Lean Aerospace Initiative
Plenary Workshop

Looking Forward to Phase III

March 23, 1999

Presented By:
Cliff Harris
MIT
Three Related Messages

- The Lean Industrial Model is evolving
- Phase III is refocused to the broader model
- If you are not personally involved with LAI, you should consider it
Presentation Outline

- Phase III Planning Schedule
- Evolving Environment
- Lean as an Evolving Model
- What is the same in Phase III
- What is different in Phase III
- How Phase III incorporates these changes
- Summary
- For you to consider
LAI Phase III
Planning Schedule

☑ 5 May 98 Executive Board - Approved planning process for LAI Phase III
☑ 11-12 Jun 98 – MIT Retreat, white paper published
  – Dr. Sheila Widnall, Tom Young, Gen. Kadish, Bill Hanson
☑ Jul/Aug 98 - IT Developed Draft Concept of Operations (includes Stakeholder expectations, Phase III products, research flow and structure, and management approach)
☑ Sept/Oct 98 - Working Group input, evaluation and approval of draft ConOps
☑ Nov 98 Executive Board – Preliminary ConOps approved
☑ Dec 98/Mar 99 Develop detailed research and budget plans
☑ Mar 99 - Working Group final approval
  ● May 99 Executive Board – Final Phase III Go-Ahead.
  ● Sep 99 – Start LAI Phase III
Evolving Environment

- Multiple “revolutions”
- Convergence and synergy create unprecedented rate of change

Trends
- Electronic communication
  - Detailed information
  - World-wide communication
- Intelligent systems
  - Extended human capabilities
  - Learning machines
- Photonics
  - More information available
  - Sensors
- New materials
  - Stronger, lighter
  - Environmentally tolerant
- Integrated CAD/CAM/CAE
  - Multi-disciplined applications
  - Proficient use by non-engineers
Evolving Environment (cont.)

- **Demographics**
  - Generation X and Baby Boomers form a “super-segment”
  - Diversity increases

- **Economics**
  - By 2000, 55% of disposable income belong to 35-54 year olds
  - By 2015 we are a mature-information-intensive economy
  - Customers define Value

- **Lifestyles**
  - Time control becomes the ultimate luxury
  - Consumers define value
  - Telecommuting changes work/family balance

- **Workstyles**
  - Virtual organizations operate with just-in-time workforce
  - Knowledge work predominates
Evolving Environment (cont.)

Constantly escalating expectations—

- Customers look for:
  - High-value, well supported products
  - Market prices; low costs
  - Responsiveness; speed
  - Customized solutions
  - Risk sharing; investment
  - Long-term relationships

- Stakeholders look for:
  - Return on investments
  - Growth
  - Leadership
  - Satisfaction and security

“Invention is the Mother of Necessity…”

R. Leigh Reid
In the 21st Century, enterprises will succeed by:

- Becoming lean, fast and efficient;
- Coping with rapid, large-scale changes;
- Anticipating future expectations;
- Exploiting technology advances;
- Accessing the requisite capabilities without maintaining excessive and costly infrastructure;
- Optimizing diversity.
Survival in the New Century

A Triad:

- Speed
- Relationships
- Competitiveness
- Knowledge
Evolving Industrial Models
A Conceptual Hierarchy

Operating as members of an EXTENDED ENTERPRISE network, individual firms come together to form VIRTUAL CORPORATIONS.

To succeed, these firms must be structured around LEAN PRACTICES (and Policy) which absolutely requires LEAN PROCESSES and which leads to LEAN PRODUCTS.

R. Leigh Reid
Extended Enterprise Focus Changes Phase III

- Industry, Government and MIT Teams spent six months defining and re-scoping Phase III
  - June off-site team produced the White Paper
  - Developed ideas and research concepts

- Stakeholders expectations were coordinated through the Integration Team

- Vision, Mission, and Research Themes were restructured around stakeholder expectations
What is the Same in Phase III

- Collaborative Structure
- Lean Principles
- Research budget
- Access to products, research, and recommendations
- Neutral forum for members
LAI Sponsors and Participants

Avionics/Missiles
- Applied Materials Inc.
- Hewlett Packard
- Raytheon Systems Co. (Dallas and El Segundo)
- Lockheed Martin Electronics & Missiles
- Textron Systems Division
- Rockwell Collins, Inc.
- TRW Inc.

Space
- Lockheed Martin Space & Strategic Missiles
- Boeing Space Transportation
- Pratt & Whitney Space Propulsion
- Hughes Space & Communications
- GenCorp Aerojet
- TRW Inc.

