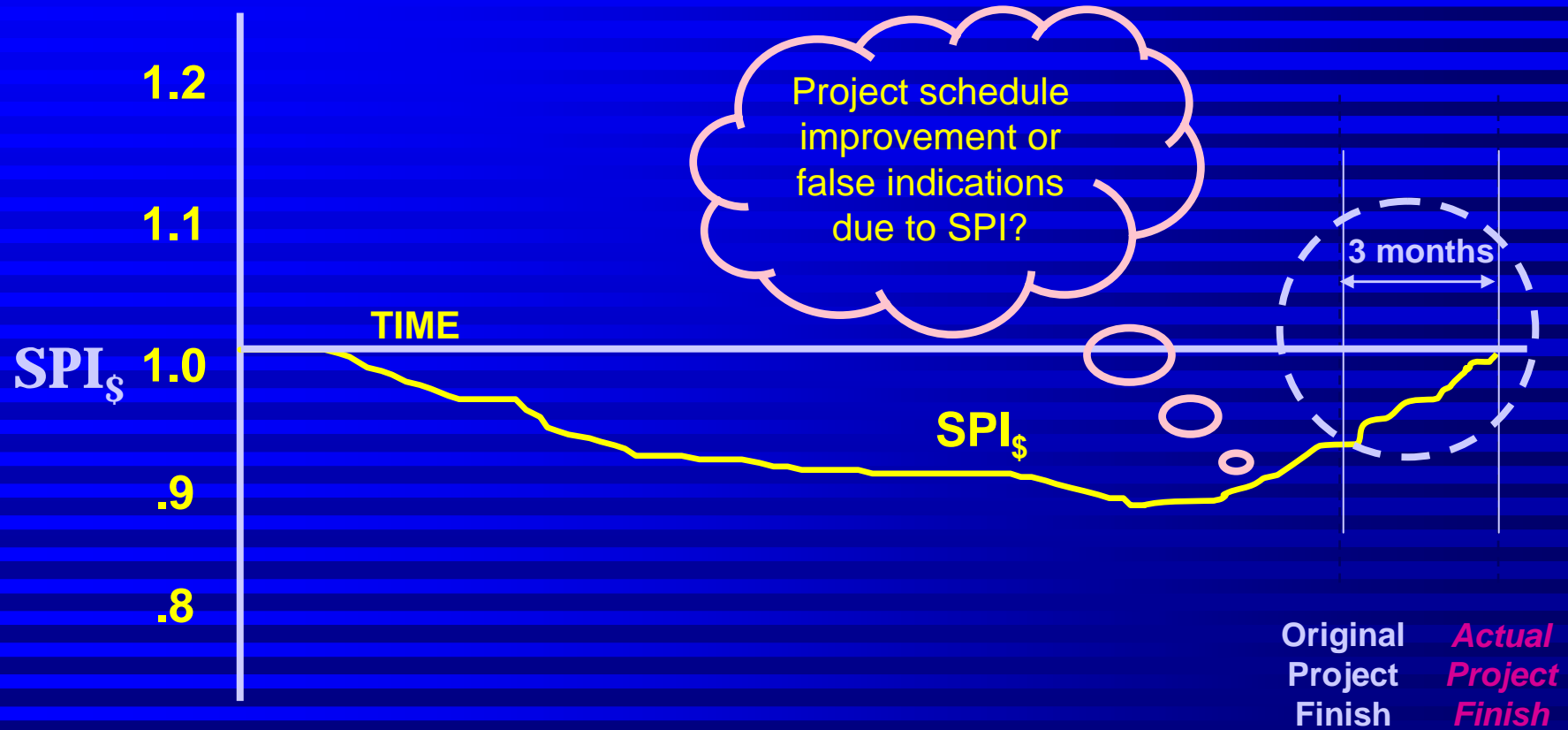
- The project is over
- The work is done
- If the project on time what is the final SPI?
- If the project finishes early what is the final SPI?
- If the project finishes late what is the final SPI?

