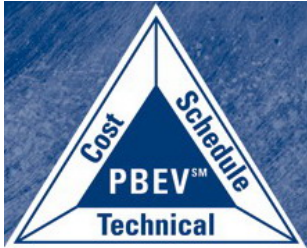# Performance-Based Earned Value®

NDIA Systems Engineering Conference
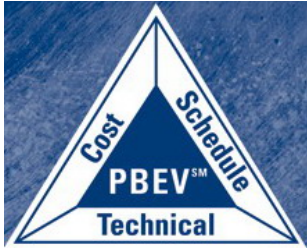**San Diego, CA**
October 25, 2006

Paul J. Solomon, PMP
Performance-Based Earned Value®
Paul.Solomon@PB-EV.com

1

Agenda

- **DoD Policy and Guidance, Customer Expectations**
- **Standards, Models, and Best Practices**
- **Project Management with Performance-Based Earned Value® (PBEV℠)**
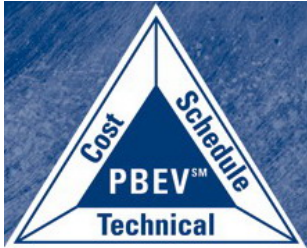- **Better Acquisition Management**

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Paul Solomon and Ralph Young and copyrighted by
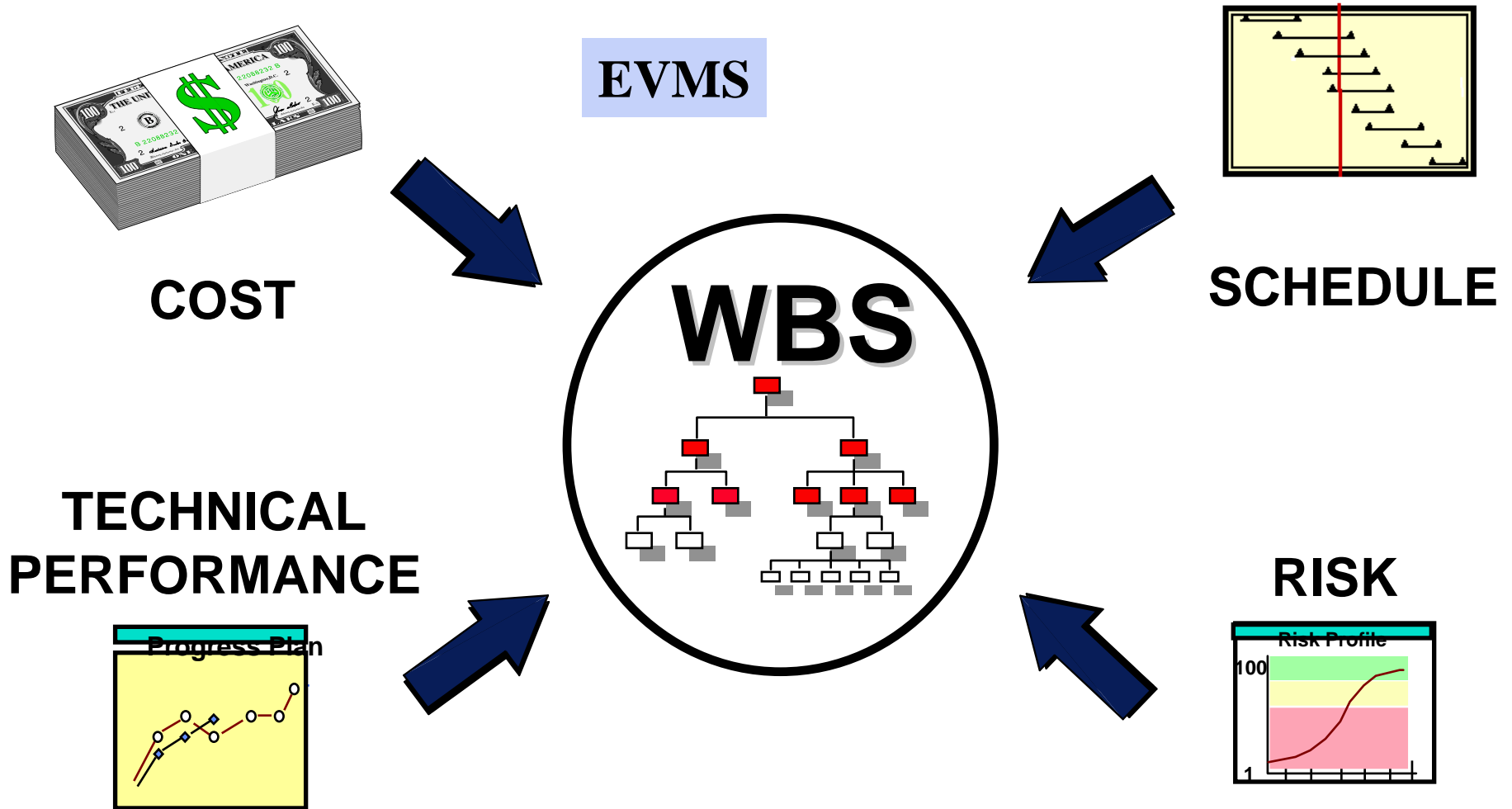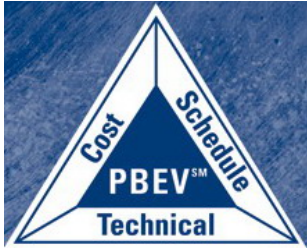**the IEEE, 2007.**

