



The Performance Metrics Model and Study (PMMS)

An Earned Value Management (EVM) Methodology

Presented at the ICEAA 2016 Professional Development & Training Workshop

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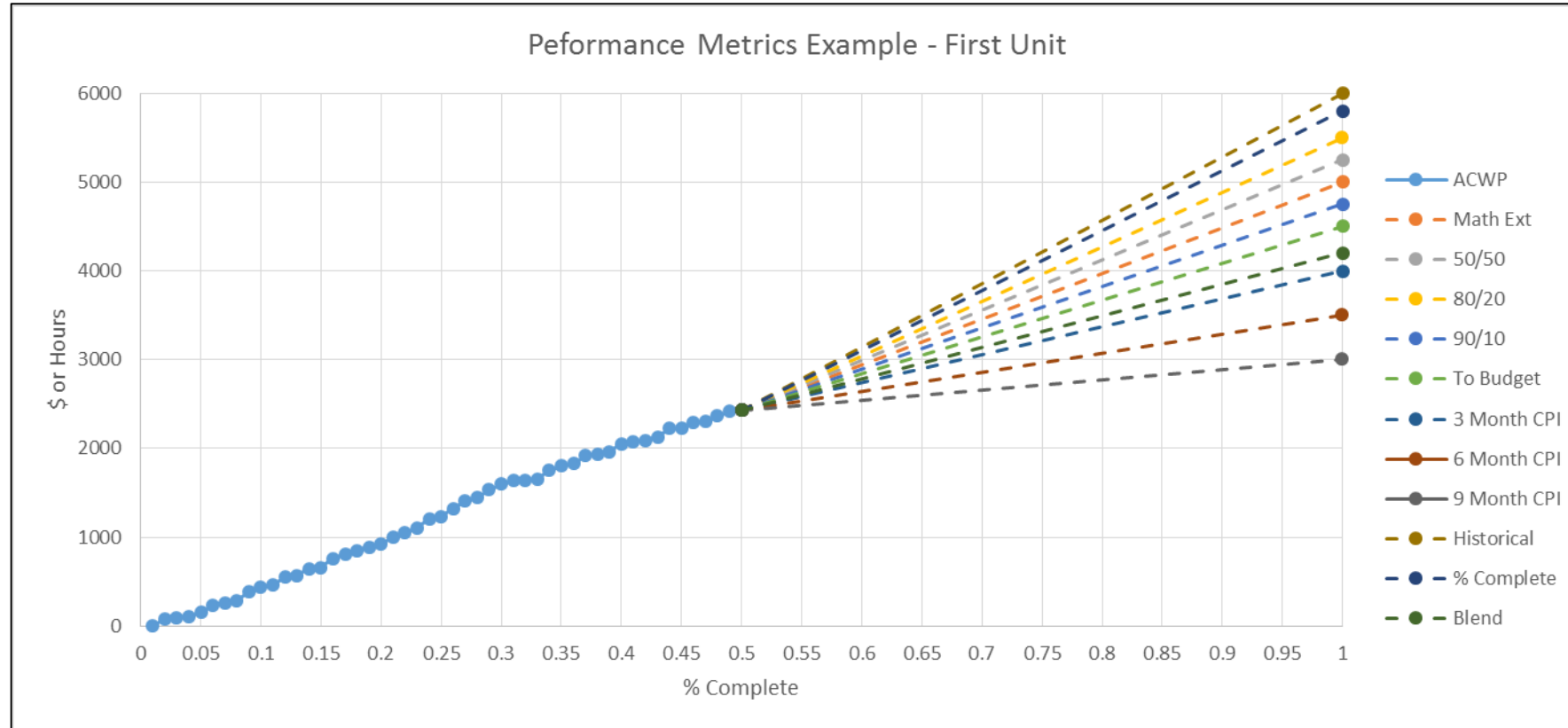
Richard Lee (NAVSEA 05C)

Robert Jones (retired from Technomics)

