Process-Performance Based Reliability (PPBR)

Standardization of Organizational Data Analysis via CMMI-Causal Analysis and Resolution (CAR)

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Agenda

- Why is a new process for reliability prediction needed
- How can a process be developed around CMMI-CAR
- What issues must the new process address relative to the organization's process health
- Summarize the process and provide one sample calculation

Industry Trends are Driving the Need for New Reliability Design and Analysis Methods

- Contractors must "build the case" for improving product reliability during product development cycle
  - *Ernest Seglie, Christopher Dipetto, Office of the Secretary of Defense, "Report of the Reliability Improvement Working Group", September 4, 2008* [1]
  - Ministry of Defence Standard 00-42, Reliability and Maintainability (R&M) Assurance Guidance Part 3 R&M Case, Issue 2 Publication 6 June 2003 [2]
  - *SAE JA1000-1, "Reliability Program Standard Implementation Guide", 1999-03-01* [3]

- Contractors will execute pay-for-performance contracts (PBL)
  - *DODD 5000.1, Department of Defense Directive, "The Defense Acquisition System", May 12, 2003, paragraph E1.1.17* [4]

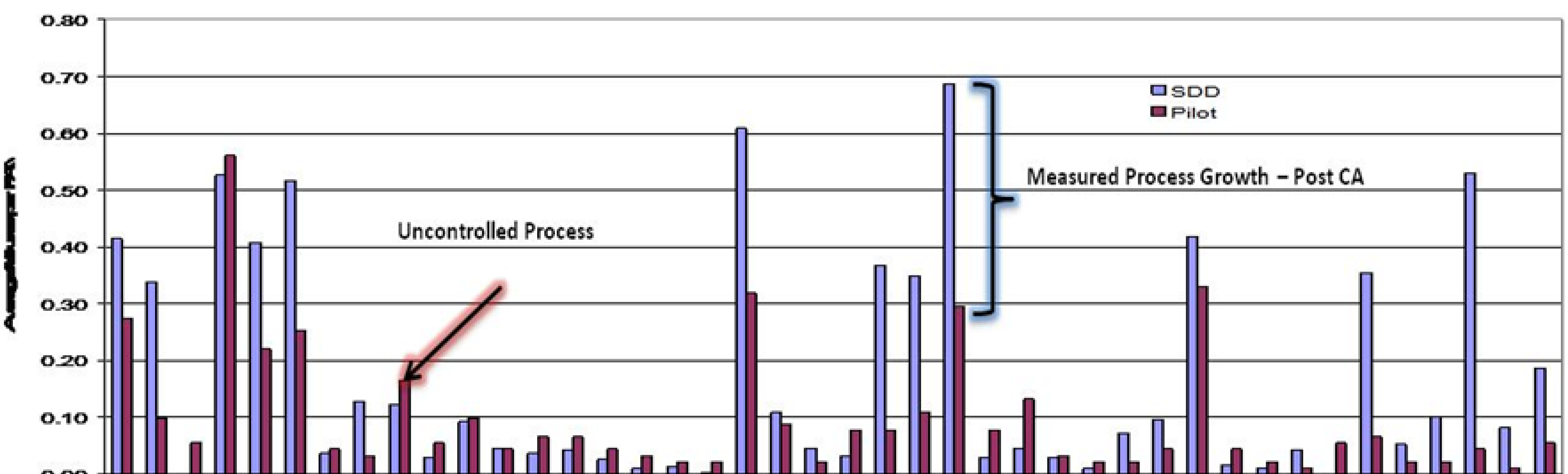
- Organizations must demonstrate continual process improvement via process performance models
  - CMMI® for Acquisition, Version 1.2, CMU/SEI-2007-TR-017, ESC-TR-2007-017, November 2007 [5]
  - CMMI® for Development, Version 1.2, CMU/SEI-2006-TR-008, ESC-TR-2006-008, August 2006 [6]

- Current Reliability prediction methods have deficiencies

Literature review has identified new direction for Reliability Engineering

The PPBR Objective is to Manage Process Reliability Growth Between Phases of Production

