IQPC IT Project Management Conference Sydney

Recent Advances in Project Prediction Techniques

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Outline

- Initial Observations and Questions
- EVM Basics
- Summary of 1990s Research Findings
- Earned Schedule
  - Project duration prediction using Earned Schedule
- Statistical Prediction
  - The next frontier to improving project prediction and performance
- Conclusion

Retrieved from: The Performance-Based Management Handbook http://www.orau.gov/pbm/pbmhandbook/Volume%202.pdf

Initial Observations

The concept of performance measurement is straightforward: you get what you measure; and can't manage a project unless you measure it.

From Performance-Based Management: Eight Steps to Develop and Use Information Technology Performance Measures Effectively (US) General Services Administration

The most common mistake organizations make is measuring too many variables. The next most common mistake is measuring too few.

Mark Graham Brown Keeping Score (1996)

All high-performance organizations whether public or private are, and must be, interested in developing and deploying effective performance measurement and performance management systems, since it is only through such systems that they can remain high-performance organizations.

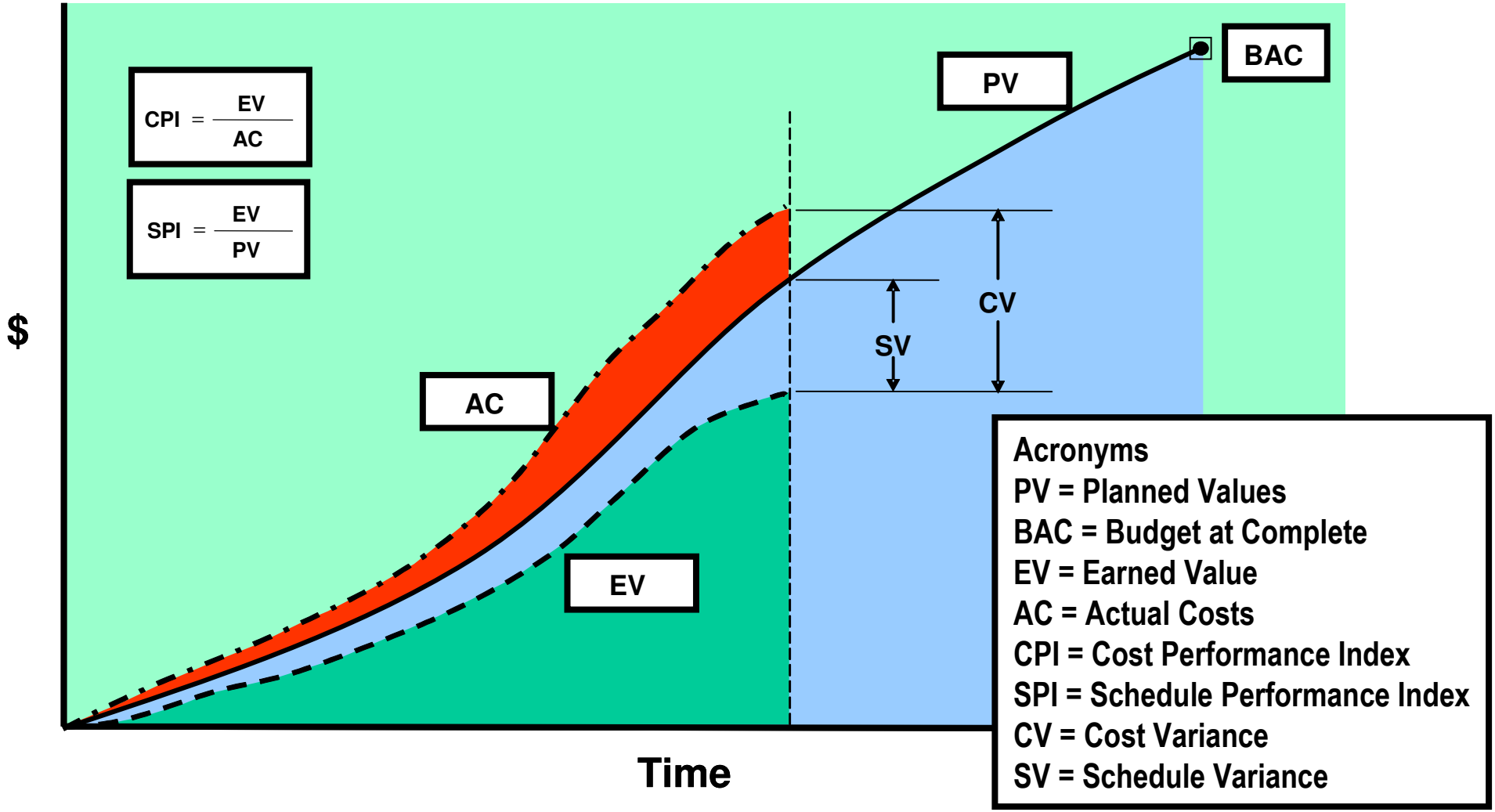
National Performance Review Serving the American Public: Best Practices in Performance Measurement (1997)

Questions

- How do we track and validate project progress to costs incurred and estimated costs at completion ?
  - Comparing Plan versus Actual Costs ?
  - Comparing Actual Cost to date to Total Approved Cost ?
  - “Burn rate” analysis ?
  - Bottoms-up re-estimates to complete ?
- How do we track and validate schedule progress and estimated completion dates ?
  - Critical path path analysis ?
  - Comparing actual progress to the baseline schedule ?

Are there improved techniques ?