Project Management Shortfalls

- **Inadequate early warning**
- **Schedules, EV overstate true progress**
- **Remaining work underestimated**
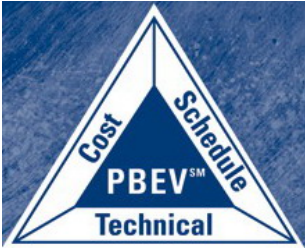
Does EVMS Really Integrate?

EVMS

COST

SCHEDULE

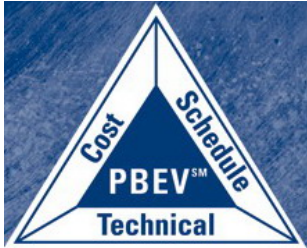TECHNICAL PERFORMANCE

Progress Plan

WBS

RISK

Risk Profile

100

1

Value of Earned Value

EVM data will be reliable and accurate only if:

- The right base measures of technical performance are selected

and

- Progress is objectively assessed.
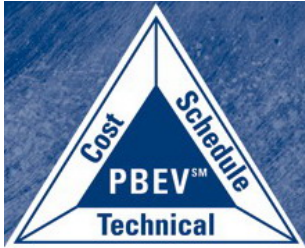
DoD Policy and Guidance, Customer Expectations

Government Pays But Fails to Get Desired Outcomes

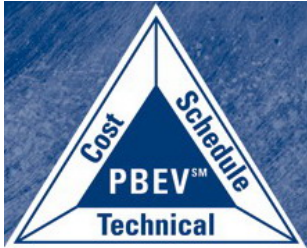| GAO Report	Title	Findings and Recommendations
06-66	Defense Acquisitions: DOD Paid Billions in Award and Incentive Fees *Regardless of Acquisition Outcomes*	● Contractors not held accountable for achieving desired outcomes: o Cost goals o Schedule goals o *Desired capabilities* ● Programs do not capture early on the requisite knowledge needed to effectively manage program risks
06-391	Defense Acquisitions: Assessments of Major Programs	DOD needs to change its *requirements* and *budgeting* processes to get desired outcomes from the acquisition process

(a) Government Accountability Office

GAO Best Practices

GAO Report	Title	Findings and Recommendations
04-722	Information Technology: DOD's Acquisition Policies and Guidance	**Best Practices and Controls:** • Ensure that *requirements* are traceable, verifiable, and controlled. • Trace requirements to system design specifications and testing documents. • Continually measure an acquisition's *performance*, cost, and schedule against *approved baselines*.
06-215	DOD Systems Modernization	

DOD Policy & Guidance on SE

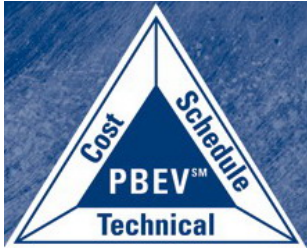**Policy for Systems Engineering in DOD Policy** 2/20/04

Defense Acquisition Guidebook (DAG) 10/8/04

Systems Engineering Plan Preparation Guide (SEP) 2/10/06
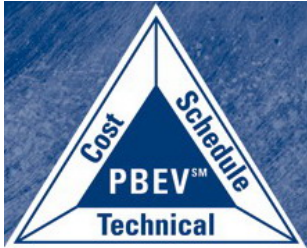
WBS Handbook, Mil-HDBK-881A (WBS) 7/30/05

Integrated Master Plan (IMP) & Integrated Master Schedule Preparation & Use Guide (IMS)   10/21/05

Risk Management Guide for DOD Acquisition (RISK) Aug. 06

DOD Policy & Guides

Policy or Guide (1 of 3)	Policy	DAG	SEP	WBS	IMS
Develop SEP	P	4.2.3.2	1.0		
Technical reviews:					
• Event-driven timing	P	4.5.1	3.4.4	3.2.3.1	2.3, 3.3.2
• Success criteria	P	4.5.1	3.4.4	3.2.3.1	
• Assess technical maturity		4.5.1	3.4.4	3.2.3.1	
Integrate SEP with:					
• IMP		4.5.1	3.4.5		1.2, 2.3
• IMS		4.5.1	3.4.5		1.2, 2.3
• Technical Performance Measures (TPM)		4.5.1	3.4.4		1.2, 2.3
• EVM			3.4.5		1.2, 2.3

