



Seminar

**LAI Lean Academy ®**  
**Lean Engineering Seminar V1.0**

**August 2007**

- **1 day Lean Engineering Seminar offered through MIT Professional Institute to class of 22 on Jul 12**
  - **Mature audience, mostly practicing engineers**
  - **Dick Lewis, Tom Bednar were supporting instructors**
- **JIT development by McManus & Murman**
  - **Jackie made the puzzle**
- **Successful outcome for alpha version**
- **Beta version to be offered as 4th day of Boeing St. Louis LAI Lean Academy in Aug 07**
  - **Dick Lewis, Venkat Allada, Steve Shade instructors**
- **Starting point for further development**

# Course Learning Objectives

**At the end of this course, you will be able to:**

- **Explain how Lean Thinking applies to engineering**
- **Describe three structured approaches to select the right product**
- **Describe how engineering applies to product lifecycle value**
- **Recognize how lean applies to engineering within an overall enterprise**
- **Demonstrate the application of value stream mapping to engineering**
- **Apply course knowledge to develop a lean engineering framework**

# Plan for the Day

- **Instructional modules**
  - *Lean Engineering Introduction*
  - *Translating Lean Thinking to Engineering*
  - *Selecting the Right Product*
  - *Product Lifecycle Value*
  - *Efficient Process Execution*
  - *Engineering-Enterprise Integration*
- **Lean Engineering Framework Exercise**
  - Teams developed a LE Framework ala LEM
  - Introduced in *Translating Lean Thinking to Engineering*
  - Incrementally developed during each module
  - Presented at end of day

# Lean Engineering Introduction

## Timing & Content

- 45 mins with 20 min of active learning
- Drivers for LE
  - Efficiency
  - Effectiveness
- Product Value
- PD Stakeholders
- Plan for the day

## Learning Objectives

At the end of this module, you will be able to:

- Restate the course faculty names and credentials
- Recognize class members with similar interests and/or backgrounds
- Recognize the need for applying lean thinking to engineering
- Report some different practices for lean engineering and traditional engineering
- Restate three categories of Product Development
- Summarize the course learning objectives and plan

## Active Learning

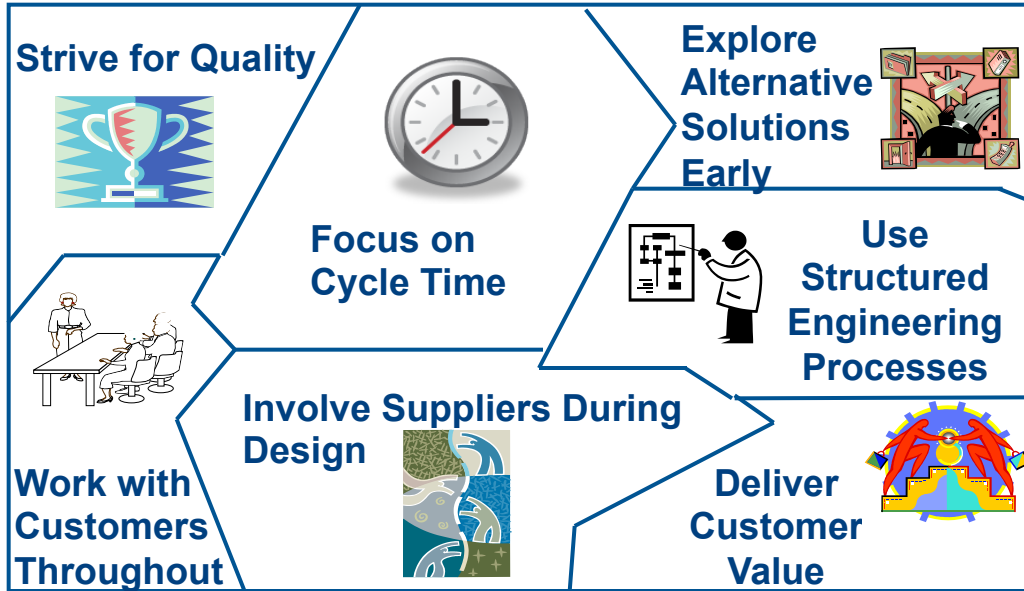
- Identify Product Development Stakeholders (5 min)
- Lean Engineering Puzzle (15 min)
- Class introduction and team formation

