DD(X) Software Measurement

Setting the Foundation for Objective Program Oversight and Informed Decision Making

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Outline

- DD(X) SW Engineering (SWE) - What does that mean?
- SW Measurement – A STANDARD Definition
- SW Measurement in the context of a US DoD Acquisition Program Office (DDx-APO)
- DD(X) SW Measurement Data Model
- DD(X) Software Tracking & Oversight Process (STOP)

DD(X) System Characteristics

- ~ $3,000,000,000 contract through CDR
- ~ 70,000 Lines in IMS
- DD(X) is a Weapons Platform
  - ✓ Sensor System
  - ✓ C4ISR System
  - ✓ Multiple Weapon Systems
  - ✓ Ship Control System
  - ✓ Logistics / Support System
- ~ 30 Organizations supporting DD(X) development

DD(X) Software Characteristics

- 26 Organizations developing / integrating software
- ~ 25 Million SLOC (not including MIS)
- Total Ship System Integration vice traditional stove-piped ship systems
- ~ $400,000,000 SW budget through CDR
- SW Budget could approach $ 1B through 5th Ship
- DD(X) Software MUST BE ENGINEERED not developed or crafted.

What is SW Engineering

- "Engineering" means something
  - ✓ Process Based, Results Oriented
  - ✓ Discipline & Rigor
  - ✓ Quantifiable Methods & Results
- IEEE Computer Society Definition of SWE
  - ✓ "The application of a
    - systematic,
    - disciplined,
    - quantifiable

    approach to the development, operation, and maintenance of software;"

IEEE Standard Glossary of Software Engineering Terminology

SW Measurement STANDARD DEFINITION

- **For DD(X), Software Measurement is defined as:**
  - ✓ **"The Systematic Application of Formal Methods, Processes, and Procedures to Quantify Attributes of the Software Process and the associated Software Work Products"**
- **Sources for the DD(X) Approach to Software Measurement include:**
  - ✓ **Practical Software & Systems Measurement**
  - ✓ **Capability Maturity Model – Integrated**
    - **Measurement and Analysis Process Area**
    - **Quantitative Project Management Process Area**
  - ✓ **ISO 15939**

Software Measurement & DD(X) APO

- **PMS500 SW Engineering is responsible for four (4) things:**
  - ✓ **Encourage, Facilitate, and Promote Engineering Behavior *****
  - ✓ **Track and evaluate industry performance against known practices that reduce risk *****
  - ✓ **Report evaluation results to PMS500 Leadership**
  - ✓ **Identify any emerging technologies, methods, etc. that may benefit the program**