DOD Guides

Guide (2 of 3)	DAG	SEP	WBS	IMS
Integrate WBS with **requirements** specification, statements of work (SOW), IMP, IMS, and EVMS			**2.2.3, 3.2.3.3**	**3.4.3**
TPMs to compare actual vs. plan: • **Technical development** • **Design maturity**	**4.5.5**	**3.4.4**		**3.3.2**
TPMs to report degree to which system **requirements** are **met:** • Performance • Cost • Schedule	**4.5.5**	**3.4.4**		
Standards and models to apply SE	**4.2.2 4.2.2.1**			
Institute **requirements management** and **traceability**	**4.2.3.4**	**3.4.4**		

Standards, Models, and Best Practices

13

DOD Technical Baselines

| DAG Technical Review	DAG Baseline	DAG	IEEE 1220
System Functional Review	System Functional Baseline	4.3.3.4.3	Validated Requirements Baseline
Preliminary Design Review	System Allocated Baseline	4.3.3.4.4	Verified Physical Architecture
Critical Design Review	System Product Baseline	4.3.3.4.5	Verified Physical Architecture
Production Readiness Review	System Product Baseline	4.3.3.9.3	Verified Physical Architecture
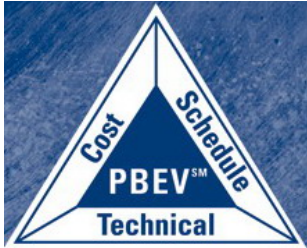
Requirements Progress

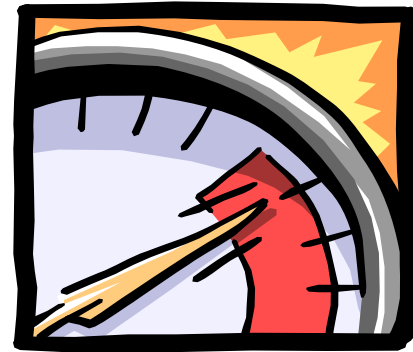| IEEE 1220	EIA-632
6.8.1.5 Performance-based progress measurement **6.8.6 Track product … metrics**	4.2.1 Planning process, Req. 10: **Progress against requirements**

6.8.1.5 d) Assess
• *Development maturity* to date
• Product's ability to *satisfy requirements*
6.8.6 *Product metrics…at pre-established control points* enable:
• Overall system *quality* evaluation
• Comparison to *planned goals and targets*
	Assess *progress …*
	• Compare system definition
	  Against requirements
	a) Identify *product metrics* and *expected values*
	  ▪ *Quality* of product
	  ▪ Progress towards *satisfying requirements*
	D) *Compare* results against requirements

Technical Performance Measures (TPM)

IEEE 1220: 6.8.1.5, *Performance-based progress measurement*	EIA-632: Glossary
TPMs are **key** to progressively assess technical progress	*Predict* future value of *key technical parameters* of the end system based on current assessments

•Establish *dates* for
  – Checking Progress
  – Meeting full conformance to requirements
	Planned value profile is time-phased achievement projected
	• *Achievement to date*
	• *Technical milestone where TPM evaluation is reported*
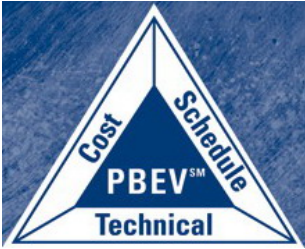
TPM

- **How well a system is achieving performance requirements**
- **Use actual or predicted values from:**
  - **Engineering measurements**
  - **Tests**
  - **Experiments**
  - **Prototypes**
- **Examples:**
  - **Payload**
  - **Response time**
  - **Range**
  - **Power**
  - **Weight**
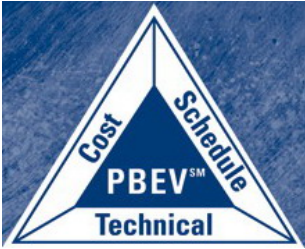
TPM

