

Earned Schedule

...an extension to EVM

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Red Earth Chapter – PMI
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Overview

- Introduction
- Earned Value Management
- Extension of EVM ...*Earned Schedule*
- Further Information
 - Bridges EVM to Network Schedule
- Summary

Introduction

About Earned Schedule

- Created in Summer 2002
- Published March 2003, *The Measurable News*
- Australian, Kym Henderson – first adopter
- Presentations made
 - IPMC, CPM (2003, 2004, 2005)
 - Australia, UK, Japan, Sweden, Belgium
- Several Papers available (references)
- “*Emerging Practice*” in new EVM Practice Standard
- CPM plans to create ES area on website

<http://www.pmi-cpm.org/>

About Earned Schedule

- CPM 2005 keynote address
 - Blaise Durante, SAF Acquisition Executive
 - Air Force application to quarterly reviews
 - Incorporation into Department of Defense schools
 - EVM Tool Vendor incorporation

About Earned Schedule

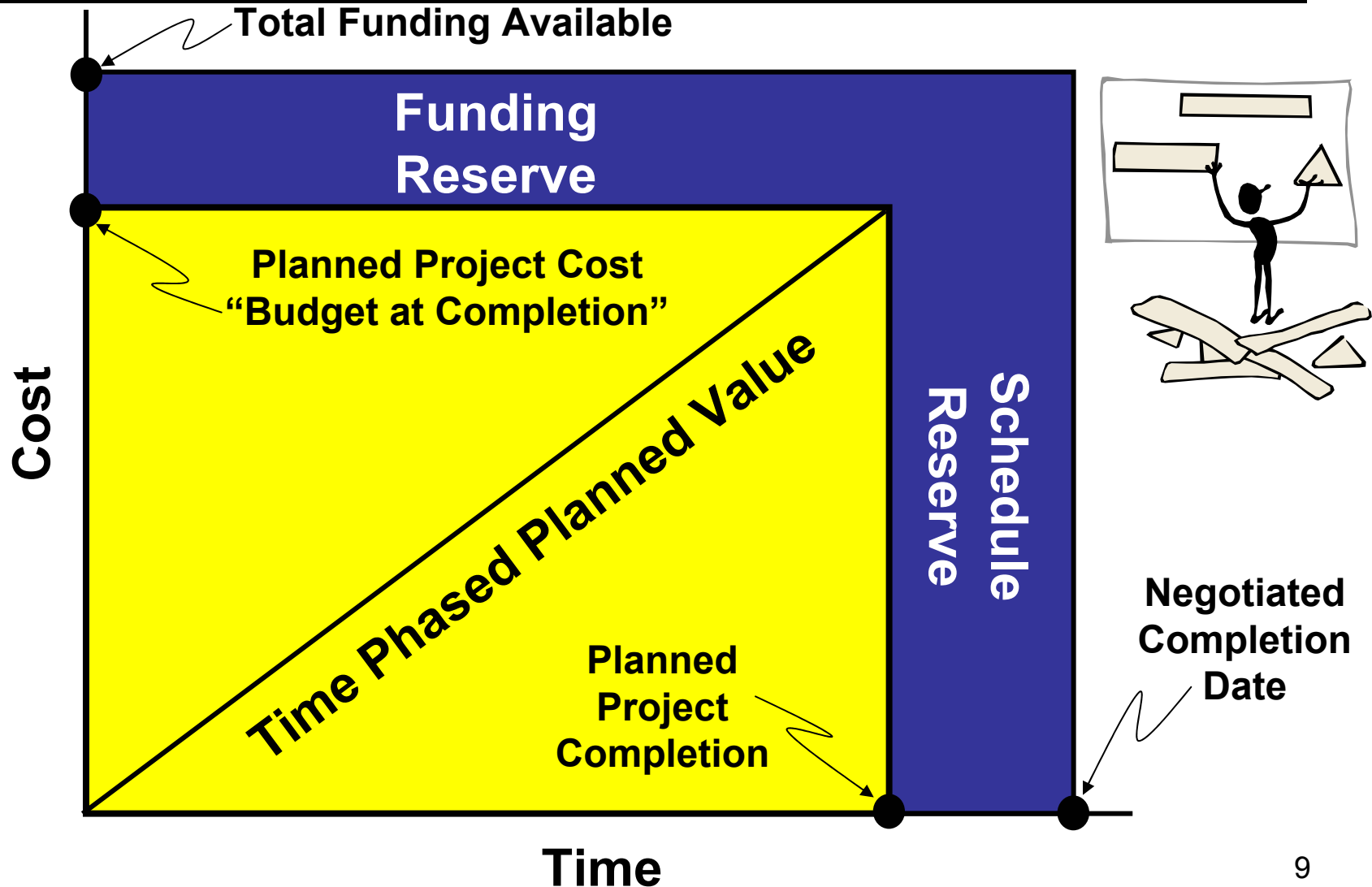
- Early Adopters
 - EVM Instructors – PMA, Mgmt-Technologies..
 - Boeing Dreamliner®, Lockheed Martin, US State Department, Secretary of the Air Force
 - Several Countries – Australia, Belgium, Sweden, ...
 - Applications across weapons programs, construction, software development, ...
 - Range of project size from very small and short to extremely large and long duration

Earned Value Management

What's Necessary to Implement EVM?

- Define the project
 - Understand the Requirements
 - Apply WBS & OBS
 - Breakdown to Tasks
- Estimate Duration & Effort
- Schedule the Tasks (defines interdependencies)
- Allocate the Budgets (defines what & who)
- Create the Performance Management Baseline

What's Necessary to Implement EVM?



Anything Else?