$SPI = EV/PV$, but

$PV = EV$, so

$EV/PV = PV/PV = 1.0!$

Graphing the Problem with SPI_{\$}



Using CPI and SPI in Estimating the Final Cost

- Simple extrapolation
- Final cost = cost of work done + (work left/past performance)
- Assumes future performance is same as past (generally true)
- $EAC(CPI) = AC + (BAC - EV) / CPI = BAC / CPI$
- $EAC(CPI, SPI) = AC + (BAC - EV) / (CPI * SPI)$

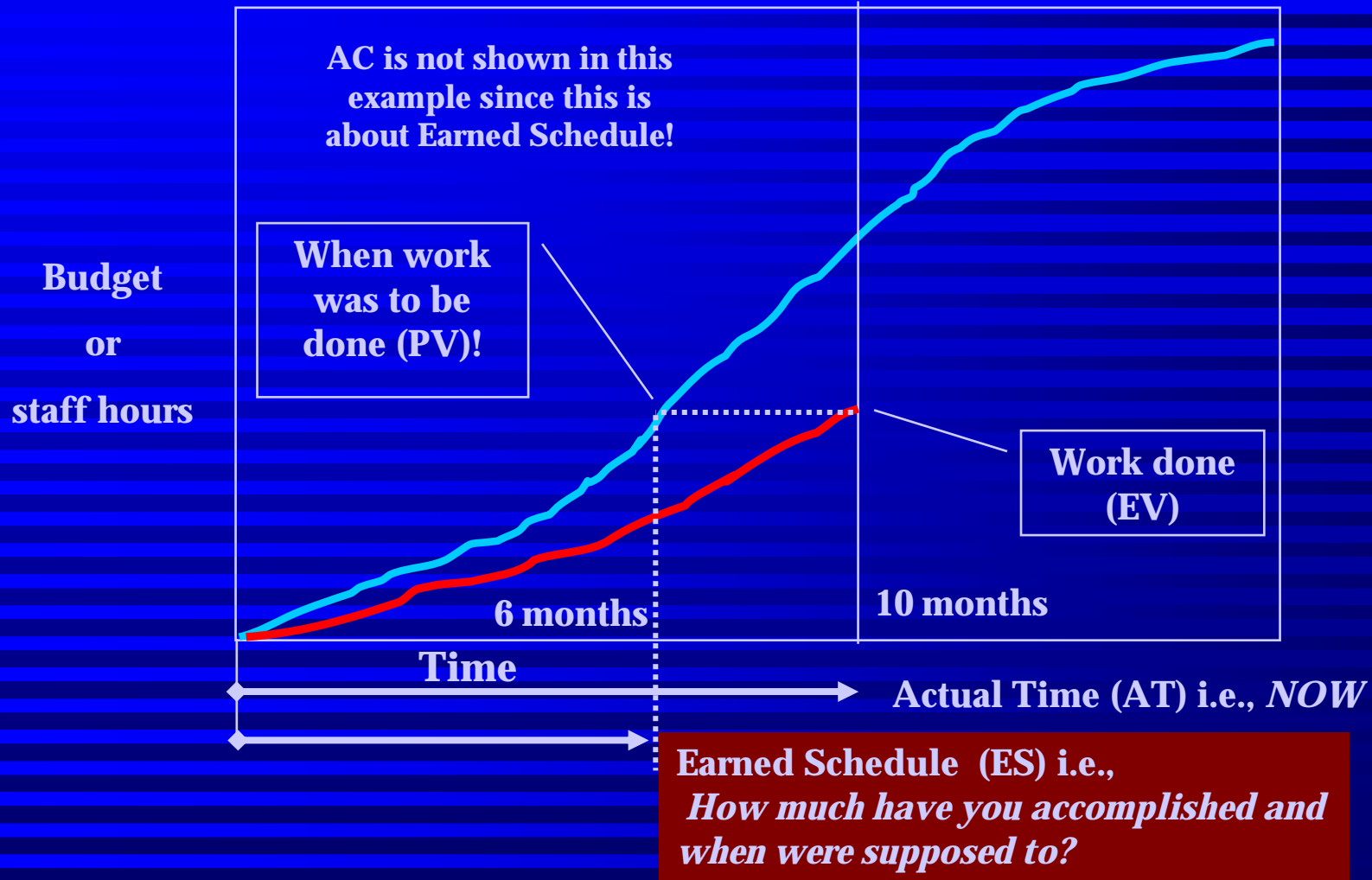
Toward the end of the project how accurate can this term be?

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The Earned Schedule Concept

Creating a Schedule Performance Index that is accurate to the end of the project.

At What Point Did I Expect to Attain My Current Earned Value?