Use TPMs as a base measure of EV

Percent Required Value

TPM Planned Value Profile

150

Tolerance Bands

100

Achievement to Date

18
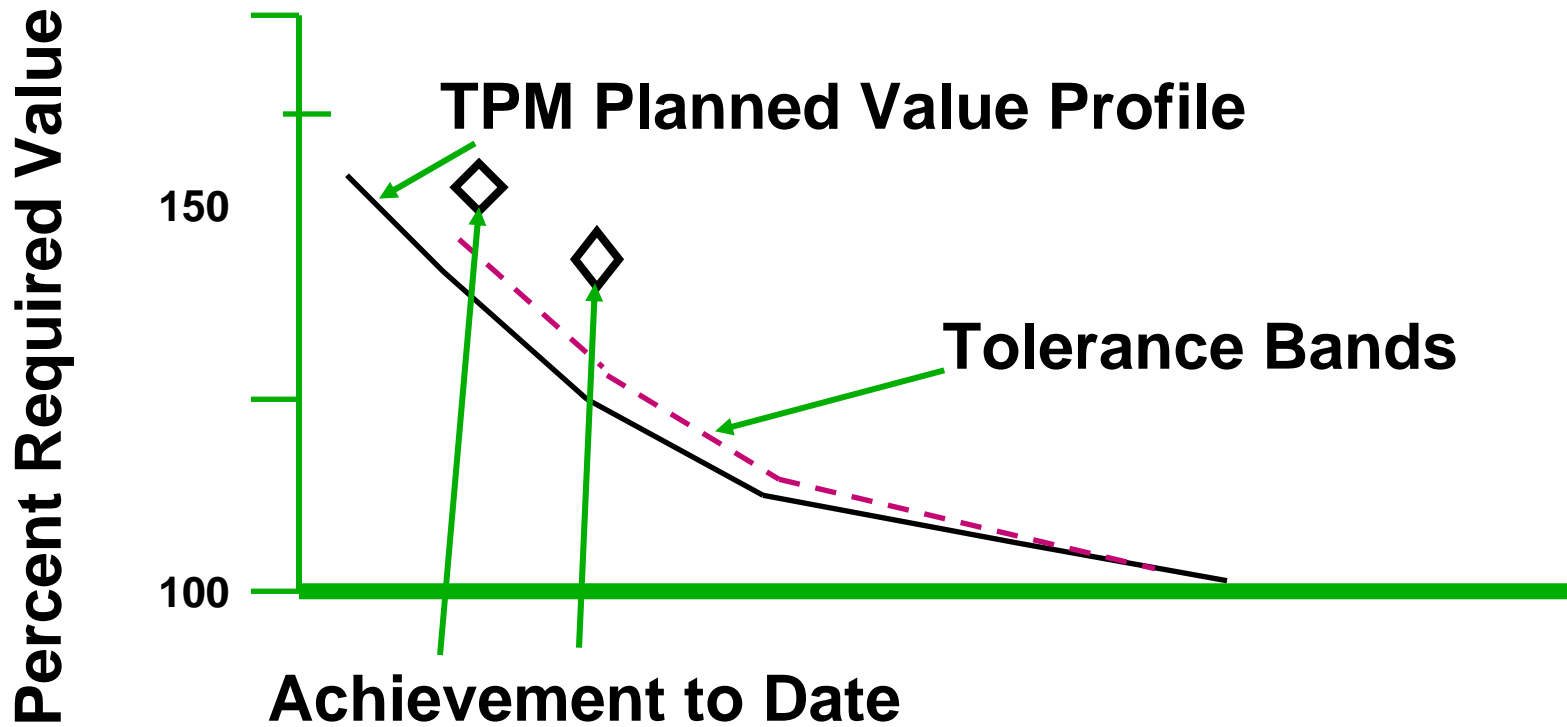
IEEE 1220, Preliminary design stage

5.2.4.1 Subsystem reviews
 	
a. **Subsystem definition**
 	
• **Mature**
 	
  – **Meet SE milestone criteria**
 	
a. **Component allocations and specifications**
 	
  – **Provide a sound subsystem concept**
 	
c. **Subsystem risks assessed and mitigated**
 	
d. **Trade-study data...substantiate that subsystem requirements are achievable**

Synthesis (Design)

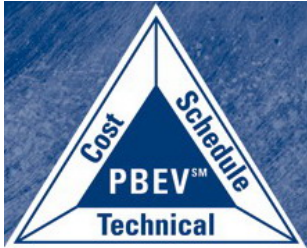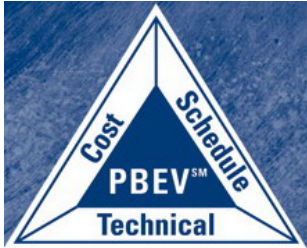| IEEE 1220, (6.6): Success Criteria |
| --- |
| • **Design solution meets:**

   – **Allocated performance requirements**

   – **Functional performance requirements**

   – **Interface requirements**

   – **Workload limitations**

   – **Constraints**

   – **Use models and/or prototypes to determine success** |

Product Requirements

- **CMMI, PMBOK Guide: Traceability and consistency**

Requirements

Product Require- ments **Baseline**

Work

- **Project Plans**
  - Task 1
  - Task 2
  - Task 3
- **Activities**
- **Work Products**

21
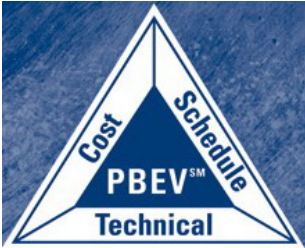
Process and Product QA

- **Product QA**
  - **CMMI:**
    - ***Objectively* evaluate work products against *clearly stated criteria***
    - ***Minimize subjectivity***
  - **EVMS:**
    - **EV is measurement of *quantity* of work**
    - **"*Quality* and *technical* content of work performed are *controlled by other means!*"**

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Project Management with Performance-Based Earned Value® (PBEV^{SM})
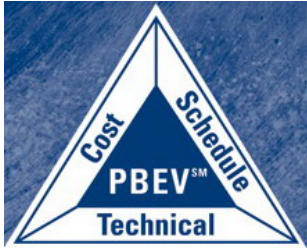
PBEV