PMMS Agenda

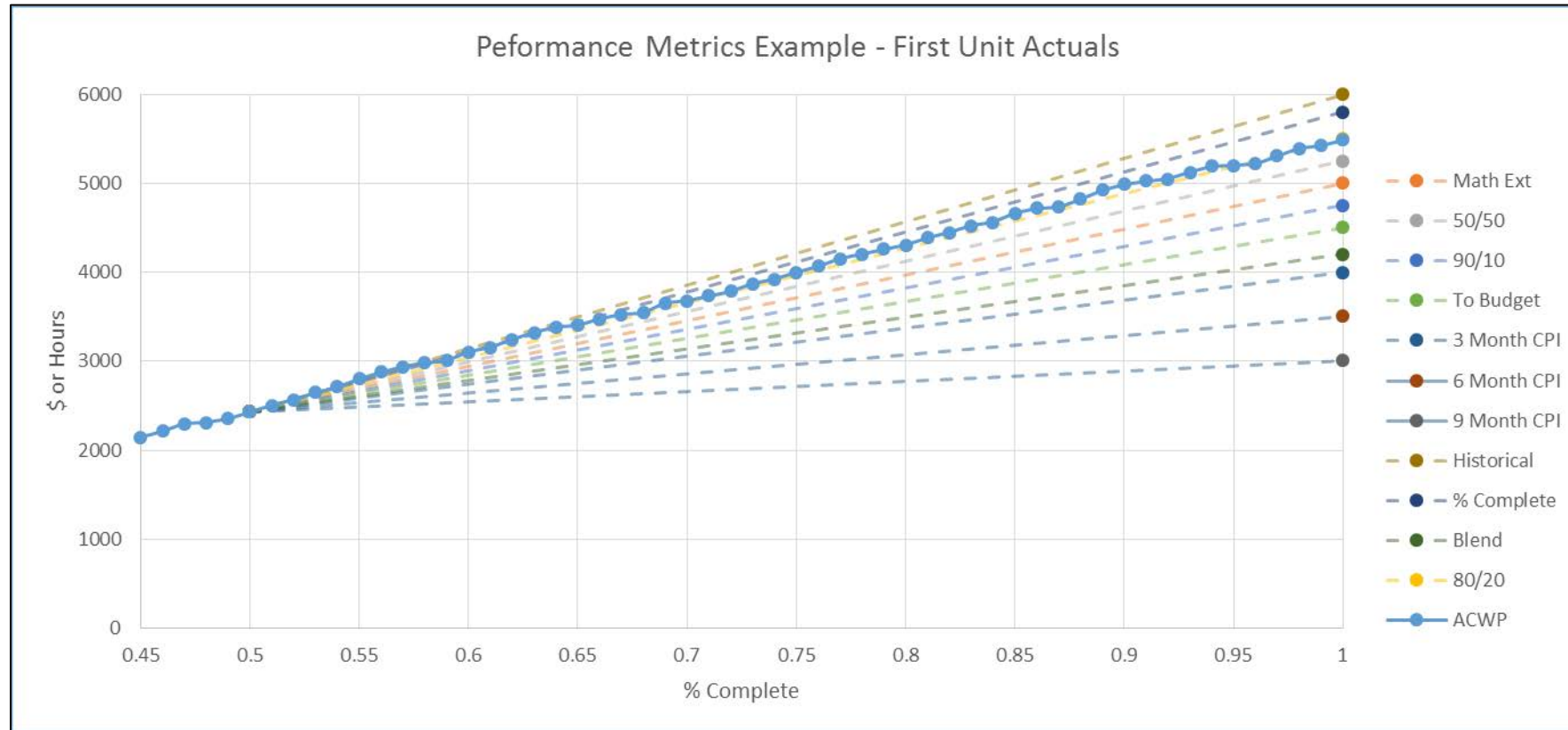
- ▶ Visualization of Process
- ▶ History
- ▶ Ground Rules / Modifications
- ▶ PMMS Set Up
- ▶ Model Execution
- ▶ Case Study
- ▶ Future Development / Ideas
- ▶ Questions/Comments

Visualization of Process (First Unit)