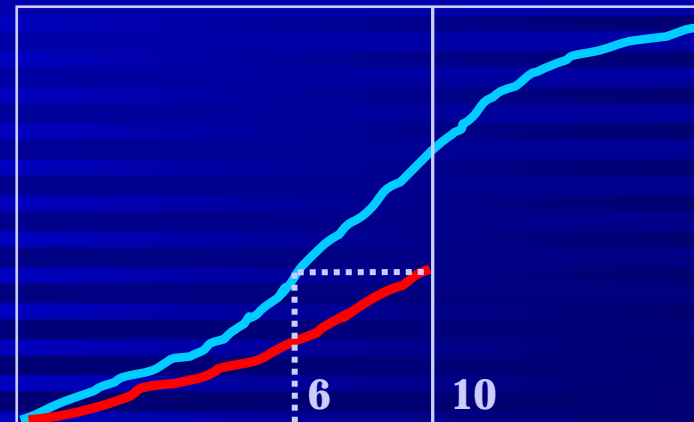


Some New Terms

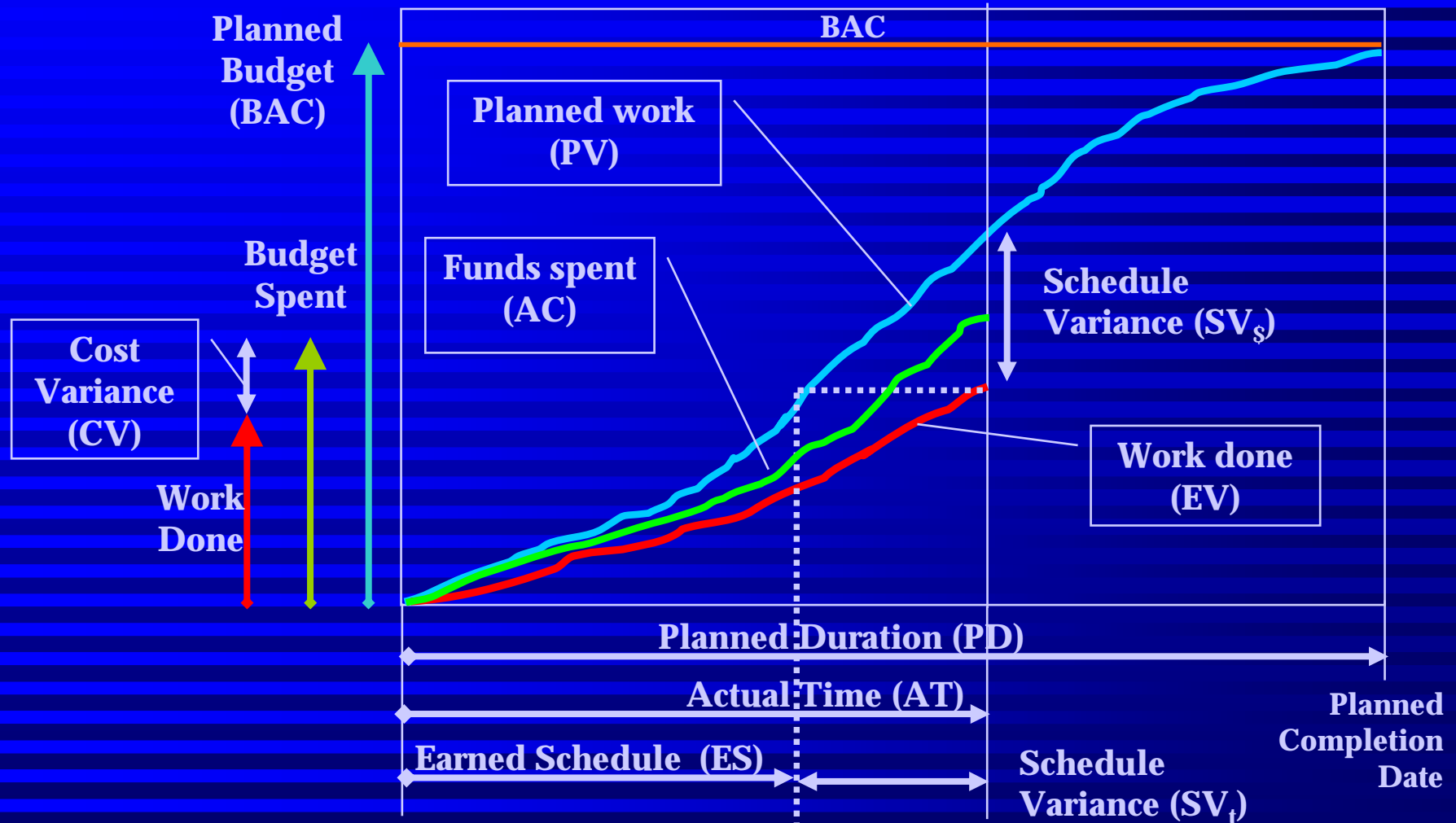
- AT = Actual Time (now, or data date)
- ES = Earned Schedule (Point in time when *current* progress was *planned* to occur)
- PD = Planned Duration (planned project duration)
- ED = Estimated Duration (estimated project duration)
- PCD = Planned Completion Date (Planned project end date)
- ECD = Estimated Completion Date (Estimated project end date)

