The C-17 Systems Engineering Journey

Kenneth Sanger/John Slye/Chantal Joubert-Honacki

27 October 2005

Overview

- More than 5,000 design changes per year have been made to the C-17, for the past three years (more than 1,000 major design changes per year)
- Formal systems engineering (SE) process established in 1998, instrumental in design development implementation
- Integral tie between C-17 SE process and overall process based management (PBM) plan
- Mission Assurance philosophy embedded in culture and processes
- Open communication and shared vision support true USAF/Boeing system engineering partnership

Integration of Processes, Tools and Training to Reinforce the Role of SE in the C-17 Development Process

C-17 Systems Engineering

Strong and Getting Stronger

USAF/Boeing C-17 Program

1990 — 2000 — 2005

- Malcolm Baldrige National Award Winner
- CAPE Gold Level
- PMBP 4 of 5
- CMMI L5
- LEAN
- PMBP (SE) 3+/5
- ISO/BQMS 10,000 Perfect Score

Processes

PBM
- Defined processes and process hierarchy
- Process Discipline

9-Step Change Process
- Effective management of change

C-17 SEMP
- Based on value stream mapping
- Ensure full traceability and application across weapons system
- Risk-based qualification

C-17 SE Manual
- Defined SE Process, Products, linkage to PBM and Tailoring Approach

AV/FC/SE-SEMP
- Follows SE Manual
- Tailored to Avionics needs

C-17 SE Manual
- Updating to reflect ties to ISO, CMMI, Malcolm Baldrige, etc

Tools

SEAMS
- Repository for Project SE data
- Design Review Entry/Exit Criteria
- Used to develop/track SE Metrics

SEAMS Upgrade
- Program/block/project hierarchy
- Internal assessments
- Mission Assurance module

People

SE Training
- Systems Engineers

SEAMS Training
- Systems engineers and project managers

SE Training
- All Air Vehicle IPT engineers and managers

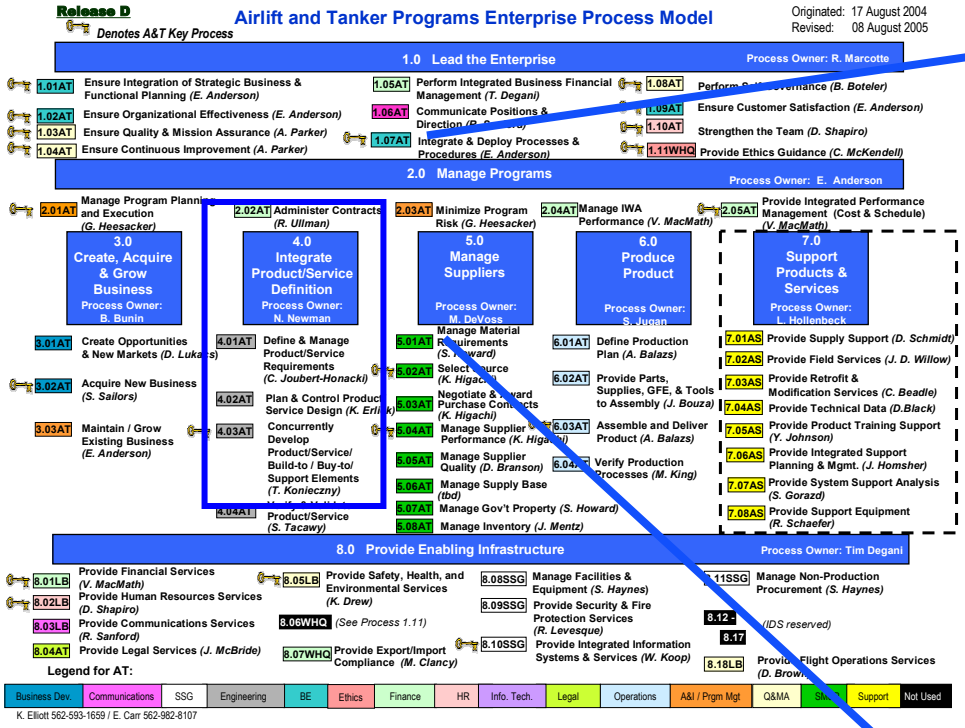
SE Organization
- Formed SE Group

IPT Deployment
- Systems Engineers Deployed to IPT Groups

SE Aligned
- Enrolled/Assigned
- Best Practices

Process Based Management Enterprise Model

USAF/Boeing C-17 Program



- **Boeing Benchmark**
- **Institutionalized**
- **Involves Customer Throughout**