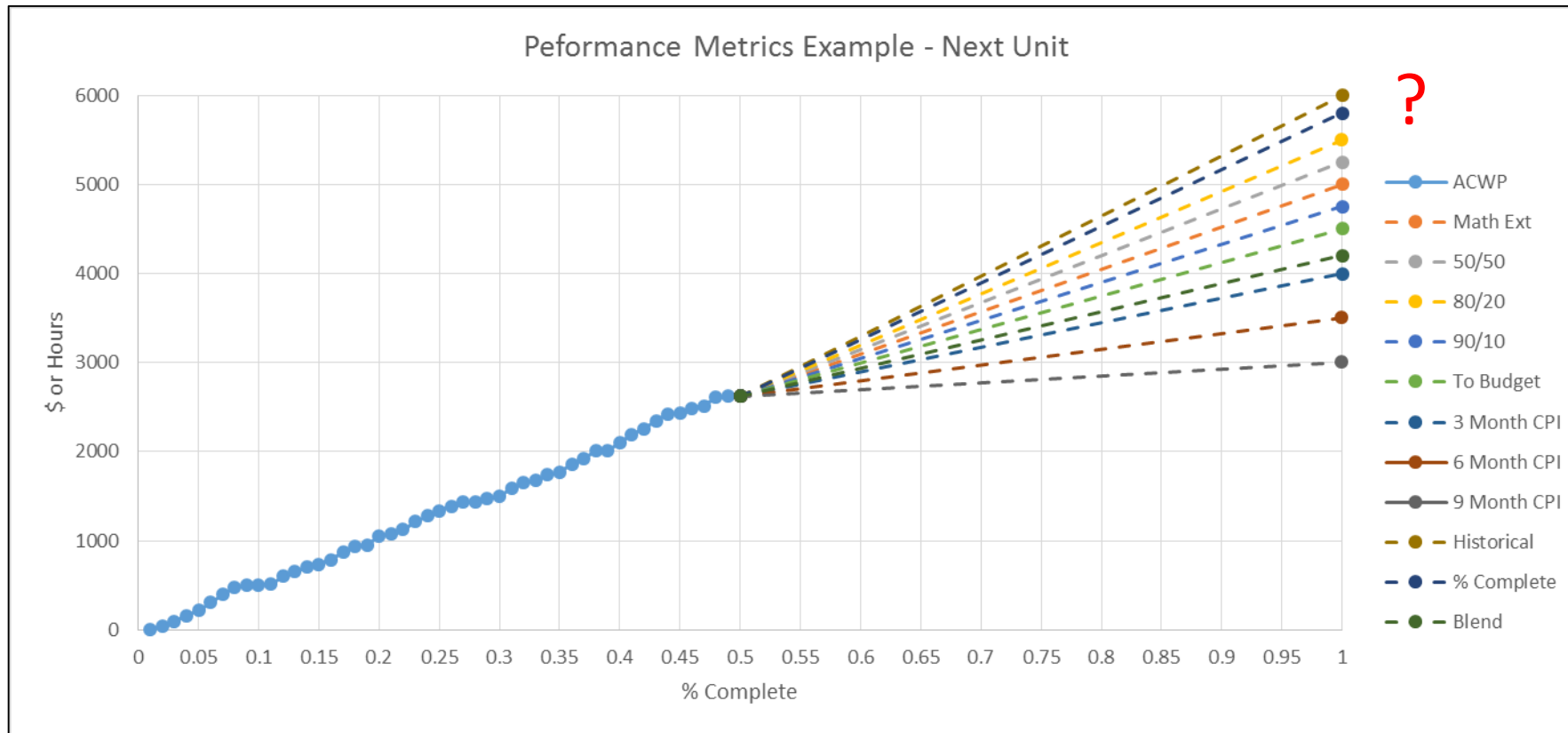
- Assume this is an element of the first unit of a large product with EVM Reporting
- It is at 50% complete, and the actuals are the blue data points.
- There are various performance metrics that can be used for generating an EAC.

Visualization of Process (Actuals)



- Now, assume the element is completed (at a later time), and these are the actuals
- The dashed lines show the projections that were made at 50% complete

Visualization of Process (Next Unit)



- Now, assume we have a technically similar unit to before.
- Shown here, the element for this new unit is now at 50% complete.
- Can the results of the previous unit (last slide) guide our decision?

History – Looking at the data

▶ Sample Data:

EVM Elements	BCWS _{cum}	BCWP _{cum}	ACWP _{cum}	BAC	CPI	SPI	EAC
Element 1	23	21	18	24	1.17	0.91	????
Element 2	20	22	25	35	0.88	1.10	????
Element 3	2	2.1	2.25	3	0.93	1.05	????