## Logistics

- Lean Engineering Puzzle for each 4-6 people

**Contacts for Questions: Earll Murman ([murman@mit.edu](mailto:murman@mit.edu)), Jackie Candido ([jcandido@mit.edu](mailto:jcandido@mit.edu))**

# Lean Engineering Puzzle



# Translating Lean Thinking to Engineering

## Timing & Content

- 75 mins with 30 min of active learning
- Lean concepts in engineering context
- Organizational examples
- Lean Frameworks

## Learning Objectives

At the end of this module, you will be able to:

- Relate basic lean principles to an engineering context
- Recognize that the engineering value stream transforms information to reduce risk
- Discuss how Lean Thinking needs tailoring to different product categories
- Recognize a lean engineering framework

## Active Learning

- Lean Engineering Framework (30 min)

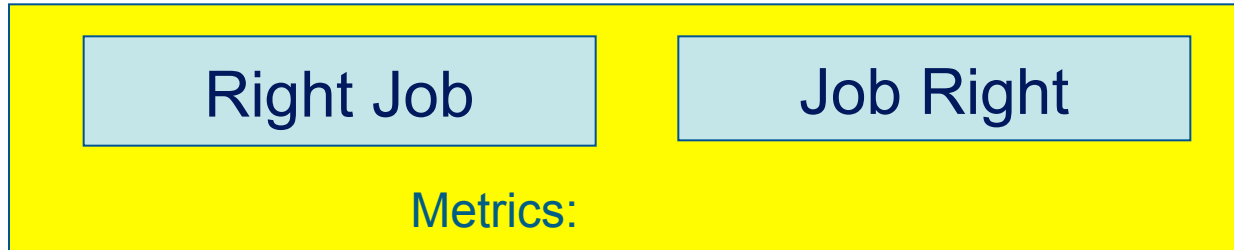
## Logistics

- LEM wall chart for each student
- Easel charts for each team

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# Draft Lean Engineering Framework

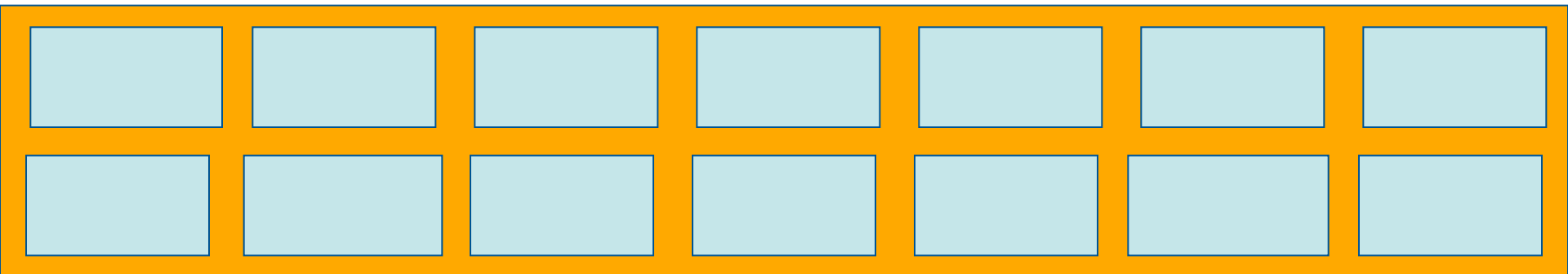
## Meta Principles



## Lean Engineering Principles



## LE Overarching Practices





# Selecting the Right Product

## Timing & Content

- 75 mins with 15 min of active learning
- Critical role of engineering in upfront product definition
- Product portfolio process
- Systems engineering front end process
- Trade space exploration
- Integrated concurrent engineering

## Learning Objectives

At the end of this module, you will be able to:

- Explain the challenges of selecting the right product concept
- Describe some structured approaches to aligning product concepts to meet stakeholder expectations
  - Structured program selection
  - Systems engineering processes
  - Modern conceptual design approaches

## Active Learning

- Lean Engineering Framework (15 min)

## Logistics

**Contacts for Questions: Hugh McManus ([hmcmanus@mit.edu](mailto:hmcmanus@mit.edu)) Dick Lewis ([RBLII@aol.com](mailto:RBLII@aol.com))**

