Does Project Performance Stability Exist? A Re-examination of CPI and Examination of SPI(t) Stability

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Kym Henderson

Vice President Research and Standards
PMI College of Performance Management *

Kym.Henderson@froggy.com.au

* The contents of this presentation are the presenter's personal views and conclusions which do not reflect an endorsed position of the PMI-CPM.
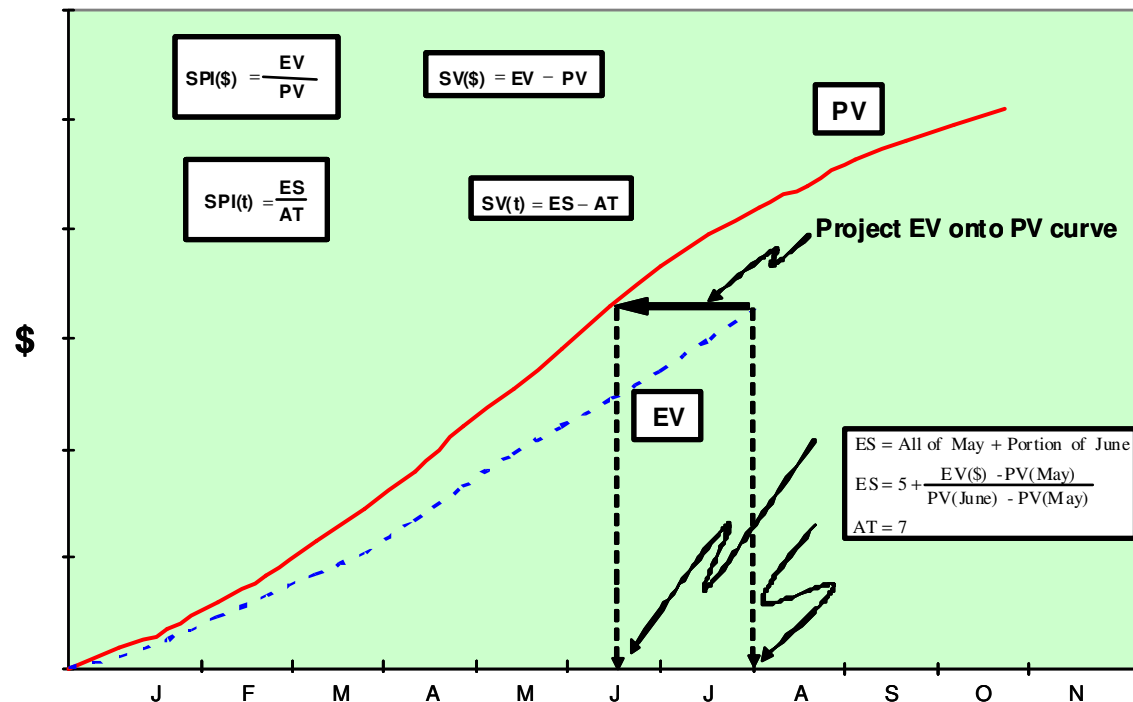
Summary of Research Post A-12 Cancellation

- ◆ Research by Dr. David Christensen and associates
  - ● CPI cum (CPI) stabilises by 20% of project completion
  - ● Stability usually defined to mean CPI at completion does not change by more than +/- .10 from CPI $_{20\%}$
    - – Initial stability research published in 1992 using data from 26 completed Air Force programs from USAF Systems Command Aeronautical Systems
    - – Subsequent research used program data from US DoD DAES database (Christensen & Heise: 1993)

- ◆ CPI stability findings since generalised as being universally applicable "to all projects using Earned Value"
  - ● Fleming and Koppelmann

Earned Schedule Brief Summary
Concept developed by Lipke in 2003

- <u>Time</u> based schedule performance metrics using EVM data
  - SV(t) and SPI(t) behaviour analogous to the EVM cost metrics
- ES metrics do not fail – work for early and late finish projects
  - Revert to zero/unity at completion only if on time schedule performance ACTUALLY achieved

$$SPI(\$) = \frac{EV}{PV}$$

$$SV(\$) = EV - PV$$

$$SPI(t) = \frac{ES}{AT}$$

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

PV

Project EV onto PV curve

EV

$$ES = \text{All of May} + \text{Portion of June}$$

$$ES = 5 + \frac{EV(\$) - PV(May)}{PV(June) - PV(May)}$$

$$AT = 7$$

$ J \quad F \quad M \quad A \quad M \quad J \quad J \quad A \quad S \quad O \quad N $