EVM Basics



Predicting Project Completion Costs

- IEAC means **I**ndependent **E**stimate **A**t **C**omplete
  - EAC ***estimates*** based on a predictive approach

Actual Costs to date

What the project needs to achieve to complete The Budgeted Cost of Work Remaining

$$\text{IEAC} = \text{AC cum} + \frac{(\text{BAC} - \text{EV cum})}{\text{PF}}$$

A Performance Factor

Performance Factors: CPI, SPI or in combination

- If the PF is CPI the formula resolves to **BAC/CPI**

Source: The Earned Value Body of Knowledge (EV-BOK) (10/98) Quentin W. Fleming WWW.QuentinF.com
http://www.pmforum.org/library/papers/QuentinFlemingPUC02.ppt or http://www.suu.edu/faculty/christensend/Pmi99qf.pdf

Contracts at 15% complete point

(Gary Christle)

- **GIVEN:**
  1. *Overrun at completion will not be less than overrun to date.*
  2. *Percent overrun at completion will be greater than percent overrun to date.*
- **CONCLUSION:** *You can't recover!!*
- **WHO SAYS:** *More than ~~300~~ 700 major DOD contracts since 1977.*
- **WHY:** *If you underestimated the near, there is no hope that you did better on the far term planning.*

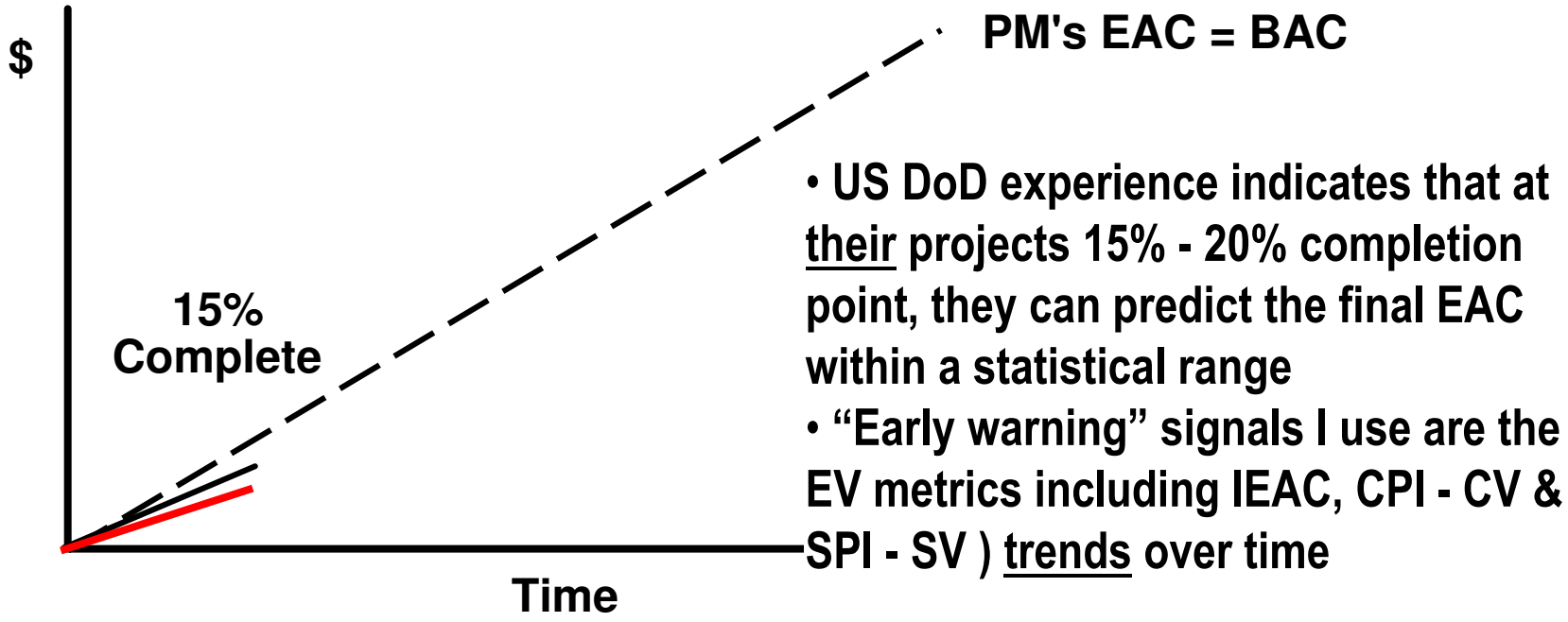
Source: The Earned Value Body of Knowledge (EV-BOK) (10/98) Quentin W. Fleming WWW.QuentinF.com
http://www.pmforum.org/library/papers/QuentinFlemingPUC02.ppt or http://www.suu.edu/faculty/christensend/Pmi99qf.pdf

Cost Risks Can Be Managed

(with an "early warning" signal)

A key benefit of Earned Value

Identifying cost risk early in the project life cycle allows for corrective action with most of the cost budget still intact ….



- US DoD experience indicates that at their projects 15% - 20% completion point, they can predict the final EAC within a statistical range
- "Early warning" signals I use are the EV metrics including IEAC, CPI - CV & SPI - SV) trends over time

