

**Lean  
Aerospace  
Initiative**



***Lean Aerospace Initiative***  
*Industry/Government/Labor/  
Academic Partnership*

**Introduction to LAI**  
September 26, 2001

*Earll M. Murman*  
*LAI Co-Director*  
*murman@mit.edu*  
*617-253-3284*

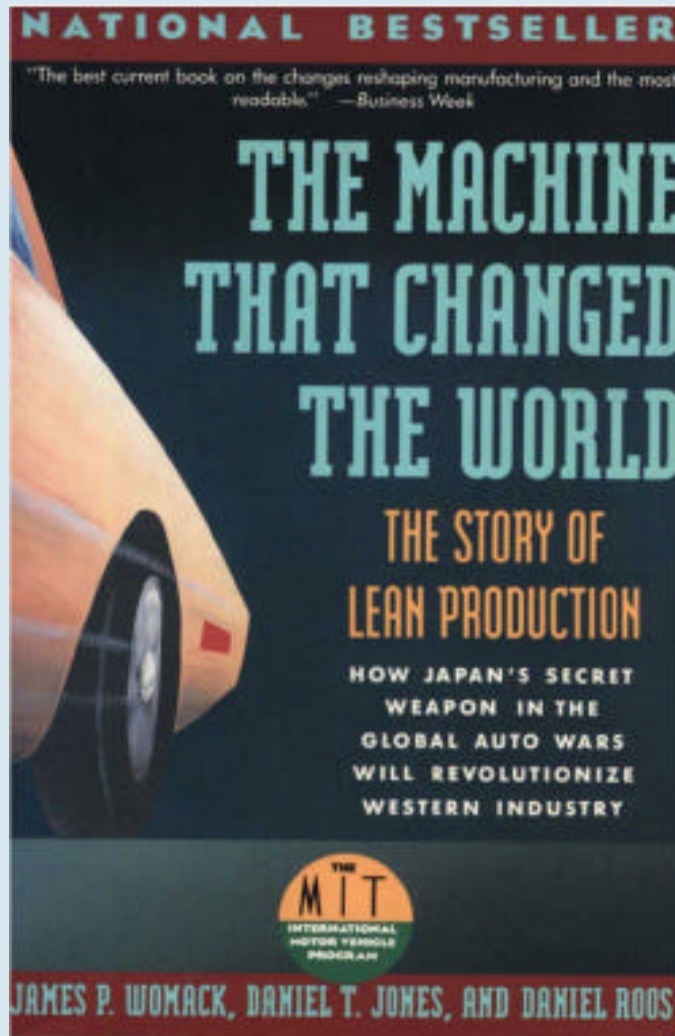


- **Why LAI?**
- **How does LAI work?**
- **What use is LAI to others?**
- **How far has LAI come and where will we go next?**

# Why LAI?



# 1993 Genesis of the Lean Aerospace Initiative



US Air Force asked:

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

- Answer: *Yes!*



# Historical Industrial Paradigms

1885	1913	1955-1990	1993-...
<b>Craft Production</b>	<b>Mass Production</b>	<b>Toyota Production System</b>	<b>Lean Enterprise</b>
Machine then harden Fit on assembly Customization	Parts inter-changeability Moving production line Production engineering Workers don't think	Worker as problem solver Worker as process owner enabled by: -- Training -- Upstream quality -- Minimal inventory -- Just-in-time Eliminate waste Responsive to change	"Lean" applied to all functions in enterprise value stream Optimization of value delivered to all stakeholders and enterprises in value chain
Highly skilled workforce Low production rates High cost	Unskilled labor High production rates Low cost Persistent quality problems Inflexible models	Low cost Improving productivity High quality product	Low cost Improving productivity High quality product Greater value for stakeholders

*"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



## 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**



## 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

## Space

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

## 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

## Other Participants

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

## Propulsion/Systems

Curtis Wright Flight Systems  
Parker Aerospace  
Hamilton Sundstrand  
Pratt & Whitney  
Rolls Royce (N.A.)