The Research Project

- Aim:
  - Re-examine CPI stability and
  - Compare the stability behavior of SPI(t) with CPI to ascertain whether SPI(t) exhibited similar stability characteristics to those extensively reported for CPI
- The Data:
  - 3 disparate commercial sector EVM data samples utilized

Source	CPI Sample	SPI(t) Sample
UK Construction	10	20
Israeli Hi Tech	12	12
Australian IT	4	5
Composite	26	37

  - The data was "scrubbed" – Re-baselined projects were excluded

The Results

◆ **Formal hypothesis testing**

  ● **Sign Test at 0.05 level of significance**

    "none of the null hypotheses can be rejected, for any of the three samples as well as the composite of all samples.
    This means that stability was not achieved for either CPI or the SPI(t) by the time the project was 20 percent complete."

	CPI Stability		SPI(t) Stability	
	Test Statistic	Test Result	Test Statistic	Test Result
UK Construction	0.623	Ho	0.748	Ho
Australian IT	1.000	Ho	0.500	Ho
Israeli Hi-Tech	0.806	Ho	0.613	Ho
Composite	0.916	Ho	0.629	Ho

Table 1: *Hypothesis Test Results*

◆ **Summary of Raw Data**

Stability Achieved		UK Construction	Australian IT	Israeli Hi-Tech	Composite
SPI(t) cum.	≤ 20%	3	0	1	4
> 20%		17	5	11	33
CPI cum.	≤ 20%	?	0	1	3
> 20%		0	4	11	23

Table 2: *Summary of Stability Achievement Related to 20 Percent Completion*

The (Lack of) CPI Stability Corroboration

- ◆ NAVAIR research by Michael Popp, mid 1990s
  - Data from same source used by Christensen
    - Known thanks to correction to paper by Mr. Wayne Abba
  - Popp sought to determine
    - "Given a program has a CPI of X and a percent complete of Y, what is the most likely finishing CPI"?
- ◆ Popp did **<u>not</u>** focus on CPI stability
  - But plotted relationships between CPI cum <u>Final</u> and CPI cum <u>Current</u> in each 10 percentile band
- ◆ Popp report now in public domain (with permission)
  - PMI Sydney Chapter website

The Correlation Plot: CPI <u>Final</u> and CPI <u>10-20%</u>

All

CORRELATION BETWEEN CUMULATIVE CPI
AT 10-20% COMPLETE AND FINAL CPI

FNLCPI.XLS   Chart 10-20
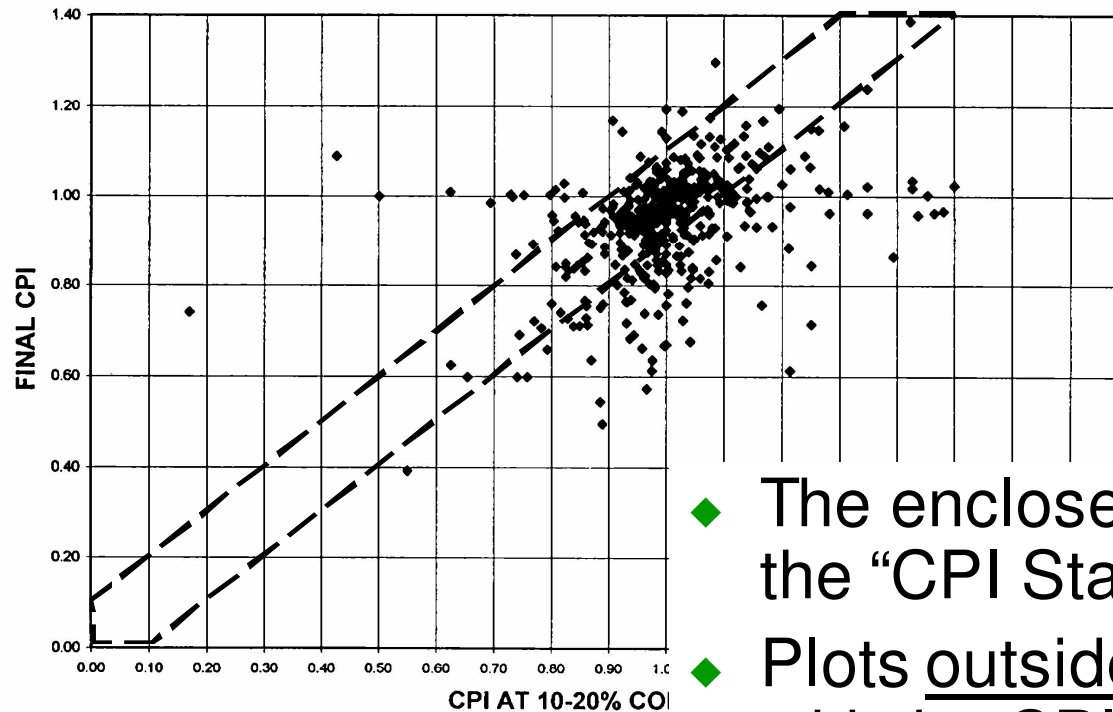
- ◆ The enclosed area bounds where the "CPI Stability rule" applies
- ◆ Plots <u>outside</u> bound area **conflict** with the CPI Stability rule