- **4 Principles and 16 Guidelines**
- **Specify most effective measures of project performance**
- **Requirements-driven plan**
- **Consistent with standards and models**
- **Tailorable and scalable, depending on risk**
- **Lean**
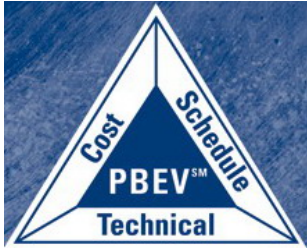
PBEV Based on Standards and Models

- **ANSI/EIA-632**
- **IEEE 1220**
- **CMMI®**
- **PMBOK® Guide**
- **INCOSE SE Handbook**
- **PSM.** *Practical Software and Systems Measurement: A Foundation for Objective Project Management*
- **Earned Value Management Systems (ANSI/EIA-748-A-1998, reaffirmed August 28, 2002) (EVMS)**

Principles of PBEV

1. Integrate product requirements and quality into the project plan.

2. Specify performance towards meeting product requirements, including planned quality, as a base measure of earned value.

3. Integrate risk management with EVM.

4. Tailor the application of PBEV according to the risk.

Supplemental PBEV Process Flow

(P) Establish product requirements and components (technical baseline) — Guideline 1.1

Define the work (WBS)

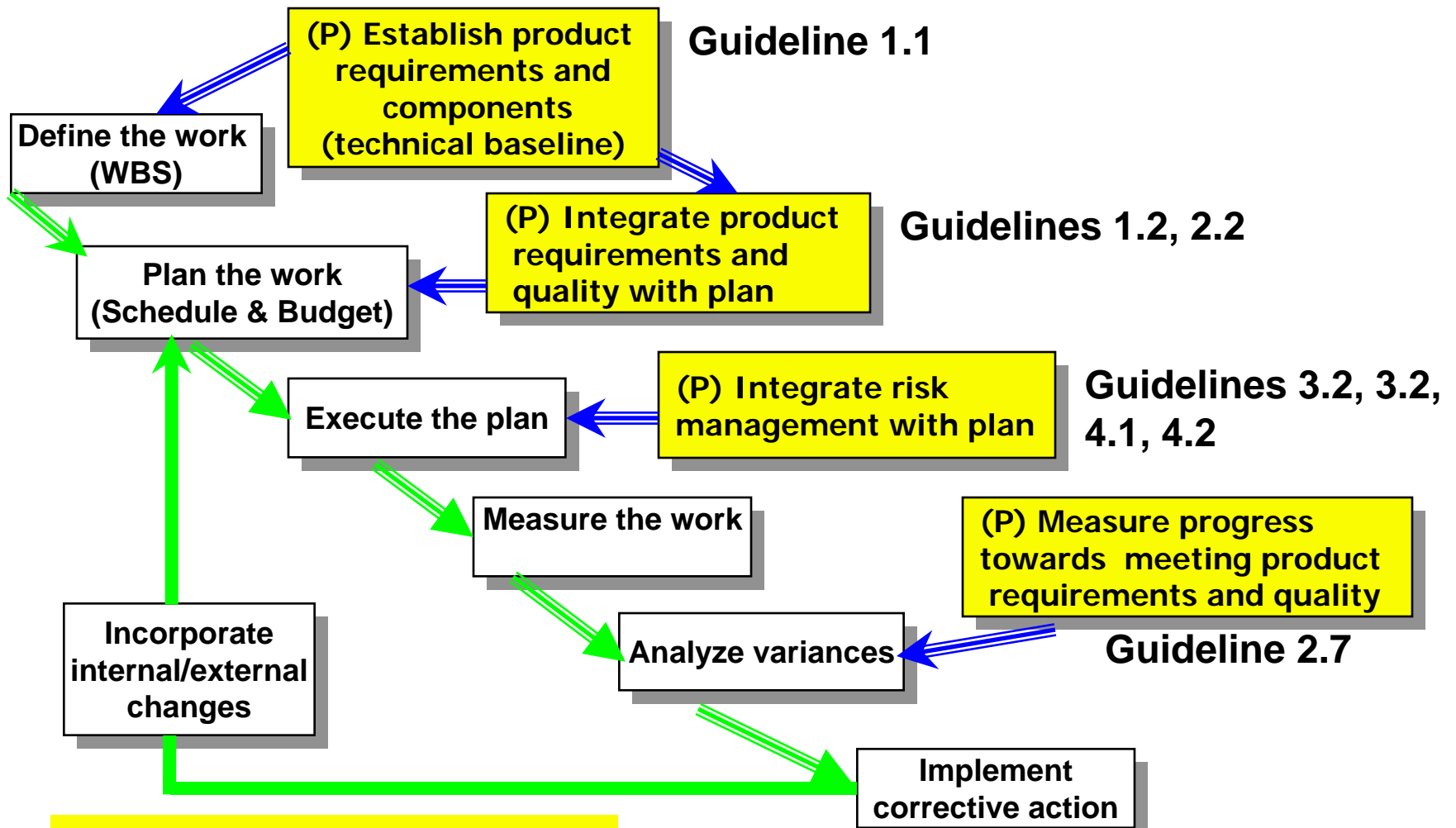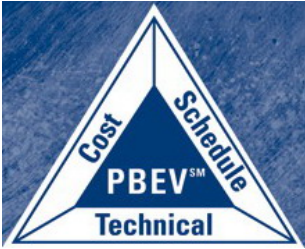**(P) Integrate product requirements and quality with plan** — Guidelines 1.2, 2.2