DD(X) SW Measurement Process Model

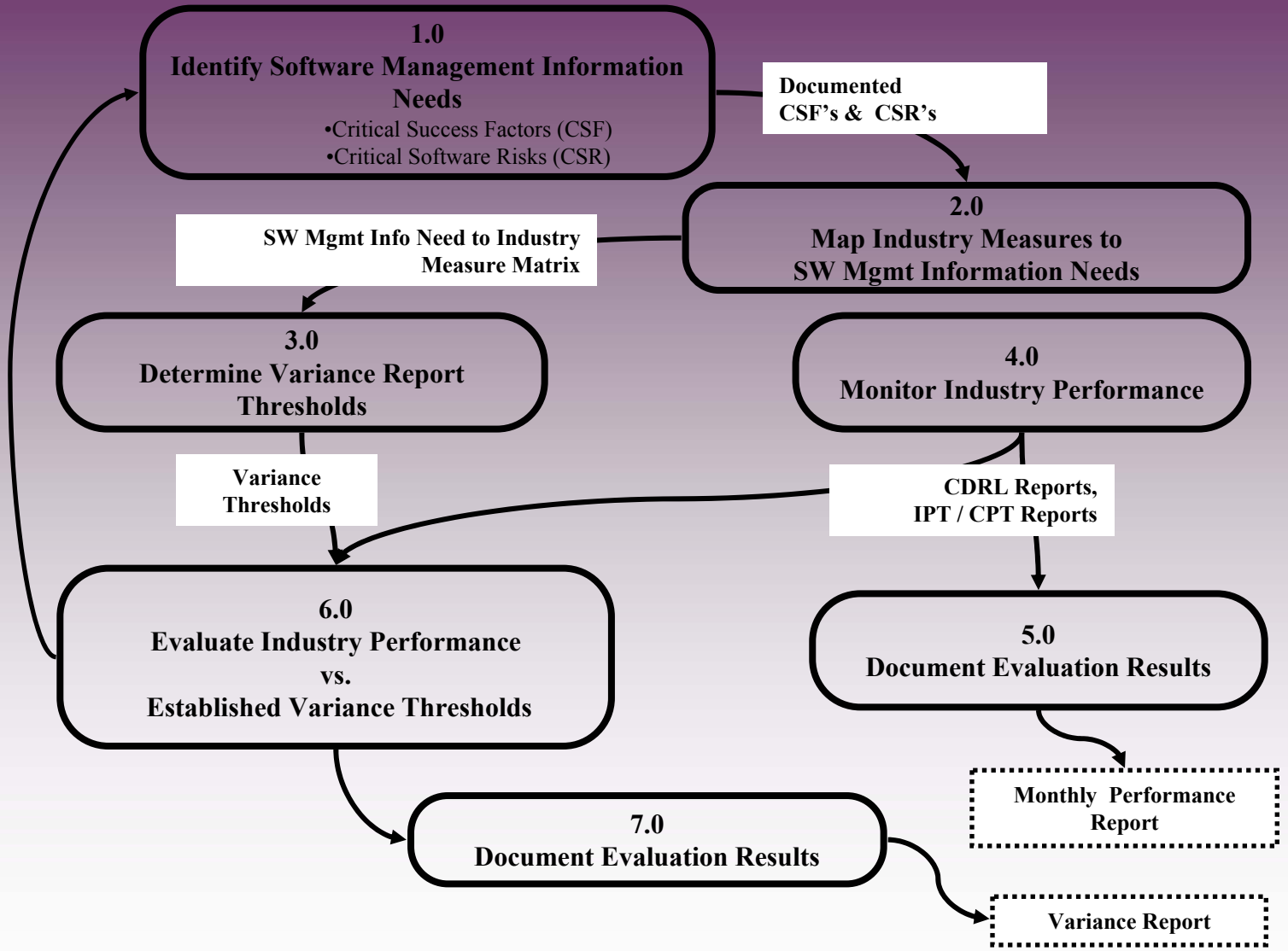


Figure 1 : Software Tracking & Oversight Process

DD(X) Software Management Information Needs

- **Stated Program Goals**
  - ✓ Zero Cost Growth
  - ✓ On-Time Development
  - ✓ 100% Contracted Functionality
  - ✓ Zero Priority 1/2 Defects
- **Identified Program Risks**
  - ✓ Concurrent Engineering
  - ✓ Distributed Development
  - ✓ …

DD(X) Software Measurement System Drivers

Adhere to Measurement System Design Constraints

- Encourage, Facilitate, and Promote Engineering Behavior
  - What you measure will affect the behavior of those who execute the processes or develop the work products being measured

DD(X) Software Measurement System Drivers

Track Critical Engineering Success Factors

- ✓ **People**
  - Sufficient, Capable, and Stable Staff
- ✓ **Process**
  - Adherence to Capable Processes
- ✓ **Technology**
  - Balance Innovation & Risk
- ✓ **Product**
  - Complete, Concise, & Quality Technical Work Products
  - Complete, Concise, & Quality Management Work Products
  - Fully Functional, High Quality Software

People Indicators

- **Sufficient**
  - ✓ **Is there enough people to get the job done?**
    - **Staffing Profiles (Planned vs. Actual)**
- **Stable**
  - ✓ **Is the work environment sufficiently stable so people can work to their potential?**
    - **Turnover (Technical, Management)**
- **Capable**
  - ✓ **Are the people capable of performing the work required?**
    - **% Qualified**

Process Indicators

- **Capability**
  - ✓ **Are the processes capable of delivering quality and performance within cost / schedule constraints?**
    - **Adherence to Best Practices**
      - **IEEE 12207, IEEE 1012, ISO 15939, etc.**
      - **CMMI, SPMN**
    - **Performance Results**
      - **Cost Variance, Schedule Variance, Defect Escapes**
- **Compliance**
  - ✓ **Are the capable processes being following?**
    - **Process Evaluation Results**
    - **Work Product Evaluation**