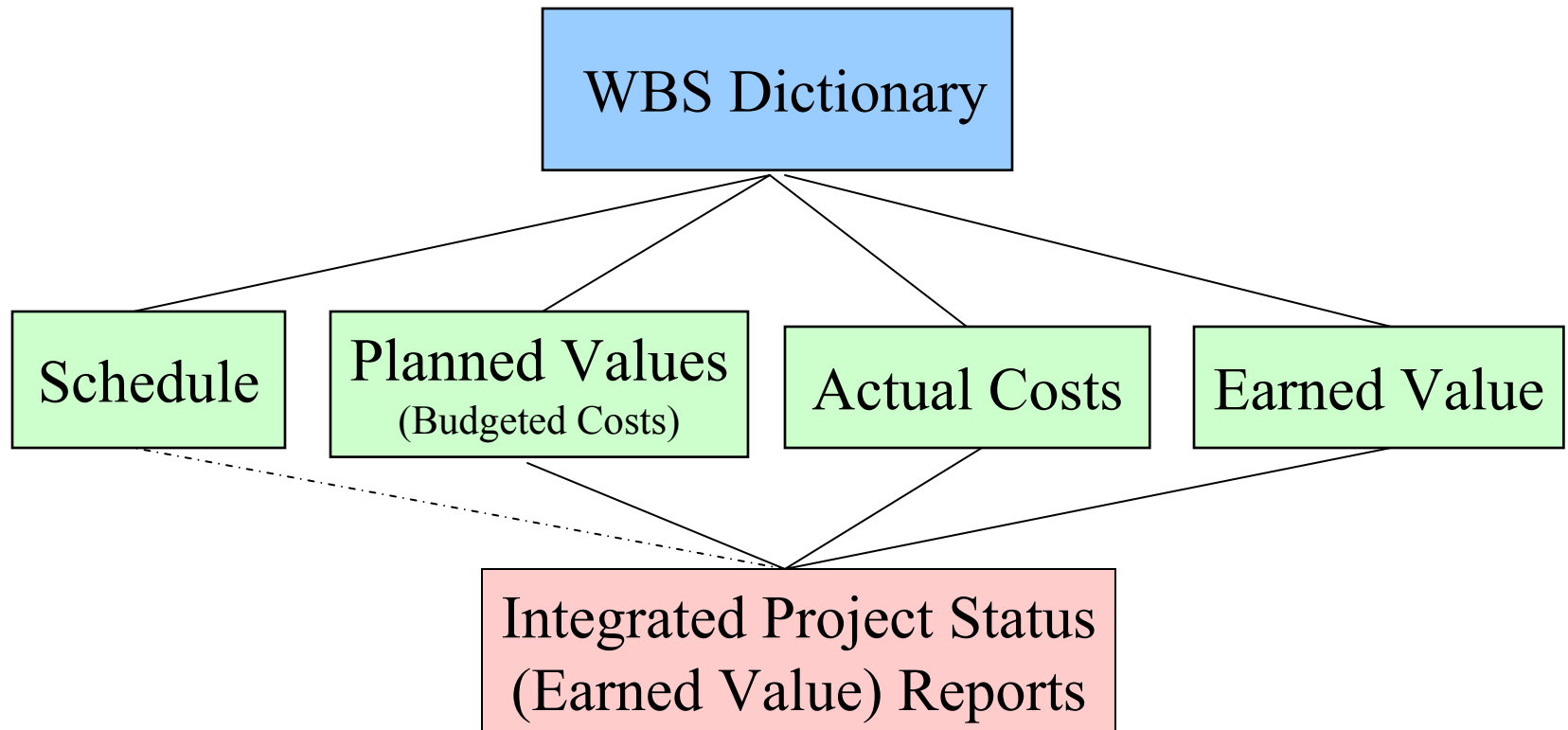
- Assign the Work
- Level the Work/Reduce the Gaps
 - If at all possible, eliminate Gaps
 - Gaps add expense with no benefit
- Iterate Estimate \Leftrightarrow Leveling until satisfied
- Evaluate the Risk
 - Estimate = 50% probable execution
 - Reserves = 90% probable execution

Then What?

- Record the time-phased Cost and Earned Value
- Evaluate & Report Progress Periodically
- Take Appropriate Management Action

What does an EVM System
Look Like?

EVM System Diagram



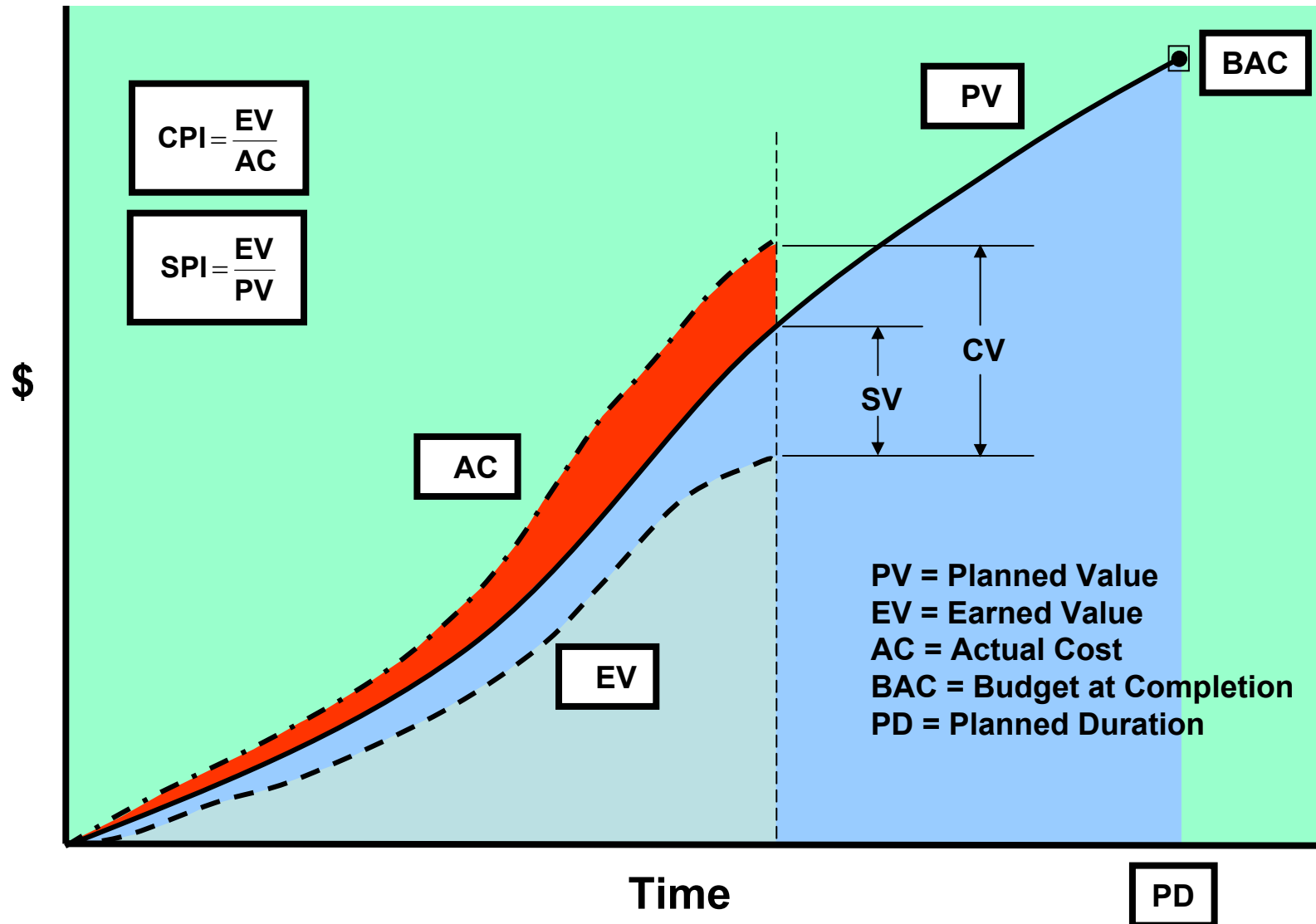
The concept is to align project activities defined in the WBS into both the schedule and financial accounting and time recording systems.

