

**A Proposal for Phase III of
The Lean Aerospace Initiative**

Submitted by

**Center for Technology, Policy and Industrial Development
Massachusetts Institute of Technology**

to

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I - Executive Summary

MIT submits this proposal for Phase III of the LAI in response to the 13 May 1999 RFP from ManTech. The proposed research topics and products have been developed by the MIT LAI team during the last year, discussed and approved by the existing LAI teams, tested against the Phase III Vision, Mission, Goals, Themes and Stakeholder Expectations, and prioritized to fit available funding.

Phase III plans have been developed with a clear focus on expected products, each of which has been assigned deliverable dates, as shown throughout the proposal. The **Phase III Capstone Products** are:

Enhanced/expanded versions of the Lean Enterprise Model - **LEM 2000, 2001, 2002** - will be released yearly coinciding with the spring Plenary Workshop.

A “wake-up call” book tentatively titled **Cheaper, Faster, Better?** will be written during Year 1 to help build momentum for adopting lean practices.

The Lean Enterprise book series will be initiated to provide an enduring source of knowledge on lean enterprise practices. Capstone book(s) tentatively titled The Lean Aerospace Enterprise will be produced by the end of Phase III.

Policy Recommendations will be developed yearly based upon research findings from LAI and related programs.

Building Block Products will contribute to the above Capstone Products providing useful interim deliverables. The more significant ones are:

- Monographs and texts for the Lean Enterprise Series
- Annual short courses on “The Lean Enterprise”
- Multimedia instructional material
- LEM data sheets
- The annual Plenary Workshops, Executive Board Meetings and Executive Board Roundtables
- Implementation and Topical LAI workshops
- Working papers, conference publications and journal articles
- Evidence of lean site visit reports

Product and Research Teams identified in the Phase III ConOps have developed integrated plans for research topics, products, and staffing. Each team will have linkages to LAI related activities, other MIT programs and centers, and external organizations which will significantly leverage the LAI resources. An expanded menu of workshops (both topical and implementation), together with team meetings, the annual Plenary Workshop, the Executive Board and the Executive Roundtable will provide greater opportunity for stakeholder participation.

The MIT LAI team will be led by senior faculty members Professors Allen, Murman and Widnall, together with the Stakeholder Co-Director. Ten additional faculty from the Sloan School of Management and the School of Engineering, along with 8 other academic and research staff, will lead research/product projects. Over 20 graduate students will participate in the Phase III LAI.

II - Introduction

MIT submits this proposal for Phase III of the Lean Aerospace Initiative in response to the 13 May 1999 RFP from ManTech. The proposed research topics and products have been developed by the MIT LAI team during the last year, discussed with and approved by the existing LAI teams, tested against the below to assure they meet the stakeholder expectations, and prioritized to fit available funding.

LAI Vision Statement

“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.”

LAI Mission Statement

“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 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.

LAI Phase III Goals

- Develop fundamental understanding of value added practices offering best life-cycle value
- Address barriers to implementation
- Make LAI a success for the workforce
- Deploy knowledge of lean practices to facilitate & enable change
- Enhance the Lean Enterprise Model to facilitate usage at all levels
- Extend and enhance the collaborative nature of the project
- Develop and effectively transmit recommended policy changes based upon LAI research findings

Phase III Research Themes

- **Time**
 - Measured by both clock speed and cycle time
- **Organizations and People**
 - Essential to enterprise success
- **Knowledge and Information Infrastructures**
 - Key enablers for an efficient enterprise
- **Government as a Lean Customer and Operator**
 - Central role in pace of change
 - Lean principles as tools for acquisition streamlining
- **Measuring the Value to the Enterprise**
 - Adding value to the shareholders, public, customers, workforce

II - Introduction

Phase III Stakeholder Expectations

- Focus on overcoming barriers to implementation
- Continue to emphasize lean manufacturing, product development, space sector topics and risk management
- Address labor integration within lean performance enterprise
- Identify metrics to measure lean enterprise progress
- Develop products which document a new paradigm of enterprise management
- Consider best life cycle value
- Policy focus on strategic concepts

MIT Expectations for Sponsored Research

MIT undertakes sponsored research projects for several reasons:

- Research is integral to the educational experience of both faculty and students.
- Research findings contribute to the world's knowledge base.
- MIT desires to have an impact on issues and problems that are central to the advancement of society.

The Lean Aerospace Initiative addresses these goals of sponsored research at MIT. The Phase III proposal has a strong core of research involving funding for a dozen faculty and over twenty student projects. Many other faculty and students will be involved through collaborative efforts funded by other sources. The proposed effort also focuses resources on products of the research, in order to contribute to the enduring knowledge base and to have a significant impact on implementation of lean practices in the defense aerospace industry and government agencies.

However, the LAI goes beyond the above considerations and serves as a model program for bringing academia together with industry, government and labor in a dynamic and interactive consortium. The LAI consortium is serving as an innovative model for research projects addressing important societal issues of the 21st century.