Plan the work (Schedule & Budget)

(P) Integrate risk management with plan — Guidelines 3.2, 3.2, 4.1, 4.2

Execute the plan

Measure the work

(P) Measure progress towards meeting product requirements and quality — Guideline 2.7

Incorporate internal/external changes

Analyze variances

Implement corrective action

(P) = Supplemental PBEV Process

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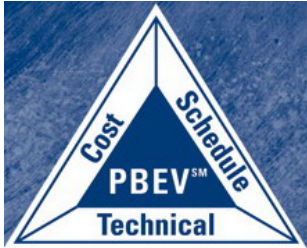
27

PBEV Techniques

- **Measure quality**
  - **Work products (partial and complete)**
  - **Technical maturity of evolving product**
  - **Use analysis, models, simulations, prototypes**
- **Base EV on**
  - **Work products (drawings, code) <u>and</u>**
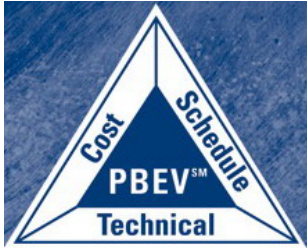 - **Quality**

Schedule Plan	Jan.	Feb.	Mar.	Apr.	May	Total
Drawings	8	10	12	10	10	50
Requirements met:						
Weight				1		1
Diameter				1		1

Status at April 30

- **Drawings completed: 41**
- **Weight requirement *not* met**
- **Diameter requirement met**

EX 1: Earned Value

| Design (drawings)	Jan.	Feb.	Mar.	Apr.	May	Total
Planned drawings cur	8	10	12	10	10	50
Planned drawings cum	8	18	30	40	50	
BCWS cur	320	400	480	400	400	2000
BCWS cum	320	720	1200	1600	2000	2000
Actual drawings completed cur	9	10	10	12	8	
Actual drawings completed cum	9	19	29	41	49	
EV (drawings) cum	360	760	1160	1640	1960	
Negative EV Reqs cum					-100	
Net EV cum	360	760	1160	1640	-1860	

SV = - 140

EX 1: Variance Analysis

Variance analysis (drawings and requirements):

- **1 drawing behind schedule**   **- 40**
- **Diameter requirement met**   **- 0**
- **Weight requirement *not* met:**   **- 100**

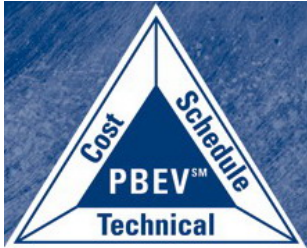**Schedule variance**   **- 140**
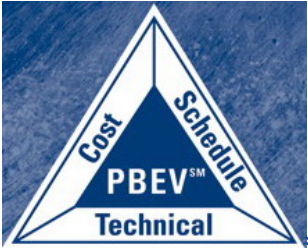
Better Acquisition Management

Acquisition Management
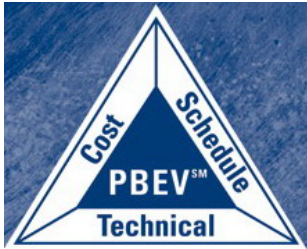
Ensure Contractors Integrate SE with EVM