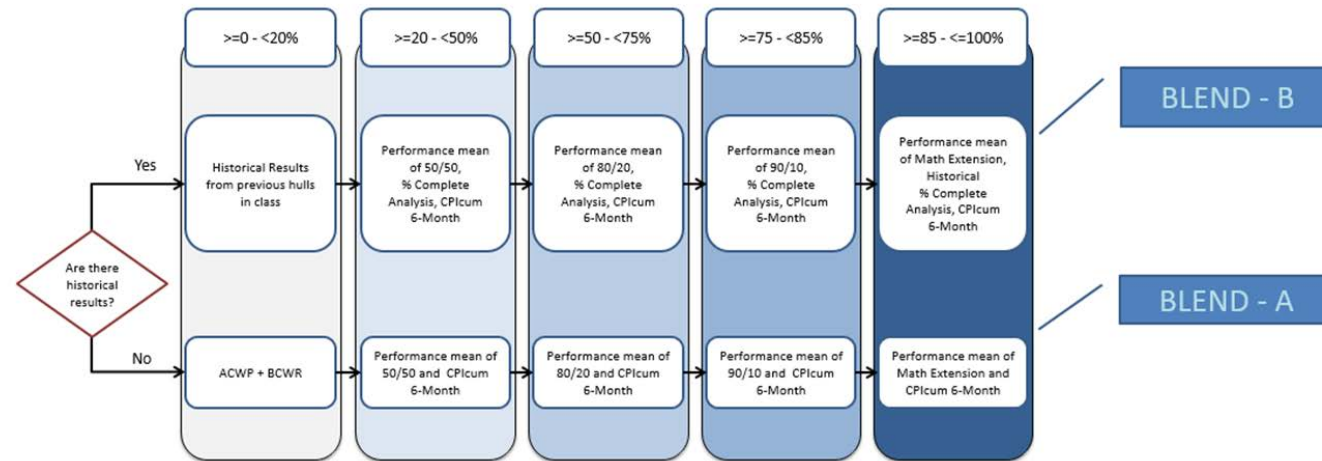
▶ What methodology creates a good EAC?

EVM Elements	Math Ext (CPI)	To Budget (1.0)	50/50 (CPI/SPI)	80/20 (CPI/SPI)	90/10 (CPI/SPI)	3 Month CPI	6 Month CPI	9 Month CPI	Historical	% Complete	Blend
Element 1	20.57	21.00	20.89	20.69	20.63	15.00	20.00	12.00	36.00	45.00	29.00
Element 2	39.77	38.00	38.13	39.07	39.41	26.00	27.00	30.00	10.00	11.00	27.00
Element 3	3.21	3.15	3.16	3.19	3.20	3.00	4.90	3.70	4.90	3.50	2.40

▶ How does our selection incorporate historical data?

History – Preliminary Solutions

► Prior Estimating Methods : Blend Method



- Pros:
 - Uses multiple Performance Metric criteria
 - Incorporates current execution with historical execution to reduce risk
 - Dynamic with respect to % Complete (uses different PMs as a section progresses)
 - Once set up, easy to make changes to % Complete ranges, and PM selections.
- Cons:
 - Relies on analyst knowledge and 'rules of thumb'
 - All Performance Metric selections weighted equally (difficult to justify different weights)
 - Some Performance Metrics may have unreasonable TCPI values (typically 3/6/9 mo. CPI)
 - Moving from one boundary to another can cause large TCPI changes (ex. 49% → 50%)

History – Preliminary Solutions

▶ Prior Estimating Methods : Median Method

EVM Elements	Math Ext (CPI)	To Budget (1.0)	50/50 (CPI/SPI)	80/20 (CPI/SPI)	90/10 (CPI/SPI)	3 Month CPI	6 Month CPI	9 Month CPI	Historical	% Complete	Blend	Median
Element 1	20.57	21.00	20.89	20.69	20.63	15.00	20.00	12.00	36.00	45.00	29.00	20.69
Element 2	39.77	38.00	38.13	39.07	39.41	26.00	27.00	30.00	10.00	11.00	27.00	30.00
Element 3	3.21	3.15	3.16	3.19	3.20	3.00	4.90	3.70	4.90	3.50	2.40	3.20

▶ Pros:

- Uses as many Performance Metrics as computed in a model
- Eliminates unreasonable TCPI values if outliers
- Incredibly easy to implement, and easy to explain to decision makers

▶ Cons:

- Selects *very moderate* answers
- Doesn't account historical data (individual Performance Metrics may have historical context)
- Changes/alterations to this method difficult to justify, addition/removal of performance metrics can change the answer