Roadmap for this Document

The Introduction concludes with a key to the notation used throughout the rest of the document. A brief section that summarizes the Major Phase III Products is followed by a brief section on Program Management. The details of the proposed work are contained in descriptions of the three Product Teams and six Research Teams that will carry out the program. Each of these descriptions covers the team charter, research topics, products, and the interactions of the team with other LAI, MIT, and external activities. The document concludes with summaries showing the coverage of the research themes by the various teams, linkages with other activities, a strategy for supplier involvement, and schedules. A glossary of terms is included as an Appendix.

II - Introduction

Notation in this Proposal uses the following conventions:

Proposed activities and deliverables are denoted by

Regular Font	for those activities/deliverables proposed as fully funded under a \$4.6 M annual budget.
<i>Italicized Font</i>	<i>for those activities/products which would be undertaken if additional funding became available.</i>
Asterisked *	for those activities/products proposed as partially funded under a \$4.6 M annual budget. These activities might be partially supported by a registration fee or undertaken in conjunction with another funded project or with support from MIT.

Dates on deliverables or activities are noted by Year (Y) and Quarter (Q) using:

Y1	September 1999 - August 2000
Y2	September 2000 - August 2001
Y3	September 2001 - August 2002
Q1	September - November
Q2	December - February
Q3	March - May
Q4	June - August

Level of Effort for different personnel categories are scheduled differently by MIT . This section provides a key to understanding quoted levels of effort. Personnel shown without a level of effort are collaborating faculty and staff.

Faculty - Assistant, Associate, Full Professor salaries during the Academic Year (Sept - May) are fully supported from Institute funds, except for Professors Widnall and Gutowski whose full 12 month salary is supported by the Institute. As such, no LOE is shown for the academic year time of faculty except for Professors Allen and Murman, a portion of whose academic salary is being used as in-kind cost sharing and is so noted. Time that will be devoted during the summer (June - Aug) and charged to the LAI is given in months. Faculty other than Profs. Widnall and Gutowski who have no LOE designated are considered as “collaborators”.

Other Academic Staff (Visiting Professors, Senior Lecturers, Senior Research Associates) have appointments varying from 9-12 months. Percentage level of efforts represent the amount of time they will be supported by LAI, based upon their particular appointment period.

Staff (research, support) normally work on a full time basis for 12 months, and level of effort is a percentage of this.

Full time graduate Research Assistants (RAs) are expected to work 30 hours per week. In this proposal, we note Full Time Equivalent RAs for each team.

III - Summary of Major Phase III Products

Capstone Products - Phase III of the LAI will result in the following major products which represent the culmination of research and related efforts undertaken during the entire duration of the Initiative:

The **Lean Enterprise Model (LEM)*** is the LAI vehicle for organizing, storing and retrieving information on lean practices in a useful form for the LAI stakeholders. The LEM, started during Phase I and transitioned to a web-based product during Phase II, will be significantly enhanced by the conclusion of Phase III. The LEM practices and metrics will be revised and updated, Transition to Lean (TTL) modules to aid implementation of lean practices will be added as they become available, and data contained in the LEM will be continuously expanded. Annual releases (LEM 2000, 2001, 2002) are anticipated coinciding with the spring Plenary Workshop. (Yearly, Q3)

A “wake-up call” book tentatively titled **Cheaper, Faster, Better ?** will be written during Y1 to help build momentum for individuals and organizations in the aerospace field towards adopting lean practices. (Y1, Q4)

The Lean Enterprise book series* will be initiated to transmit knowledge about lean practices to a wide audience. Capstone book(s) will be produced to provide an enduring source of knowledge on lean enterprise practices. The capstone book(s) will be planned in Y1 and written during Y2 and Y3. It is expected that contributing chapters and/or monographs will emerge throughout Phase III with the culminating volume(s) appearing near the end of Phase III. It is envisioned that The Lean Enterprise Series will also accept monographs/texts from non-LAI contributors, both within and external to MIT. This capstone book(s) is tentatively titled The Lean Aerospace Enterprise.

Policy Recommendations to help eliminate barriers to implementing lean practices to achieve best life cycle value will developed yearly based upon research findings from LAI and related programs. (Yearly, Q3)

Building Block Products will contribute to the above Capstone Products providing useful interim deliverables. The more significant ones are:

- Monographs and texts for the Lean Enterprise Series*
- Annual short courses on “The Lean Enterprise”*
- Multimedia Instructional Material*
- LEM data sheets*
- The annual Plenary Workshops, Executive Board Meetings and Executive Board Roundtables*
- Implementation and Topical LAI workshops*
- Working papers, conference publications and journal articles
- Evidence of lean site visit reports*

Other outreach and learning products will contribute to the Building Block products as identified in the individual team write-ups contained in this proposal. Expected completion dates on all Phase III products are shown in the individual team reports.