Airframe
- The Boeing Company (St. Louis, Seattle)
- Lockheed Martin Aeronautical Systems
- Northrop Grumman Corp.
- Raytheon Aircraft Co.

Propulsion
- Rolls Royce Allison
- General Electric Aircraft Engines
- Pratt & Whitney Gov’t Engines
- Sundstrand Corp.

Avionics/Missiles
- Applied Materials Inc.
- Hewlett Packard
- Raytheon Systems Co. (Dallas and El Segundo)
- Lockheed Martin Electronics & Missiles
- Textron Systems Division
- Rockwell Collins, Inc.
- TRW Inc.

Other Government
- DARPA
- DLA
- NASA
- NAVAIR
- AMCOM
- OUSD(A&T)
- NRO

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)

Other Participants
- UAW
- AIA
- DSMC
- IDA
- Wharton (Univ of Penn)
- Univ of Chicago
- International Collaborations:
  - Univ of Linköping
  - UK LAI

MIT
- Lead Researchers
- Faculty, staff
- Students
- Neutral Catalyst
Lean Principles

Meta-Principles

Waste Minimization • Responsiveness To Change

Enterprise Principles

Right Thing at Right Place, Right Time and in Right Quantity
Optimal First Unit Delivered Quality
Continuous Improvement
Effective Relationships within the Value Stream
Budget is the Same

- Budget is the same as 5 previous years
- Member cost is the same as Phase II
- Stakeholders guide research emphasis
- Requirements are tailored in the ConOps to fit the budget
- $6.8 million in research opportunities were tailored to fit $3.8 million by managing “cost as a design requirement”
What is Different

- The industrial model is evolving through technology and stakeholder expectations
- Research is increasing on barriers to lean
  - Organizations and People
  - Lean Customer Practices
    - (read as “extended enterprise policy”)
  - Knowledge Deployment
- Linked research programs are growing
- Implementation is the competency of the government, industry, and workforce
# Linkages to Other Activities

<table>
<thead>
<tr>
<th>Teams</th>
<th>LSRP</th>
<th>LARA</th>
<th>ELSV</th>
<th>CIPD</th>
<th>LMP</th>
<th>ICIMOT</th>
<th>IMVP</th>
<th>ICSM</th>
<th>DAC</th>
<th>MOT</th>
<th>SDM</th>
<th>LFM</th>
<th>UKAI</th>
<th>LARP</th>
<th>NIST</th>
<th>BENS</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEM</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Knowledge Deployment</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Policy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Product Development</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manufacturing Systems</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Supplier Networks</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Organizations and People</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test &amp; Space Operations</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:** The table indicates linkages between various activities and teams.
LAI Phase III
Stakeholder Expectations

- Implementation emphasis - Overcoming barriers
- Document new paradigm on enterprise management
  - Continue LEM development, and develop enduring products (books, publications)
  - Workshop publications & case studies
- Stay the course on lean manufacturing
- Metrics to measure lean enterprise progress
  - Suitable for program management and product development
LAI Phase III
Stakeholder Expectations

- Address Labor integration within lean performance enterprise
- Increase emphasis on space topics and risk management
- Consider best life cycle value
- Policy focus on strategic concepts
- Manageable/doable goals & expectations
Phase II Vision
To significantly reduce the cost and cycle time for military aerospace products throughout the entire value chain while continuing to improve product performance

Phase III Vision
To deliver military aerospace products at significantly reduced costs and cycle time while meeting or exceeding performance expectations and enhancing the effectiveness of our national workforce.
Phase II Mission
Define and help implement roadmaps for fundamental change in both industry and government operations, based on lean practices

Phase III Mission
To enable fundamental change within industry and government operations that supports the continuing *transformation* of the US aerospace enterprise towards providing aerospace *systems offering the best life-cycle value*
A system offering best life-cycle value is defined as a system introduced at the right time and right price which delivers best value in mission effectiveness, performance, affordability and sustainability and retains these advantages throughout its life.
Lean Aerospace Initiative

**PHASE I**
- Defined Expectations
  - Need for the LEM
  - “How to” Emphasis
- Established Collaborative Mechanisms
  - Executive Board
  - Plenary Workshops
  - Research Teams
- Research Focus
  - Domestic Military Aircraft
  - Utilized IMVP Model
  - Benchmarking & Case Studies