Ground Rules / Modifications

- ▶ 1. Group data into bins of 5% complete (0-5%, 5-10%, etc.)
 - Modification: If data is more clustered or sparse, adjust as necessary.
- ▶ 2. Assume an EVM element (WBS mapping, Major Milestone) is “done” at 95% + complete.
 - Modification: If large ACWP changes occur between 95% and 100%, consider raising the threshold. The threshold should be when ACWPCum has ‘leveled off’.
- ▶ 3. The “Best” Performance Metric is the one with the least average %error (Prediction – ACWPFinal), averaged over historical deliveries.
 - Example: An element has 2 observations in one bin (42%, 44%), the error for each Performance Metric is the average error of both observations.
 - Furthermore, if there are 3 previous units delivered, then the “best” Performance Metric for each bin is the one with the lowest average error.

PMMS Set Up – Data Setup 1

- ▶ **Need: Historical EVM Data (cumulative values are easier)**
 - BCWP, BCWS, ACWP, BAC
- ▶ **Determine: TCPI for every methodology for every historical point.**
 - Math Ext for Jan 2011, Feb 2011 ...
 - 50/50 for Jan 2011, Feb 2011, ...
- ▶ **Determine: EAC estimates using TCPI values.**
 - Traditional EVM Gold Card Method: $ACWP_{cum} + [BAC - BCWP_{cum}]/TCPI$
- ▶ **For elements > 95% Complete: For each Performance Metric, determine error**
 - $Error = EAC - ACWP_{Final}$
- ▶ **Determine Percent Error (for comparisons)**
 - $Percent\ Error = Error/ACWP_{Final}$



PMMS Set Up – Data Setup 2

- ▶ Set up 5% Complete Bins
- ▶ Determine: Average error for each method for each bin
 - Error (0-5%, 50/50) = Average Error for all observations between 0% and 5% complete using the 50/50 (CPI/SPI) method
- ▶ Determine: Performance Metric with minimum error in each bin
 - Error (0-5%) = Performance Metric that has the Minimum Average Error

