Improving Systems Engineering Process Through Value Stream Mapping

By
Brent Theodore
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

• Integral tie between C-17 SE process and overall Process Based Management (PBM)

• Mission Assurance philosophy embedded in culture and processes

• Open communication and shared vision support true USAF/Boeing system engineering partnership
Vision:

• The C-17 Enterprise is the World Class Leader in Systems Engineering:
  • Robust, standardized, effective, & efficient Systems Engineering products, processes, & tools are applied & integrated across the C-17 Program to enable mission success
  • For all system development there are thoroughly defined and validated requirements, at all levels that are fully traceable from customer needs through verification and validation
  • Risks are defined and managed to ensure balanced technical, schedule, and cost performance throughout the product life cycle (Develop, Produce, Operate, Support)

Mission:

• To define & ensure common application of SE processes using a controlled tailored approach, that will facilitate C-17 program and mission success
Driving Forces for Change ~ Where We Were

- People
  - Gain greater Systems Engineering (SE) understanding
  - Initiate common SE focus
- Improve Customer satisfaction (external)
  - Systems Engineering (SE) Imperative
  - Customer Involvement
- Need to Institutionalize systems engineering
  - Greater Process discipline
  - Internal customer satisfaction
- Increase Focus on Supplier Systems Engineering (SE)
  - Requirements
  - Quality
Priorities

• Institutionalize systems engineering
  – People: Training / rotation / communication / knowledge transfer
  – Process discipline, metrics

• Strategic roadmap
  – Near term actions / address customer concerns
  – Long range vision to keep focus
  – Supplier SE roadmap
Systems Engineering Imperative Context

External Influences
- USAF C-17 Upgrades
- Industry Initiatives (INCOSE, CMMI, LAI, …)
- Enterprise Value Stream Mapping (identifies SE as focus area)
- SE Survey

Internal Influences
- Process (ISO, PBM, …)
- Organization (IPTs)
- People resources
- C-17 baseline
- SE HILT
- Tool capabilities

SE Process
- Understand situation
- Define requirements
- Perform trade study
- Develop and implement plan

Infrastructure
- Common vision buy-in
- Management commitment
  - Participation
  - Resources
- PBM framework
- Project participation
- Employee Involvement
- Lessons learned database

World class leader in systems engineering enabling mission assurance
• Boeing Benchmark
• Institutionalized
• Involves Customer Throughout
SE Strategy Implementation Plan

• Near term actions (6 months) and long term vision will be integrated into single SE improvement plan.
  – Nine focus areas identified in early self assessment
  – Best practice implementation based on internal (Boeing) systems engineering survey (external to C-17)
  – 22 improvement projects from the 3 VSMs
  – Discipline to process
    • Metrics, Training, Communication, updated processes and command media
  – Engineering Best Practices corrective action plan
  – SE Manual updates
  – Implementation of IDS Command Media and SE HILT Common Tools and Processes
### Recent Accomplishments

- Two sessions of Value Stream Mapping (VSM) Completed in 2005
  - Phase A Jun 05, Customer needs – CDR
  - Phase B Dec 05, CDR - Verification)
- Technical Flowdown to Suppliers VSM Completed (Feb 2006)
- SE Tool Training @ SG
- OSS&E Training by SG & Boeing in LB

### Current Focus Areas:

1. 22 Improvement Plans (from VSMs)
   - Requirement definition
   - Key opportunities to improve cycle time reduction suppliers
2. Program Level Metrics
   - PMBP (SE) Improvement Plan
3. Training Engineering in SE Processes

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### We Are Here

Maturing from “breakthrough” to “strengthening” SE processes

<table>
<thead>
<tr>
<th>Step 1</th>
<th>Step 2</th>
<th>Step 3</th>
<th>Step 4</th>
<th>Step 5</th>
<th>Step 6</th>
<th>Step 7</th>
<th>Step 8</th>
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<tbody>
<tr>
<td>Initial Self-Assessment</td>
<td>Initially Identified Current State</td>
<td>Set Vision</td>
<td>Initial Focus Areas Identified</td>
<td>SE Survey (external to C-17)</td>
<td>Evaluation &amp; Planning (for VSM)</td>
<td>Value Stream Mapping</td>
<td>Develop Implementation Plan</td>
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<td><strong>Implement Plan</strong></td>
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Participation