Technology Indicators

- **Maturity**
  - ✓ **Does the selected technologies balance innovation with risk?**
    - **Bleeding Edge vs. Leading Edge**
- **Change Tolerance**
  - ✓ **Will the selected technologies provide the best long term value to the Navy and provide for system enhancements over time?**
    - **Proprietary vs. Open Source**

Work Product Indicators

- **Quality**
  - ✓ **Are the software work products of requisite quality?**
    - **Management Products (Adhere to standards?)**
      - **SDP, Risk Plan, CM Plan, Q-Mgmt Plan**
    - **Technical Products (Clear, Concise, Complete?)**
      - **Requirements Specifications, Design Documentation**
      - **SW Code, Test Cases**
- **Performance**
  - ✓ **Does the software perform in accordance with our expectations?**
    - **Measures of Performance (MOP)**
    - **Technical Performance Measures (TPM)**
    - **Critical Technical Parameters (CTP's)**

Measurement Data Table

Critical Success Factor	Indicator	TD	PM	Periodic Reports During ...							
		Thres-hold	Thres-hold	REQ	ARCH	DES	•C & UT	SwI	SwQT	SyI	SyQT
People	•Staff Sufficiency			Q	Q	Q	Q	Q	Q	Q	Q
	•Staff Capability	85%	75%	Q	Q	Q	Q	Q	Q	Q	Q
	•Staff Stability	85%	75%	Q	Q	Q	Q	Q	Q	Q	Q
Process	•Capability	na	na	Q	Q	Q	Q	Q	Q	Q	Q
	•Compliance	na	na	Q	Q	Q	Q	Q	Q	Q	Q
	•Cost Performance	5%	10%	M	M	M	M	M	M	M	M
	•Schedule Performance	5%	10%	M	M	M	M	M	M	M	M
	•Quality Performance	???	???	M	M	M	M	M	M	M	M
Tech-nology	Maturity (Leading-Bleeding Edge)	na	na	As Introduced							
	Longevity	na	na	As Introduced							
	Sustainability (Open – Proprietary)	na	na	As Introduced							

Measurement Data Table

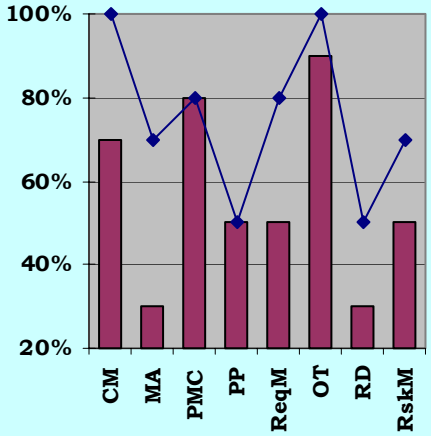
Critical Success Factor	Indicator	TD	PM	Periodic Reports During ...							
		Thres-hold	Thres-hold	R	A	D	C	Sg	S	S	S
Product – Mgmt	Clear, Concise, and Complete SDP	na	na	Q	Q	Q	Q	Q	Q	Q	Q
	Clear, Concise, and Complete CM Plan	na	na	Q	Q	Q	Q	Q	Q	Q	Q
	Clear, Concise, and Complete RM Plan	na	na	Q	Q	Q	Q	Q	Q	Q	Q
	Clear, Concise, and Complete QA Plan	na	na	Q	Q	Q	Q	Q	Q	Q	Q
Product – Tech – Reqts	Traceability: R 2 D	90%	75%	M	M	M	M	M	M	M	M
	Stability	95%	85%	M	M	M	M	M	M	M	M
	Clarity	na	na	M	M	M	M	M	M	M	M
	Testability	na	na	Q	Q	Q	Q	Q	Q	Q	Q
Product – Tech – Design	Traceability: D 2 C	90%	75%	M	M	M	M	M	M	M	M
	Stability	95%	85%	M	M	M	M	M	M	M	M
	Clarity	na	na	M	M	M	M	M	M	M	M
	Testability	na	na	Q	Q	Q	Q	Q	Q	Q	Q