IV - Program Management

Executive Board Member

The Massachusetts Institute of Technology Executive Board member and Co-Chair will be Institute Professor Sheila E. Widnall as nominated by MIT's President Charles Vest. The roles and responsibilities of this position will be:

- Assure MIT support for LAI
- Assure that the MIT LAI Co-Directors are executing the LAI program plan
- Interface with the other LAI Executive Board Co-Chairs and members
- Interface with senior DoD and USAF personnel as appropriate
- Represent LAI to external audiences as needed

LAI Co-Directors

The LAI will be directed by a three person team representing the major MIT participating organizations and the consortium stakeholders. Professor Earll Murman will represent the School of Engineering, Professor Tom Allen will represent the Sloan School of Management. Mr. Cliff Harris will (initially) represent the stakeholders. The roles and responsibilities of the Co-Directors will be:

- Overall responsibility for LAI execution
- Lead the Research Council in its role of research planning and guidance
- Serve as members to the LAI Integration Team
- Interface with LAI stakeholders
- Interface with MIT's Executive Board member
- Point of contact with faculty, staff and stakeholders
- Cultivate and develop new members
- Represent LAI to external audiences as needed

Research Council

The Research Council consists of the MIT LAI team co-leads, co-directors and Executive Board member. The Research Council has responsibility for strategic research planning, assuring integration of LAI research and product team activities, assuring research quality and enhancing research productivity. Some specific roles performed are:

- Develop and review research priorities
- Identify new research relevant to LAI and additional research contributors
- Identify integrative research topics
- Identify key research products and methods to disseminate LAI research to consortium members
- Review proposed research projects and the content of LAI research
- Review approved research projects at periodic intervals
- Stimulate use of quality methods and analysis to ensure quality control of ongoing research

IV - Program Management

Program Manager

The Program Manager's responsibility is to run the LAI on a day-to-day basis to ensure all action items, planning, major event coordination, products and milestones are accomplished. Mr. J. Tom Shields will serve as the LAI Program Manager. Some specific roles and responsibilities are:

- Prepare LAI internal plans and schedule with inputs from all LAI members
- Coordinate the compilation and release of contractually required reports
- Coordinate the distribution of items to sponsors
- Coordinate administrative activities necessary to accomplish major events
- Coordinate student RA appointments
- Manage equipment and computer resources
- Plan and administer the LAI budget
- Interface with USAF administrative managers

Ms. Deneen Silviano will assist Mr. Shields in the administration of the program.

Principal Investigators

All MIT sponsored research projects have designated Principal Investigators who are responsible for assuring that projects are executed on schedule and within budget to meet the agreed upon statement of work. Professors Earll Murman and Thomas Allen will be the Phase III LAI Principal Investigators.

Program Management Personnel

Sheila Widnall
Earll Murman (25% AY, 1 mo summer)
Tom Allen (10% AY, 0.5 mo summer)
Tom Shields (50%)
Deneen Silviano (25%)
Stakeholder Co-Director

V - Product Teams

Lean Enterprise Model (LEM)

Charter: The LEM is a vehicle for organizing, storing and retrieving information. The team will enhance and maintain the LEM, including updating the intellectual architecture and data content. In addition, the team will enable and conduct research on enterprise-level topics. It will also serve as the primary interface to externally funded LEM-related activities.

Products:

Learning products:

- “Transition to Lean for Executives” workshop (Y2)
- “Metrics” topical conference/workshop (Y1,Q2)

Enduring products:

- LEM 2000 (2001, 2002)* – Continuous additions of new data from both internal and external sources. Coordination and execution of annual review of intellectual architecture. Ongoing maintenance of web-based LEM. (Yearly, Q3)
- Book contribution – Integrating the Lean Enterprise (Y3)
- *Monograph – Lean Metrics (Y3)*

Research topics

- Enterprise-wide metrics for “lean”* – Conduct research to understand how enterprise-wide measures affect lean behavior and explore alternative measures that would incentivize lean behaviors.
- *Enterprise Issues - enterprise integration, information/knowledge requirements; maturity models*

Coordination with external LEM-related activities

The LEM team will coordinate and integrate the activities of externally funded LEM-related activities known as the Advanced Enterprise Center (potential new project) including efforts such as:

- LEM Dynamic Knowledge Base
- External Data Sources
- Transition-to-Lean
- Simulation Development

Links to related LAI activities

- Lean Sustainment Research Program
- Labor Aerospace Research Agenda
- Evidence of Lean Site Visits

Links to other MIT activities

- International Motor Vehicle Program
- Center for Innovation in Product Development
- Leaders for Manufacturing Program
- Systems Design and Management Program
- International Center for Research on the Management of Technology

Links to external activities/organizations

- UK LAI
- National Institute of Standards

V - Product Teams

Team leadership: Dr. Debbie Nightingale (36%)

Other faculty, staff, students: Prof. John Hauser
Other LAI team leads
2 RAs

Team meeting schedule

Expected to have two product team meetings per year.

V - Product Teams

Knowledge Deployment (KD)

Charter: The charter of the Knowledge Deployment team is to develop, and/or enable, and deliver products key to implementing results generated from LAI research, and as appropriate, from other related programs or activities. Three broad product categories for multiple audiences will be addressed: Outreach, Learning, and Enduring products.

Outreach products to build awareness and understanding of LAI research results and to open channels for the ongoing exchange of information:

- Plenary Conference* (Q3), Executive Board* (Q3), Executive Roundtable* (Q1) - Yearly
- LAI Web Site - continual
- LAI Communication Toolkit (Standardized “news”) - Quarterly
- Media Relations (News Releases, OP-Ed) – ongoing
- Success Stories* (with ManTech Site Visits, Lean Forum, Industry Days, LEM) - ongoing
- On-Line Moderated Discussion Groups - as needed
- Speakers Bureau* - as needed
- On-Campus Lecture Series* - ongoing
- *LAI Road Show: displays for trade shows/expos, member-based “events”*

Learning products The transfer of substantive knowledge to emphasize action learning and to “flow” through ideas for future codification.