Alternative SPI and SV formulas!!

- $SV_t = ES - AT$ (Schedule Variance in time units, note subscript versus $SV_{\$}$)
- $SPI_t = ES/AT$ (SPI in time units)
- EXAMPLES:
 - $SV_t = 6 \text{ months} - 10 \text{ months} = -4 \text{ months}$
 - $SPI_t = 6/10 = 0.6$



The Traditional and the New



Traditional and New EVM Analysis Tools

Traditional

$$SPI_{\$} = \frac{EV}{PV}$$

$$CPI = \frac{EV}{AC}$$

$$EAC = \frac{BAC}{CPI}$$

$$SV_{\$} = EV - PV$$

$$CV = EV - AC$$

New

$$SPI_t = \frac{ES}{AT}$$

$$ED = \frac{PD}{SPI_t}$$

$$ECD = start_date + ED$$

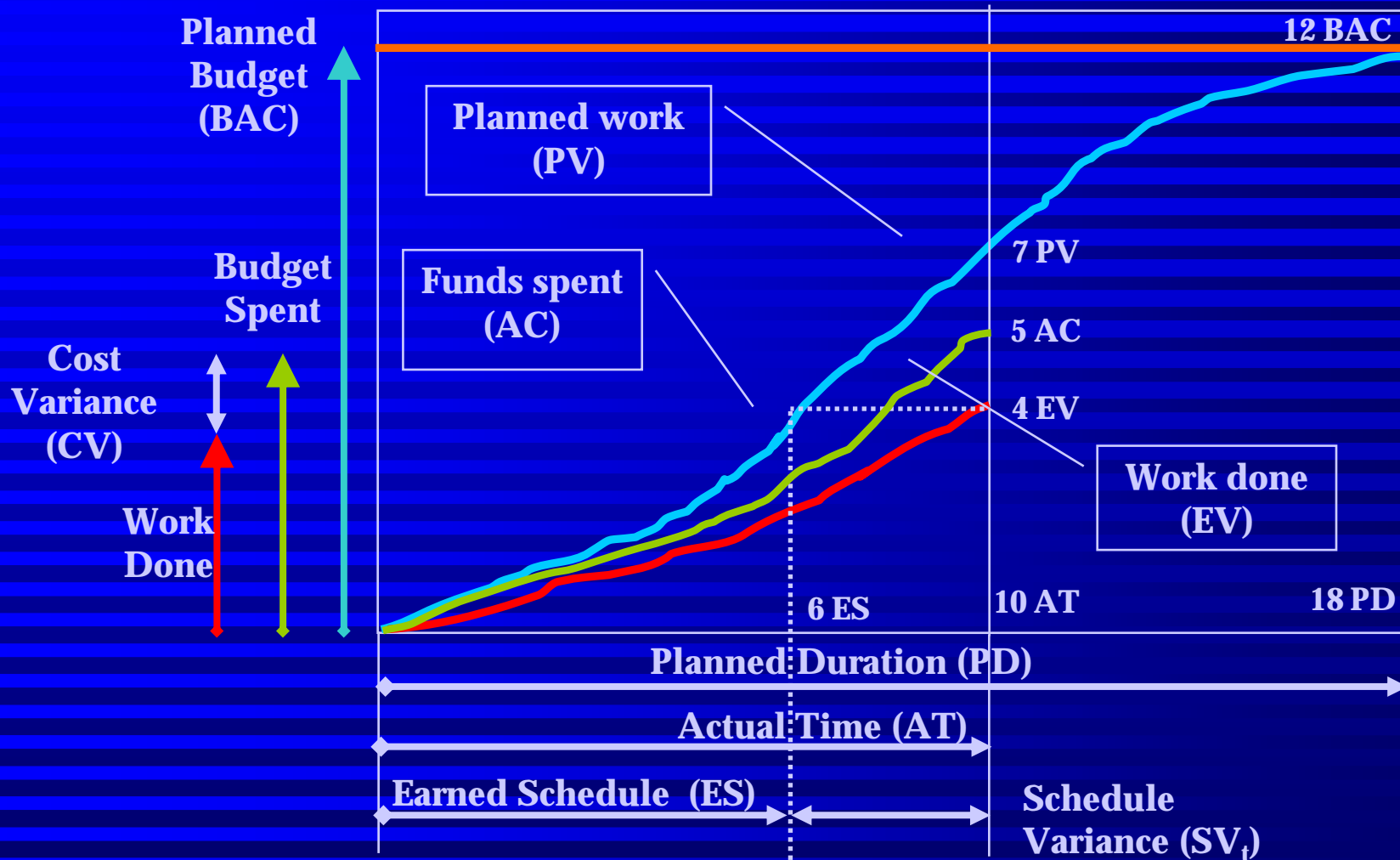
$$SV_t = ES - AT$$

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Comprehensive Example

Putting all the pieces together.

Comprehensive Example



Comparing EV and ES Schedule Analysis

Traditional

$$SPI_{\$} = \frac{EV}{PV} = \frac{\$4}{\$7} = 0.57$$

$$SV_{\$} = EV - PV = \$4 - \$7 = -\$3$$

New

$$SPI_t = \frac{ES}{AT} = \frac{6months}{10months} = 0.6$$

$$SV_t = ES - AT = 6months - 10months$$

$$SV_t = -4months$$

$$ED = \frac{PD}{SPI_t} = \frac{18months}{0.6} = 30months$$

