Lean Aerospace Initiative
Industry/Government/Labor/Academic Partnership

Introduction to LAI
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Agenda

➢ Why LAI?
➢ How does LAI work?
➢ What use is LAI to others?
➢ How far has LAI come and where will we go next?
Why LAI?
US Air Force asked:

Can the concepts, principles and practices of the Toyota Production System be applied to the military aircraft industry?

• Answer: Yes!
<table>
<thead>
<tr>
<th>Year</th>
<th>Paradigm</th>
<th>Characteristics</th>
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<tbody>
<tr>
<td>1885</td>
<td>Craft Production</td>
<td>Machine then harden, Fit on assembly, Customization, Highly skilled workforce, Low production rates, High cost</td>
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<tr>
<td>1913</td>
<td>Mass Production</td>
<td>Parts interchangeability, Moving production line, Production engineering, Workers don’t think, Unskilled labor, High production rates, Low cost, Persistent quality problems, Inflexible models</td>
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<tr>
<td>1955-1990</td>
<td>Toyota Production System</td>
<td>Worker as problem solver, Worker as process owner enabled by: Training, Upstream quality, Minimal inventory, Just-in-time, Eliminate waste, Responsive to change, Low cost, Improving productivity, High quality product, Greater value for stakeholders</td>
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<tr>
<td>1993-...</td>
<td>Lean Enterprise</td>
<td>“Lean” applied to all functions in enterprise value stream, Optimization of value delivered to all stakeholders and enterprises in value chain, Low cost, Improving productivity, High quality product, Greater value for stakeholders</td>
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“Lean” is eliminating waste in order to create value.
Some Lean Lingo

➢ **Muda** - Japanese word for “waste” - 7 wastes
   ➢ *Overproduction, waiting time, transportation, inventory, processing, movement, rework*

➢ **Value** - *Something of worth to someone else*
   ➢ *Function/cost or Function/(cost x time)*

➢ **Kaizen** - continuous incremental improvement

➢ **Pull** - Downstream activities determining upstream activities
   ➢ Implemented by *Kanban*

➢ **Single piece flow** - performing a complete series of actions on one part, rather than a single action on many parts
Lean Aerospace Initiative

Consortium

➢ Airframe, engine, avionics, missile and space companies
➢ Air Force agencies and System Program Offices (C-17, F-22, JSF, Training)
➢ NASA, Army, Navy representatives
➢ Pentagon—OSD, AF HQ
➢ United Auto Workers, International Association of Machinists

Purpose

To instigate, enable and support an industrial revolution in aerospace as significant as mass production

Phase III - $4M/yr - 50% Government • 33% Industry • 17% MIT
### The Lean Aerospace Initiative Community

#### Avionics/Missiles
- BAE Systems North America
- Hewlett Packard
- Northrop Grumman ESSS
- Raytheon Systems Co.
- Raytheon Systems and Electronics Sector
- Rockwell Collins, Inc.
- Textron Systems Division

#### Airframe
- Boeing Military Aircraft & Missiles
- Boeing Commercial Airplane Group
- Boeing Phantom Works
- Lockheed Martin Aeronautical Systems
- Northrop Grumman ISS
- Raytheon Aircraft Co.
- Sikorsky

#### MIT
- Center for Technology, Policy, and Industrial Development
- School of Engineering:
  - Aerospace
  - Mechanical
- Sloan School of Management

#### US Air Force
- Aeronautical Systems Center
- Air Force Research Laboratory
  - (Materials and Manufacturing Directorate)
  - Space and Missile Center
- SPOS: JSF, F-22, C-17, Training (JPATS)

#### Space
- Boeing Space & Communications
- GenCorp Aerojet
- Lockheed Martin Space & Strategic Missiles
- Northrop Grumman ESSS Space Sector
- Spectrum Astro
- TRW Space and Electronics

#### Other Participants
- UAW
- IAM
- AIA
- DSMC
- IDA
- International Collaborations:
  - Linköping University
  - Warwick, Bath, Cranfield
  - Nottingham Universities

#### Other Government
- DCMA
- NASA
- NAVAIR
- AMCOM
- OUSD(AT&L)
- NRO

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#### Propulsion/Systems
- Curtis Wright Flight Systems
- Parker Aerospace
- Hamilton Sundstrand
- Pratt & Whitney
- Rolls Royce (N.A.)
“Delivering military aerospace products at significantly reduced costs and cycle time while meeting or exceeding performance expectations and enhancing the effectiveness of our national workforce”
“To enable fundamental change within industry and government operations that supports the continuing transformation of the US aerospace enterprise towards providing aerospace systems offering best life-cycle value”

A system offering best life-cycle value delivers best value in mission effectiveness, performance, affordability and sustainability at the right time and right price—advantages retained throughout product life.
How does LAI work?
Consortium Governance

Co-Chairs
Government (Lt Gen Reynolds)
MIT (Dr. Sheila Widnall)
Industry (Mr. James Pitts, NGC)

Executive Board
Senior executives from member organizations

Co-Directors
MIT Engineering (Dr. Earll Murman)
MIT Sloan School (Dr. Tom Allen)
Stakeholder (Mr. Fred Stahl)