Evaluating Project Performance using EVM

How Do I Evaluate Performance?

- Assess Earned Value
 - What Has Been Accomplished?
- Performance Versus Plan
 - Is the Project performing as Planned?
- Remaining Work versus Resources
 - Can the Project Complete within Negotiated Cost and Completion Date?
 - Are Reserves Being Used?

Project Status using EV



Project Status

- Present Values of Variances or Indexes

- Variances

- Cost Variance (CV)

$$CV = EV - AC$$

- Schedule Variance (SV)

$$SV = EV - PV$$

- Indexes

- Cost Performance Index (CPI)

$$CPI = EV / AC$$

- Schedule Performance Index (SPI)

$$SPI = EV / PV$$

Project Outcome

- Prediction of Project Outcome

- Trend of Periodic Values
- Performance to Achieve Planned Cost

To Complete Performance Index (TCPI)

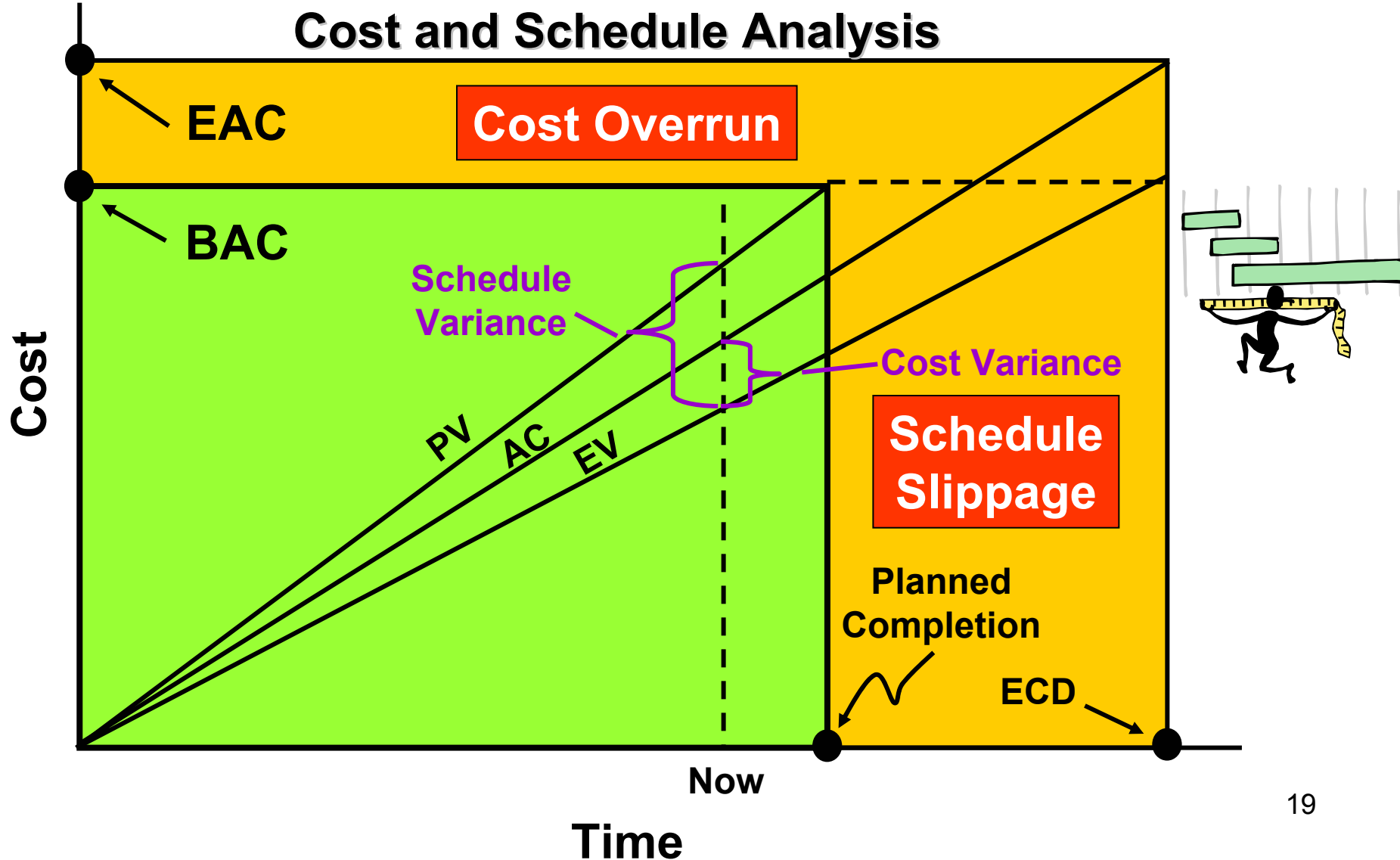
$$TCPI = (BAC - EV) / (BAC - AC)$$

- Performance to Achieve Estimated Cost

$$TCPI = (BAC - EV) / (EAC - AC)$$

where EAC is Estimate at Completion

Project Outcome Prediction



Prediction

- Independent Estimate at Completion (IEAC)
 - $IEAC_1 = BAC / CPI$
 - $IEAC_2 = AC + (BAC - EV) / PF$
 - where $PF = \text{Performance Factor}$
 - $BAC - EV = BCWR$
 - where $BCWR = \text{Budgeted Cost for Work Remaining}$
- Performance Factors
 - CPI
 - SPI
 - $wt1 * CPI + wt2 * SPI$, where $(wt1 + wt2 = 1)$
 - $CPI * SPI$
 - CPI_x , a moving average over x months

Anything Peculiar?

- Where are the predictors for schedule?
...None Exist
- Why? *...Experts believe EVM cannot be used to predict schedule*
...Schedule indicators exhibit erratic behavior
- Then Why is SPI Used in the PFs?
...Good question

Earned Value Management Limitations

EVM Limitations

- EVM is a wonderful management method
 - Uniquely connects cost, schedule, and requirements
 - Facilitates scientific approach to project management
 - Fosters project planning from historical performance
 - Provides project status described by numerical evidence

EVM Limitations

- However, EVM has deficiencies
 - Schedule indicators are flawed for late projects
 - **EVM practitioners pay attention to Cost and ignore Schedule data**
 - **Has caused EVM to be focused in financial management**
 - **Schedule management is segregated**
 - Indicators are not directly connected to deliverables ...or management action

Extensions to EVM

- **Earned Schedule** resolves schedule indicators flaw
- Concept of **Schedule Adherence** addresses connection to deliverables (*which is an extension of ES*)
- Development of **PM indicators** has evolved to improved management methods

Earned Schedule

So, what's the problem?