Collect & Analyze Industry Measurement Reports

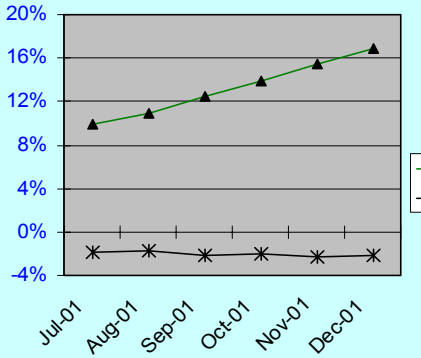
- DD(X) Design Agent prepares a 'Composite Measurement Report' each month
  - ✓ Content was negotiated between the DA and PMS500
  - ✓ Includes Indicators, Derived, AND Base Measures
- PMS500 SW Engineering (SWEng) extracts pre-selected data (base / derived measures) from the CMR
- SWEng analyzes measurement data for variances and trends.
- A Composite SW Measurement Brief is prepared by SWEng for PMS500 leadership

Sample Measurement Report

Process

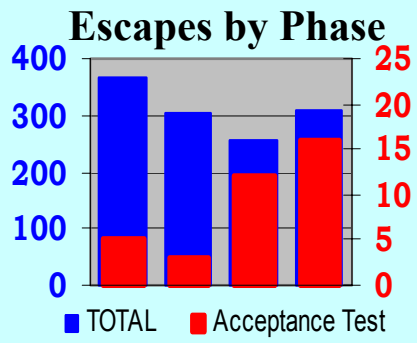


CMMI 2

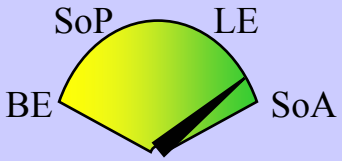


CV 16%

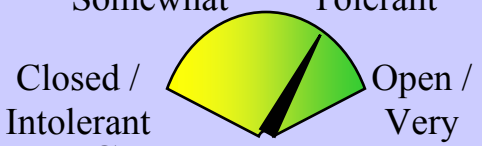
SV - 2%



Process Technology



Maturity

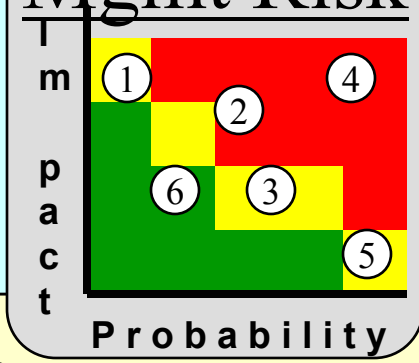


Change Tolerance

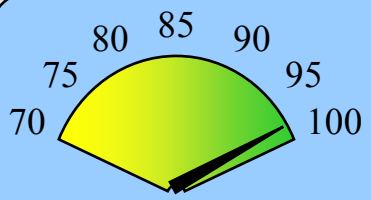
Implementation: Very Effective

Supportability: Very Likely

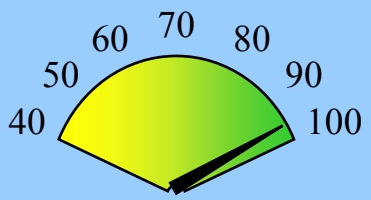
Mgmt Risk



Staff



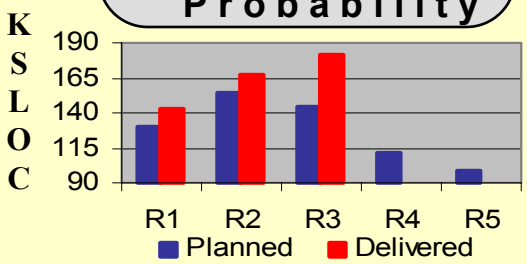
Stability



Sufficiency

Required Training: 69 %

C P M's

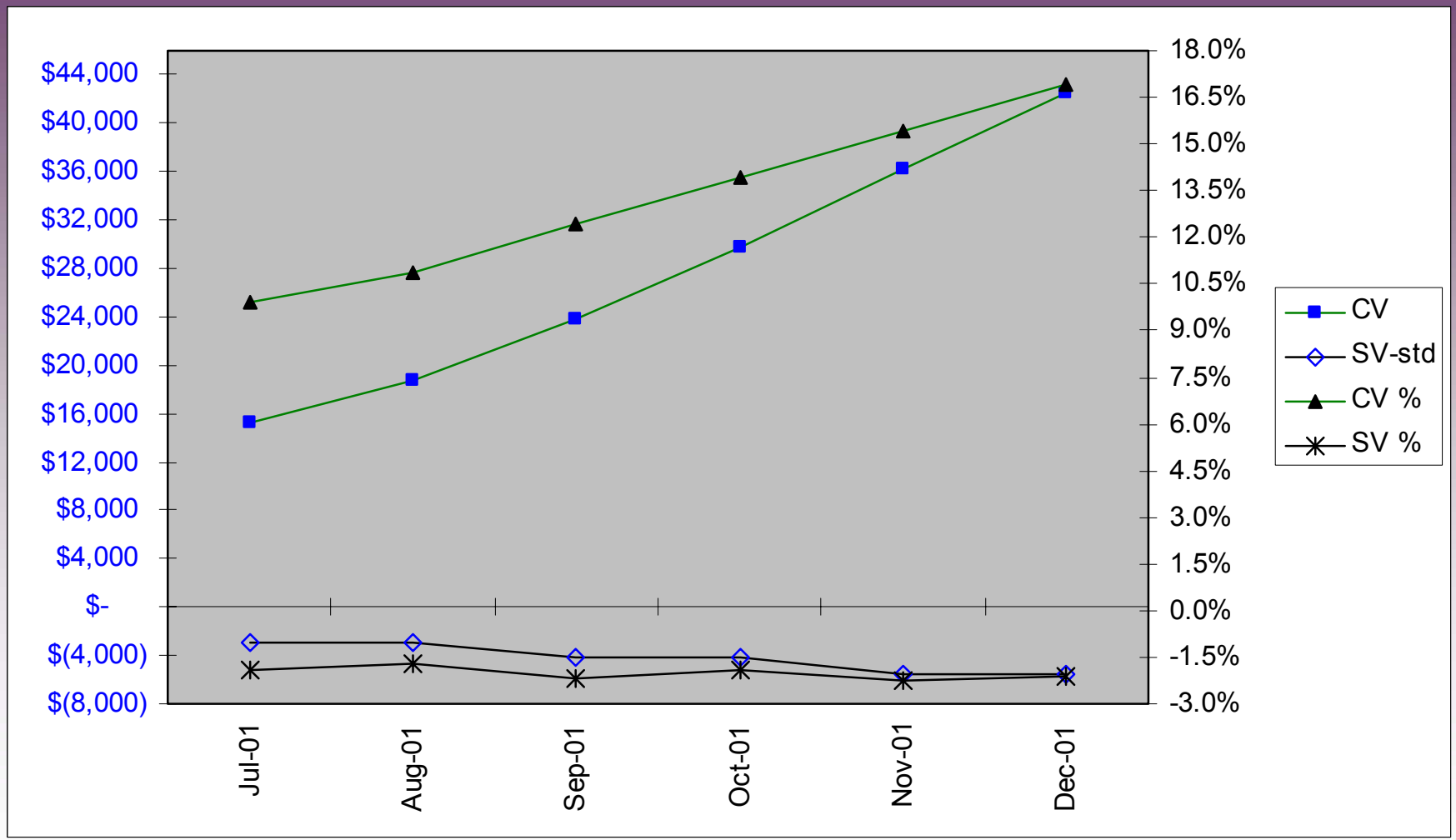