9/19/96

Additional Analysis
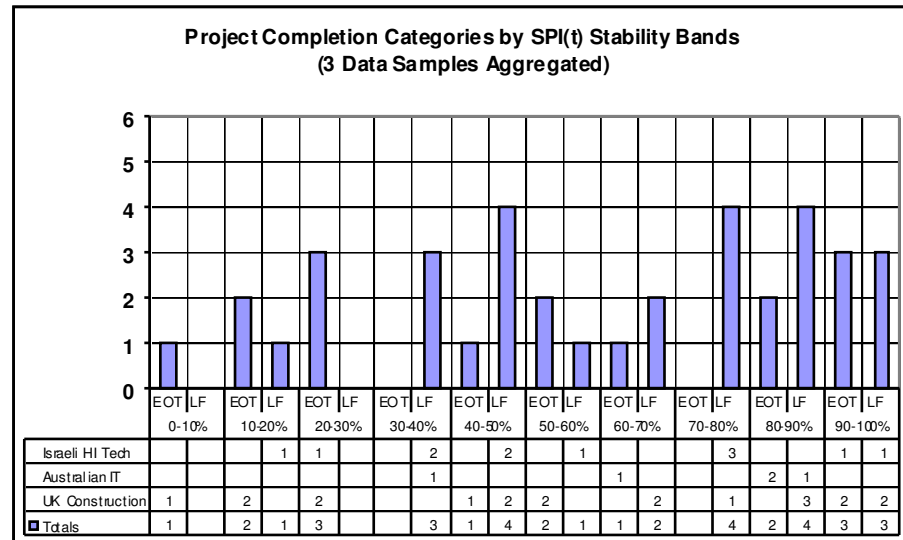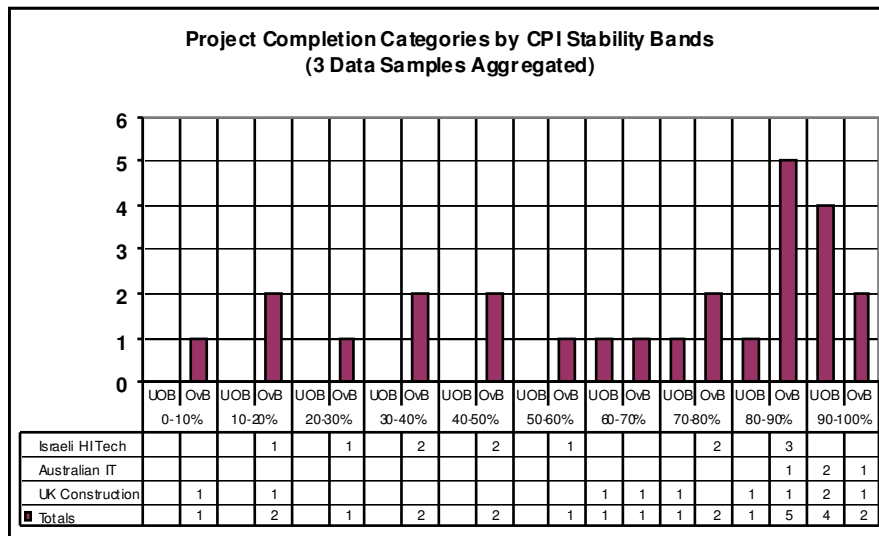
- Commercial sector data
  - Within each 10% complete percentile band projects were categorized as follows:
- Cost at completion:
  - Under or On Budget (UOB)
  - Over Budget (OvB).
- Schedule at completion:
  - Early or On Time finish (EOT)
  - Late Finish (LF).
- Purpose:
  - To determine whether achieving earlier stability correlated to improved cost and schedule outcomes at completion