- Left unmanaged, organizations have limited visibility of reliability and cost growth between phases of development
  - Normalized defect counts are unavailable for between-phase comparisons
  - Defects are not uniformly categorized between development activities
  - Corrective action effectiveness is unknown
  - Unincorporated corrective action varies randomly from last phase performance
- A standard process and single web-based tool provides synergy across multiple functional groups within an organization
  - Normalized defects are continuously monitored and measured within and between phases
  - Correlations are established between categories of development and field defects

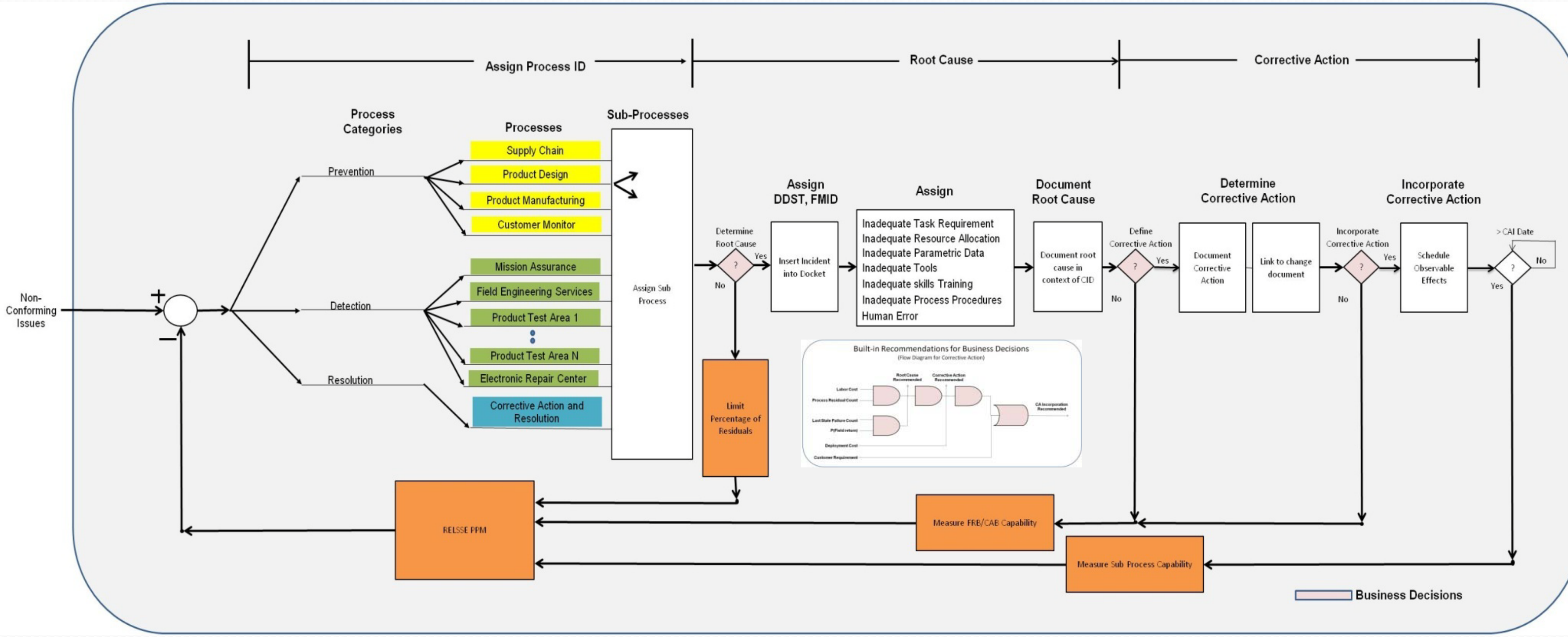


Individual Process Categories Between Two Phases of Development

Properly Defined Metrics Answer Five Critical Questions