Tabular View (Excel)

1/31/06	2/28/06	3/31/06	4/30/06	5/31/06	6/30/06	7/31/06	8/31/06	9/30/06	10/31/06
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PV - CUMULATIVE (BCWS)	0	1800	3500	5000	6100	8400	10300	12500	12900	14200	16800
EV - CUMULATIVE (BCWP)	0	680	1900	4340	5600	6700	9100	11230	12450	12650	12750
AC - CUMULATIVE (ACWP)	0	500	1800	4400	5725	7025	9025	12525	14025	15025	16025

EARNED SCHEDULE - DATE		1/13/06	2/1/06	3/17/06	4/16/06	5/8/06	6/11/06	7/13/06	7/30/06	8/11/06	8/19/06
EARNED SCHEDULE- DAYS		11	30	73	103	125	159	191	208	221	228
ACTUAL (ELAPSED) TIME - DAYS		28	56	87	117	148	178	209	240	270	301
PLANNED DURATION OF REMAINING WORK		351	332	289	259	237	203	171	154	141	134
TIME REMAINING		334	306	275	245	214	184	153	122	92	61
SCHEDULE VARIANCE (DAYS)		-17	-26	-14	-14	-23	-19	-18	-32	-49	-73
SPI(t)		0.37	0.52	0.84	0.88	0.84	0.89	0.91	0.86	0.81	0.75

New EVM Analysis Products

- Time Based Schedule Performance Index {SPI(t) or SPI_t }
- Time Based Schedule Variance {SV(t) or SV_t }
- Estimated Duration (ED)
- Estimated Completion Date (ECD)