4.0
Integrate Product / Service Definition

4.01
Define and Manage Product / Service Requirements

4.02
Plan & Control Product / Service Design

4.03
Concurrently Develop Product / Service / Build-to / Buy-to / Support Elements

4.04
Verify / Validate Products/Services

Mission Assurance – The Third Dimension

Domain expertise & experience - Independent Reviews

Baldrige National Quality Program

Overarching Framework
- Management Leadership
- High level visibility

Business Excellence

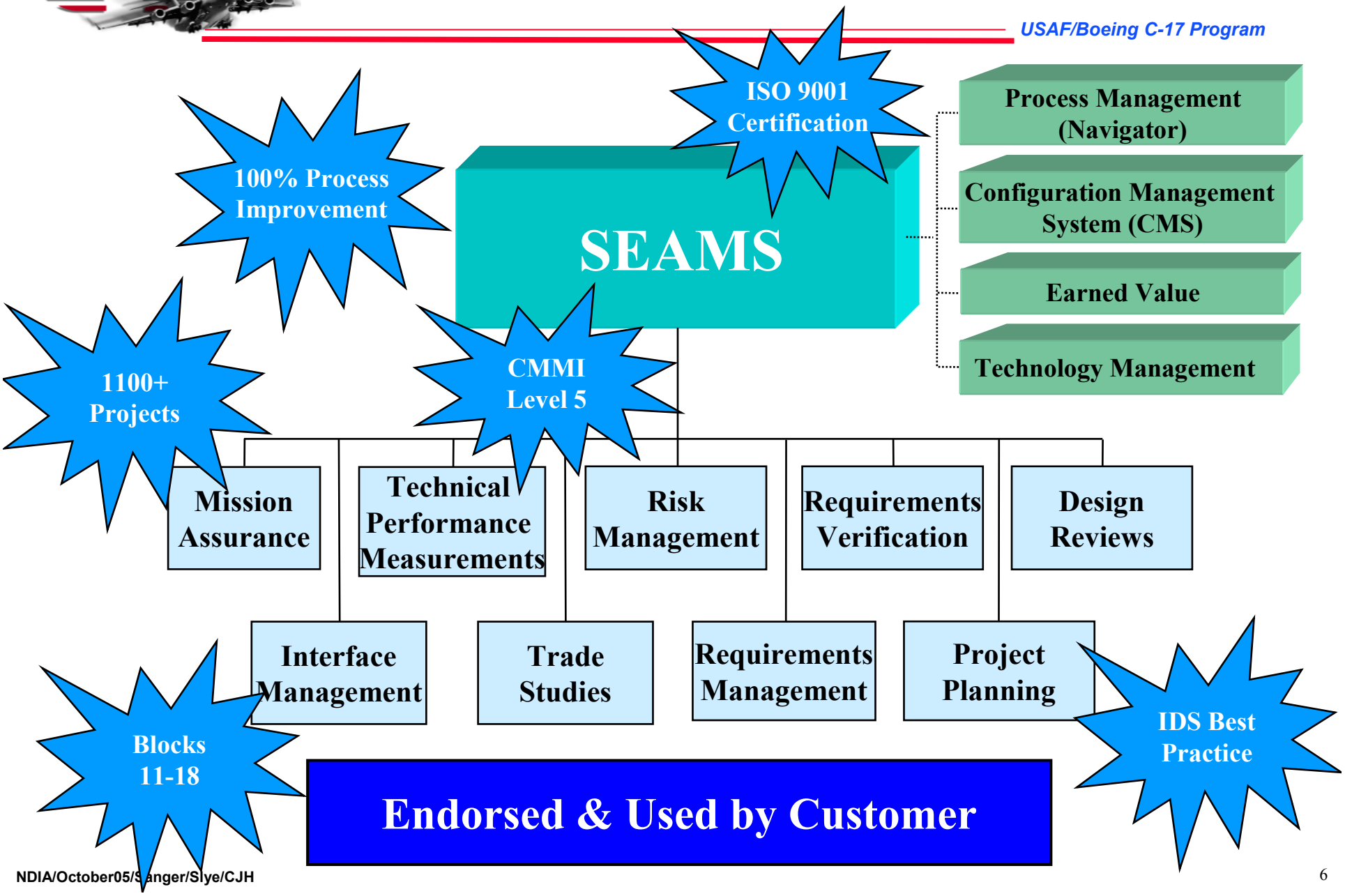
Capability Maturity Model Integration
Doing
- Implementation
- Metrics driven

PMBP
Program Management Best Practices
Managing
- Maturity matrix
- Review feedback

Lean
Lean Enterprise
Thinking
- End to End
- Value Stream Analysis

BOEING QUALITY BQMS MANAGEMENT SYSTEM
Being
- Quality in everything/culture
- Fundamental supporting concept