## 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 Government

DCMA  
NASA  
NAVAIR  
AMCOM  
OUSD(AT&L)  
NRO



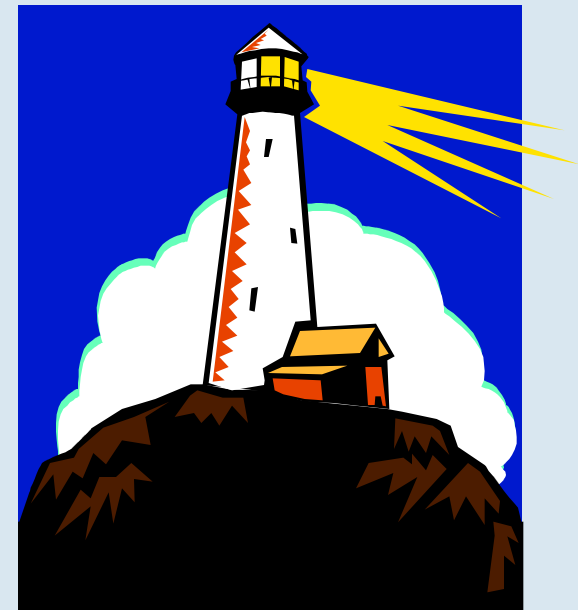


## *LAI Vision of the Greater Aerospace Enterprise*

*“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*



**Product  
Development**

**Supplier  
Networks**