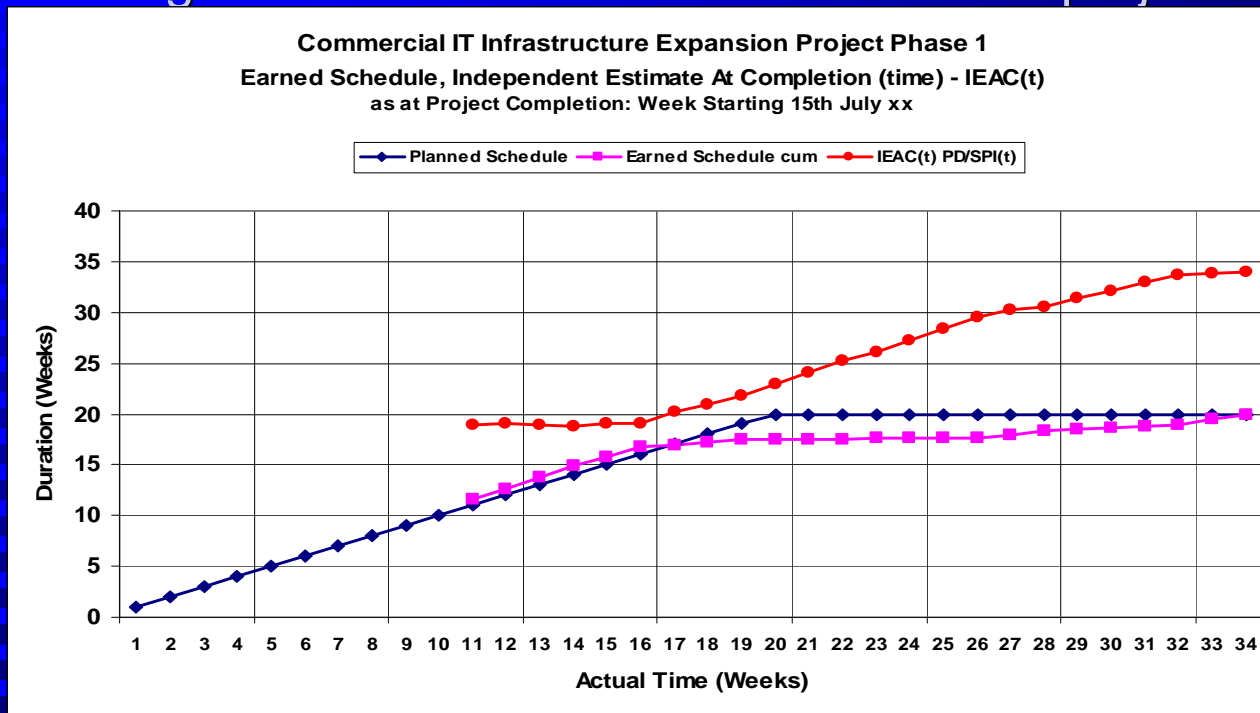
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Research Results

Does Earned Schedule analysis really work?

Empirical Evidence (Henderson)