Critical Timelines: 100 %

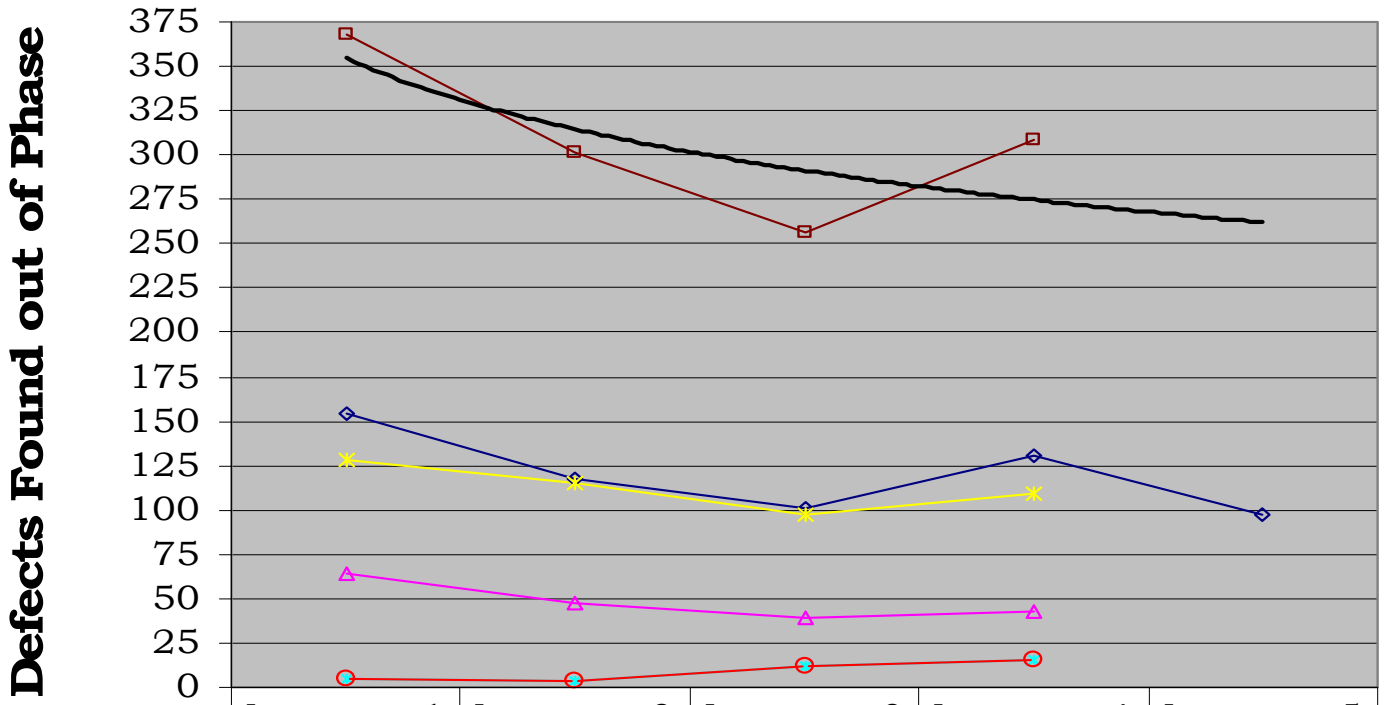
Mgt Products

Software Development Plan	VGood
Risk Mgmt Plan	Good
Certification Plan	VGood
Requirements Specs	Ok
Design Documentation	Poor
Source Code	Poor

Process - Cost / Schedule Variance

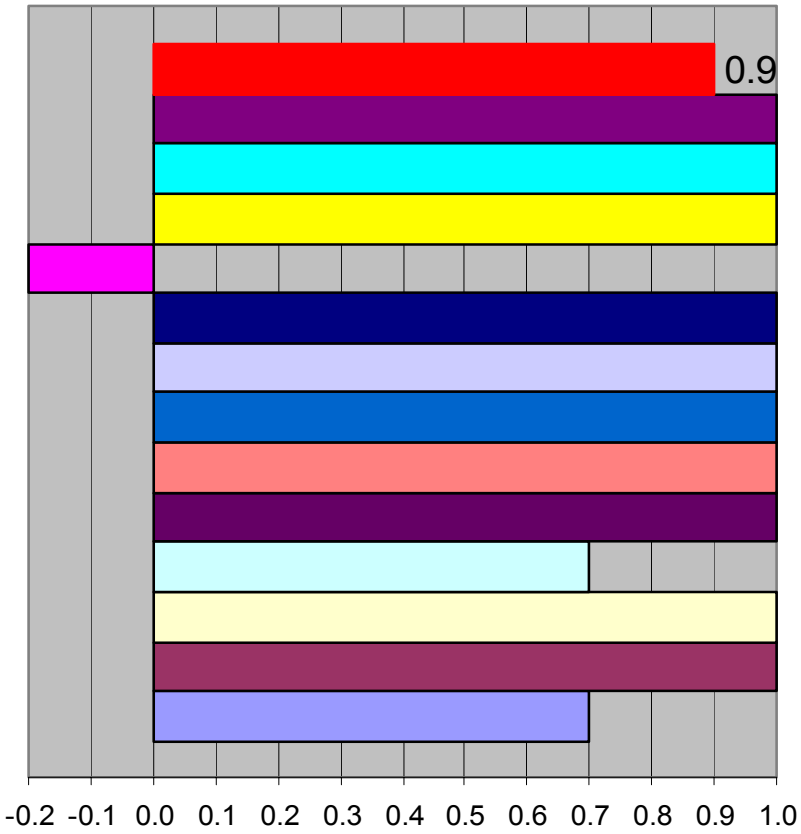


Process - Escapes by Activity & Phase



	Increment 1	Increment 2	Increment 3	Increment 4	Increment 5
Requirements	154	117	101	130	97
Design	64	48	39	43	
Code & Unit Test	128	115	97	109	
Integration Test	5	3	12	16	
Acceptance Test	5	3	12	16	
TOTAL	368	302	256	309	