**Organizations  
& People**

**Knowledge  
Deployment**

**Lean  
Enterprises**

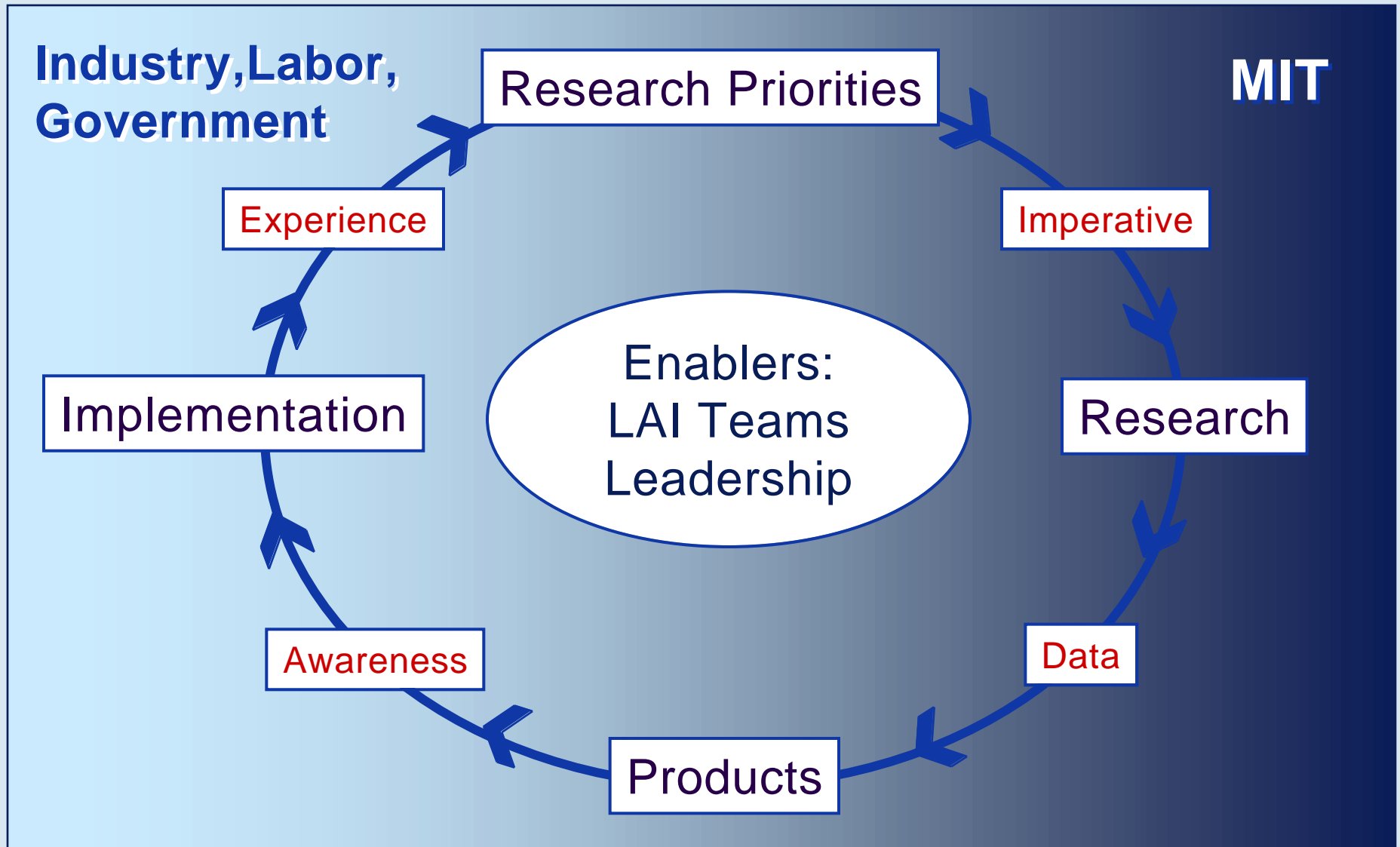
**Manufacturing  
Systems**

**Acquisition**

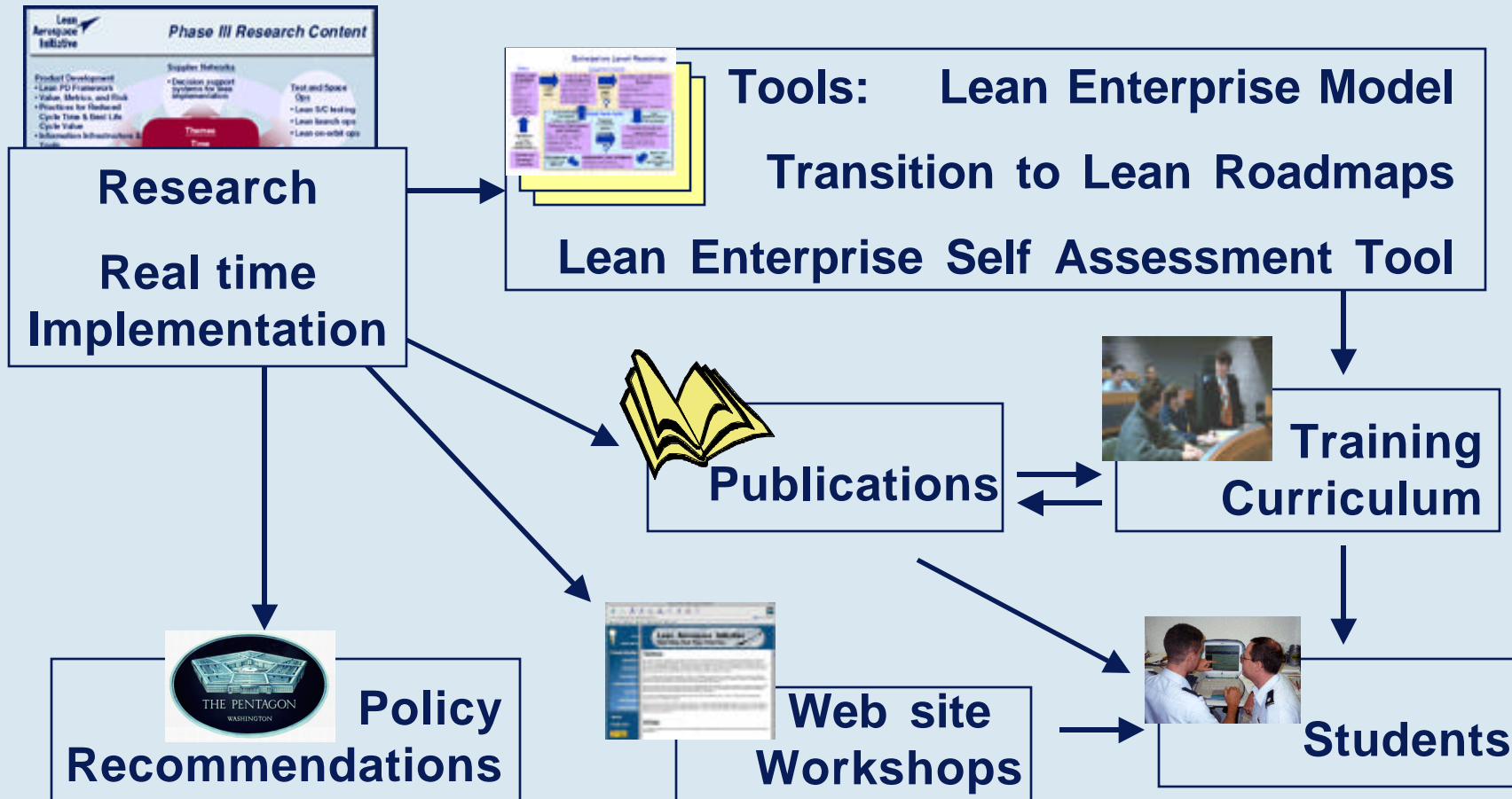
**Team Compositions: MIT, Industry, Government, Labor  
Team Sizes: 20 - 80 members per team**