- Workshops - enable/support consistent planing and execution of all LAI team sponsored workshops as noted in individual team plans, including follow-up activities such as On-Line Moderated Discussion Groups.
 - Implementation workshops*
 - Three per year, planned in conjunction with other teams (Yearly, Q1, Q2, Q4)
 - Tentative titles for Year 1
 - Implementing Value Engineering in Product Development (PD) Q1
 - Implementing High Performance Work Organizations II(O&P) Q2
 - Implementing Lean Supplier Practices (SN) Q4 or Manufacturing System Design Considerations (MS) Q4
 - Topical workshops* - planned by individual teams (Yearly, Q1, Q2, Q3, Q4)
- Instructional Forums
 - Summer Academies* - annual summer short courses on “The Lean Enterprise”
 - Open-enrollment at MIT* (Yearly, Q4)
 - *Site-based at stakeholder organizations on a fee-for-service basis**
 - MIT subjects*
 - *Executive Education**
 - *Distance Learning Series**
- Multi-media instructional material*
- *Reference and Lending Library of member-generated training on lean*

Enduring products where knowledge resides to provide foundations for generations.

- Wake up call book: Cheaper, Faster, Better? (Y1,Q4)
- The Lean Enterprise book and monograph series (Content by LAI Teams; KD team as enabler). Titles of candidate volumes
 - Monographs
 - Product Development Value Stream (PD - Y1, Q4)
 - Pull in Product Development (PD - Y2, Q4)
 - Lean Product Development Implementation (PD - Y3, Q4)

V - Product Teams

- Value Steam of on-orbit operations (TSO)
- Manufacturing System goals in the Defense Aerospace Industry (MS - Y1, Q4)
- Manufacturing Systems in the Aerospace Industry (MS- Y2, Q4)
- Manufacturing System Design in Complex Industries (MS - Y3, Q4)
- Lean Launch Operations (Y2),
- Lean Spacecraft Testing (Y3)
- Lean Space Operations (Y3)
- Lean Acquisition (AQ - Y3, Q3)
- *Monograph – Lean Metrics (LEM)*
- Contributions to culminating book(s), The Lean Aerospace Enterprise - tentative list (Y3)
 - Integrating the Lean Enterprise (LEM)
 - Lean Product Development (PD)
 - Production System Design (MS)
 - Superchains (SN)
 - *Organizations and People (O&P)*
- Other publications (journal articles, conference papers, working papers)

Links to LAI related activities

- Include LARA and Lean Sustainment outputs in all above products as appropriate
- Jointly develop workshops and other products with international collaborators (LARP, UK LAI)
- Links to related web sites
- Formalize relationship with ManTech Site Visits, Lean Forum, Industry Days to better extract success stories.

Links to MIT activities

- Link to web sites
- Co-develop above products such as workshops and on-campus lectures
- Incorporate other MIT contributions to The Lean Enterprise book series

Team leadership:

Dr. Joel Cutcher-Gershenfeld (25%)
Prof. Earll Murman (20% AY, 0.8 mo summer)
Ms. Deneen Silviano (75%)

Other faculty, staff, students:

Writer - TBD (100%)
Web administrator - TBD (100%)
2 RAs (Y1,2), 1 RA (Y3) - Note: These RAs will normally be allocated to other teams
Betty Barrett

Team meeting schedule

Expected to have 1 “summit” meeting per year – with additional product or task specific meetings be held in conjunction with Plenary; rotating sites/hosts as needed.

V - Product Teams

Policy (PO)

Charter: Ensure that important policy issues are addressed by LAI research, develop high-impact policy recommendations based on research from LAI and closely related programs, and provide a forum for dialogue within LAI on defense acquisition policy issues related to best life cycle value.

Products:

- Policy recommendations: develop recommendations where research findings from LAI and all closely related programs suggest that changes in current policy would yield substantial benefits in best life cycle value to the warfighters (Yearly, Q3)
- Articles in acquisition related publications presenting recommendations and the supporting research (ongoing)
- Executive Roundtable Meetings: Provide support for the annual Executive Roundtable meetings focusing on policy issues and topics that impact the delivery of best lifecycle value in defense acquisition (Yearly, as needed)

Links to related activities:

- Other organizations involved in the study and formulation of military acquisition policy, such as the Business Executives for National Security (BENS) and its “Tooth-to-Tail” Commission.

Team leadership: Prof. Sheila Widnall
Dr. Eric Rebentisch (15%)

Other key team members: LAI Executive Board Co-Chairs

Team meeting schedule:
As needed to support Executive Roundtable Meetings.

VI - Research Teams

Product Development (PD)

Charter: Conduct research that will allow understanding and implementation of Lean Product Development, and the integration of product development in the Lean Enterprise, in order to significantly reduce product development cycle times and increase the total life-cycle value of military aerospace products.