# Product Lifecycle Value

## Timing & Content

- 60 mins with 30 min of active learning
- IPPD/IPTs
- System Engineering II
- Integrated tools for DFX, DFQ
- Commonality considerations

## Learning Objectives

At the end of this module, you will be able to:

- Discuss how systems engineering can contribute to doing the job right
- Restate the importance of DFX and DFQ
- Recognize the benefits and limitations of using commonality in product design

## Active Learning

- DFX exercise sailing rigging (15 min)
- Lean Engineering Framework (15 min)

## Logistics

- Sailing rigging exercise kits for each team
- Easel charts for each team

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# DFX Exercise Components

**Clevis**



**Wire Cable**



**Nut and Bolt**



**Pin and Cotter Pin**



**Ring and Pin**



**Snap Ring**



**Lean Engineering DFX Worksheet**

	Nut and Bolt	Cotter Pin	Ring and Pin	Snap Ring
Number of Parts				
Time to Assemble				
Tools Required <sup>1</sup>				
Assembly Ease <sup>2</sup>				
Susceptibility to wear <sup>2</sup>				
Susceptibility to failure <sup>2</sup>				
Manufacturing cost <sup>3</sup>				
Other lifecycle considerations				

1. A real assembly operation would probably require tools – determine what, if any.
2. Use relative scale of Easy, Moderate, Difficult
3. Use relative scale of low, medium, high

# Efficient Engineering Execution

## Timing & Content

- 90 mins with 45 min of active learning
- Engineering wastes
- PDVSM examples
- PDVSM methods
- Coupling/iterations in engineering activities

## Learning Objectives

At the end of this module, you will be able to:

- Recognize the sources of engineering waste
- Describe how value stream mapping can be applied to engineering
- Experience a simple exercise in PDVSM
- Diagnose some common pathologies of PD value streams
- Describe methods for designing a better future state

## Active Learning

- PDVSM exercise (30 min)
- Lean Engineering Framework (15 min)

## Logistics

- PDVSM exercise handout
- Easel charts for each team

Contacts for Questions: Hugh McManus ([hmcmanus@mit.edu](mailto:hmcmanus@mit.edu))

**ABC Aero PD Case Study**  
(a fictional but representative product development process)

ABC Aero's Engineering department does a variety of engineering tasks for both internal and external customers. These vary from simple change orders from the ABC aircraft production line, to new and derivative component design work.

The department is organized into 4 functional working groups: Design, Analysis Systems Engineering (SE), and Validation, Verification and Testing (VVT), plus a management group. Their functions are defined below.

A group of managers gets the internal and external work from a variety of customers. These work packages are assigned a rating from 1 to 5 based on the complexity of the job. The jobs are then sent to the systems engineering department. Jobs that are finished (have cleared VVT) are logged, a report is written, and the results distributed to the customers. These tasks take only a day or two each, but the work tends to show up in clumps, so during a busy time there may be several jobs in queue waiting for either assignment or completion.