# LAI Consortium Process Flow - Shared Roles and Responsibilities



# What use is LAI to others?

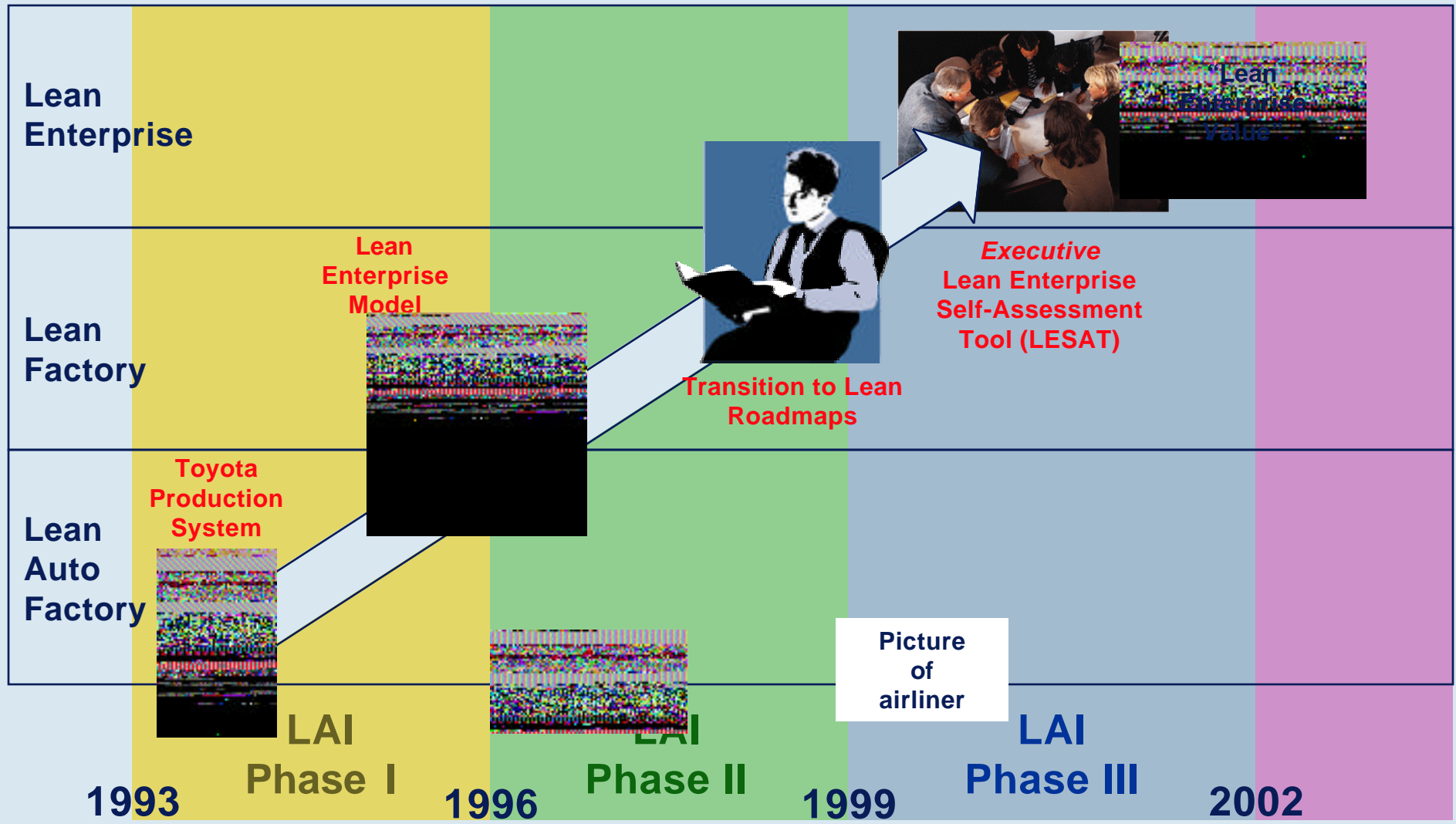


**Stakeholder Defined Value**  
 Knowledge Base • Implementation Framework • Research Products • Neutral Forum





# Lean Aerospace Journey And LAI Products



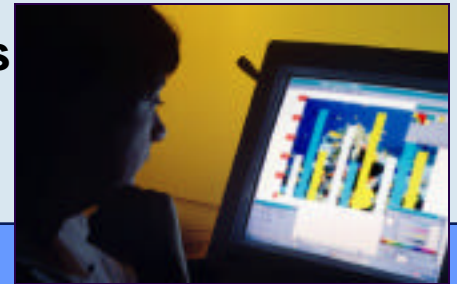


# Lean Enterprise Model

## Practices and Benchmark Data

Meta-Principles/Enterprise Principles

Enterprise Level Metrics



### Overarching Practices

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