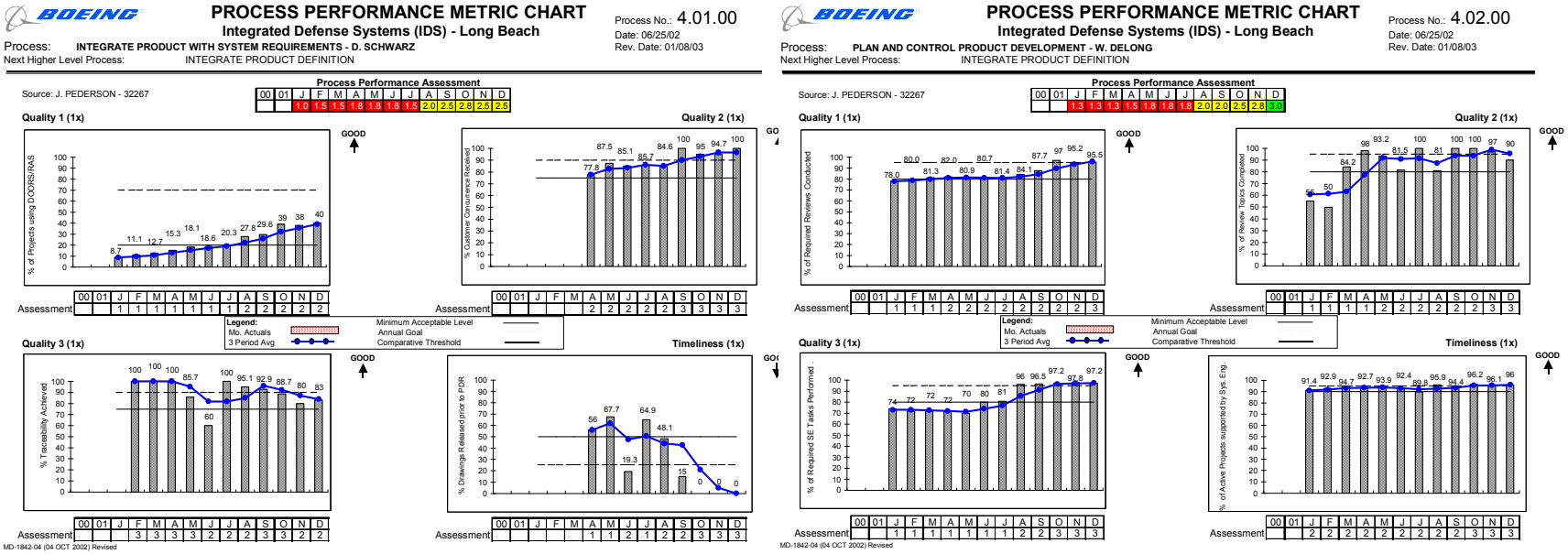
SEAMS Deployment Summary



SEAMS Directly Supports Metrics

USAF/Boeing C-17 Program

- **Performance Metrics Defined and Coordinated With Internal and External Customers**
- **Project Data Used to Measure and Manage the Related Processes**
- **Root Cause and Corrective Action Triggered by Variances to Plan**



IDS Systems Engineering Training Plan

Basic

- SE Methodology 40-hour course
- 1-day SE Overview
- Web-based training modules on SE
- Best Practices on-line training
- On the job Protégé Training

Intermediate

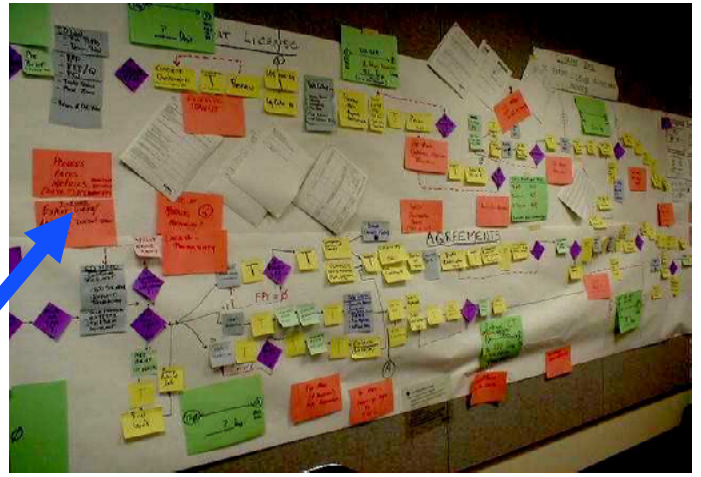
- Advanced SE Class
- 2 day SE Process Update
- Workshops on SE Tasks
- "How to" training in SE process areas
- Non-SE to SE Training/Mentoring
- SE Certificate Programs – UA Huntsville, UC Irvine