Major research topics:

- Product Development Value Stream (Continuing project from Phase II)
- "Pull" in Product Development
- Value, Metrics, and Risk
- Reduced Cycle Time
- Technology Insertion and the Product Development Process (Continuing project from Phase II)
- Optimizing Replacement of Obsolete Avionics System (Continuing project from Phase II, joint topic with LSI)
- Improving Cross-Functional Communications: Mechanisms for Knowledge Transformation (Continuing project from Phase II, joint topic with MS)
- Supply Chain Design for Best Lifecycle Value, including Early Supplier Integration and Information Infrastructure for Collaborative Product Development (joint topic with SN)
- *COTS, Modularity and Platform*
- *Tools for Lean PD*
- *Enterprise Knowledge Management and the PD process*
- *Product Development in the Lean Enterprise*
- *Lean Skills (in collaboration with O&P topic "Structuring the value stream for lifetime learning and employee development")*

Products:

Outreach products:

- Web site input (continuous)

Learning products:

- Two team working meetings per year (Yearly, Q2 and Q3)*
- Annual topical or implementation workshop (Yearly, Q1 or Q2 or Q4)*
- Contributions to annual LAI summer short courses (Yearly, Q4)
- Graduate academic course content "Lean Product Development" (Y3)*

Enduring products:

- Contributions to the Lean Enterprise Model (LEM) - ongoing
- Monographs (candidate titles):
 - Product Development Value Stream (Y1, Q4)
 - "Pull" in Product Development (Y2, Q4)
 - Lean Product Development Implementation (Y3, Q4)
- Book contribution on Lean Product Development (Y3)

Links to LAI related activities:

- Lean Sustainment Research Project (LSRP)
- Lean Forum/Industry Days
- Air Combat Command (ACC) OFP research project

VI - Research Teams

Links to MIT activities:

- Center for Innovation in Product Development (CIPD)
- International Center for Research on the Management of Technology (ICRMOT)
- Management of Technology Program (MOT)
- System Design and Management (SDM) master's program
- Leaders for Manufacturing (LFM) master's program

International collaborations:

- UK Lean Aerospace Initiative (UKLAI)
- Lean Aircraft Research Program (LARP) in Sweden

Team leadership:

Prof. Ed Greitzer (0.5 mo summer)
Dr. Hugh McManus (60%)

Other faculty, staff, students:

Dr. Joyce Warmkessel (18%)
Prof. John Deyst (0.5 mo summer)
Prof. Earll Murman (5% AY, 0.2 mo summer)
Prof. Steve Eppinger
Prof. Kevin Otto
Prof. Anna Thornton (0.5 mo summer)
4 RAs

Team meeting schedule:

Expected to have three team meetings/workshops per year, one to coincide with Plenary meeting.

VI - Research Teams

Manufacturing Systems (MS)

Charter: An efficient production system does not just happen, it must be designed. Therefore, the goal of the Manufacturing Systems Research Team is to document, analyze and communicate the design attributes and relationships that lead to significant performance improvements in manufacturing systems in the defense aerospace industry.

Major research topics:

- Production System Design
- Design and Management of Complex Manufacturing Systems (concluding project from Phase II)
- Improving Cross-Functional Communications: Mechanisms for Knowledge Transformation (Continuing project from Phase II, joint topic with PD which used to be titled Transition to Production)
- *Human Resource Performance Measures*

Products:

Outreach products:

- Web site input (continuous)

Learning products:

- Two team working meetings per year (Yearly, Q1 and Q3)*
- Contributions to annual LAI summer short courses* (Yearly, Q4)
- Annual topical or implementation workshops *
 - Manufacturing System Design Considerations* (Y1, Q4)
 - Manufacturing System Design Space Options for the Defense Industry* (Y2, Q2)
 - Manufacturing System Design in Complex Industries* (Y3, Q2)
- Graduate seminar or modification to existing ME subject* (Y2, Q1)
- Real-time scheduling methods (Y2, Q3)
- Development of decision tools to identify possible manufacturing system designs and transition timing (Y2, Q4)

Enduring products:

- Contributions to the Lean Enterprise Model (LEM) - ongoing
- Archival monographs:
 - Manufacturing System goals in the Defense Aerospace Industry (Y1, Q4)
 - Manufacturing Systems in the Aerospace Industry (Y2, Q4)
 - Manufacturing System Design in Complex Industries (Y3, Q4)
- Book contribution on Production System Design (Y3, Q2)

Possible policy recommendations:

- Effect of progress payments on manufacturing system design
- Effect of system measures on manufacturing system design
- Effect of annual procurement uncertainty on manufacturing system design

Links to LAI related activities:

- Labor Aerospace Research Agenda (LARA)
- Evidence of Lean Site Visits (ELSV)

VI - Research Teams

Links to MIT activities:

- System Design and Management (SDM) master's program
- Leaders for Manufacturing (LFM) master's program
- Operations Research Center
- Laboratory for Manufacturing and Productivity (LMP)
- Production System Design Laboratory (PSDL)

Team leadership:

Prof. Tim Gutowski
Mr. Tom Shields (30%)

Other faculty, staff and students:

Prof. David Cochran (1 mo summer)
Dr. Stanley Gershwin (10%; Y1)
Prof. Anna Thornton
Dr. Stanley Gershwin (Y2,3)
2.5 RAs

Team meeting schedule:

Expected to have three team meetings/workshops per year, one to coincide with Plenary meeting.