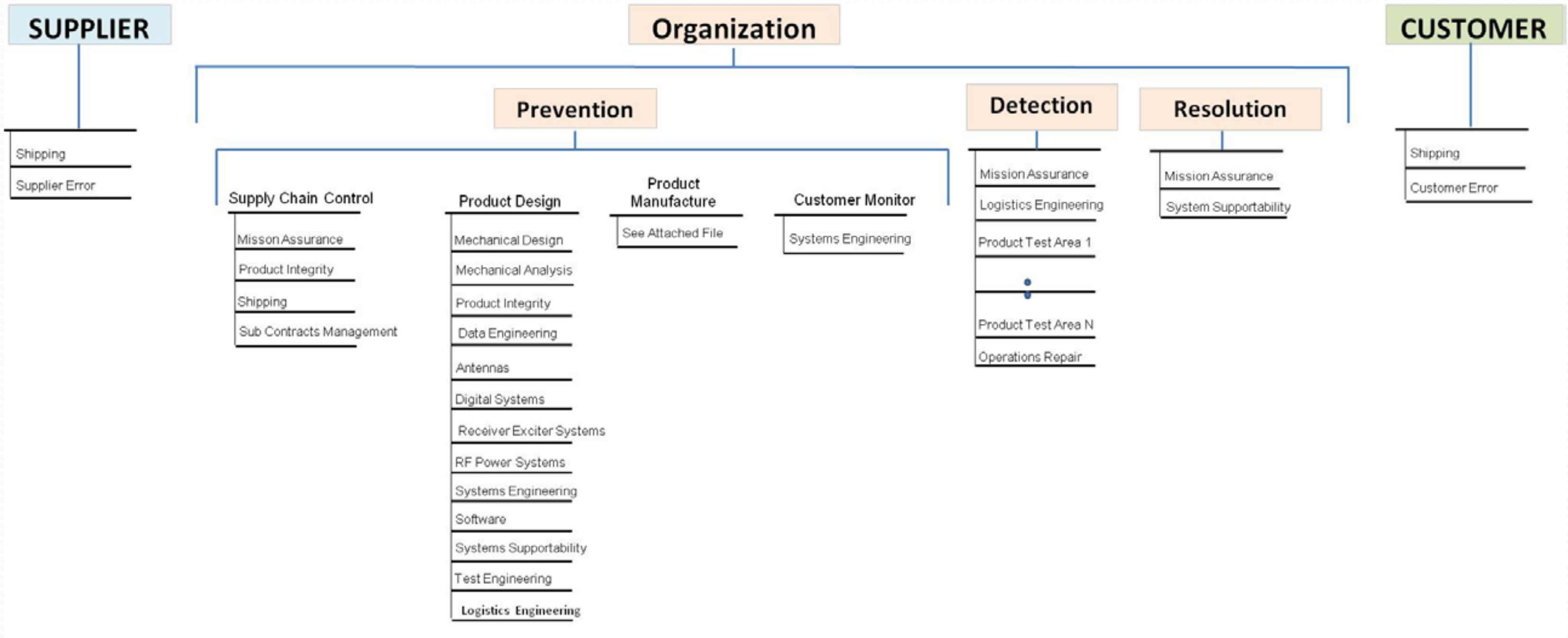
- Is the probability of a field defect warrant the cost of determining and incorporating corrective action?
- Are defects falling through the cracks?
- Are the separate FRB's within the organization performing satisfactorily?
- Is the correction capability of each organizational sub-process maintaining control?
- Has reliability growth occurred?

PPBR Introduces a CMMI-CAR Compliant Closed-Loop Corrective Action System



- Reliability activities are integrated systematically across an organization
- Measurement performance of analyst, Failure Review Board, sub-process, and organizational management
- 4-step process: Product reliability is not simply measured it is managed (via business decisions) to ensure growth between phases of program development