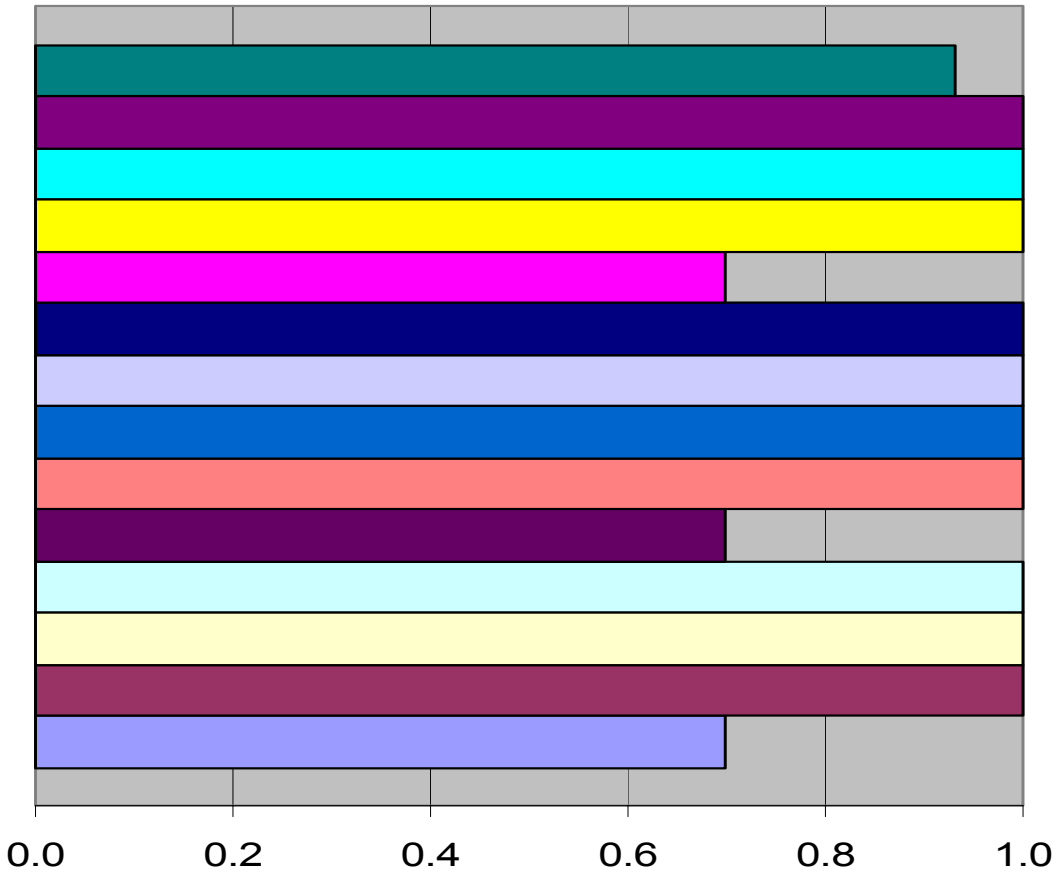
Technology - Maturity



- **SUMMARY EVALUATION**
- Rationale ROSE
- Rationale ClearQuest
- PVCS
- Object Orientation for Sys Development
- Object Orientation for SW Development
- Formal Requirements Quality Checklists
- Formal Design Quality Checklists
- Formal Code Inspection Checklists
- DOORS
- Simulation / Modeling
- Interative / Evolutionary Requirements
- Incremental SW Delivery
- Code Modularization