VI - Research Teams

Supplier Networks (SN)

Charter: Develop and deploy concepts, strategies and tools that optimize value streams supporting the design, production and sustainment of aerospace systems offering best lifecycle value.

Major research topics:

- Incentivizing investment in new technologies by suppliers (continuing from Phase II)
- Strategies, practices, enabling tools, methods and decision-support systems for flowing lean principles throughout the value stream [e.g., change management strategies, coordination mechanisms, gainsharing, common business practices, electronic integration, knowledge management, performance metrics] (potential joint topic with UK-LAI and LARP)
- Supply chain design for achieving best lifecycle value, including early supplier integration and information infrastructure for collaborative product development (joint topic with Product Development; in collaboration with Acquisition topic “Policies and strategies for achieving best lifecycle value in acquisition of complex military aerospace systems with varying technology clockspeeds”; potential joint topic with Lean Sustainment Research Project, as well as with UK-LAI and LARP)
- *Cross-functional integration of procurement, production and sustainment operations and processes*
- *Optimizing centralized/decentralized procurement strategies*
- *Developing sustaining supplier relationships in an environment of changing aerospace market conditions*
- *Mapping the supplier knowledge value stream*
- *Designing new information-technology-mediated organizational structures, business practices and management strategies fostering interorganizational learning*
- *Linking technology roadmaps across government-prime-supplier networks*

Products:

Outreach products:

- Regional Supplier Workshops targeted at lower-tier aerospace suppliers*-ongoing
- Web-based communication products - ongoing
- *Annual “for fee” conferences on special topics open to all small-to-medium sized aerospace suppliers**

Learning products:

- Annual topical or implementation workshops*
- Decision-support system for lean implementation: “Transition-to-lean” supply chain management reference framework, performance metrics and toolset (Y1,Q4)
- Contributions to summer short course - Yearly Q4
- *Information Technology (IT) tools for mapping supplier knowledge value streams*

Enduring products:

- Contributions to the Lean Enterprise Model (LEM) - ongoing
- Conference reports, working papers and publications
- Book contribution - Superchains (Y3)

Links to LAI-related activities:

- Lean Sustainment Research Project
- International collaborations (e.g., UK-LAI, LARP)
- Labor Aerospace Research Agenda (LARA)

VI - Research Teams

Links to MIT activities:

- Integrated Supply Chain Management Program (ISCM), Center for Transportation Studies
- System Design and Management (SDM) Program
- Center for Innovation in Product Development (CIPD)
- International Motor Vehicle Program (IMVP)

Team leadership:

Dr. Kirk Bozdogan (37.5%)
Prof. Charles Fine (0.5 mo summer)

Other faculty, staff, students:

Prof. Duncan Simester
Prof. Dan Frey (0.5 mo summer)
Mr. James Rice
Prof. Sandy Jap
1.5 RAs

Team meeting schedule:

Expected to have two per year (one in conjunction with the annual LAI Plenary Conference and the other linked to annual topical or implementations workshops)

VI - Research Teams

Organizations and People (O&P)

Charter: The Organizations and People research team will be created in LAI Phase III to identify organizational strategies, practices, and processes that foster the transition, development and maintenance of the lean enterprise, specifically as they relate to organizations and people.

Major research topics:

- Organizational structures, incentives, and leadership practices that facilitate sustained change and improvement
- The role of organizational and functional cultures in making the transition to lean
- Human capital strategies and practices to maintain long-term core competence and competitiveness
- Knowledge transformation processes and practices in complex settings
- *Structuring the value stream for lifetime learning and employee development*
- *Tools and structures from managing enterprise knowledge*

Products:

Outreach products:

- Web site input (continuous)

Learning products:

- Summer short courses/workshops* (Yearly, Q4)

Enduring products:

- Contributions to the Lean Enterprise Model (LEM) - ongoing
- Working Papers (Y2 and Y3)
- *Contribution to Book (Y3)*

Links to LAI related activities:

- Labor Aerospace Research Agenda (LARA)
- UK Lean Aerospace Initiative (UKLAI)
- Lean Aircraft Research Program (LARP) in Sweden

Links to MIT activities:

- Center for Innovation in Product Development (CIPD)
- International Center for Research on the Management of Technology (ICRMOT)
- Management of Technology Program (MOT)
- System Design and Management (SDM) master's program
- Leaders for Manufacturing (LFM) master's program

Team leadership:

Prof. Thomas Allen (10% AY, 0.5 mo summer)
Dr. Eric Rebentisch (75%)

Participating researchers:

Senior Sloan School Faculty (1.0 mo summer)
Prof Paul Carlile (0.5 mo summer)
Dr. Joel Cutcher-Gershenfeld (25%)
Prof. Tom Kochan
3.5 RAs

Team meeting schedule:

Expected to have 3 team meetings per year (Q2, Q3, and Q4)

VI - Research Teams

Test and Space Operations (TSO)

Charter: Develop lean approaches for testing and operations of space systems with a view to increasing life cycle value.