The Results

- "… achievement of earlier stability is not correlated with improved final cost and/or schedule outcomes"

- For UOB and EOT projects where cost and schedule stability was achieved late … achieving earlier stability would have been disadvantageous … to the final outcome(s) … **because project performance progressively improved over the life of those projects.**

Project Completion Categories by CPI Stability Bands
(3 Data Samples Aggregated)

	UOB OvB 0-10%		UOB OvB 10-20%		UOB OvB 20-30%		UOB OvB 30-40%		UOB OvB 40-50%		UOB OvB 50-60%		UOB OvB 60-70%		UOB OvB 70-80%		UOB OvB 80-90%		UOB OvB 90-100%	
Israeli HI Tech				1		1		2		2		1				2		3		
Australian IT																		1	2	1
UK Construction	1			1									1	1	1		1	1	2	1
Totals	1			2		1		2		2		1	1	1	1	2	1	5	4	2

Project Completion Categories by SPI(t) Stability Bands
(3 Data Samples Aggregated)

	EOT LF 0-10%		EOT LF 10-20%		EOT LF 20-30%		EOT LF 30-40%		EOT LF 40-50%		EOT LF 50-60%		EOT LF 60-70%		EOT LF 70-80%		EOT LF 80-90%		EOT LF 90-100%	
Israeli HI Tech				1	1			2		2		1				3			1	1
Australian IT								1					1					2	1	
UK Construction	1		2		2			1	2	2				2		1		3	2	2
Totals	1		2	1	3			3	1	4	2	1	1	2		4	2	4	3	3

The Conclusions

- The widely reported CPI stability rule cannot be generalized to "all projects using Earned Value"
  - Claiming the rule had <u>unqualified</u> universal applicability to "all projects using Earned Value" an unfortunate overstatement
- CPI stability rule cannot be generalized even within US DoD
- Based on commercial sector EVM data analysis
  - **Achieving early stability is not necessarily "good"**
  - **Achieving late stability is not necessarily "bad"**
- Where projects have not exhibited "CPI stability"
  - EVM practitioners can now know that this is neither unique,
  - Nor is it necessarily an adverse reflection on … those projects
- The consistent behavior to CPI demonstrated by SPI(t) provides further support for the validity of SPI(t) metric and ES method

The Consequences

Thanks Kym,

"I think it is traditional to burn heretics at the stake and then accept their findings as true after an appropriate delay of several years or decades – there were a few notable exceptions, Galileo spring to mind, he merely was placed under house arrest ….. I look forward to seeing how you go.

The paper certainly makes sense and is a great piece of research."

E-mail dated 6 May 08 from Patrick Weaver, Director
Mosaic Project Services Pty Ltd, Melbourne Australia

The Way Forward

- Those interested should read the paper, supporting materials and make up their own minds

- More research is needed to determine whether there are project performance characteristics:
  - Which result in early CPI stability (i.e. the rule applies)
  - **Where early CPI stability was not achieved due to progressively improving CPI performance**

- Academic research aimed at establishing a theoretical rationale for project performance instability

- Researchers repeating the current research using different data samples
  - Lipke's Stability Point Calculator is in the public domain

- ***Test for xPI stability on your own completed projects***

What About Earned Schedule?