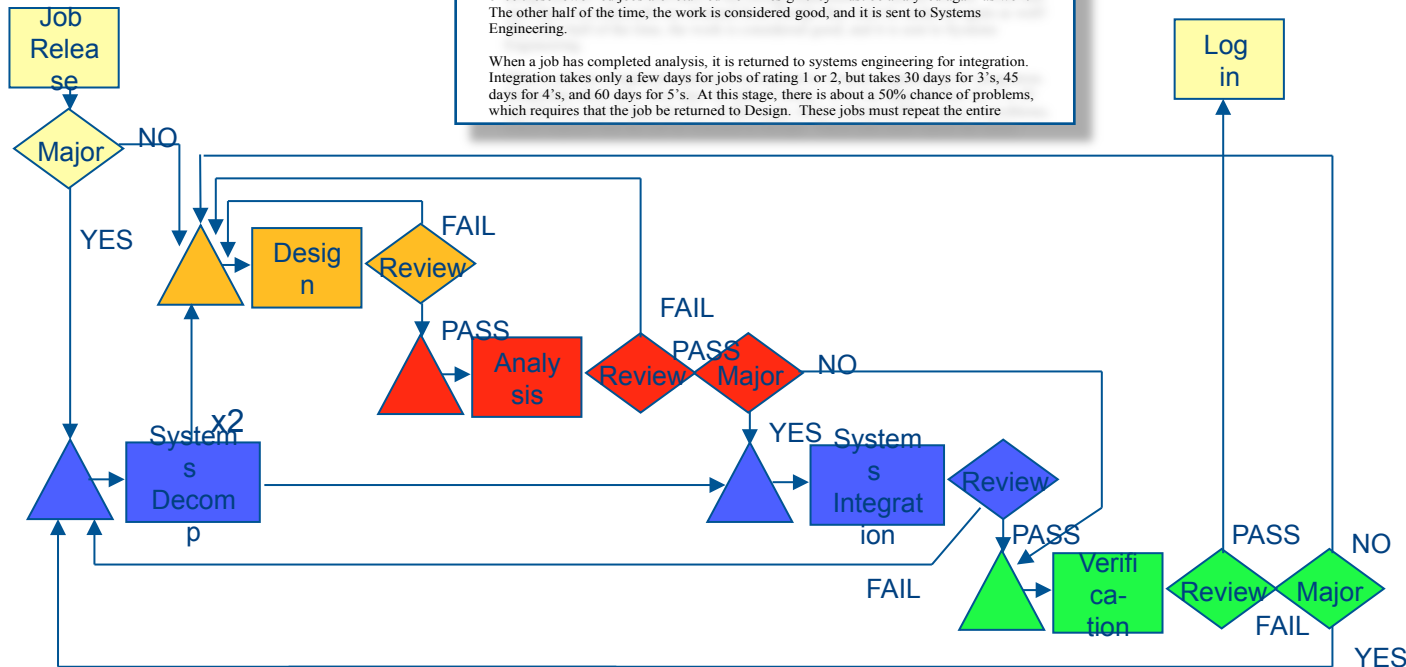
Systems Engineering does two tasks. When they receive a job they define requirements, interfaces, and verification criteria, then pass the job on to Design. This takes only a few days, and errors are rarely found in this work until after it leaves Systems Engineering (so there is no rework, at least yet...)

Design is organized into 2 teams with similar capabilities. New work is assigned to a team based on availability. The team takes 15 working days per rating "point" to do the work, i.e. work with a rating of 1 typically takes 15 days, 2's take 30, etc. When the work is complete it is reviewed; about 30% of the work is found to be insufficient and requires rework, which takes approximately the same amount of time as the original work. Complete, accepted design work is sent to Analysis.

Analysis takes design packages from Design. Analysis also has 2 teams with similar capabilities, and, like Design, work is assigned to whichever team is available. Functional analyses are carried out on the designs. This takes about 25 working days per rating "point," so work with a rating of 1 takes 25 days, 2's take 50, etc. At the end of the analysis work, a review takes place. About half the time, problems are found with the design and the work is sent back to the Design department for further rework. Note that once these reworked jobs are returned from Design they must be analyzed again as well! The other half of the time, the work is considered good, and it is sent to Systems Engineering.

When a job has completed analysis, it is returned to systems engineering for integration. Integration takes only a few days for jobs of rating 1 or 2, but takes 30 days for 3's, 45 days for 4's, and 60 days for 5's. At this stage, there is about a 50% chance of problems, which requires that the job be returned to Design. These jobs must repeat the entire

# PDVSM Exercise



# Enterprise Integration

## Timing & Content

- 30 mins

### Research results for

- Involvement of customer & end user during design phase
- Early supplier integration
- Integration of IPTs
- Impact of continuity of program leadership on requirement rework

## Learning Objectives

At the end of this module, you will be able to:

- Restate why customers and suppliers should be involved in engineering design
- Discuss how Integrated Product Teams support engineering-enterprise integration

## Active Learning

- None

## Logistics

Contacts for Questions: Earll Murman ([murman@mit.edu](mailto:murman@mit.edu))

# Lean Engineering Framework Exercise

## Timing & Content

- 2 hours 15 min
- 75 min in 4 modules
- 30 min wrap up
- 30 min for team presentations

## Learning Objectives

At the end of this exercise, you will be able to:

- Recognize a lean engineering framework
- Apply course knowledge to develop a Lean Engineering Framework