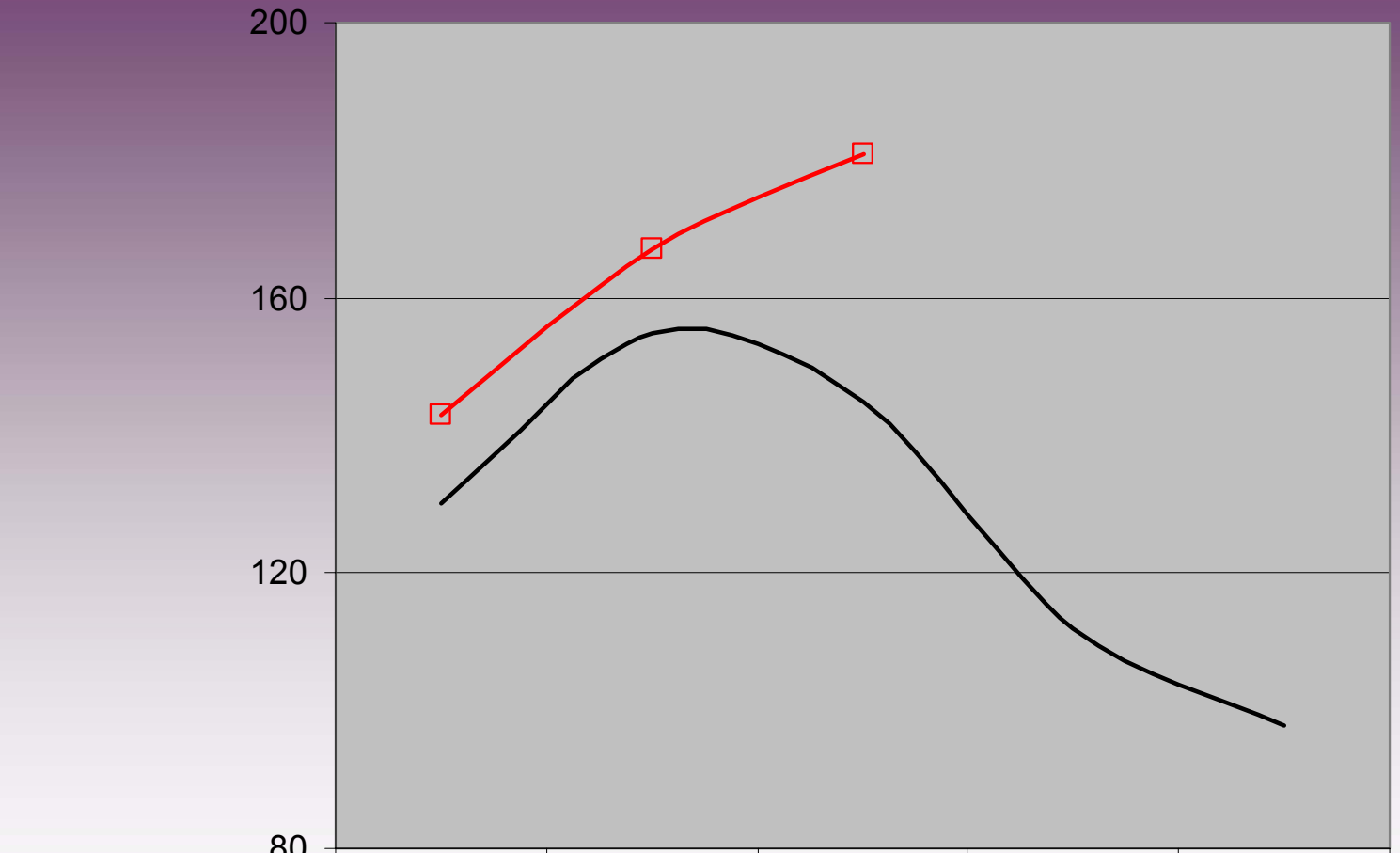
State of the Art = .80 - 1.0
Leading Edge = .40 - .70
State of Practice = .10 - .30
Bleeding Edge = -.20 - 0.0

Technology - Implementation



Very Effective = .08 - 1.0
Effective = .40 - .70
Nominal = .10 - .30
Counter Effective = -.20 - 0.0

CPM's - SW Size (KSLOC)



	Release 1	Release 2	Release 3	Release 4	Release 5
Planned SLOC	130	155	145	112	98
Delivered SLOC	143	167	181		

Conclusion

- The Process and Data Models from PSM have been tremendously valuable in developing the DD(X) Software Tracking & Oversight Program
- Guidance from PSM, CMMI, and ISO15939 continues to be useful tools as DD(X) refines it's approach to software measurement
- As DD(X) proceeds forward, the quantitative foundation that has been established will bring great benefits to DD(X) leadership in making mid-course corrections