Summary of 1990s EVM Research

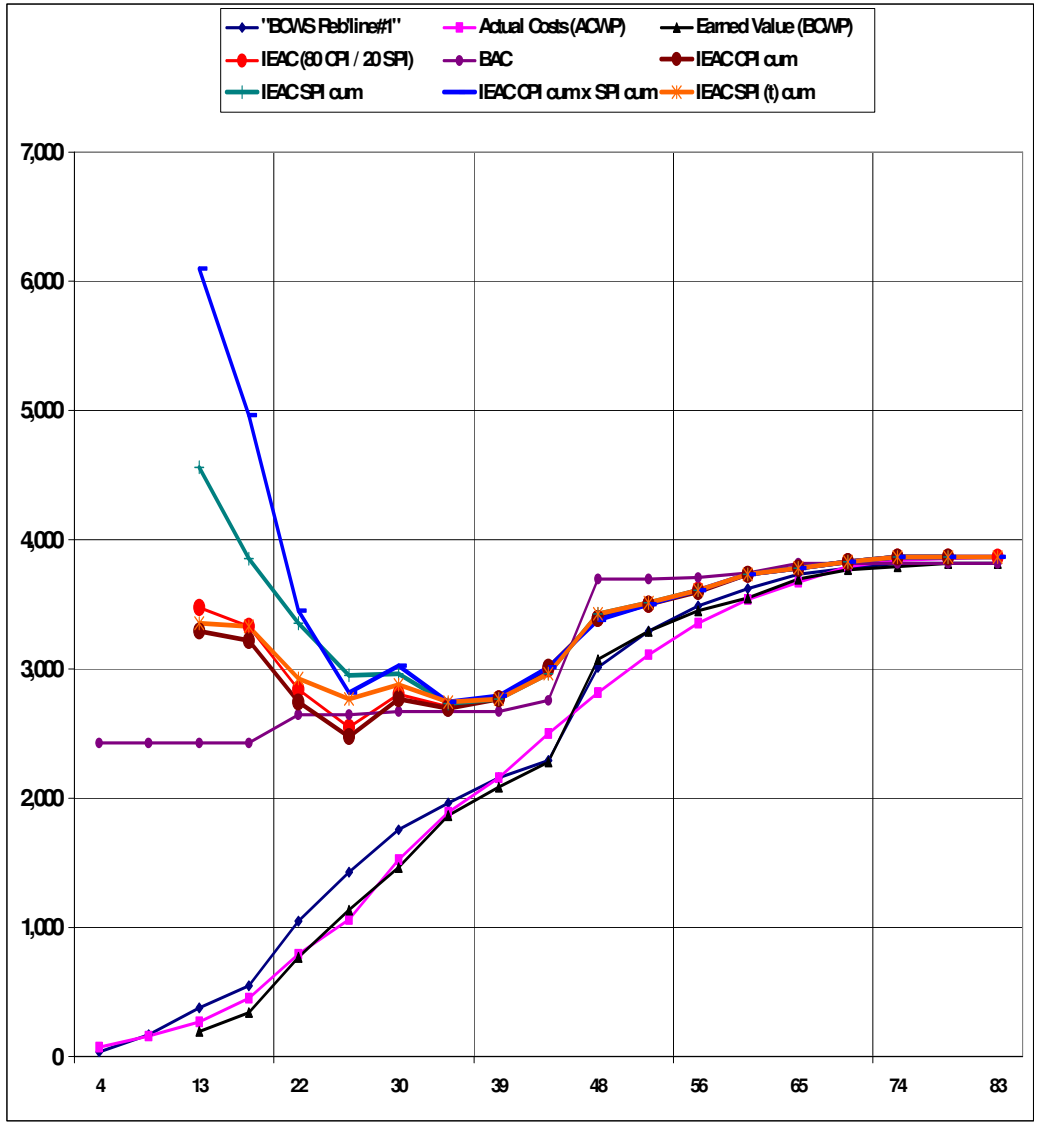
- Dr. David Christensen Ph.D. and associates
  - Using data from the US Defense Department - Defense Acquisition Executive Summary (DAES) database

1) CPI cum stabilises at the project 15-20% completion point
   - Stability means **+/- 10%** (usually minus) at project completion
2) IEAC using **CPI cum** provides the "floor" IEAC for the "statistical EAC range" for US DoD projects
3) IEAC using **CPI cum x SPI cum** often provides a "most likely" IEAC for the "statistical EAC range" for US DoD projects
4) CPI tends to worsen from 15-20% complete to completion

Source: Using The Earned Value Cost Management Report To Evaluate The Contractor's Estimate At Completion, David S. Christensen, Ph.D. Acquisition Review Quarterly—Summer 1999 http://www.dau.mil/pubs/arq/99arq/chrisevm.pdf or http://www.suu.edu/faculty/christensend/EVMReport.pdf
Source: Determining An Accurate Estimate At Completion, David S. Christensen, Ph.D. National Contract Management Journal 25:17-25 1993 http://www.suu.edu/faculty/christensend/eacncmj.pdf