**Metrics - Barriers - Interactions**

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

**Data Sheets (~225)**

**Supporting Practices (~300)**

**Internet Links (~600)**

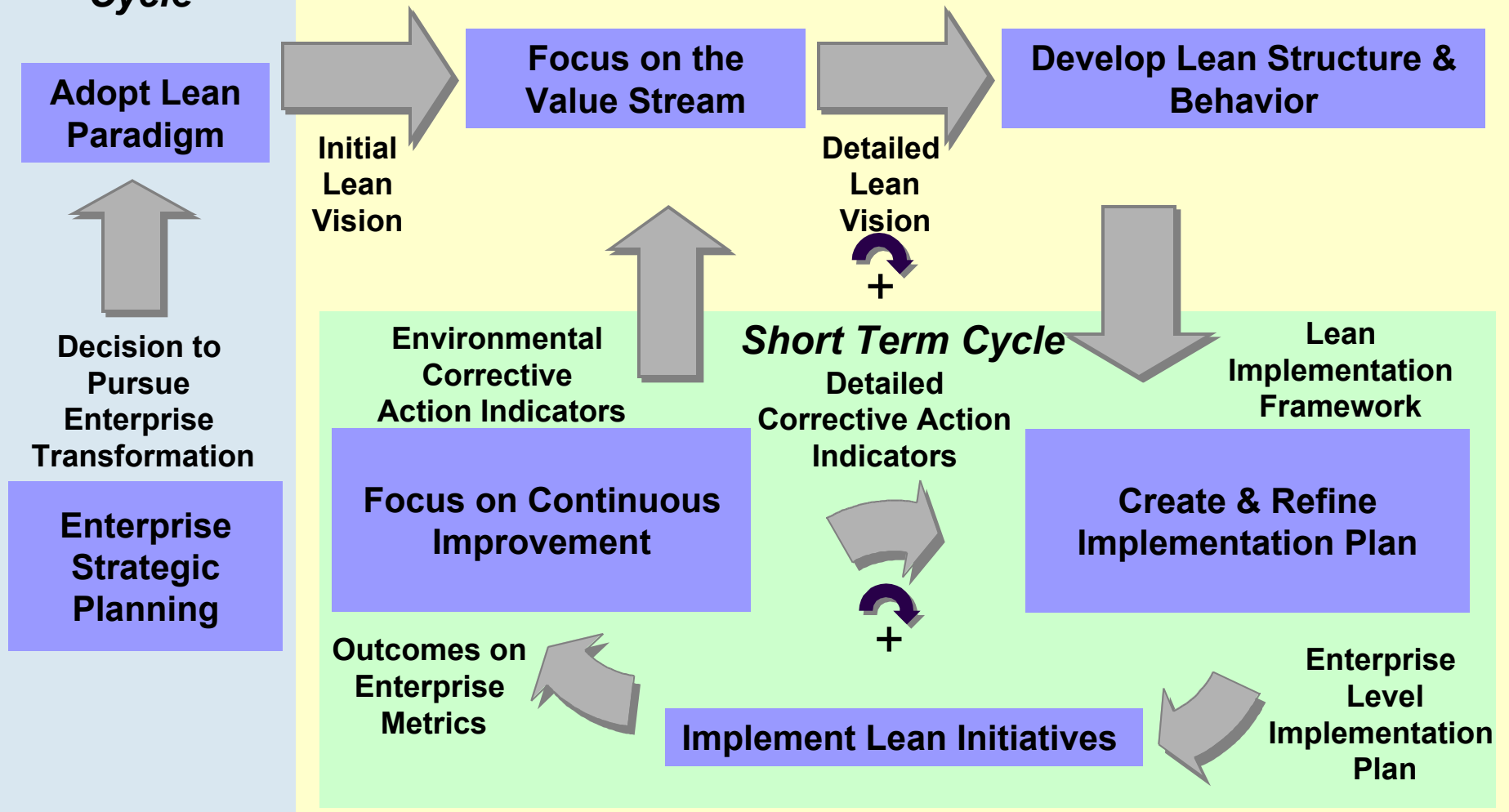
Lean  
Aerospace  
Initiative



# Enterprise Transition To Lean (TTL) Roadmap

Entry/Re-entry  
Cycle

Long Term Cycle





# Lean Enterprise Self Assessment Tool

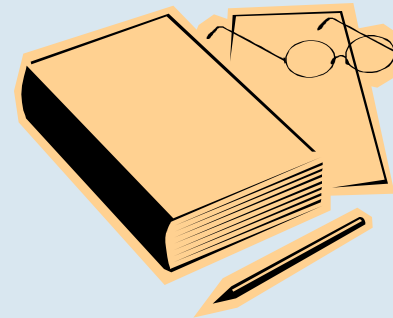
World  
Class



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

	1	2	3	4	5

Capability  
maturity  
model



Supporting  
materials



# *Lean Enterprise Value: Insights from MIT's Lean Aerospace Initiative*

Preface