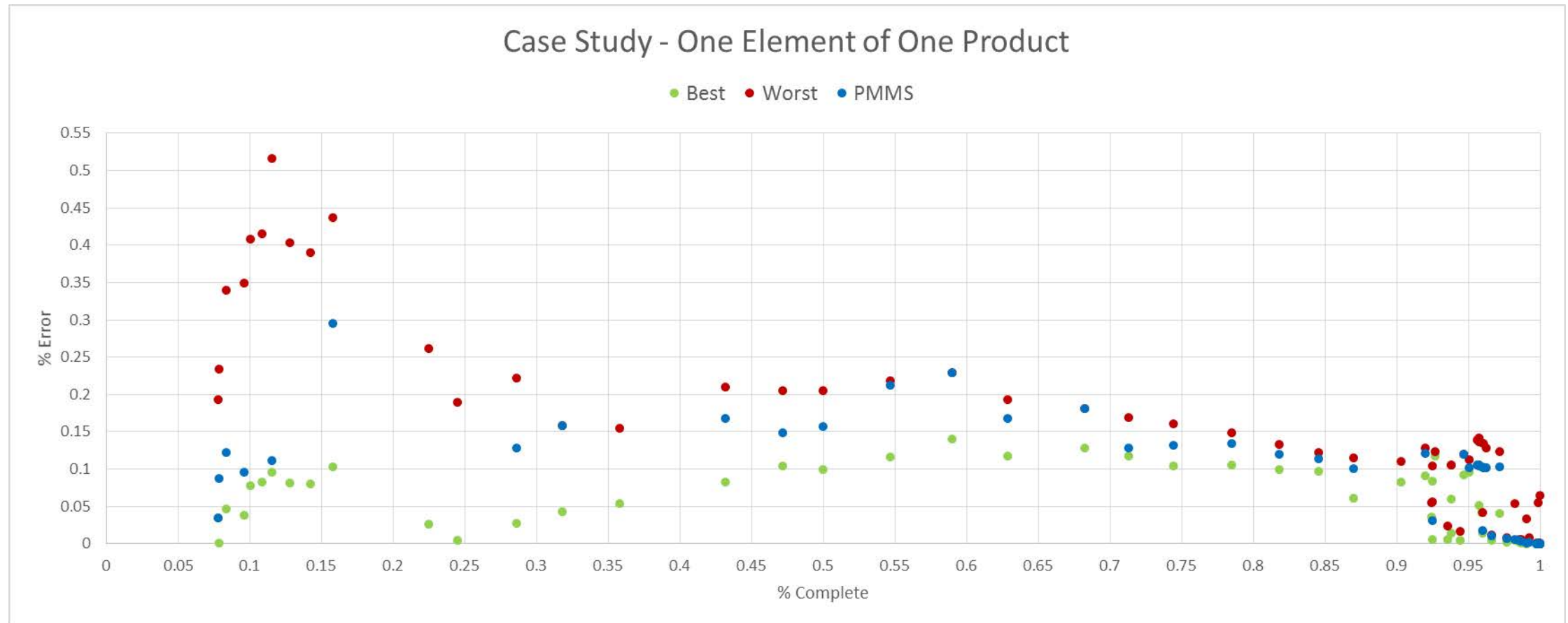
		Method								
		Math Ext (CPI)	To Budget (1.0)	50/50 (CPI/SPI)	80/20 (CPI/SPI)	90/10 (CPI/SPI)	CPI*SPI	3 Month CPI	6 Month CPI	Best Method
Low Range	High Range	1	2	3	4	5	6	7	8	
>0	<=0.05									
>0.05	<=0.1	86%	6%	15%	84%	69%	6%	72%	21%	2
>0.1	<=0.15	73%	48%	88%	97%	92%	40%	2%	79%	7
>0.15	<=0.2	82%	70%	21%	74%	89%	55%	21%	65%	7
>0.2	<=0.25	2%	59%	79%	95%	19%	20%	90%	83%	1
>0.25	<=0.3									
>0.3	<=0.35	35%	70%	44%	63%	83%	41%	9%	53%	7
>0.35	<=0.4									
>0.4	<=0.45	18%	75%	96%	35%	20%	14%	65%	92%	6
>0.45	<=0.5									
>0.5	<=0.55	2%	28%	25%	13%	10%	24%	45%	92%	1
>0.55	<=0.6									
>0.6	<=0.65									
>0.65	<=0.7	41%	67%	7%	3%	44%	52%	26%	22%	4
>0.7	<=0.75									
>0.75	<=0.8	61%	93%	81%	97%	65%	34%	90%	87%	6
>0.8	<=0.85	70%	93%	55%	57%	58%	16%	88%	77%	6
>0.85	<=0.9									
>0.9	<=0.95	31%	31%	99%	95%	90%	40%	32%	71%	1
>0.95	<1	95%	22%	80%	92%	19%	52%	70%	47%	5