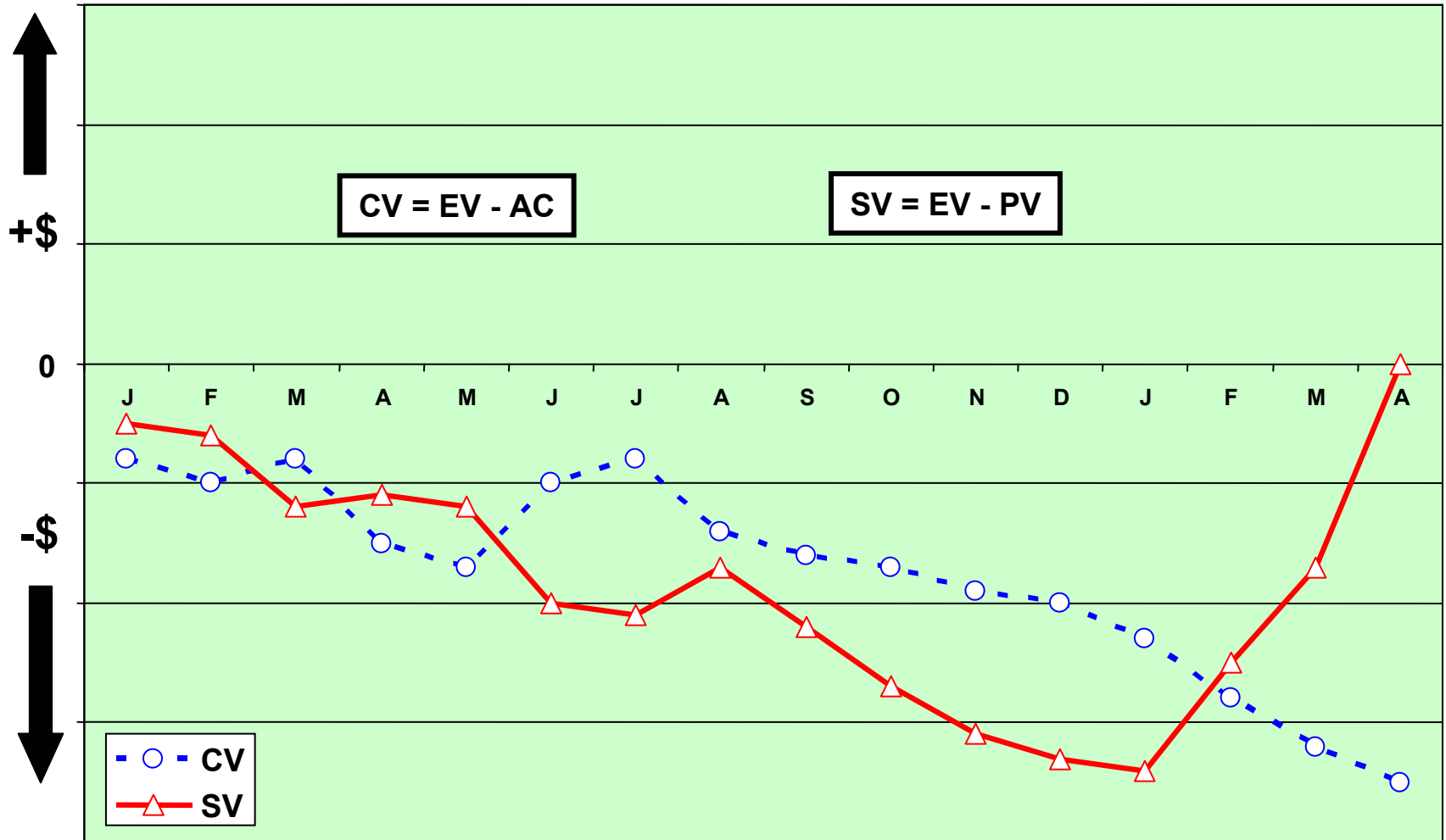
- Traditional schedule EVM metrics are good at beginning of project
 - Show schedule performance trends
- But the metrics don't reflect real schedule performance at end
 - Eventually, all “budget” will be earned as the work is completed, no matter how late you finish
 - SPI improves and ends up at 1.00 at end of project
 - SV improves and ends up at \$0 variance at end of project

So, what's the problem?

- Traditional schedule metrics lose predictive ability over the last third of the project
 - Impacts schedule predictions, EAC predictions
- **Project managers don't understand schedule performance in terms of budget**

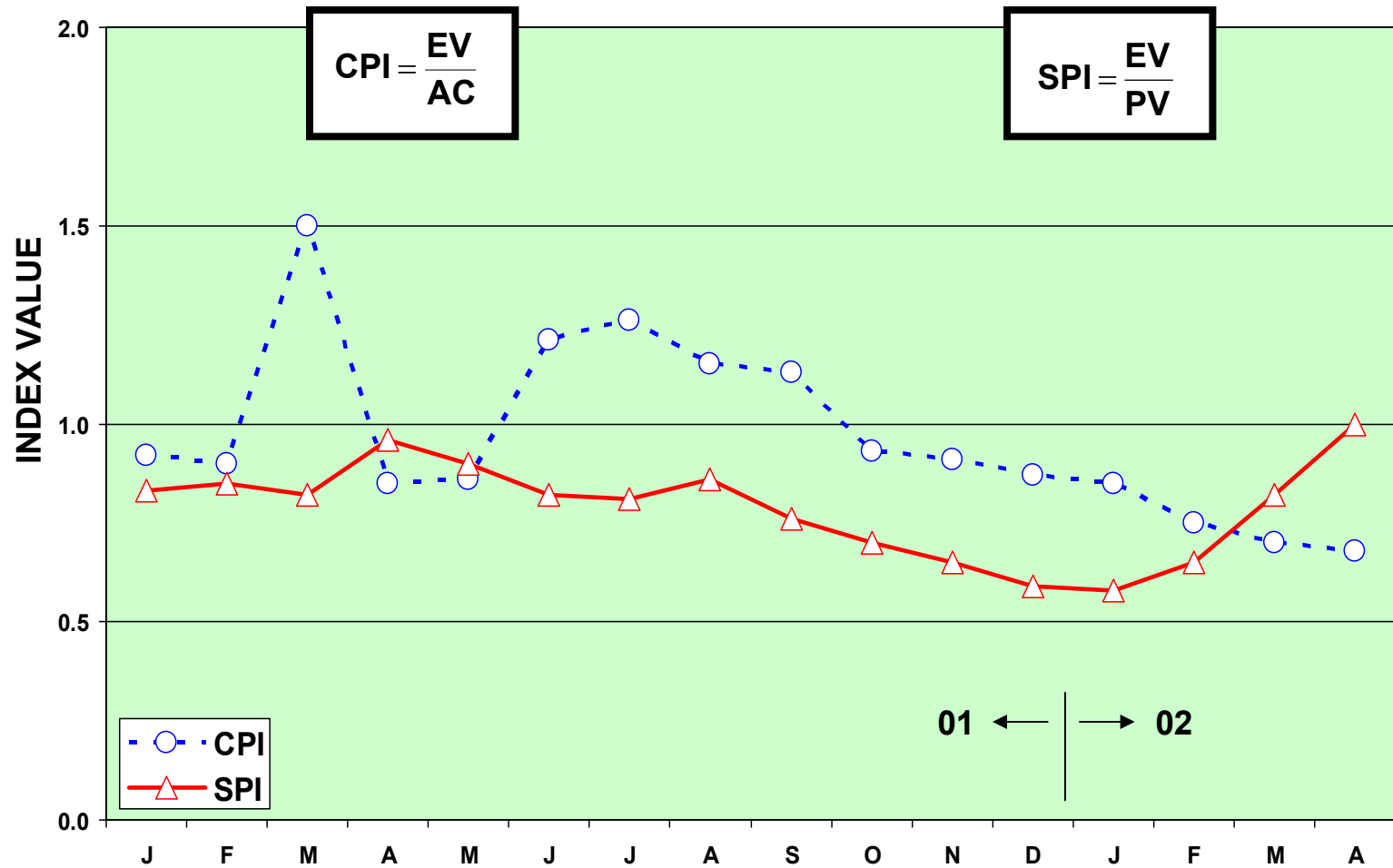
...Like most of us!

