Lean Enablers for Managing Engineering Programs

Presentation to the INCOSE Enchantment Chapter – June 13 2012

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Conduct a study within 1 year, that
- Identifies the key challenges in managing engineering programs and
- Identifies and documents best practices to overcome these challenges

Ensure highest possible degree of applicability and practicality by
- Focusing on needs of program managers from industry and government,
- Develop the results through a group of subject matter experts and
- Validate the results extensively.
180+ current members representing 35+ organizations

http://lean.mit.edu
Development Process

- Based on **concrete challenges**, not thin air
- Incorporates **start-of-the-art knowledge** from literature
- Developed by group of 15 **subject matter experts** through year-long, weekly meetings
- Feedback through wider **community of practice** (180+ members)
- Discussed at 4 **large and very successful workshops**, involving both PMI and INCOSE members
- Backed-up by **two validation surveys**
- Validated by **content analysis** management practices of highly successful programs
Use of Lean Enablers in Successful and Unsuccessful Programs:
Level of Agreement of Respondents

- **LE 1.x: Respect**
  - Successful Program: Agree
  - Not Successful Program: Neither agree, nor disagree

- **LE 2.x: Value**
  - Successful Program: Agree
  - Not Successful Program: Neither agree, nor disagree

- **LE 3.x: Value Stream**
  - Successful Program: Agree
  - Not Successful Program: Neither agree, nor disagree

- **LE 4.x: Flow**
  - Successful Program: Agree
  - Not Successful Program: Neither agree, nor disagree

- **LE 5.x: Pull**
  - Successful Program: Agree
  - Not Successful Program: Neither agree, nor disagree

- **LE 6.x: Perfection**
  - Successful Program: Agree
  - Not Successful Program: Neither agree, nor disagree

Average N: 63 programs per category; all differences are statistically significant
MOTIVATION
How are we doing in the management of large-scale engineering programs?

• Regarding cost?
• Regarding schedule?
• Regarding delivering the benefits we promised?
Management of Large-Scale Engineering Programs: DOD Example

- Total cost growth: $296 billion
- Average schedule overrun: 22 months
- Similar situation in other industries

US Department of Defense Development Portfolio – Change to initial estimate (2008)

Sources: GAO 06-368, Bloomberg, GAO 10-374T
What is a serious engineering program challenge in your organization?

1. Reactive Program Execution
2. Lack of stability, clarity and completeness of requirements
3. Insufficient alignment and coordination of the extended enterprise
4. Value stream not optimized throughout the entire enterprise
5. Unclear roles, responsibilities and accountability
6. Insufficient team skills, unproductive behavior and culture
7. Insufficient Program Planning
8. Improper metrics, metric systems and KPIs
9. Lack of proactive management of program uncertainties and risks
10. Poor program acquisition and contracting practices
How bad are unstable requirements?

Increase of R&D Cost in DoD Programs

- Decreased, deferred or deleted requirements: 80%
- New or enhanced requirements: 70%
- Stable requirements: 10%

Source: GAO-11-233SP
INNOVATION BY BRIDGING KNOWLEDGE DOMAINS
Study Design: Innovation by Bridging Knowledge Domains

Lean Thinking + Systems Engineering + Program Management = Unique, Relevant and Actionable Advice

Unique
- Three world-class organizations and thought leaders joined forces
- Industry, government and academia participation

Relevant
- Massive challenges in program execution: Cost and schedule overruns
- Integration of knowledge and professional domains
-Extensively validated

Actionable
- Concrete advice
- Mapped to known challenges and existing standards
- Guidance for implementation
The Guide to LEAN ENABLERS for MANAGING ENGINEERING PROGRAMS

• Section 1: Introduction
  - Document overview
  - Motivation and impact
  - Applicability and scope
• Section 2: Overview Lean Thinking
  - Value and waste
  - Six lean principles
• Section 3: Integration of Program Management and SE
  - Relationship program management and SE
  - Introduction to program management and SE
  - Stakeholders and value
• Section 4: Top 10 Challenges
• Section 5: Lean Enablers
  - List of Enablers
  - Mapping to program management, challenges and SE
• Section 6: Complementary improvement approaches
  - Agile, CMMI, and EVM
• Section 7: Implementation recommendations
• Section 8: Barriers to implementation
• Appendix
  - Complementary information sources
  - References
  - Detailed mapping’
Baseline Recommendations

Guide to Lean Enablers for Managing Engineering Programs

- Challenges in Managing Engineering Programs
- Lean Enablers for Managing Engineering Programs
- Complimentary Improvement Approaches
- Implementation Suggestions
- Implementation Barriers
- Appendix: Lots of mappings and tables

Introduction to Lean Thinking

Alignment of Program Management and Systems Engineering

Improvement need, program context

http://lean.mit.edu
Lean Enablers: 300 Best Practices in 40 Categories

Lean Enablers for Managing Engineering Programs

Lean Enablers 1: Respect for people
- 6 enablers
- 37 sub-enablers

Lean Enablers 2: Capture the value as defined by the customer
- 7 enablers
- 44 sub-enablers

Lean Enablers 3: Map the value stream
- 10 enablers
- 69 sub-enablers

Lean Enablers 4: Flow the work processes
- 10 enablers
- 67 sub-enablers

Lean Enablers 5: Let customer pull value
- 2 enablers
- 8 sub-enablers

Lean Enablers 6: Pursue perfection in all processes
- 8 enablers
- 50 sub-enablers

http://lean.mit.edu

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EXAMPLES
Programs fail or succeed primarily based on people, not processes or tools

What is the key to motivating knowledge workers? Money! Really?