The Current Approach to Project Cost Prediction

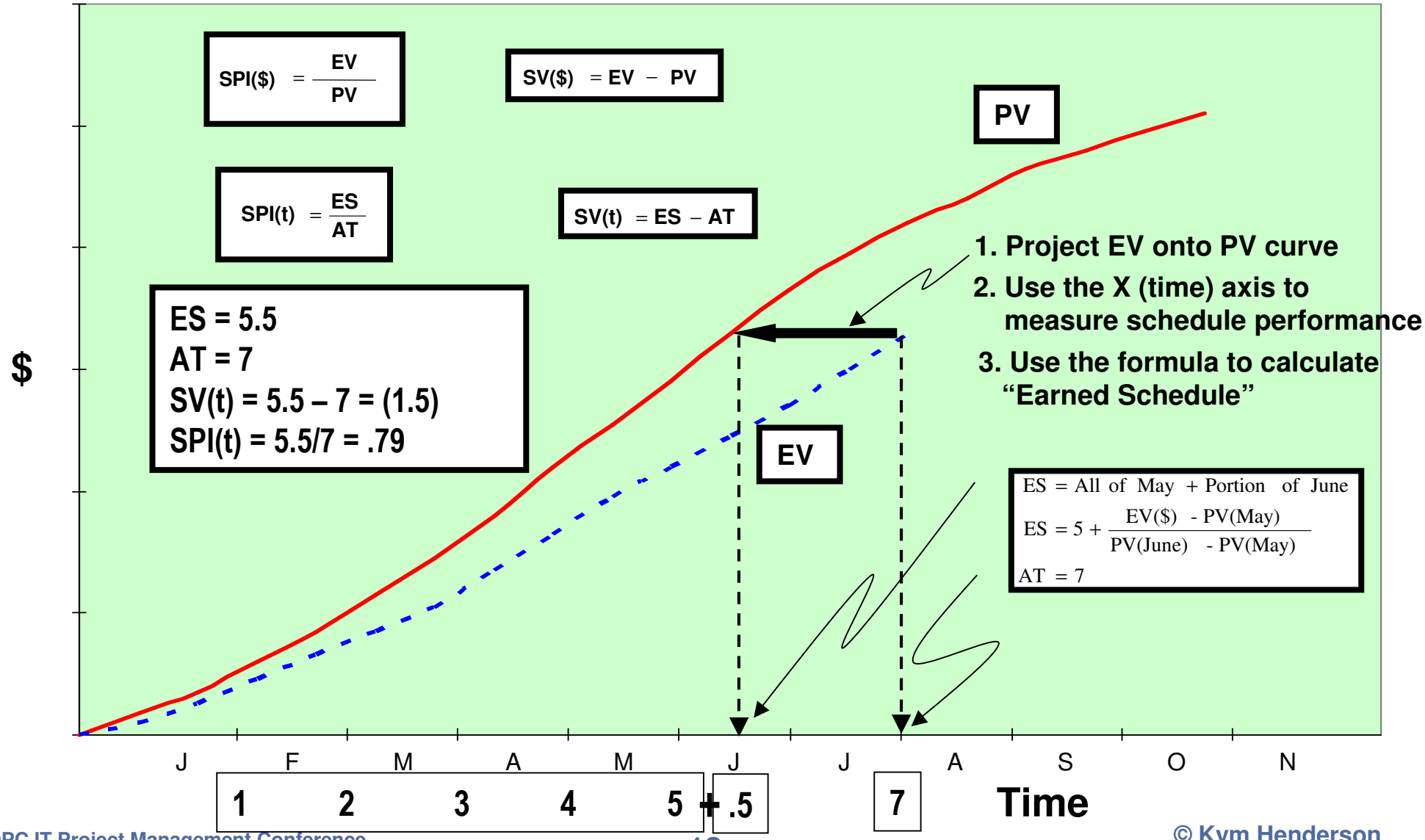
- Calculate a range of IEACs using CPI cum and SPI cum
  - Use to cross-check the bottoms up ETC and EAC
- Apply professional judgment
  - To assess the “reasonableness” of the bottoms up estimate
  - Remember
    - US DoD research indicates IEAC CPI cum is the “best case” estimate
    - CPI cum tends to worsen (by 10%) from 15-20% complete to completion
  - The predicted estimates are still estimates
    - At least consider (or factor) in risk and the risk of the unforeseen



What About Schedule Duration Prediction ?

- **Not possible using the Earned Value SPI**
  - SPI($) will **always** equal **unity** at project completion
    - Irrespective of actual project duration issues; i.e. **Late finish**
- **Why ?**
  - At completion Earned Value will always equal Planned Value at completion (the BAC) because
    - **Earned Value** is calculated by reference to **Planned Value**
    - (BAC if being derived from Percentage Completion)
      - If BAC equals **$100** and the project is 100% complete
      - Earned Value = $100 x 100% = **$100**
      - **SPI($) = $100/$100 = 1**
  - A “quirk of algebra” due to the SPI calculation method

Earned Schedule: The Concept
Seminal paper published in 2003



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 $EV \geq PV$

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

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

Earned Schedule: The Schedule Indicators

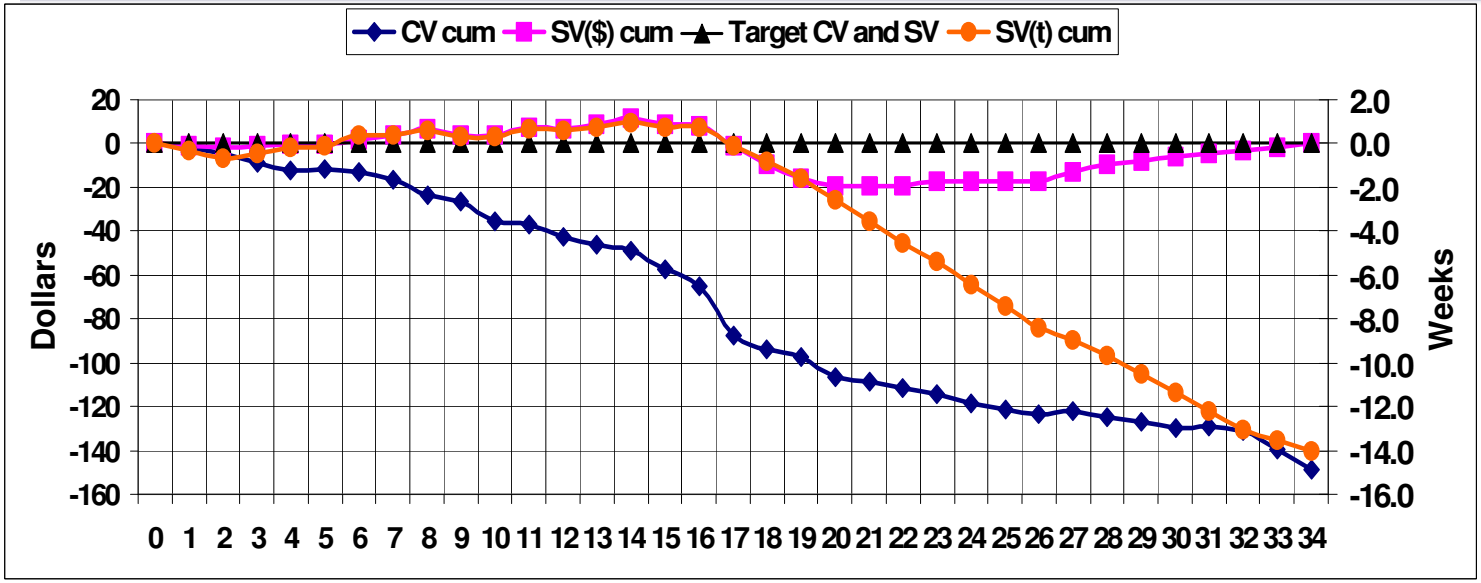
- The Earned Schedule Indicators
  - Schedule Variance (time):