Cost and Schedule Variances



Note: Project completion was scheduled for Jan 02, but completed Apr 02.

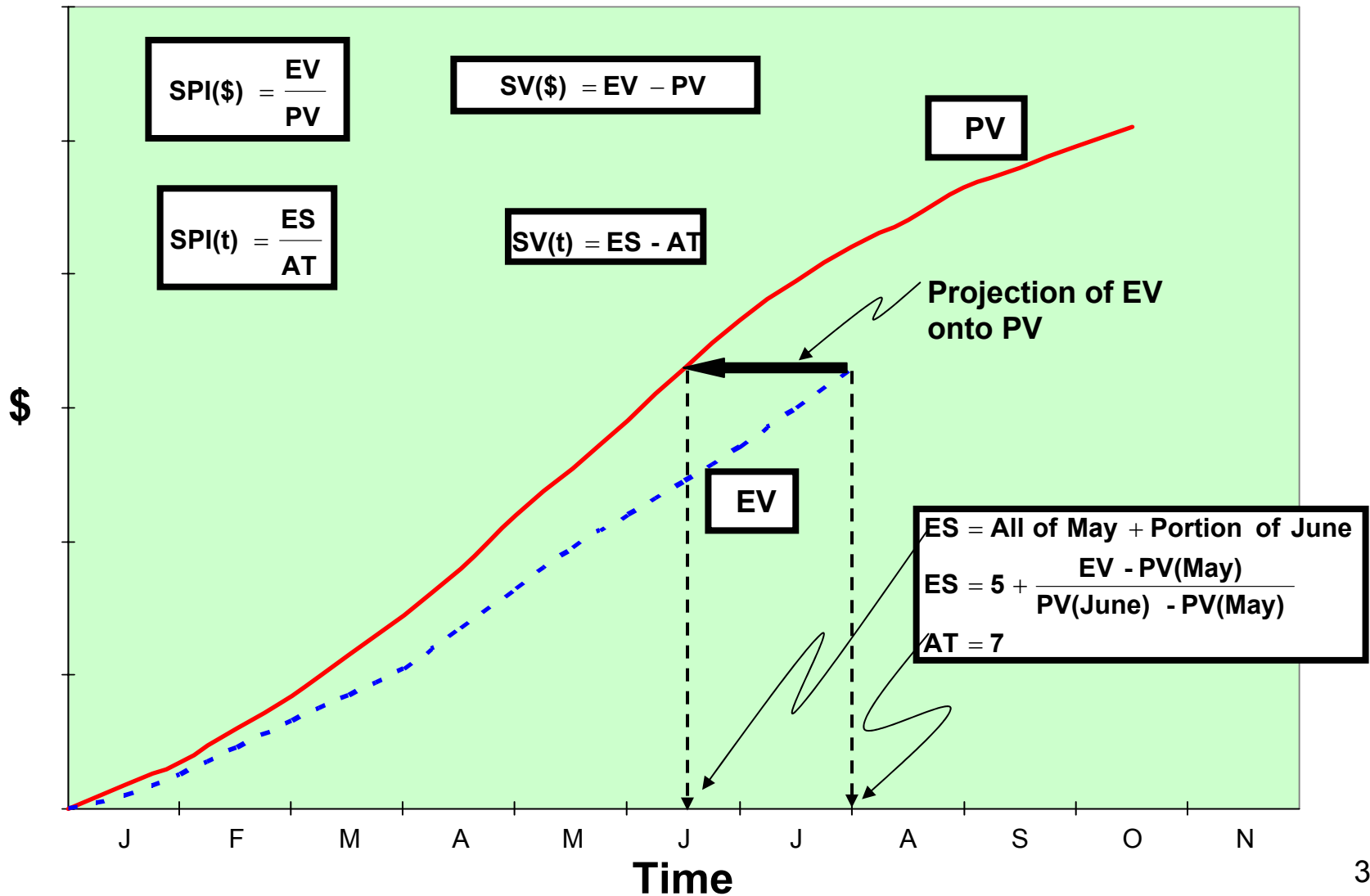
Cost and Schedule Performance Indices



Note: Project completion was scheduled for Jan 02, but completed Apr 02.