- **Requirements, incentives, insight:**
  - **Solicitation/Request for Proposal (RFP)**
  - **Integrated Master Plan (IMP)**
  - **Integrated Baseline Review (IBR)**
  - **Integrated Master Schedule (IMS)**
  - **EVMS compliance assessments**
  - **Independent technical assessments**
  - **Monitor consistency and validity of reports**
  - **Independent EAC and risk assessments**
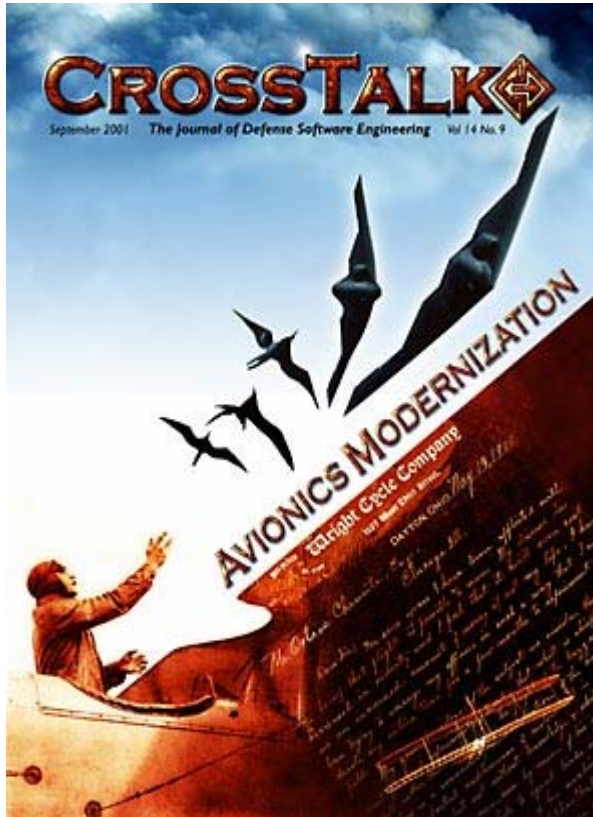 - **Award fee criteria**
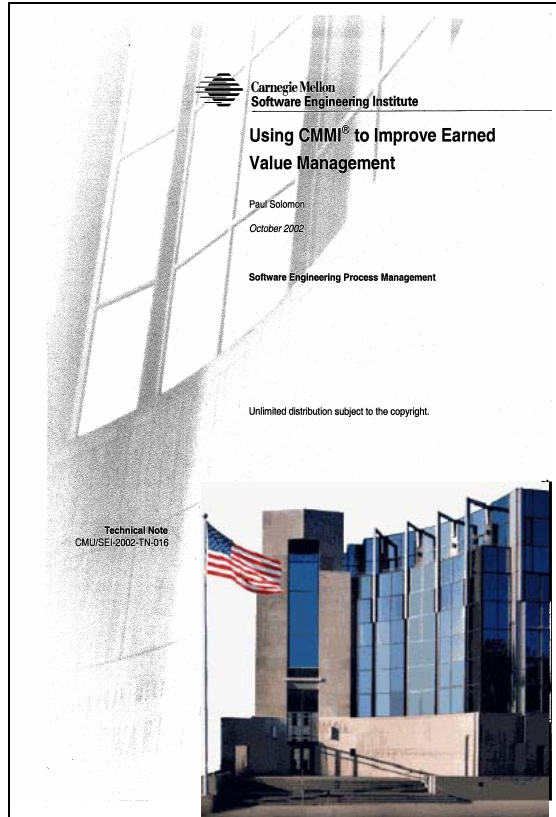
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Summary
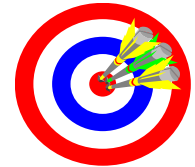
- **Integrate**
  - **Systems engineering with PBEV**
    - **Product requirements**
    - **Manage the technical baseline**
    - **Technical performance measures**
    - **SE life cycle work products**
  - **Technical>schedule>cost performance**
- **Lean process**
  - **Less work packages with right base measures**
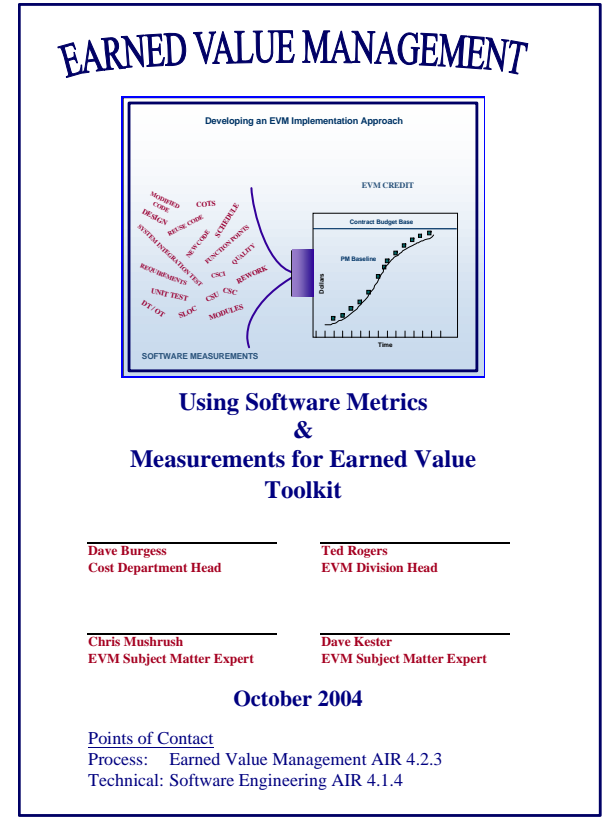- **Agile**

Process Improvement

Sept. 2001
Aug. 2005
May 2006

SEI / CMMI

NAVAIR
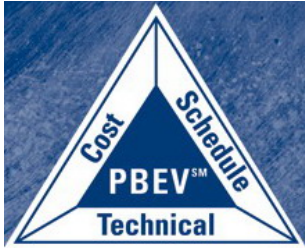
Process Improvement

But wait.

There's more!