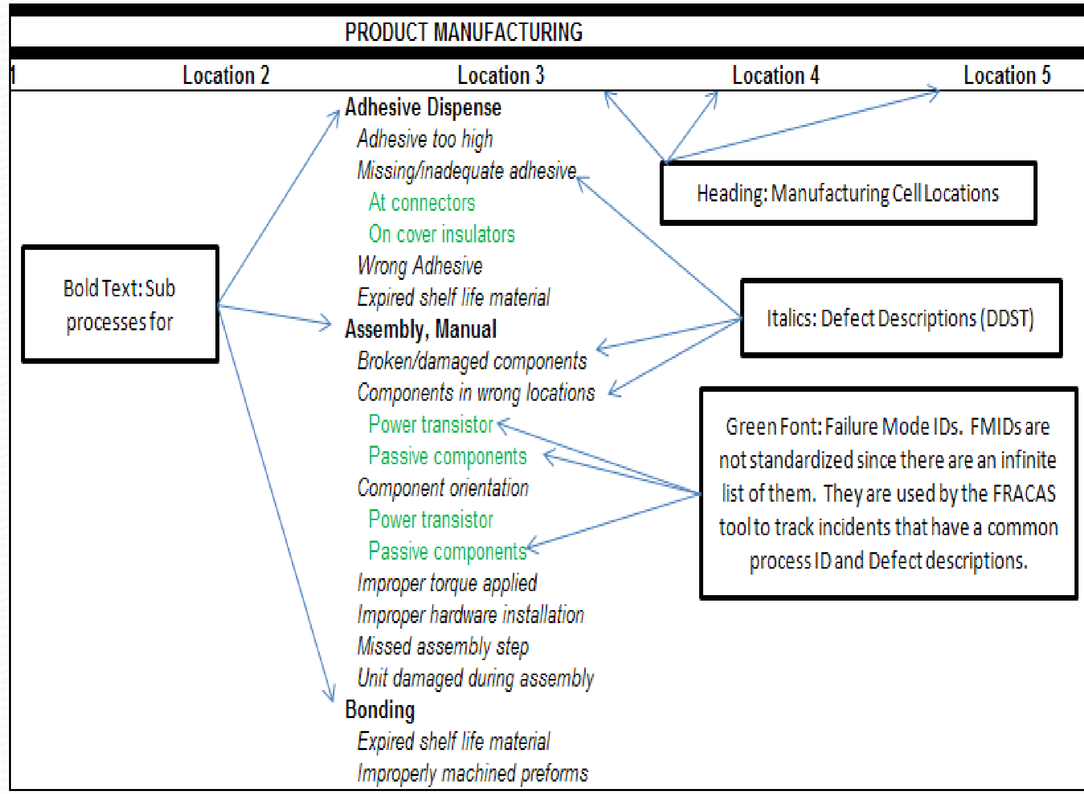
Step 1 –Define the Process Structure and Assign the Process ID (PID)



- Not all defects are within the span of control of the organization
- Organizational processes are categorized as related to prevention, detection, and resolution
- PID defines the sub-process that the defect has escaped from

Steps 2 – Define the DDST/FMID and Identify the Root Cause

- Make decision to determine root cause for current PID
  - Assign PID to a new or existing docket
- Complete the path associating process to physical defect
  - Defect Description (DDST) and Failure Mode ID (FMID) are docket level attributes



Examples:

Failure Description: Solder joint is cracked on PLCC, MC68HC11F1FN.

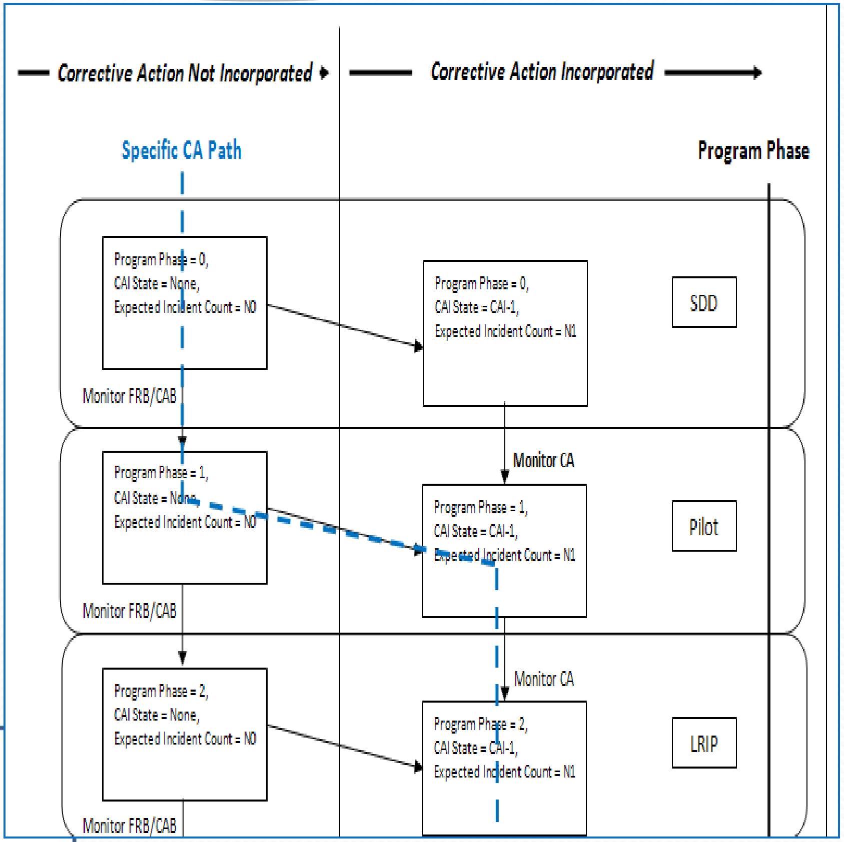
PID Structure1: Prevention/Product Design/Mechanical Analysis/PoF/Insufficient solder height