Model Execution

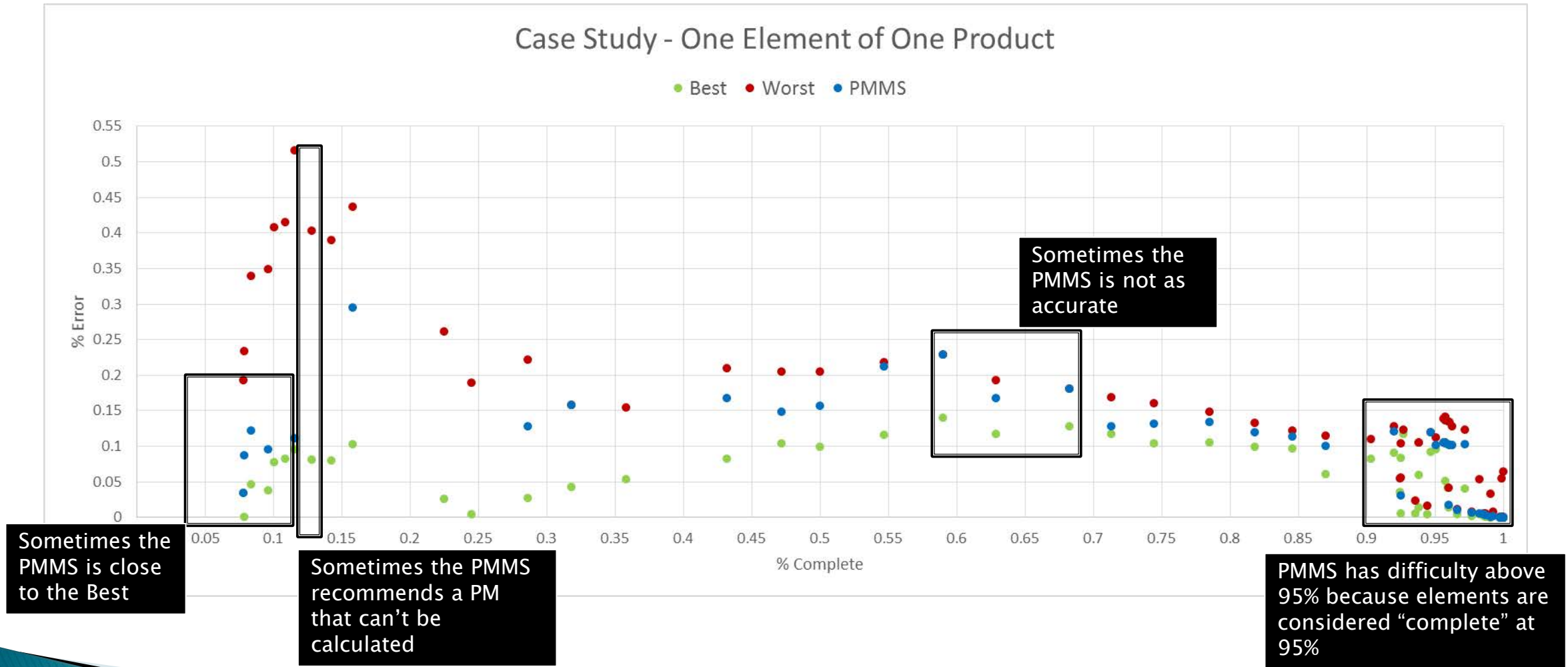
Element	Unit Number	SPI	CPI	% Complete	Selected	TCPI	EAC	VAC	CPI @ Complete	Recommended	(Populated From Perf Metrics Study)			
					Estimation Method					Estimation Method	TCPI	EAC	VAC	CPI @ Complete
Element 1	1	0.91	1.17	49.4%	Math Ext (CPI)	1.17	122	40	0.44	Math Ext (CPI)	1.17	122	40	0.44
Element 2	1	1.10	0.88	45.3%	6 Month CPI	1.04	186	-49	0.32	6 Month CPI	1.04	186	-49	0.32
Element 3	1	1.05	0.93	30.0%	Blend A	1.08	157	-14	0.21	Blend A	1.08	157	-14	0.21
Element 1	2	0.63	0.92	14.7%	Historical	1.00	170	-29	0.95	50/50	0.77	470	-329	0.80
Element 2	2	0.62	0.91	17.4%	50/50	0.97	162	-4	0.75	50/50	0.97	162	-4	0.75
Element 3	2	0.22	0.35	74.3%	80/20	0.97	149	-49	0.11	80/20	0.97	149	-49	0.11
Element 1	3	0.72	0.71	86.0%	9 Month CPI	1.07	182	37	0.91	9 Month CPI	1.07	182	37	0.91
Element 2	3	0.36	0.87	77.9%	90/10	1.09	148	41	0.20	90/10	1.09	148	41	0.20
Element 3	3	0.08	0.89	59.3%	To Budget (1.0)	1.00	107	-3	0.31	To Budget (1.0)	1.00	107	-3	0.31

- ▶ Analyst still makes decisions on Performance Metrics selections.
 - ▶ At times PMMS may give recommendations that aren't sensible. This is usually because there isn't enough historical data.
- ▶ PMMS can serve as a second opinion, a tie breaker, or for helping defend an analyst performance metric selection.

Case Study Results



Case Study Results - Annotated



Future Development / Ideas

- ▶ **Expand Case Study**
 - Determine how effective PMMS is across multiple elements/products
 - Find areas for improvement to the PMMS
- ▶ **Use Case Study Results to Improve PMMS**
 - Example: PMMS should have a second recommendation if the one it recommends can not be computed (as seen on previous slide)
- ▶ **Apply PMMS to other programs**
 - The PMMS appears to be a good candidate for any program that delivers multiple quantities of similar products and has Earned Value data (Aircraft, Submarines, Surface Ships, UAV, etc.)
- ▶ **Incorporate earlier techniques in an innovative way**
 - Guide logic for making/adjusting blends with PMMS
 - Have PMMS work as a 'warning system' to indicate where programs were having Cost/Schedule troubles historically.

Questions/Comments

- ▶ Thank you for your time.
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