- Systems Group – 7 (Avionics, Conf Mgt, Structures, Lean, Production Ops, Support Systems, Systems Eng)
- Boeing Systems Engineers (non C-17) – 6 (AFS, Anaheim, C-130, Canoga Park, Huntington Beach, 767 Tanker)
- Analysis and Integration – 4 (Block Integration, Configuration Mgt, Change Mgt, Program Mgt Systems)
- DCMA - 2
- Supplier Management - 2
- Support Systems – 1
- Production Operations - 1
- Lean Enterprise – 3
Apply Lean Techniques to Identify Improvements

1. Define the boundaries
2. Define the objectives
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
Near Term Improvement Projects identified

☐ Interface Management
☐ Project Reviews
☐ Requirements Process Enablers
☐ Needs Definition
☐ Systems Integration

☐ Trade Study Improvement
☐ Verification Improvement
☐ Project Team Memberships
☐ Statement of Requirements (SOR)
☐ Development Improvement

Future State
By working jointly significant SE progress improvements have been made
• Use PICK process
  – Possible
  – Implement
  – Consider
  – Kill
### SE VSM Project Schedule & Plan

#### Identified 22 projects from 3 VSMs
- Closed 11, Transferred 2
- Stimulating IPT integration
- Enterprise-wide collaboration

#### Table: Project Details

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<tr>
<th>#</th>
<th>Title</th>
<th>Team Leader</th>
<th>ECD</th>
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<td>Jim Settlemyre</td>
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**Project Testing Capability (green) - 95% Confidence**

#### Diagram: Project Testing Capability

- [Green Diagram]

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**Project Management (LPT)**

- [Diagram: Project Management (LPT)]

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**Objectives**

- [List of objectives]

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**Approach**

- [List of approach steps]

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**References**

- [List of references]

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**Appendix**

- [Appendix content]
# Metrics Summary Overview

## Program-Level Metrics Review: Measuring Effectiveness of SE Process

### Metric Titles

<table>
<thead>
<tr>
<th>Aug-06</th>
<th>Sep-06</th>
<th>Oct-06</th>
<th>Nov-06</th>
<th>Dec-06</th>
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## Systems Engineering Health

1. **SE Scorecard**
   - G
   - G

2. **Best Practices Assessment (SE Unique)**
   - 2a. **Program Management Best Practices**
     - G
     - G
   - 2b. **Engineering Best Practices**
     - G
     - G

3. **Risk Management Effectiveness**
   - 3a. **Project Approved Within Normal Lead Time**
     - G
     - B

## Predictive Metrics

1. **Requirements Quality** *(Engineering-Quality)*
   - N/A
   - N/A

2. **After-Initial Release/Initial Release** *(Engineering-Quality)*
   - G
   - G

3. **Design Reviews: Critical Action Items** *(IMP/IMS)*
   - G
   - G

## Reactive Metrics

1. **Advanced Assembly Orders** *(Production-Quality)*
   - G
   - G

2. **LRU Tag Trend** *(Production-Quality)*
   - G
   - G

3. **Deviations & Waivers** *(Production-Quality)*
   - G
   - G

## Operational Metrics

1. **MTBM (I), Inherent** *(Aircraft Reliability)*
   - B
   - B

2. **# of Work Packages with RHI >= 10** *(Aircraft Safety)*
   - G
   - G
Systems Engineering Training

- Operational, Suitability, Survivability & Effectiveness conducted by SG and Boeing in Long Beach
- SE tool training provided on site to SG
- SE Overview training scheduled for all Air Vehicle engineers & project managers
We are moving toward our vision of Systems Engineering Excellence.
Summary

• Number of driving forces for change
• Used a structured, lean engineering analysis of systems engineering to take Systems Engineering on C-17 Program to the next level
  – Performed value stream map on product development process from customer need through verification
    • Identify key improvement areas
    • Integrated plans into System Engineering Strategic Imperative
• Built on our strong Process Based Management (PBM) foundation
• Change the culture
• Training is essential to deployment / sustainment
• Process application is key to institutionalization
• Application of Systems Engineering process execution encompasses everyone
• Communicate at all levels

Application of Lean techniques is key in supporting our journey to Systems Engineering Excellence