Major research topics:

- Satellite System Testing: Investigation of distribution of discrepancies found in satellite integrated system testing (Continuing from Phase II). Examination of initial on-orbit test and evaluations to develop the value stream and evaluate approaches to shorten test cycle.
- Launch operations: Develop a model for expendable launches to help determine recommendations for streamlining measures under different operating scenarios (Continuing from Phase II). Evaluation of lean launch operations for reusable launch. (Continuing from Phase II)
- Space system operations: Lean theory will be applied to generate a “lean operations” concept, with life cycle value as a core optimizer. (Continuing from Phase II)

Products:

Outreach:

- Web site input (continuous).

Learning products:

- Satellite System Testing Model (Y1)
- Workshops
 - Lean Launch Operations* (Y1, Q2),
 - Lean Space Test and Operations* (Y2, Q2)
 - Design and Policy Recommendations* (Y3, Q2)

Enduring products:

- Contributions to the Lean Enterprise Model (LEM) - ongoing
- Monographs:
 - Lean Launch Operations (Y2),
 - Lean Spacecraft Testing (Y3)
 - Lean Space Operations (Y3)

Possible policy recommendations:

- Launch Operations (Y2)
- Lean Space Operations (Y3)

Links to LAI related activities: Lean Sustainment Research Project

Links to MIT activities: Space Systems Laboratory

Team leadership:

Prof. Dan Hastings (1 mo summer)
Dr. Joyce M. Warmkessel (36%)

Other faculty, staff, students

Dr. Stanley Weiss
4 RAs (Y1,2), 3.5 RAs (Y3)

Team meeting schedule:

Expected to have two team meetings a year in fall and spring.

VI - Research Teams

Acquisition (AQ)

Charter: Perform research on policies, strategies, practices and tools that will ensure best lifecycle value in weapon systems acquisition.

Major research topics

- Best practices in requirements generation (continuing from Phase II)
- Managing subsystem commonality (continuing from Phase II)
- Managing overhead costs through activity-based-costing methods (continuing from Phase II)
- Policies and strategies for achieving best lifecycle value in acquisition of complex military aerospace systems with varying technology clockspeeds (in collaboration with Product Development topics “Technology Insertion and the Product Development Process” and “Optimizing Replacement of Obsolete Avionics Systems”; in collaboration with Supplier Networks topic “Supply chain design for achieving best lifecycle value, including early supplier integration and information infrastructure for collaborative product development”; potential joint topic with Lean Sustainment Research Project)
- Contract design for managing government-prime-supplier relationships for delivering best lifecycle value
- Best practices in price-based weapon systems acquisition
- Acquisition policy implications of industry consolidation and globalization
- *Information-technology-mediated organizational structures for weapon system acquisition management*
- *Modeling and simulation methods for dynamic lifecycle acquisition*
- *Mapping acquisition knowledge value streams*
- *Diffusion of innovations in acquisition practices throughout the government*
- *Linking government and industry technology roadmaps for timely technology development, maturation and insertion into new and existing weapon system platforms*

Products:

Outreach products:

- Web-based products - ongoing
- Special topical reports - ongoing

Learning products:

- Annual topical or implementation workshops*
- *“Transition-to-Lean” framework and management guide for lifecycle acquisition (Y2, Q4)*

Enduring products:

- Contributions to the Lean Enterprise Model (LEM) - ongoing
- Conference reports; working papers; publications - ongoing
- Lean acquisition monograph - (Y3, Q3)

Policy recommendations

Links to LAI-related activities:

- Lean Sustainment Research Project
- Air Combat Command (ACC) OFP research project
- Labor Aerospace Research Agenda (LARA)

VI - Research Teams

Links to MIT activities:

- System Design and Management Program (SDM)
- Management of Technology Program (MOT)
- Center for Innovation in Product Development (CIPD)
- International Center for the Management of Technology (ICRMOT)

Team leadership:

Prof. Wesley Harris (1 mo summer)
Dr. Kirk Bozdogan (37.5%)

Other faculty, staff, students

Dr. Eric Rebentisch (10%)
3.5 RAs (Y1,2), 3 RAs (Y3)
Prof. Sandy Jap

Team meeting schedule:

Expected to have two per year (one in conjunction with the annual LAI Plenary Conference and the other linked to annual topical or implementations workshops)

VII - Teams/Themes Matrix

Five major Phase III research themes are listed in the Introduction. These themes were explicitly used in the development and prioritization of the Phase III team plans. The below matrix illustrates how each teams plans relate to these themes.

Teams	Themes				
	Time	Organizations and People	Government as a Lean Customer & Operator	Knowledge & Information Infrastructure	Value of Lean
LEM	√	√	√	√	√
Knowledge Deployment	√	√	√	√	√
Policy		√	√		√
Product Development	√	√	√	√	√
Manufacturing Systems	√	√	√	√	√
Supplier Networks	√	√	√	√	√
Organizations and People		√	√	√	
Test and Space Operations	√	√	√		√
Acquisition	√	√	√	√	√

VIII - Linkages to Other Activities

LAI leverages a large number of other activities, programs, and centers. Explicit interactions have been identified in each team's section. A summary is given below.