    SV(t) = ES – AT, where AT = actual time
  - Schedule Performance Index (time):

    SPI(t) = ES / AT
- Key Points:
  - ES Indicators constructed to behave in an analogous manner to the EVM Cost Indicators, CV and CPI
  - SV(t) and SPI(t) not constrained by PV calculation reference
    - Calculated by reference to “Actual Time”
  - SV(t) and SPI(t) provide duration based measures of schedule performance

Earned Schedule Research Using Real Projects Data

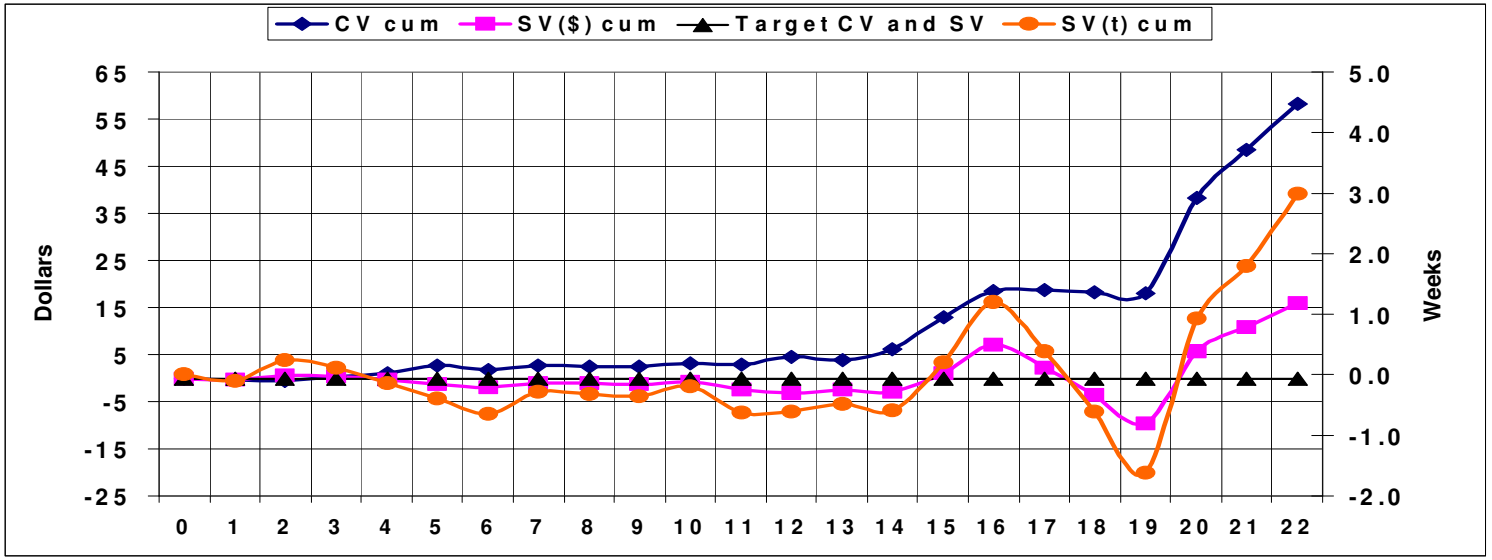
Confirms the ES metrics behave correctly for Late and Early Finish projects



Late Finish project

SV(t): -14 weeks ✓

SV($): $0 ?



Early Finish project

SV(t): +3 weeks ✓

SV($): $16K ?

(Trends to $0 at Planned Completion!)

Benefits of Earned Schedule

- Time based indicators of schedule performance
  - Using EVM data
- Predictor of project duration
  - Independent of the project network schedule
- Is facilitating the development of
  - "Bridging analytical techniques between EVM data and the network schedule
  - Very advanced quantitative project management techniques
    - Risk planning and outcome prediction for schedule and cost
- **NO ADDITIONAL EVM DATA COLLECTION REQUIRED**
  - Actual Costs are not required for Earned Schedule

Other Benefits of Earned Schedule:
Independent Estimates at Completion (time) and Completion Date

- Calculation of Independent Estimate of Completion (time)

  IEAC(t) = Planned Duration / SPI(t)

- Independent Estimate of Completion Date (IECD)

  IECD = Project Start Date + IEAC(t)

- Behaviour of IEAC(t) and IECD is analogous to the EVM cost equivalent, the Independent Estimate at Compete (IEAC)

- Potential Benefits
  - Sanity checking “real schedule” measures
  - Detection of schedule performance trends over time