## Active Learning

- All

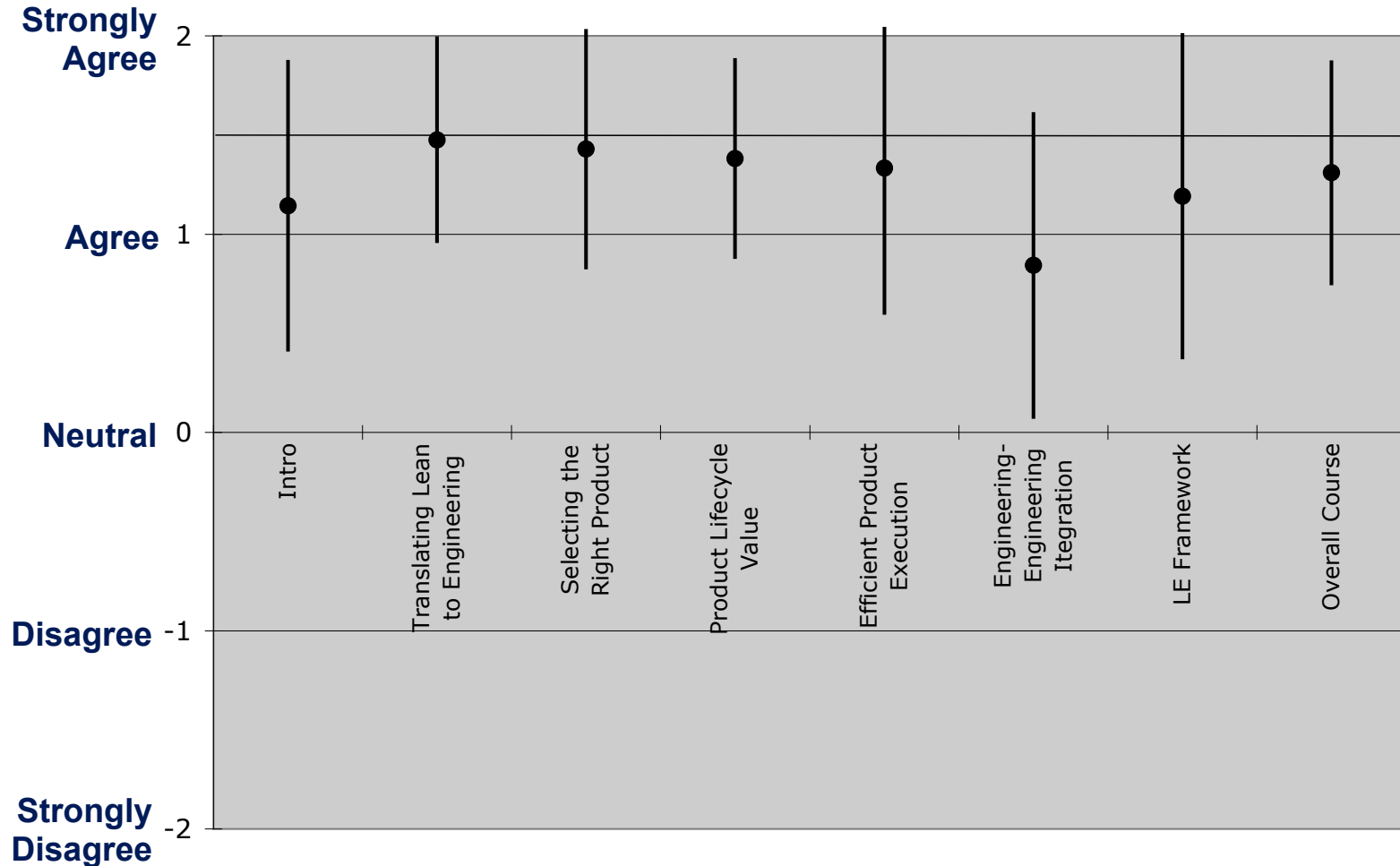
## Logistics

- LEM Charts
- Easel charts for each team

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# Student Evaluation Data

***"The instruction helped me to achieve the learning objectives and contributed to my comprehension of the concept"***





# Student & Instructor Comments

## Things done well

- **Course structure/flow**
- **Good coverage of lean engineering related to PD**
- **Good examples**
- **Active learning exercises**
  
- **Worked well for diverse class**
- **For alpha version, went ok**

## Things to do better

- **Time management**
- **Trim/tune module content**
- **Less theory/more application**
- **More structure for LE Framework exercise**
- **More time for PDVSM**
  
- **Improve timing**
- **Improve Enterprise module**

**Would work well as a 1-1/2 day offering, with adequate time for application related content**