- Findings derived from a small set of real life project



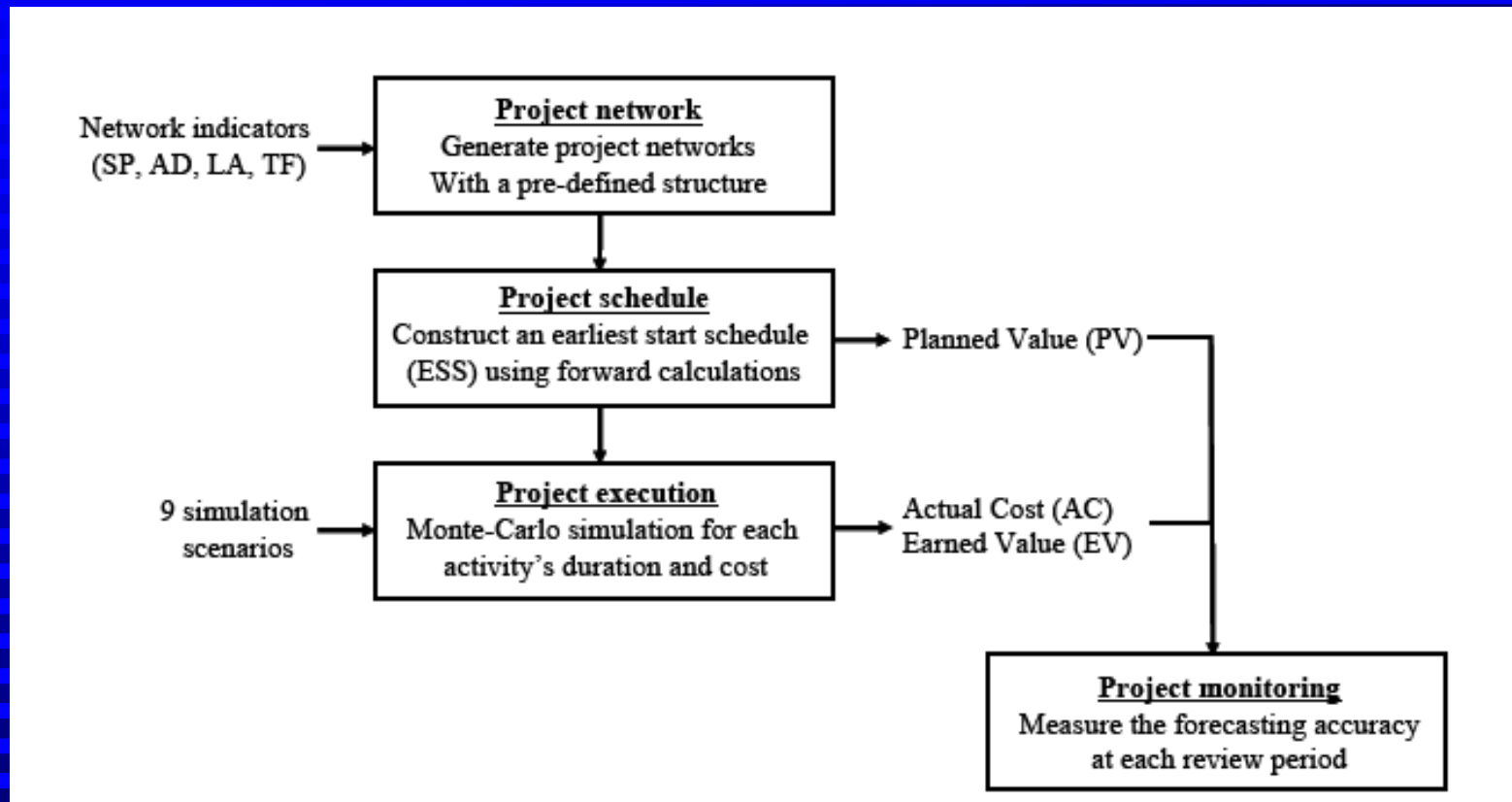
Henderson, K., 2003, "Earned schedule: a breakthrough extension to earned value theory? A retrospective analysis of real project data", *The Measurable News*, Summer 2003, 21, 13-17

Academic Research (Vanhoucke)

- Created 3,100 project activity networks
- Constructed a schedule for each network
- Simulated (executed) activity duration and cost in a controlled way (9 execution scenarios, each schedule subjected to each scenario 100 times)
- Monitored and forecasted at each reporting period
- Analysed the data ($3.100 \times 9 \times 100 = 2,790,000$ project data sets)

Vanhoucke M., Vandevoorde St., *A Simulation and Evaluation of Earned Value Metrics to Forecast the Project Duration*, Ghent University, Working Paper 2005/312, June 2005

Research Process



The Nine Simulation Scenarios

■ Critical Path Activities

- Real Duration < Planned Duration
- Real Duration = Planned Duration
- Real Duration > Planned Duration

■ Non-Critical Path Activities

- Real Duration < Planned Duration
- Real Duration = Planned Duration
- Real Duration > Planned Duration

		Critical activities		
		-	0	+
Non-critical activities	-	1 SPI(t) > 1 RD < PD	4 SPI(t) > 1 RD = PD	7 SPI(t) > 1 RD > PD
	0	2 SPI(t) > 1 RD < PD	5 SPI(t) = 1 RD = PD	8 SPI(t) < 1 RD > PD
	+	3 SPI(t) < 1 RD < PD	6 SPI(t) < 1 RD = PD	9 SPI(t) < 1 RD > PD

Academic Research Results

- “The results reveal that the Earned Schedule method outperforms, on the average, all other forecasting methods.”

Vanhoucke M., Vandevorde St., *A Simulation and Evaluation of Earned Value Metrics to Forecast the Project Duration*, Ghent University, Working Paper 2005/312, June 2005

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Earned Schedule Maturity

Current state of Earned Schedule
development and deployment

Earned Schedule Maturity

- First paper: March 2003, PMI-CPM Measurable News
- Over twenty-five presentations and publications
- A growing trend and management expectation
- Yet to appear in commercial EVM software products, plug-ins for MS Project and 37 Cobra available.
- Early Adopters
 - USAF
 - Lockheed Martin
 - Belgium
 - Management Technologies (education, processes, tools)

USAF Planning

- Air Force understands the potential of Earned Schedule
- Demonstrating Earned Schedule on a sample set of programs
- Building a body of evidence on a larger set of programs
- Validate the Earned Schedule as a value added program management tool
- Integrate Earned Schedule as a tool in Air Force Acquisition

The Good News!