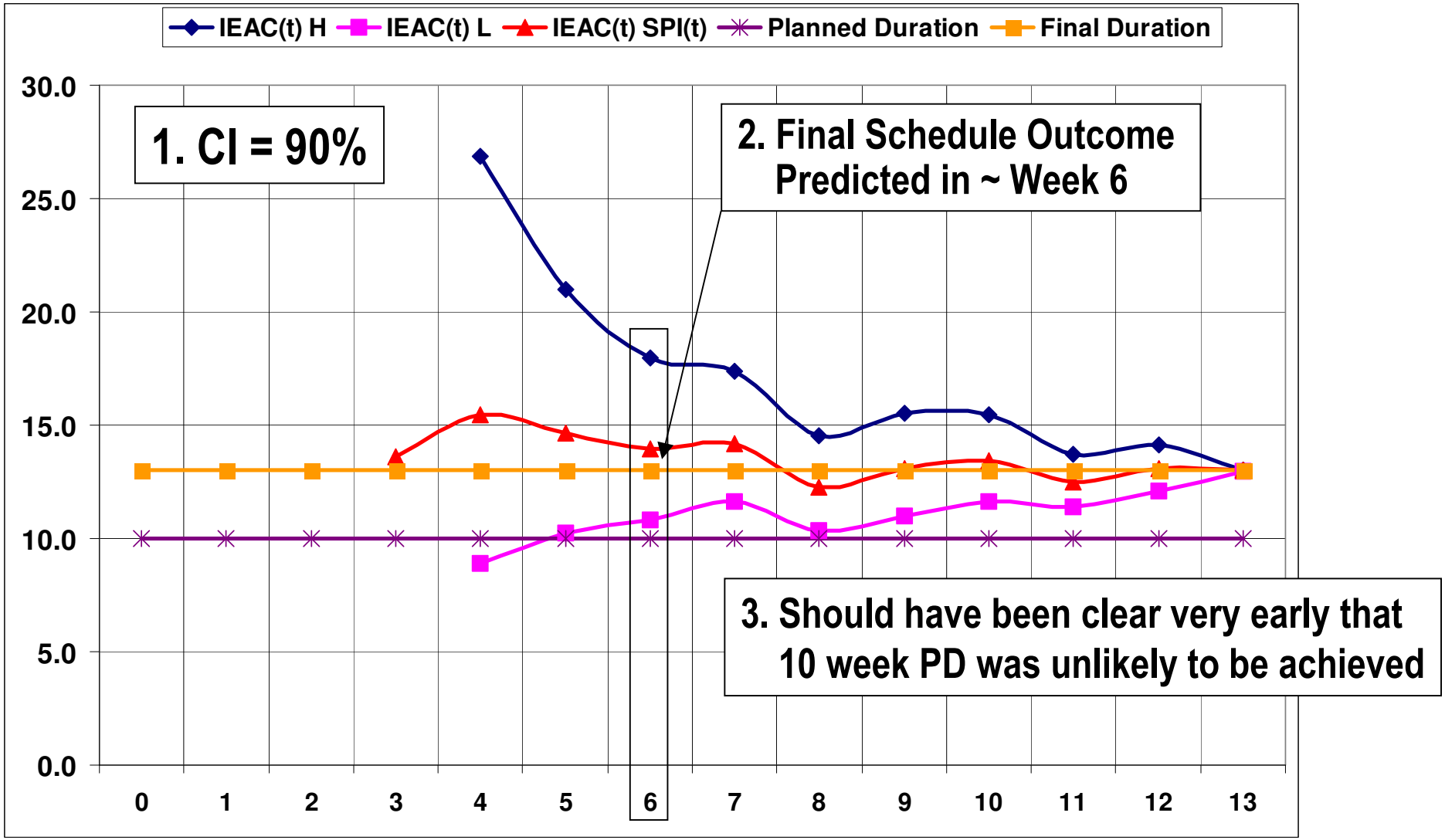
Cost and Schedule Prediction using Statistical Methods
The Next Frontier

- What's Needed?
  - Performance Measurement Baseline "S Curve" Data
    - Provides Planned Cost and Planned Duration information
  - Normalised Performance Factors
    - Log of SPI(t) for Duration and Log of CPI for Cost
      - Research confirms CPI is not normally distributed
  - Standard Deviation(s)
    - Calculated from the periodic logarithmic values of SPI(t) and CPI to date
  - Confidence Limit or Confidence Interval
    - User Definable based on project context
      - 90% CL, 95% CL, 98% CL, 99% CL, 6Sigma …..
      - Higher Confidence Limit provides more "safety"
      - The trade-off is higher Limits may initially overstate the final actual outcomes
  - Actual project performance data
    - Actual Costs and Earned Value

Cost and Schedule Prediction using Statistical Methods
The Next Frontier

- **Don't get scared of the statistical "stuff"**
  - Performance Measurement Baseline "S Curve" Data
  - Actual project performance data
    - Actual Costs and Earned Value
  - **Should already be available**
    - **(EV can be calculated from Percentage Complete)**
- The statistical "stuff" is either calculated
  - Normalised Performance Factors
    - Log of SPI(t) for Duration and Log of CPI for Cost
  - Standard Deviation(s)
    - Calculated from periodic logarithmic values of SPI(t) for Duration and CPI for Cost
- Or user defined
  - Confidence Limit or Confidence Interval

Retrospective Real Project Example
Schedule Duration Prediction for a Time Critical Project



Why Bother?