Advanced

- USC/UM Rolla Certificate and Masters in SE
- Stevens Institute of Technology Certificate, Masters and PhD in SE
- NPS/MIT Certificate and Masters in SE
- BLC 5-day Leadership in SE Training (in work)
- Mentor Junior Engineers

Lean VSM Process Outline

1. Define the boundaries
2. Define the value
3. "Walk" the process
   - Identify tasks and flows of material and information between them
4. Gather data
   - Identify resources for each task and flow
5. Create the "current state" map
6. Analyze current conditions
   - Identify value added and waste
   - Reconfigure process to eliminate waste and maximize value
7. Visualize "ideal state"
8. Create the "future state" map
9. Develop and track action plans



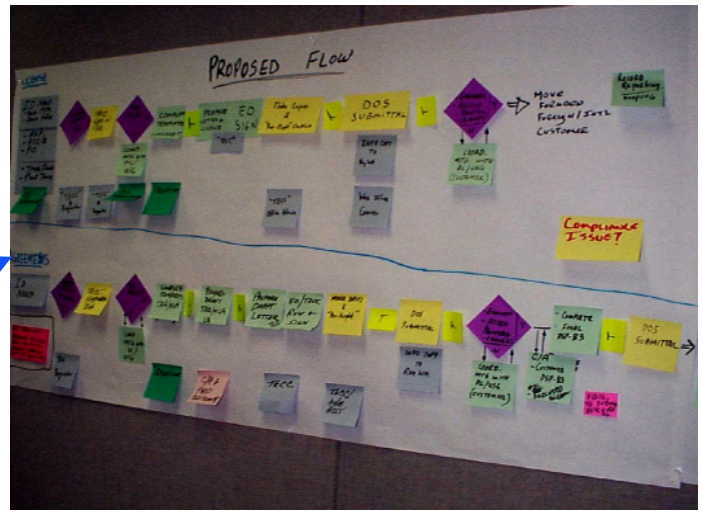
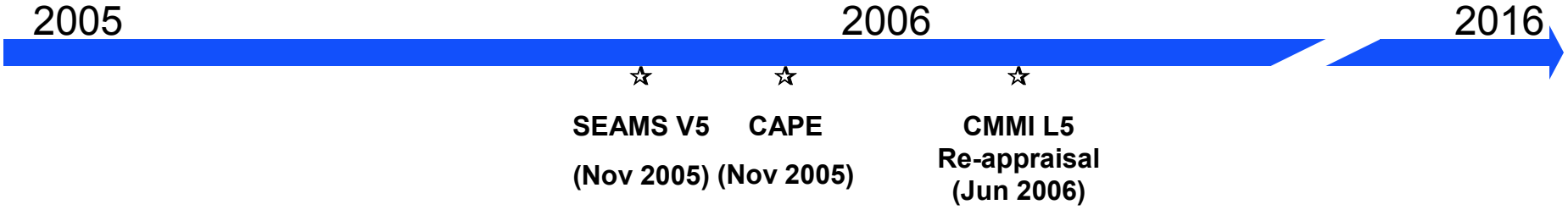


Photo source: Raytheon

SE Strategy Implementation Plan Integrates Short-Term and Long-Term Actions

USAF/Boeing C-17 Program



C-17 SEMP
- Based on value stream mapping
- Ensure full traceability and application across weapons system
- Risk-based qualification

C-17 SE Manual
- Updating to reflect ties to ISO, CMMI, Malcolm Baldrige, etc

SEAMS Upgrade
- Program/block/project hierarchy
- Internal assessments
- Mission Assurance module

SE Training
- All Air Vehicle IPT engineers and managers

SE Aligned
- Enrolled/Assigned
- Best Practices

9 Focus Areas

SE Certification

Value Stream Mapping Process

Common Tools & Processes

SE Strategic Imperative

Best Practice (SE Survey)

Architecture

9 Improvement Projects

Conduct Accelerated Improvement Workshop (AIW) on requirements management

Template Procurement Specification

Implement Enrolled/Assigned
- Common processes
- Common training
- Shared vision

Engineering Best Practices CAP

Discipline to Processes

Rotation of People

Summary

- We Are Moving Toward Our Vision of Systems Engineering Excellence
- Process Based Management and Integrated Tools are Essential to Accomplishing Our Goals
- Training Is Essential to Deployment/ Sustainment
- Process Application Is Key to Institutionalization
- Application of Systems Engineering Process Execution Encompasses Everyone


BOEING