■ Previously

- EVM was great at cost management
- EVM was “ok” at schedule management, *sometimes*

■ Now

- EVM can address both cost and schedule well
- EVM can estimate
 - Cost at completion
 - Completion date!
- SPI_t can record project outcome in lessons learned

Credit to Discoverers, Advocates, & Researchers

- Henderson Kym, Earned Schedule: A Breakthrough Extension to Earned Value Theory? A Retrospective Analysis of Real Project Data, The Measurable News, Summer 2003
- Robert Handshuh, New Concept in Earned Value - Earned Schedule, PMI Southeast Regional Conference USA, June 2005
- Walt Lipke & Kym Henderson, Earned Schedule Status Update and Early Adaptor Applications Feedback, 17th IPMC November 2005
- Vandevoorde St., Vanhoucke M., A Comparison of different project duration forecasting methods using earned value metrics, Ghent University, working paper 2005/312, June 2005
 - Published in "International Journal of Project Management"

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Conclusions

So What?

Facts About Earned Schedule

- Allows SPI_t to be faithful to the project's end
- Provides a reliable means to calculate an estimated completion date
- Provides a useful schedule performance metric for project history and lessons learned
- May provide a better estimated completion date than critical path methods!

Why use ES?

- More intuitive schedule information
- Schedule variance (SV) in time units (intuitive to most people)
- Cost variance (CV) in *resource* (\$\$) units
- SPI_t retains utility to project end
 - SPI_t does not automatically creep toward 1.0 near project end
 - SPI_t captures the final project schedule performance data
- Can finally estimate *Project Completion Date*

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Reference and Contact Information

Tell me more!

Seminal Documents

- Lipke, Walter, “Schedule is Different”, The Measurable News, March and Summer 2003
- Henderson, Kym, “Further Development in Earned Schedule”, The Measurable News, Spring 2003
- Henderson, Kym, Earned Schedule: A Breakthrough Extension to Earned Value Theory? A Retrospective Analysis of Real Project Data, The Measurable News, Summer 2003

The Measurable news is a quarterly publication of the Project Management Institute's College of Performance Management

www.pmi-cpm.org

Other References

- Earned Schedule Status Update and Early Adopter Applications Feedback
Presentation facilitated by Walt Lipke and Kym Henderson, 17th IPMC November 2005
- Earned Schedule Leads to Improved Forecasting:
Presentation by Walt Lipke, intended for 17th IPMC November 2005
- Earned Schedule in Action: Paper by Kym Henderson, published PMI CPM Journal, The Measurable News "Spring" 2005
- Forecasting Project Schedule Completion by Using Earned Value Metrics, Presentation by Ing. Stephan Vandevoorde, Senior Project Manager, Fabricom Airport Systems and Prof. Dr. Mario Vanhoucke, Ghent University, Belgium, Early Warning Signals Conference, V.U.B. Brussels, June 2005
- Not Your Father's Earned Value: Earned Schedule overview paper by Ray Stratton, published on Projects@Work (<http://www.projectsatwork.com>) 24 Feb 2005
- Connecting Earned Value to the Schedule: Paper by Walt Lipke, published PMI CPM Journal, The Measurable News, "Winter" 2004

One-Stop Shopping

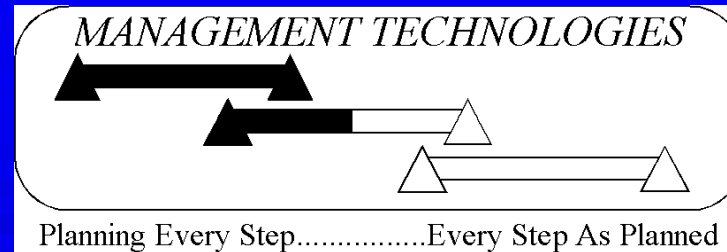
- www.earnedschedule.com
- www.mgmt-technologies.com
- “*The Earned Value Management Maturity Model*®”, published by Management Concepts, Vienna VA

In Closing

If you are not practicing Earned Schedule as part of your
Earned Value Management System

*.....you are practicing 20th Century
Earned Value Management!*

Discussion and Questions



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