Earned Schedule Concept

Earned Schedule Concept



Earned Schedule: The Formulae

- ES_{cum} is the:

Number of completed PV time increments EV exceeds
+ the fraction of the incomplete PV increment

- $ES_{cum} = C + I$ where:

C = number of time increments for $EV \geq PV$

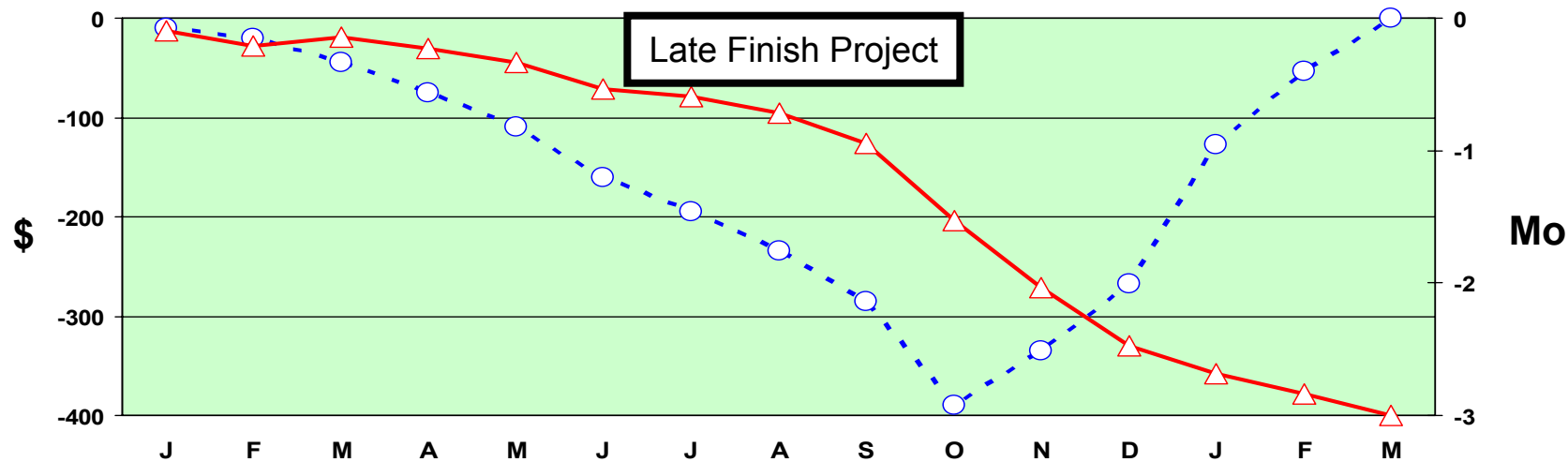
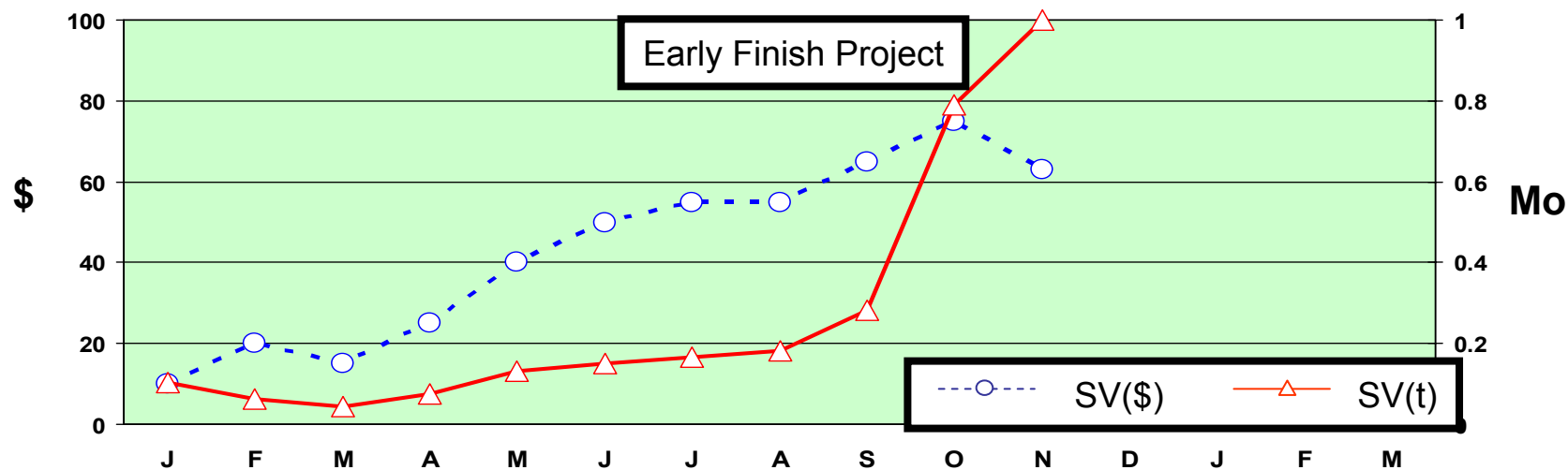
$$I = (EV - PV_C) / (PV_{C+1} - PV_C)$$

- $ES_{period}(n) = ES_{cum}(n) - ES_{cum}(n-1)$
 $= \Delta ES_{cum}$

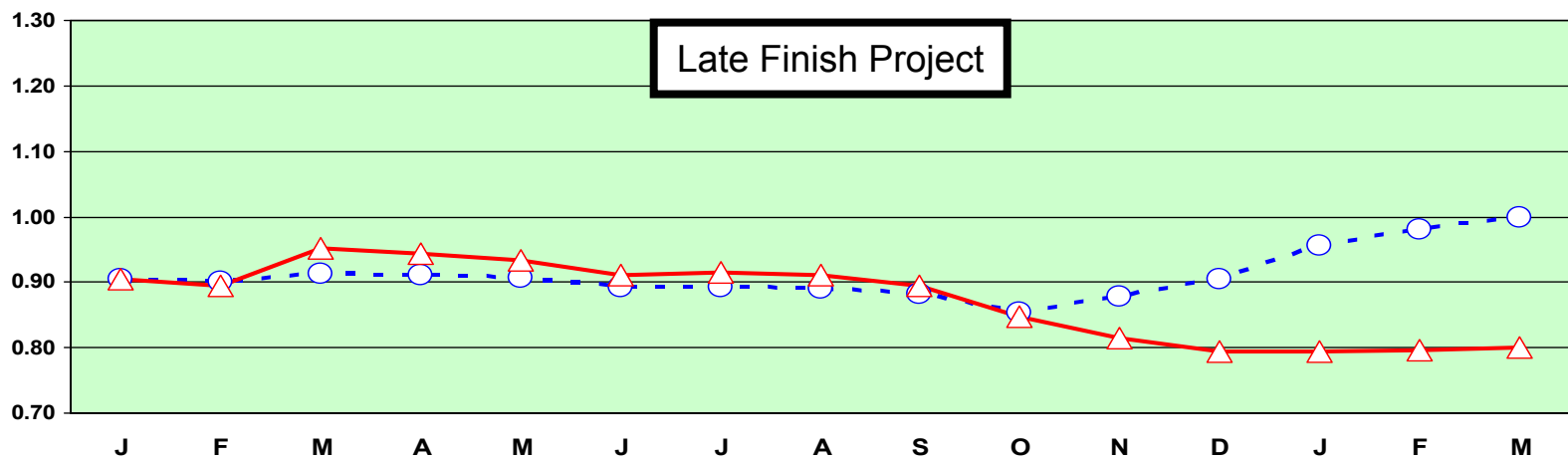
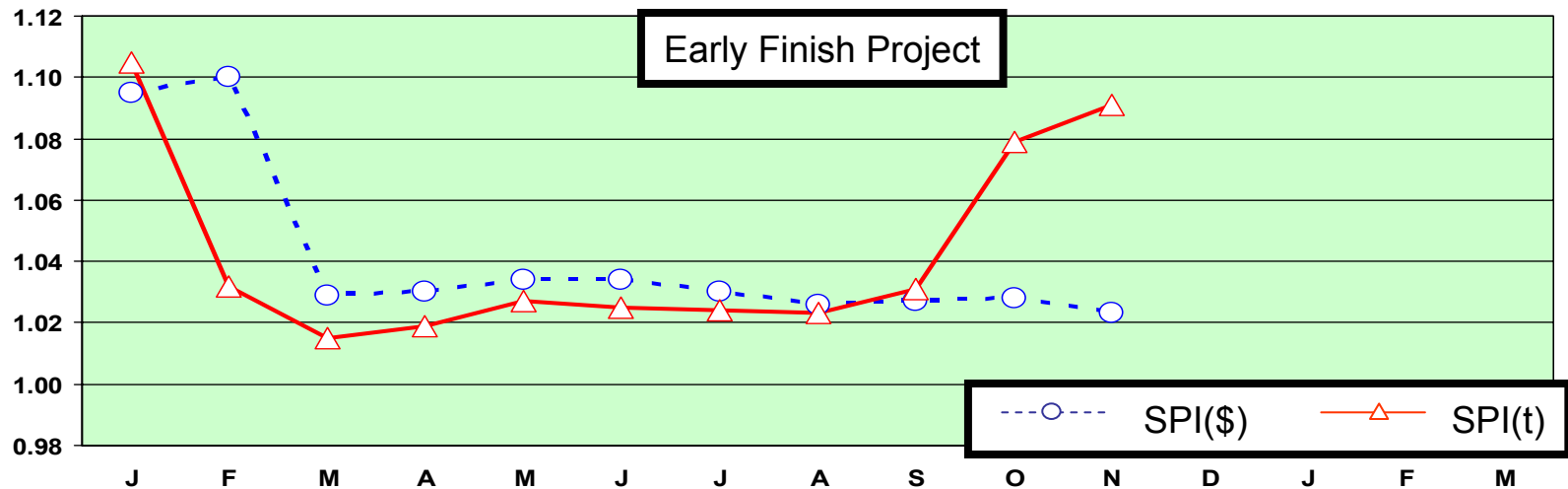
Earned Schedule: The Schedule Indicators