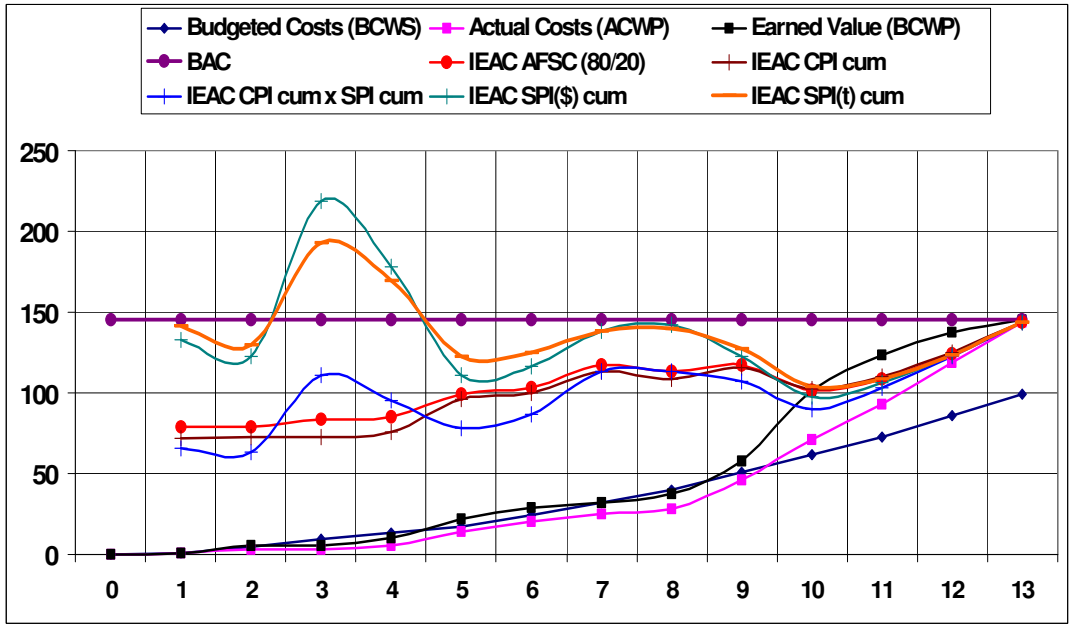
- Earlier prediction of final project cost and duration during project execution

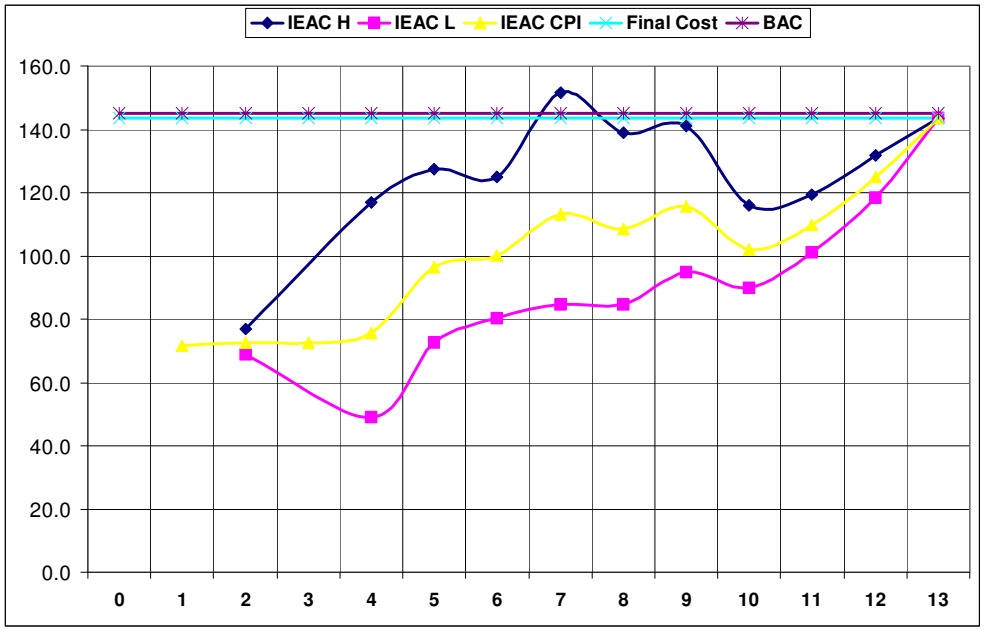
- Facilitates early warning for either:
  - Corrective action with most of the cost budget and schedule still intact; or
  - Contingency planning based on the projected outcomes

Why Bother?

- Can also be used to **prospectively** calculate cost and schedule contingencies at project proposal / tender phase
- What's important ?
  - Achieving cost and schedule outcomes
    - Increase the Confidence Limit
      - from 90% to 95% to 98 % to 99% to 6Sigma
    - The trade-off is "competitiveness"
  - "Winning the business"
    - Reduce the Confidence Limit ….
    - But this increases the risk of the desired outcome(s) not being achieved
  - **Allows for an objective calculation and quantification of the risk – reward trade-off**

Other Benefits





- Simplifies the analysis of cost prediction(s) compared to current practice
- Allows user definable Confidence Limits to be set
  - Similar to SPC Control Limits
- In conjunction with “Earned Schedule”
  - Similar predictive capability and analysis is available for Project Duration

Anbari, Frank T, Phd, Earned Value Project Management Method and Extensions, Project Management Journal Volume 34, Number 4, December 2003, Project Management Institute

The Benefits of Predictive Utility

- Anbari provides a pertinent observation with respect to project forecasting techniques:

> **Forecasting in project management may well be a self-defeating prophecy, and that may be good for the organization. Large deviations usually attract management's attention and result in corrective action. Small deviations are usually left alone. By quantifying and highlighting such deviations, EVM [and ES] helps focus management's interest on projects or work packages that need the most attention**

- In project management we are not seeking "perfect prediction"
  - **We seek early warning signals to enable proactive corrective action**

Sarbanes-Oxley: Does Compliance Require Earned Value Management on Projects? Quentin W. Fleming & Joel Koppelman (Contract Management, April 2004) http://www.quentinf.com/CM_Apr04_p26.pdf

Another Benefit of Predictive Utility

- It is argued that the IEAC costs predictors especially have an important role in validating the accounting provisions for future project costs
  - Particularly for major capital investment projects

This new duty, required by Sarbanes Oxley, in the opinion of the authors, will include the use of all proven and reliable project management techniques, including and perhaps in particular the use of earned value project management.