	LEM	KD	PO	PD	MS	SN	O&P	TSO	AQ
LAI-related activities									
Lean Sustainment Research Project (LSRP)	√	√		√		√		√	√
Labor Aerospace Research Agenda (LARA)	√	√			√	√	√		√
Evidence of Lean Site Visits (ELSV)	√	√			√				
Lean Forum/Industry Days (LF/ID)		√		√					
Air Combat Command (ACC) OFP research project				√					√
MIT Centers and Programs									
Center for Innovation in Product Development (CIPD)	√			√		√	√		√
International Center for Research on the Management of Technology (ICRMOT)				√			√		√
International Motor Vehicle Program (IMVP)	√					√			
Integrated Supply Chain Management Program (ICSM)						√			
Operations Research Center (ORC)					√				
Laboratory for Manufacturing and Productivity (LMP)					√				
Production System Design Laboratory (PSDL)					√				
Space Systems Laboratory (SSL)								√	
Management of Technology Program (MOT)				√			√		√
System Design and Management (SDM) Program	√			√	√	√	√		√
Leaders for Manufacturing (LFM) Program	√			√	√		√		
International Collaborations									
UK Lean Aerospace Initiative (UKLAI)	√	√		√		√	√		
Swedish Lean Aircraft Research Program (LARP)		√		√		√	√		
External Organizations									
National Institute of Standards (NIST)	√								
Business Executives for National Security (BENS)			√						

IX - Strategies for Linking with Suppliers

In Phase III, a three-pronged strategy will be pursued to link LAI more closely with the aerospace supplier base: **collaboration** with other programs or organizations with similar interests; **outreach** activities directly undertaken by LAI to disseminate lean principles; and possible **supplier membership** in LAI.

- **Collaboration:** Opportunities for collaboration with other programs and organizations are being identified for joint initiatives expected to synergize capabilities, conserve LAI resources, and multiply LAI's impact by disseminating lean principles more broadly throughout the aerospace supplier community. One example is regional supplier workshops started in Phase II, funded by AFRL (ManTech) and launched in association with LAI. Organized by the New England Regional Suppliers Institute (NESI) and hosted by LAI member companies, two pilot workshops have already been held for lower tier suppliers in New England supporting LAI consortium member companies. Additional workshops have also been held on the West Coast, organized by the California Manufacturing Technology Center (CMTC).

Other opportunities for collaboration are also being explored, both to extend the concept of regional supplier workshops and to define new initiatives. Programs or organizations offering potential targets of opportunity include: The Supplier Council of the Aerospace Industries Association (AIA); and Manufacturing Extension Partnership (MEP) initiative of the National Institute of Standards and Technology (NIST).

- **Outreach:** Direct LAI outreach activities in specific areas are being targeted for linking LAI with suppliers. These would include focused conferences at member sites, access to benchmarking research results (for suppliers participating in the survey) and special topical reports as well as targeted implementation products.
- **Membership:** Alternative "models" for supplier membership in LAI have been explored by an ad hoc LAI Supplier Membership Committee and the Integration Team. Membership options, benefits and costs (to both LAI and potential supplier new supplier members) and appropriate fee structures are being defined.

This three-pronged strategy for linking with suppliers is expected to widen and deepen the mutually-advantageous dialogue within the LAI stakeholder community embracing suppliers, to help establish a common vision, shared goals, and accelerated adoption of lean principles throughout the aerospace supplier base.

X - Integrated Yearly Schedule

In an effort to balance the workload of the LAI staff and researchers and to assure that major deliverables are delivered, an integrated schedule has been developed. This schedule, applied repetitively over the three years, will also allow member organizations to better plan their resource needs. We understand that flexibility will be required about these dates; nonetheless, for planning purposes, the activities charted in the table below will constitute the planned interaction between the LAI participants.

		Sep-Nov	Dec-Feb	Mar-May	Jun-Aug
Meetings	Plenary			✓	
	Working Group			✓	
	Executive Board				✓
	Round Table	✓			
	DMC		✓		
	INCOSE				✓
	AERO EXPO		✓		
	AIAA				✓
Products	Impl. Wkshp	✓	✓	✓	✓
	Topical Wkshp	✓	✓	✓	✓
	Team Meeting	✓	✓	✓	✓
	Short Courses				✓
	Ann./Qtly Reports	✓	✓	✓	✓

- Scheduled LAI Meetings
- Opportunities for Outreach & Joint Meetings
- Product Focused Meetings
- Firm
- Possible Meeting (based on product plans)

Appendix - LAI Glossary

Team Meeting:

Team-specific focused meeting on planning, team research and progress reports. Not an “open-enrollment” session. Managed by the team itself.

Plenary Conference

Large popular venue with mass appeal; fee-based open enrollment for the LAI community; more top-level coverage of a theme; involves guest presenters from within and outside LAI; in general, more focused on “delivery” of information. Facilitated, in part, by the KD Team.

Workshop

Smaller (50-75 attendees) learning venue with a more specific focus and with either an implementation or topical appeal spanning a short length of time (1-3 days); fee-based open-enrollment within the LAI community; generally designed to maximize two way flow of information; data collected may contribute to future research and products. Organized by an LAI product or research team; enabled by the KD Team

Short Course

Broadly, a week-long fee-based instructional activity with curriculum modules originated by LAI research and product teams or related MIT programs., The KD team will enable the LAI generated short courses. Initially open to the LAI community (not to an MIT student audience), but subsequent courses will be offered to a wider audience, perhaps at an increased fee.