- **Examples**
- **Templates**
- **Tips**
- **Standards**
- **FAR**

PERFORMANCE-BASED EARNED VALUE®

PBEV = EVM + Quality

PAUL J. SOLOMON, PMP

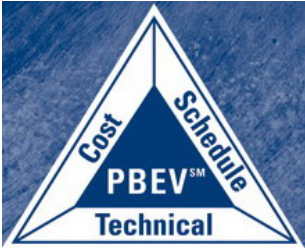RALPH R. YOUNG, DBA

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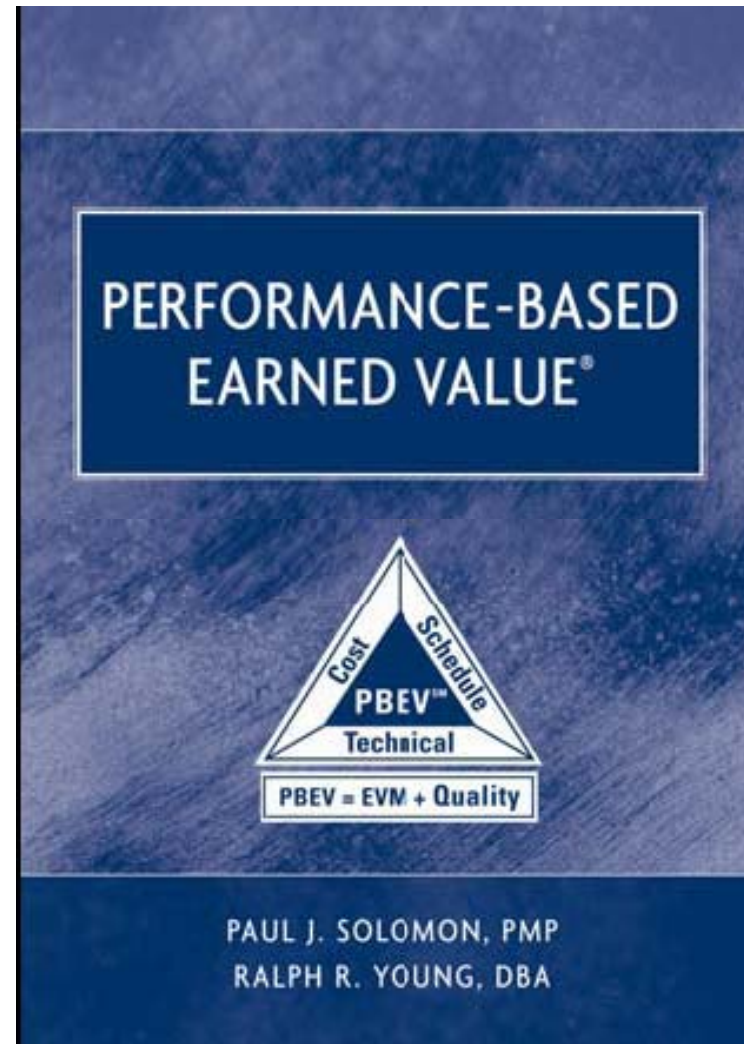
References

- ®CMMI Is Registered by Carnegie Mellon University in the U.S. Patent and Trademark Office.
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- ® PMBOK is registered by the Project Management Institute in the U.S. Patent and Trademark Office
- American National Standards Institute (ANSI)/Electronics Industries Alliance (EIA). ANSI/EIA 632, *Processes for Engineering a System*, EIA, Arlington, VA, 1998.
- CMMI, *Capability Maturity Model Integration-Systems Engineering/Software Engineering/Integrated Product and Process Development, Version 1.1*, 2002.
- INCOSE 2006. International Council on Systems Engineering (INCOSE). *INCOSE Systems Engineering Handbook, version 3.* June 2006. page 7.11
- Institute of Electrical and Electronics Engineers (IEEE). IEEE Std 1220™-2005*, IEEE Standard for Application and Management of the Systems Engineering Process. New York, 2005.*
- Naval Air Systems Command (NAVAIR*). "Using Software Metrics & Measurements for Earned Value Toolkit."* Department of the Navy (October 2004).

References

- **PSM.** *Practical Software and Systems Measurement: A Foundation for Objective Project Management*, Version 4.0b, October 2000 (www.psmsc.com).
- **Solomon, Paul . "Practical Software Measurement, PBEV",** *CrossTalk* **(September 2001) www.stsc.hill.af.mil/crosstalk/2001/09/index.html.**
- **Solomon, Paul. "Going From PBEV to the CMMI",** *CrossTalk* **(September 2002) www.stsc.hill.af.mil/crosstalk/2002/09/index.html.**
- **Solomon, Paul , "Using CMMI to Improve Earned Value Management" (CMU/SEI-2002-TN-016) (October 2002). www.sei.cmu.edu/publications/documents/02.reports/02tn016.html**
- **Solomon, Paul , "Integrating Systems Engineering with Earned Value Management",** *Defense Acquisition, Technology and Logistics (AT&L) Magazine* **(May 2004). www.dau.mil/pubs/dam/05_06_2004/may-june04.pdf.**
- **USAF Space & Missile Systems Center, "Systems Engineering Primer and Handbook" (January 2004)**
- **Young, Ralph R.** *Effective Requirements Practices* **(Addison-Wesley, 2001).**
- **Solomon, Paul. "Performance-Based Earned Value",** *CrossTalk* **(August 2005) www.stsc.hill.af.mil/crosstalk/2005/08/index.html.**
- **Solomon, Paul. "Practical, Performance-Based Earned Value",** *CrossTalk* **(May 2006)**