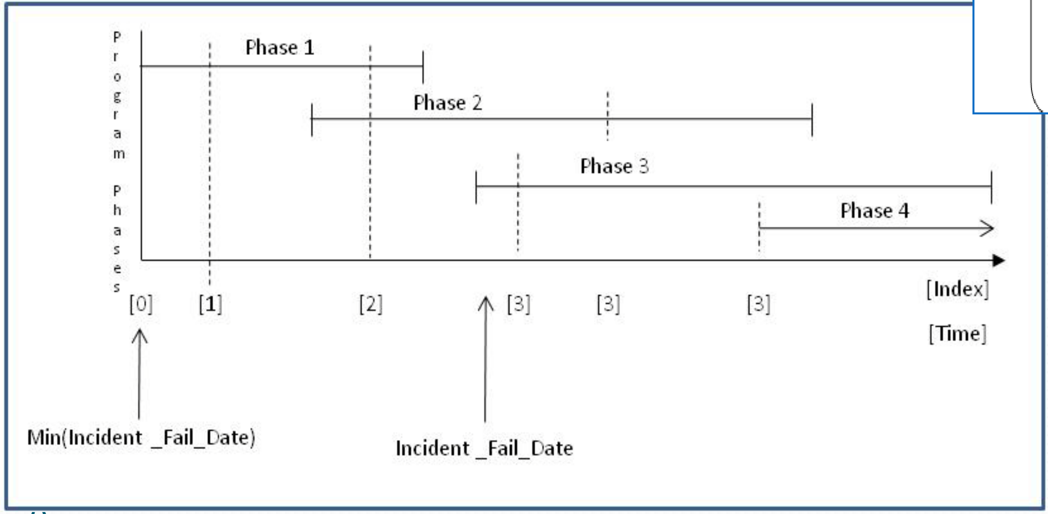
PID Structure 2: Prevention/Product Manufacture/Assembly, Manual/Broken or damaged components

Process Identification	Name:								
	Location:	Mechanical Design			Mechanical Analysis			Product Ir	
Sub process Identification	Name:	Modules	Wired Chassis	System Installation	PoF	Vibration	Thermal	Components Engineering	Materials & Processes
Defect Description (DDST)	Collect Customer Requirements								
	Allocate Requirements Internally								
	Allocate Requirements Externally								
	Select Parts/Materials								
	Perform Analysis								
	Generate Schematic/Drawing								
	Generate Test Plans								

Step 3 – Assign Corrective Action Tracking Index

- Corrective action resides in one of two states "incorporated" or "not incorporated"
- Defects reside in one of two states "customer" or "non-customer" returns
- 4 key docket-level parameters provide state-control
  - Program Phase, Corrective action Index, Fail Date, and Customer return status