Foreword

Acknowledgements

***Part I Higher, Faster, Farther!***

Chapter 1 The 21<sup>st</sup> 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***

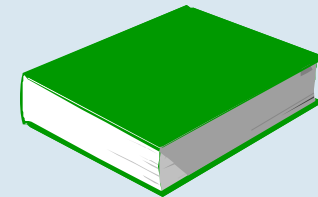
Chapter 7 A Value Creation Framework

Chapter 8 Program Value

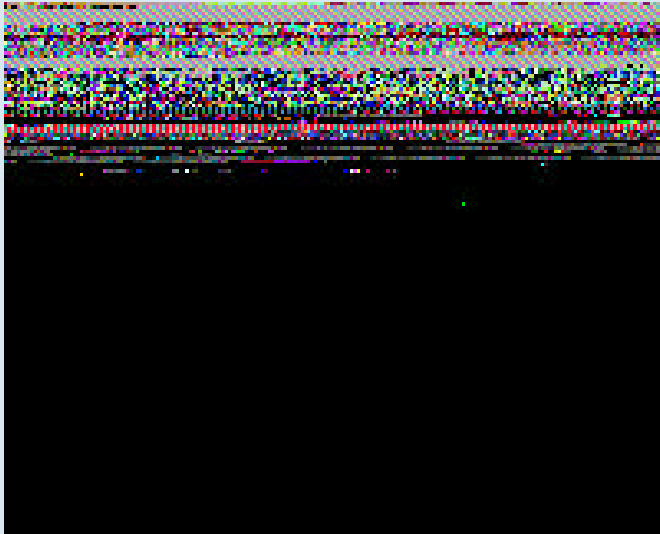
Chapter 9 Corporate and Government Value

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?



## Journey of the Aerospace Industry



- ★ 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)





**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***