◆ Paper demonstrates that using Earned Schedule, research opportunities are equally applicable to project schedule performance
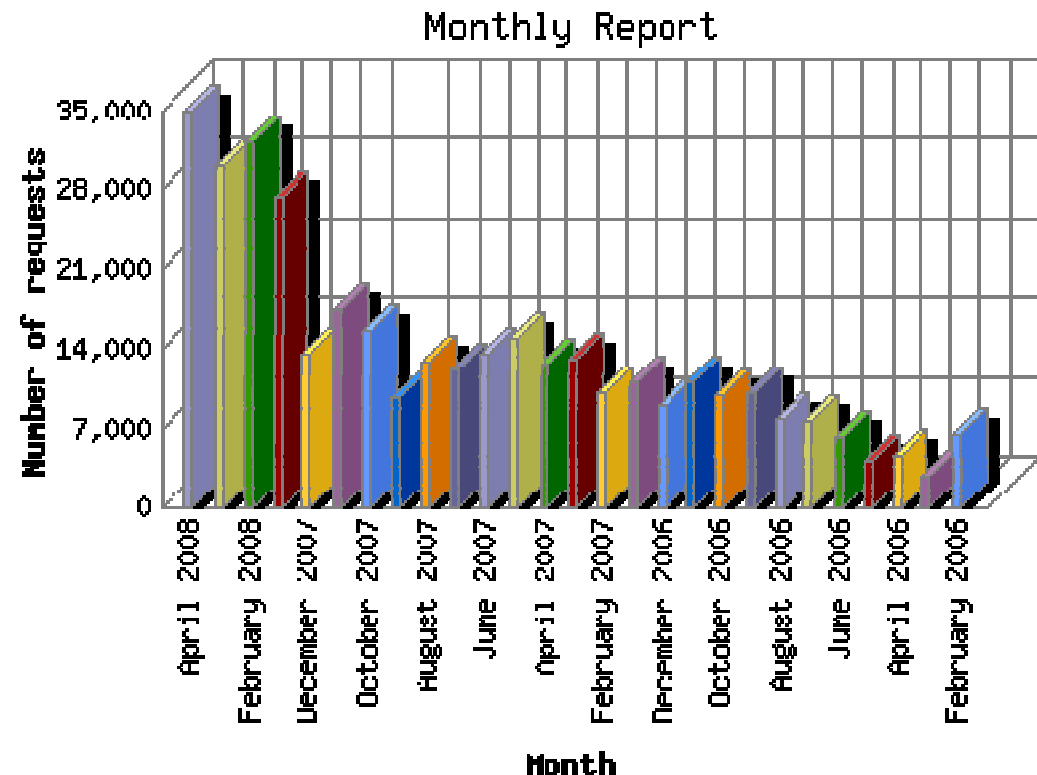
◆ Opinion on Earned Schedule varies:
- **Particularly amongst EVM "thought leadership"**

◆ Website metrics
- **> 30,000 hits each month from Feb to Apr 2008**
- **> 20 GB data downloaded from site since Feb 2006**

◆ **Conclusion**

Earned Schedule has momentum and achieved its place in the project management domain

Monthly Report

Information Sources

◆ Earned Schedule Website
  http://www.earnedschedule.com

◆ PMI Sydney Chapter Website
  http://sydney.pmichapters-australia.org.au/
  Click "Education," then "Presentations and Papers" for .pdf copies

◆ **Crosstalk (online version of paper)**
  http://www.stsc.hill.af.mil/crosstalk/2008/04/

Calculators and Analysis Tools

http://www.earnedschedule.com/Calculator.shtml

◆ **Please respect copyright ©**

◆ **Feedback requested**

  ● Improvement / Enhancement suggestions

  ● <u>Your</u> assessment of value to Project Managers

  ● Disclosure of application and results

    – (with organization permission and/or anonymously)

  ● Application assistance if needed (upon email request)

Contact Information

	Kym Henderson	Dr. Ofer Zwikael	Walt Lipke
Email	kym.henderson@froggy.com.au		
		ofer.zwikael@vuw.ac.nz	
			waltlipke@cox.net
Phone	+61 414 428 537	+64 4 463 5143	+1 (405) 364-1594