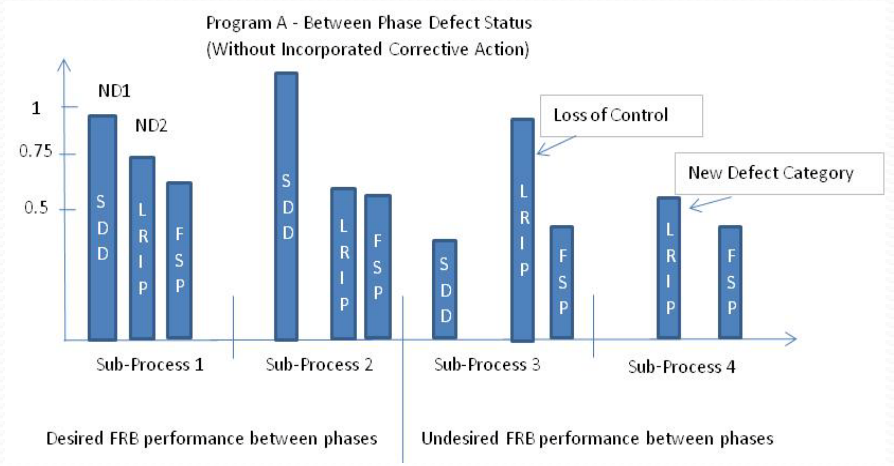




- State sequencing for non-customer defects is completely automated

Step 4: The Output Metrics Answer the 5 Critical Questions

- FRB Effectiveness example answers only one of 5 key questions
  - Affects only dockets that have not had corrective action incorporated
  - Is only meaningful when measured across sub-processes not within sub-processes
  - Alarms monitor rate of defect accumulation
  - Provides three measurements of improvement



Parameter Definitions:

ND1	Normalized defect ratio for sub-process 1 during the baseline phase
ND2	Normalized defect ratio for sub-process 1 during the phase subsequent to the baseline
N1	Total number of defects associated with sub-process 1 collected at the end of the baseline phase
N2	Total number of defects associated with sub-process 1 collected at the end of the subsequent phase
T1	total number of assemblies at risk (assembled) during the baseline phase
T2	total number of assemblies at risk (assembled) during the subsequent phase
N	The actual number of defects currently collected in a docket for the current phase
T	The actual number of assemblies currently at risk, i.e., defined as OK for stores
Cpk-FRB	The average correction capability of FRBs within the organization
Sub-process alarm	Indicates that the rate of defects collecting in the docket will cause the last phase limit to be exceeded

Parameter Calculations:

ND1 = N1/T1 — For the baseline phase

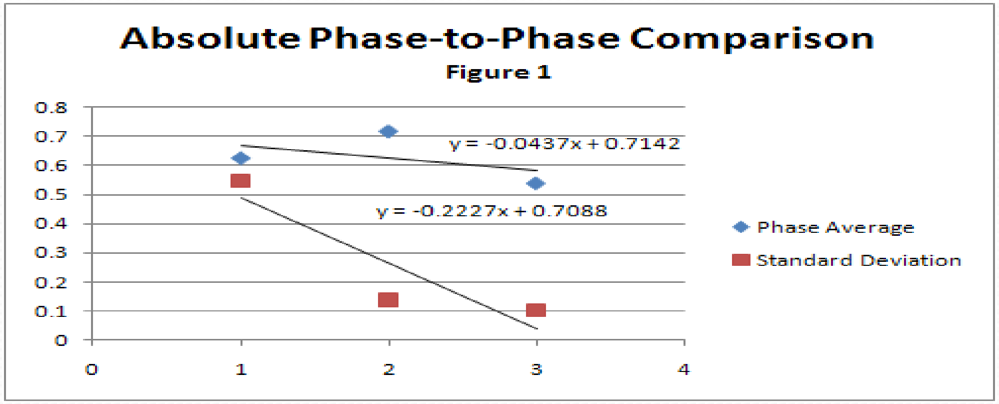
NDi = Ni/Ti — In general

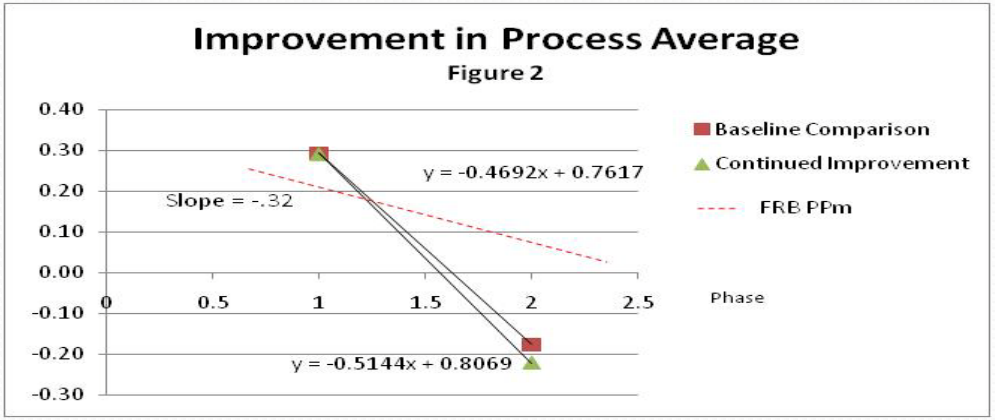
Sub-process alarm = $N > (N1/T1)*T*C_{pk\text{-}FRB}$ — Are defects accumlating at a rate higher than expected? The alarm is ALWAYs referenced to phase 1, i.e, (N1/T1)

					Baseline Comparison		Continued Improvement	
	PID/DDST	SDD	LRIP	FSP	SDD/LRIP	SDD/FSP	SDD/LRIP	LRIP/FSP
	1	0.95	0.75	0.65	-0.21	-0.32	-0.21	-0.13
	2	1.2	0.62	0.6	-0.48	-0.50	-0.48	-0.03
	3	0.35	0.9	0.45	1.57	0.29	1.57	-0.50
	4	0	0.6	0.45				-0.25
Phase to Phase	Average	0.625	0.7175	0.5375				
	Std Deviation	0.548483	0.138654	0.103078				
Baseline Comparison	Average				0.29	-0.18		
	Std Deviation				1.12	0.41		
Continued Improvement	Average						0.29	-0.22
	Std Deviation						1.12	0.25

Results can Demonstrate the Effectiveness of FRB and Provide a CMMI-PPM

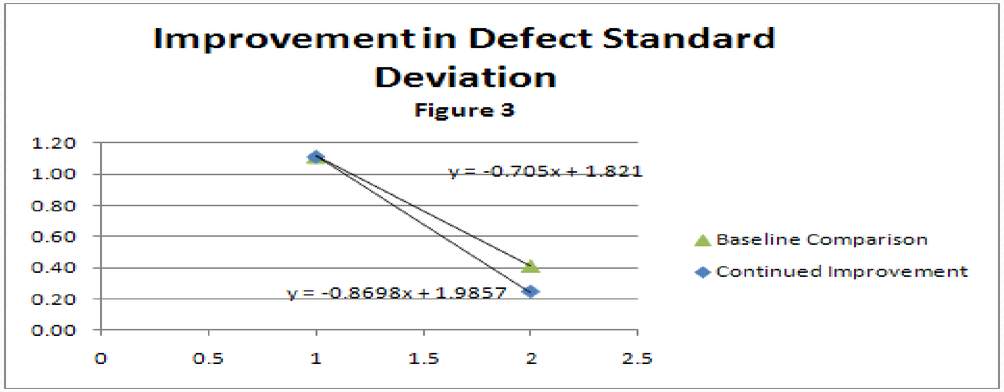
- Metrics show negative slopes for decreasing defect count
- Single phase comparisons measure absolute performance





- CMMI Process performance model measures consistent performance

- Standard deviations provide evidence of decreased dispersion between phases



Summary

- New industry requirements require a fresh look at reliability prediction
- CMMI-CAR integrates the physical and process aspects of failure
- 5 critical questions define the algorithm for corrective action control and measurement
- CMMI-PPMs are developed around the measured results

Questions?

References

[1] Ernest Seglie, Christopher Dipetto, Office of the Secretary of Defense, "Report of the Reliability Improvement Working Group", September 4, 2008

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