- Schedule Variance (time):
 - $SV(t) = ES_{cum} - AT_{cum}$
where AT = actual time
 - $SV(t)_{period} = \Delta ES_{cum} - \Delta AT_{cum}$
normally $\Delta AT_{cum} = 1$
- Schedule Performance Index (time):
 - $SPI(t) = ES_{cum} / AT_{cum}$
 - $SPI(t)_{period} = \Delta ES_{cum} / \Delta AT_{cum}$

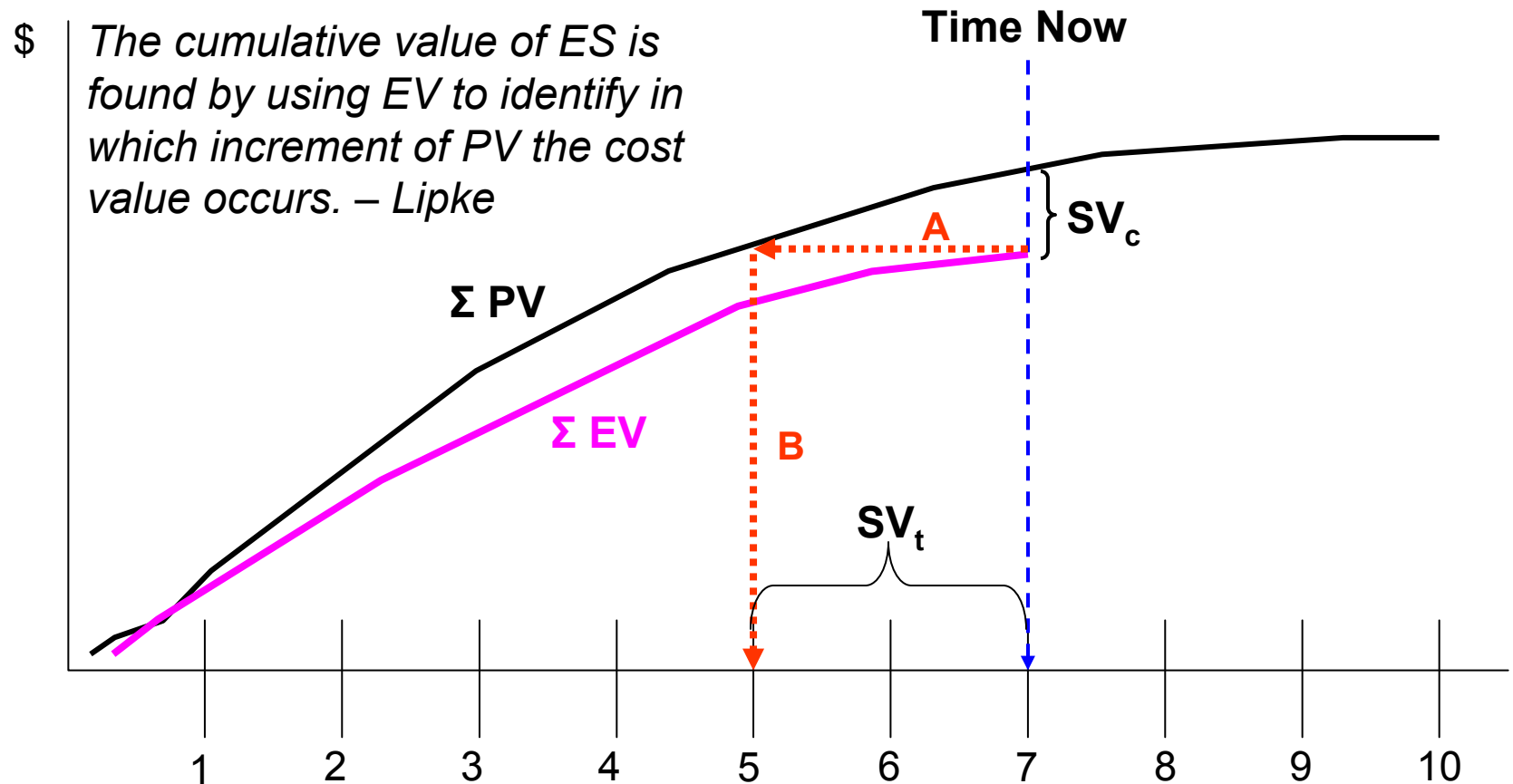
Schedule Variance Comparison



Schedule Performance Index Comparison



Earned Schedule : How it Works



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?