LAI Operations
Joint teams from MIT, industry, government and organized labor.
LAI Team Structure

Team Compositions: MIT, Industry, Government, Labor
Team Sizes: 20 - 80 members per team
Industry, Labor, Government

Research Priorities

Imperative

Research

Data

Products

Awareness

Implementation

Experience

Enablers: LAI Teams Leadership
What use is LAI to others?
Lean Aerospace Initiative

LAI Product Value Stream

Tools:
- Lean Enterprise Model
- Transition to Lean Roadmaps
- Lean Enterprise Self Assessment Tool

Research
- Real time Implementation

Policy
- Recommendations

Publications

Web site
- Workshops

Training Curriculum

Students

Stakeholder Defined Value
- Knowledge Base
- Implementation Framework
- Research Products
- Neutral Forum

web.mit.edu/lean
Lean Enterprise Model
Practices and Benchmark Data

Meta-Principles/Enterprise Principles

Enterprise Level Metrics

Overarching Practices

- Identify & Optimize Enterprise Flow
- Implement Integrated Product & Process Development
- Maintain Challenge of Existing Processes
- Assure Seamless Information Flow
- Develop Relationships Based on Mutual Trust & Commitment
- Nurture a Learning Environment
- Optimize Capability & Utilization of People
- Continuously Focus on the Customer
- Ensure Process Capability and Maturation
- Make Decisions at Lowest Possible Level
- Promote Lean Leadership at all Levels
- Maximize Stability in a Changing Environment

Metrics - Barriers - Interactions

Data Sheets (~225)

Enabling Practices (~60)
Metrics - Data - Barriers - Interactions

Supporting Practices (~300)

Internet Links (~600)
**Enterprise Transition To Lean (TTL) Roadmap**

**Entry/Re-entry Cycle**
- Adopt Lean Paradigm
- Decision to Pursue Enterprise Transformation
- Enterprise Strategic Planning

**Long Term Cycle**
- Focus on the Value Stream
  - Initial Lean Vision
  - Detailed Lean Vision
- Develop Lean Structure & Behavior

**Short Term Cycle**
- Focus on Continuous Improvement
  - Environmental Corrective Action Indicators
  - Detailed Corrective Action Indicators
- Create & Refine Implementation Plan
  - Lean Implementation Framework

**Enterprise Level Implementation Plan**
- Implement Lean Initiatives
- Outcomes on Enterprise Metrics
  - +

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**Lean Aerospace Initiative**

web.mit.edu/lean
Lean Enterprise Self Assessment Tool

Tool for executive self-assessment of the present state of “leaness” of an enterprise and its readiness to change.

Assessment Matrix

Capability maturity model

Supporting materials

World Class
Lean Enterprise Value: 
Insights from MIT’s Lean Aerospace Initiative

Preface
Foreword
Acknowledgements

Part I Higher, Faster, Farther!
Chapter 1 The 21st Century Challenge
Chapter 2 The Cold War Legacy
Chapter 3 Monuments and Misalignments

Part II Better, Faster, Cheaper?
Chapter 4 Lean Thinking
Chapter 5 Islands of Success
Chapter 6 Lean Enterprises

Part III Creating Enterprise Value
Chapter 7 A Value Creation Framework
Chapter 8 Program Value
Chapter 9 Corporate and Government Value
Chapter 10 National and International Value
Chapter 11 Future Value

Manuscript
To be delivered
to publisher
October 2001
16 current MS & PhD students

- 8 Aeronautics-Astronautics
- 4 Technology & Policy
- 2 Technology & Management
- 1 Mechanical Engineering
- 1 Sloan School
- 1 USAF Fellow

57 graduated MS & PhD students

- 12 entered government service
- 10 entered aerospace industry
- 15 entered consulting industry
- 18 entered other professions
- 2 continuing studies at MIT

25 affiliated MS & PhD students
How far has LAI come and where will we go next?
LAI is extending “lean” knowledge and know-how
Complex products with low rate production
Whole enterprise
Extended enterprise including the government customer

LAI helps an important national industry accelerate a fundamental, systemic transition from craft/mass to Lean

LAI educates

LAI is a new model for industry-government-academic-labor collaboration
What’s New in 2001

➢ Renewed top level Air Force support
  ➢ Gen Lester Lyles: Get the message out!
  ➢ Mrs. Darleen Druyun—Endorsement
  ➢ Lt Gen Raggio—“LAI is delivering value”

➢ Phase III emphasis
  ➢ Lean Enterprise Self-Assessment Tool
  ➢ Curriculum, with other universities
  ➢ Graduates with “lean experience”

➢ LAI Follow-On (Beginning Sept 2002)
  ➢ Executive Board planning underway
  ➢ “Concept of Operations” — to be signed by Co-Chairs at Executive Roundtable (December 13)
Why Do We Need an LAI Follow-On?

From LAI Executive Subcommittee (“G9”)

➢ Do for the rest of the enterprise what we did for manufacturing

➢ Educate “everybody” about lean

➢ Sustain lean knowledge and tools and help members use them