If EVM is so Good...Why Isn't it used on all Projects?", **Quentin W. Fleming & Joel Koppelman (The Measurable News Spring 2004). Retrievable (PMI-CPM members area) from:** http://www.pmi-cpm.org/members/downloads/measnews/MN2004_spring/0403.fleming-koppelman.pdf

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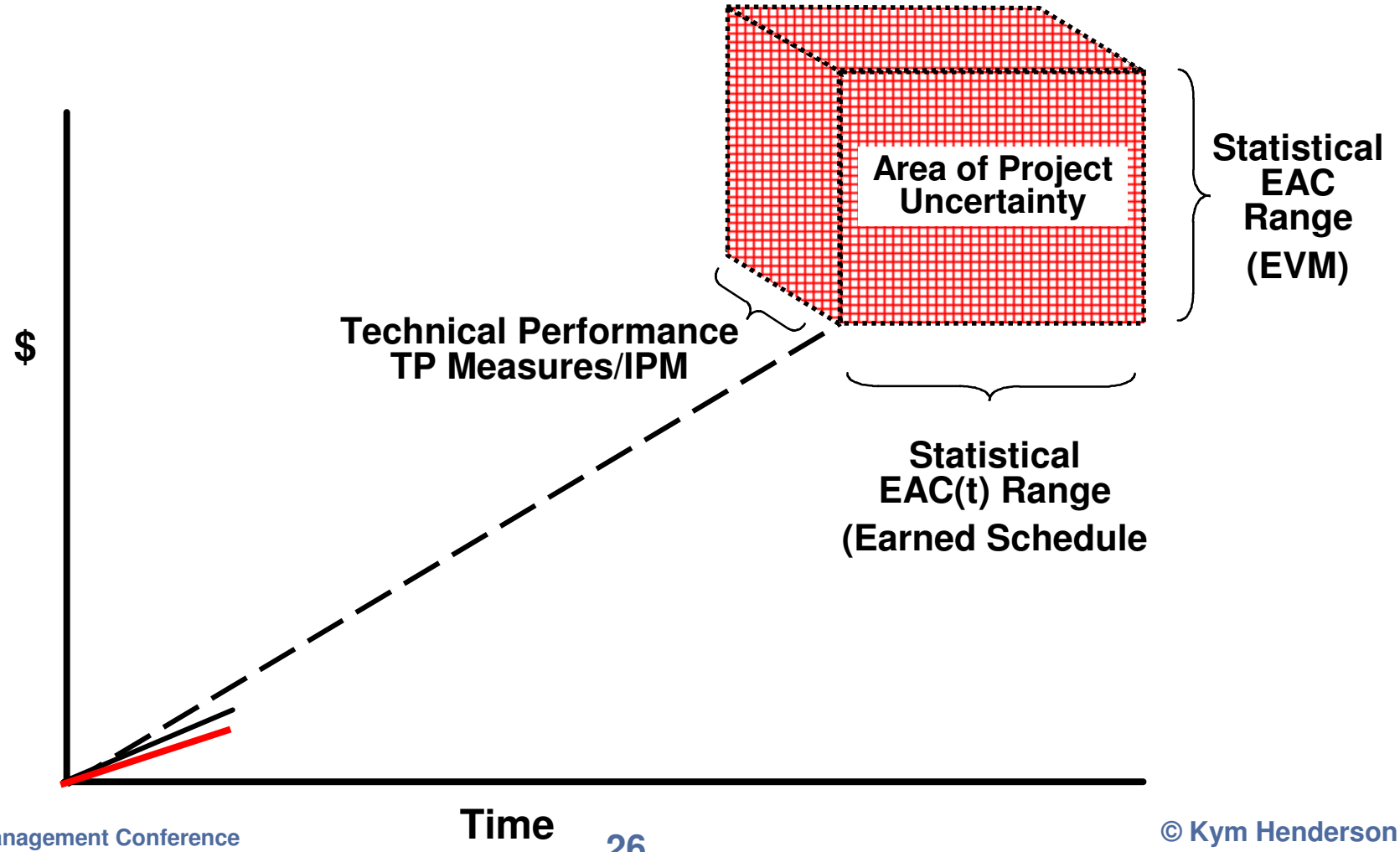
http://www.pmforum.org/library/papers/QuentinFlemingPUC02.ppt or http://www.suu.edu/faculty/christensend/Pmi99qf.pdf

Earned Value, Earned Schedule & TPM

An integrated solution for managing project uncertainty



Conclusions

- Improving projects performance within a portfolio is difficult but possible
- The **starting position** for improved project performance is having **quantitative project performance measures** in place
  - Quantitative performance measure are NOT “Planned” and “Actual” Costs
- The hard part is getting to the **starting position**
- Once the starting position is achieved
  - The follow-on improvements are relatively straightforward
- The benefits which can be derived are extremely significant
  - For project managers, their teams and all project stakeholders

Available Resources

http://www.earnedschedule.com or
http://sydney.pmichapters-australia.org.au/
Click "Education," then "Presentations and Papers" for .pdf copies

ES Calculator & Analysis Tools

- **Freely provided upon email request**
  - Application assistance if needed
- **Please respect Copyright**
- **Feedback requested**
  - Improvement / Enhancement suggestions
  - Your assessment of value to Project Managers
  - Disclosure of application and results (with organization permission)

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