Watch Dan Pink at http://www.youtube.com/watch?v=u6XAPnuFjJc (or Google “Dan Pink RSA”)

Source: danpink.com
Example 1: Treat People as Your Most Important Asset (LE 1.x.x)

1.1.x Build a program culture based on respect for people

1.2.x Motivate by making the higher purpose of the program and program elements transparent

1.3.x Support an autonomous working style

1.4.x Expect and support people in their strive for professional excellence and promote their careers

1.5.x Promote the ability to rapidly learn and continuously improve

1.6.x Encourage personal networks and interactions

Source: danpink.com
What challenges do you address by helping people to become highly capable and motivated?

Mismanagement of competency and knowledge

- Insufficient program planning
- Insufficient alignment and coordination of the enterprise
- Improper metrics, metric systems and KPIs
- Processes locally optimized and not integrated
- Lack of proactive risk management
- Unstable, unclear and incomplete requirements
- Firefighting: Reactive program execution

- Unclear roles, responsibilities and accountability
- Poor acquisition and contracting practices
Associated Lean Methods and Tools

- **Mastery:**
  - Create Specialist Career Path to develop towering (technical) competence
  - Communities of Practice (internal and external)
  - Mentoring
  - Hire for attitude, train for skill

- **Autonomy:**
  - Kaizen: Bottom-up continuous improvement processes
  - Responsibility-based planning and control

- **Purpose:**
  - Create a shared vision that draws out the best in people (e.g. through value stream mapping)
Example 2: Optimize the value stream (LE 3.x.x) and create flow (LE 4.x.x)

- Use formal value stream mapping methods to identify and eliminate management and engineering waste, and to tailor and scale tasks. (LE 3.1.4)
- Use Lean tools to promote the flow of information and minimize handoffs. Implement small batch sizes of information, low information in inventory, low number of concurrent tasks per employee, small takt times, wide-communication bandwidth, standardization, work cells, and training. (LE 4.1.19)
Addresses challenge of value stream not being optimized throughout the entire enterprise

Time share of different types of activities in Engineering Programs

- Waste (Activity idle) 62%
- Activity Executed 38%
- Waste 15%
- Necessary waste 11%
- Value added 12%

Source: McManus, 2005, Oppenheim, 2004
## Waste in Engineering Programs - Examples

<table>
<thead>
<tr>
<th>Seven Wastes</th>
<th>Engineering Program Examples</th>
</tr>
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<tbody>
<tr>
<td><strong>Waiting</strong></td>
<td>• Waiting for information or decisions</td>
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<tr>
<td></td>
<td>• Information or decisions waiting for people to act</td>
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<td></td>
<td>• Large queues throughout the review cycle</td>
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<td>• Long approval sequences</td>
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<td>• Unnecessary serial effort</td>
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<tr>
<td><strong>Over-Processing of Information</strong></td>
<td>• Refinements beyond what is needed</td>
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<td></td>
<td>• Point design used too early, causing massive iterations</td>
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<td></td>
<td>• Uncontrolled iterations (too many tasks iterated, excessive complexity)</td>
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<td></td>
<td>• Lack of standardization</td>
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<td></td>
<td>• Data conversions</td>
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<tr>
<td><strong>Inventory of Information</strong></td>
<td>• Keeping more information than needed</td>
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<td></td>
<td>• Excessive time intervals between reviews</td>
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<td></td>
<td>• Poor configuration management and complicated retrieval</td>
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<td></td>
<td>• Poor 5 S's (sorting, straightening, systematic cleaning, standardizing, and sustaining)</td>
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<td>in office or databases</td>
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<tr>
<td><strong>Rework, Defects</strong></td>
<td>• The killer “re’s”: Rework, Rewrite, Redo, Re-program, Retest...</td>
</tr>
<tr>
<td></td>
<td>• Unstable requirements</td>
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<tr>
<td></td>
<td>• Uncoordinated complex task taking so much time to execute that it is obsolete when finished and has to be redone</td>
</tr>
<tr>
<td></td>
<td>• Incomplete, ambiguous, or inaccurate information</td>
</tr>
<tr>
<td></td>
<td>• Inspection to catch defects</td>
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</table>

...
Why “Flow” is key: Information rots!