Schedule Analysis

Schedule Analysis with EVM?

- The general belief is EVM cannot be used to predict schedule duration
- Most practitioners analyze schedule from the bottom up using the networked schedule*"It is the only way possible."*
 - Analysis of the Schedule is overwhelming
 - Critical Path is used to shorten analysis
(CP is longest path of the schedule)
- Duration prediction using Earned Schedule provides a macro-method similar to the method for Cost – a significant advance in practice

Schedule Outcome

- Prediction of Project Schedule Outcome

- Trend of Periodic SV(t) and SPI(t) Values
- Performance to Achieve Planned Duration

To Complete Schedule Performance Index

$$TSPI = (PD - ES) / (PD - AT)$$

- Performance to Achieve Estimated Duration

$$TSPI = (PD - ES) / (ED - AT)$$

where ED is Estimated Duration

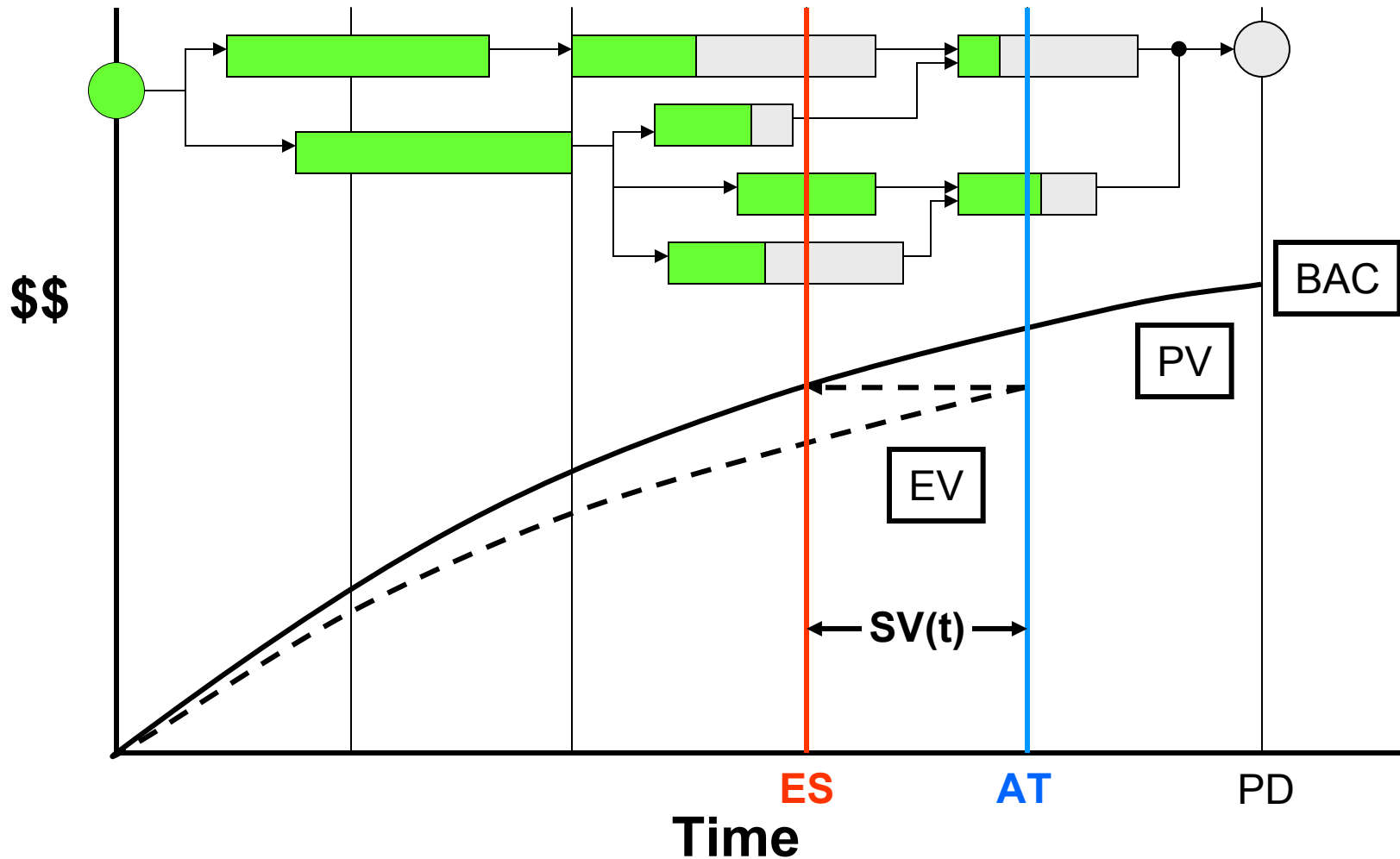
Schedule Prediction

- Independent Estimate at Completion (Time)
 - $IEAC_1(t) = PD / SPI(t)$
 - $IEAC_2(t) = AT + (PD - ES) / PF(t)$
 - where $PF(t) = \text{Performance Factor (Time)}$
 - $PD - ES = PDWR$
 - where $PDWR = \text{Planned Duration for Work Remaining}$
- Performance Factors ...??

And There is More ...

Earned Schedule

Bridges EVM to “Real” Schedule



How Can This Be Used?

- **Tasks behind** – possibility of impediments or constraints can be identified
- **Tasks ahead** – a likelihood of future rework can be identified
- The identification is independent from schedule efficiency
- **PMs can now have a schedule analysis tool connected to the EVM Data!!**

Earned Schedule Summary

Earned Schedule Summary

- Derived from EVM data ... only
- Provides time-based schedule indicators
- Indicators do not fail for late finish projects
- Application is scalable up/down, just as is EVM
- Schedule prediction is better than any other EVM method presently used
 - $SPI(t)$ behaves similarly to CPI
 - $IEAC(t) = PD / SPI(t)$ behaves similarly to $IEAC = BAC / CPI$
- **Facilitates bridging EVM to the schedule**

Earned Schedule References

- “Schedule is Different,” *The Measurable News*, March & Summer 2003 [Walt Lipke]
- “Earned Schedule: A Breakthrough Extension to Earned Value Theory? A Retrospective Analysis of Real Project Data,” *The Measurable News*, Summer 2003 [Kym Henderson]
- “Further Developments in Earned Schedule,” *The Measurable News*, Spring 2004 [Kym Henderson]
- “Connecting Earned Value to the Schedule,” *The Measurable News*, Winter 2004 [Walt Lipke]
- “Earned Schedule in Action”, *The Measurable News*, Spring 2005 [Kym Henderson]

<http://sydney.pmichapters-australia.org.au/>

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Earned Schedule Calculator

- Excel spreadsheet available upon request

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