**PHASE II**
- Developed Products
  - LEM (Reference & Transition Modules
  - Implementation Workshops
- Expanded Collaborative Participation
  - Space Sector
  - MOUs with International initiatives
- Research Focus
  - Integrated Planning
  - Cross-cutting Topics
  - Added Test & Ops
  - Policy Recommendations

**PHASE III**
- Deploy products to support implementation
  - Enhanced LEM
  - Books, journal articles
  - Framework for lean acquisition environment
- Leverage the collaboration that has been built
  - Integrate Supplier Base
  - Involve the C²I Sector
  - Address support issues
  - Executive Roundtable once a year
- Research focus
  - Best life-cycle value
  - Identify barriers to change/develop mechanisms to change

LAI Phase III
Evolution in Scope
LAI Phase III
Program Structure

LAI Co-Directors
- MIT (Engineering & Sloan School)
- Stakeholder (Industry or Gov’t)

Research Teams
- Manufacturing Systems
- Product Development
- Supplier Networks
- Organizations & People*
- Test & Space Operations
- Acquisition Policy & Management

Product Teams
- Lean Enterprise Model
- Knowledge Deployment*
- Policy*

* Denotes change from Phase II
• **Time**  
  – Measured both by clock speed and cycle time

• **Organizations and People**  
  – Essential to enterprise success

• **Knowledge and Information Infrastructure**  
  – Key enablers for an efficient enterprise

• **Government as a Lean Customer & Operator**  
  – Central role in pace of change

• **Measuring Value to the Enterprise**  
  – Adding value to shareholders, public, customer, employees  
  – Best life-cycle value for the product
Theme driven products:

- **Workshops**
  - Defined by themes and research maturity
  - Aligned with publications and communication needs

- **Lean Enterprise Model (LEM)**
  - Expansion of transition to lean module
  - Mapping to customer practices

- **Publications**
  - Strategy is to have a pervasive impact
  - Focused workshops deliver input to interim publications
  - Series of books capturing “How To” & “Best Practices” to help stakeholders train & change
  - Synergistic and complementary to LEM

- **Policy**
  - Framework for a Defense Aerospace “Lean Customer Strategy” based on LAI Research
  - Pro-Active engagement by Executive Board members
Lean Aerospace Initiative

LAI Phase III Product Flow
Major Themes

Themes
- Time
- Org & People
- Information
- Lean Customer
- Added Value

Research
- Research teams develop plans and conduct research around the themes

Workshops
- Teams integrate research results and develop/ conduct focused workshops

Products & Publications
- Research results and workshop findings are consolidated in publications

Phase III LEM
LAI Phase III Products (1)

● **Outreach Products:**
  Build awareness and understanding of research results for ongoing exchange of information
  - Member events (Executive Board, Plenary Workshops)
  - Web-based dissemination of LAI work products & reports
  - Member news (LeanAir III Newsletter; LAI-News Bulletin)
  - Team Workshops

● **Implementation/Educational Products:**
  Emphasize action learning and “flow” through ideas
  - Lean Enterprise Model (LEM)
  - Implementation workshops
  - Regional supplier workshops
LAI Phase III
Products (2)

- **Enduring Products:**
  Provide codification of knowledge for future uses
  - Lean enterprise book series
  - MIT graduates entering the aerospace workforce
  - Curriculum; summer subjects; seminars

- **Policy Recommendations:**
  Help eliminate governmental barriers to lean
  - Recommendations based on research findings
  - Executive roundtable
# Teams/Themes Matrix

<table>
<thead>
<tr>
<th>Teams</th>
<th>Themes</th>
<th>Value of Lean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Best Lifecycle Value</td>
<td>Time</td>
</tr>
<tr>
<td>LEM</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Knowledge Deployment</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Policy</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Product Development</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Manufacturing Systems</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Supplier Networks</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Organizations &amp; People</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test &amp; Space Operations</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Lean Customer Practices</td>
<td>✓</td>
<td></td>
</tr>
</tbody>
</table>
Summary

- The industrial environment is changing
- The Stakeholders have refocused LAI
- The Vision and Mission serve the broader focus and still provide a unifying concept
- There are more research teams, but two will be assisting implementation more than supporting heavy research
- Phase III proposal is progressing well.
For You to Consider

- There is notable progress at each site visit
- Progress, focus, and penetration is very different
- If you accept that we talked about new survival requirements, then,
  - Are you as an individual
  - Your company
  - Your current contribution in government service
    - On a pathway to survival?
- Should you as an individual be a leader in the change?
- Should you be a stakeholder member of a focus or product team?
- Should your multidivisional company have more direct members?