Rot and rework of information in inventory

- Percentage of information items affected by 'rot'
- Amount of required rework (as % of original work in inventory)

Source: Kato 2005
How information inventory is created: Task switching

Average Information Inventory Time (engineering days) by Root Cause

- Switching to urgent task within project
- Waiting for information from other task
- Switching to urgent task outside project
- Other

Source: Kato 2005
Engineering Value Stream Mapping Process

Getting started
- Identifying key stakeholders
- Defining the team
- training the team
- Bounding the problem
- Defining the value
- Understanding value creation

Mapping the current state value stream
- Mapping tasks and flows
- Collecting data
- Evaluation of value
- Understanding interactions

Identifying waste
- Understanding types of waste
- Identifying different types waste

Improving the process
- Establishing takt time
- Assuring information availability
- Balancing the line
- Eliminating inefficient reviews
- Eliminating other wastes
- Mapping the future state

Source: McManus, 2005
Example Value Stream Maps:
All shapes and sizes

1 type of waste, one value stream

7 types of waste, three coupled value streams

Source: Kato 2005

Reducing Work in Progress through simple visual management (and prioritization)

Average from 972 cases at Boeing:
- Reduction of work in progress: 69%
- Improvement of quality (reduction of defects): 3.2x
- Improvement of throughput (reduction of lead time): 3.4x
- Time to implement method: 4 weeks
LEAN ENABLERS AND PROGRAM SUCCESS
Content analysis:
PMI Project (Program) of the Year Winners of the last 10 years
Application of Lean Enablers in “Best Practice Programs” –
The more detailed the reports, the more Enablers we found

- Deepwater (GAO-06-546) 74%
- 2011 Prairie Waters 65%
- 2010 Dallas Cowboys Stadium 60%
- 2009 Flour Power Plant 37%
- 2009 BAA Heathrow 19%
- 2008 QIT - Fer et Titane 23%
- 2007 Nuclear Cleanup 35%
- 2006 Rocky Flats Plant 26%
- 2005 Quartier International de 26%
- 2004 Haradh Gas Plant 37%
- 2003 Winter Olympics 42%
- 2002 Hawiyah Gas Plant 42%
- 2001 River of Aluminum 35%
- 2000 The Troja Reactor 35%

Based on application documents & GAO report
Based on brief reports
Every Lean Enabler was used at least once

<table>
<thead>
<tr>
<th>Lean Enabler</th>
<th>Relative Use</th>
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<tbody>
<tr>
<td>Flow 3</td>
<td>93%</td>
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<tr>
<td>Value 3</td>
<td>93%</td>
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<tr>
<td>Respect 1</td>
<td>78%</td>
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<tr>
<td>Value Stream 10</td>
<td>76%</td>
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<td>Perfection 6</td>
<td>71%</td>
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<tr>
<td>Value Stream 6</td>
<td>71%</td>
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<td>Flow 10</td>
<td>71%</td>
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<td>Respect 5</td>
<td>64%</td>
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<td>Value 4</td>
<td>64%</td>
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<td>Value Stream 8</td>
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<td>Perfection 5</td>
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<td>Respect 4</td>
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<td>Flow 2</td>
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<td>Flow 7</td>
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<td>Perfection 2</td>
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<tr>
<td>Value Stream 5</td>
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</table>
Most popular vs rarely used enablers

Almost always found

• Build a program culture based on respect for people
• For every program, use a program manager role to lead and integrate program from start to finish
• Frequently engage the stakeholders throughout the program lifecycle
• Develop a Communications Plan

Rarely found

• Pull tasks and outputs based on need, and reject others as waste
• Pursue Lean for the long term
• Use probabilistic estimates in program planning
Use of Lean Enablers in Successful and Unsuccessful Programs:
Level of Agreement of Respondents

- LE 1.x: Respect
- LE 2.x: Value
- LE 3.x: Value Stream
- LE 4.x: Flow
- LE 5.x: Pull
- LE 6.x: Perfection

Average N: 63 programs per category; all differences are statistically significant.
THE ROAD AHEAD
Overview of Year 2 Activities –
Working Draft

Year 2 Activities

Area 1: “Communication and Marketing”
- Overview material
- “Centralized” communication activities
- Implementation pilots

Area 2: “Training and Teaching Material”
- Extended Documentation of LE
- Lean Methods / Workshops
- Metrics
- Other elements

Company- and organization-specific communication
“Format” of Area 2 activities: Open Knowledge Portal
Currently: Proof of Concept & Prototyping Activities

Main Page

Welcome!
This is the prototype of the Knowledge Portal to Lean Management Techniques for Engineering Programs!

Enablers - Core Themes

1. Lean Enablers to Treat People as Your Most Important Asset (Lean Principle 6)
2. Lean Enablers to Maximize Program Value (Lean Principle 1)
3. Lean Enablers to Optimize the Value Stream (Lean Principle 2)
4. Lean Enablers to Create Program Flow (Lean Principle 3)
5. Lean Enablers to Create Pull in the Program (Lean Principle 4)
6. Lean Enablers to Pursue Program Perfection (Lean Principle 5)

Getting started

- For a quick overview of formatting your text, see the short introduction to Wikitext (it looks a little bit scary first, but makes you feel like a real pro after 5 minutes).
- Consult the User's Guide for information on using the wiki software.
- Configuration settings list
- MediaWiki FAQ

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- Become a subject matter expert – Monday, 1-2pm EDT