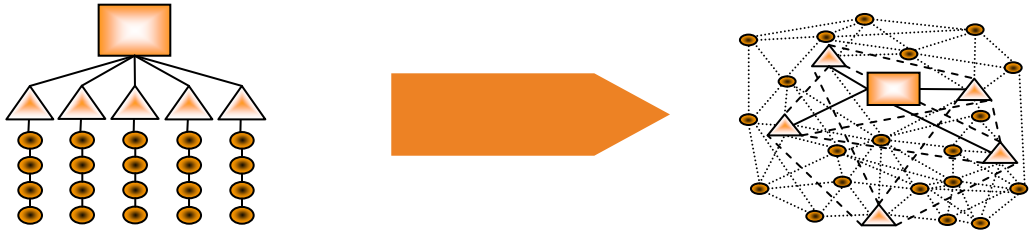
Highlights of Enterprise Transformation Research

Debbie Nightingale

April 24, 2008

The Challenges of Complex Enterprises Requires a Systems Approach

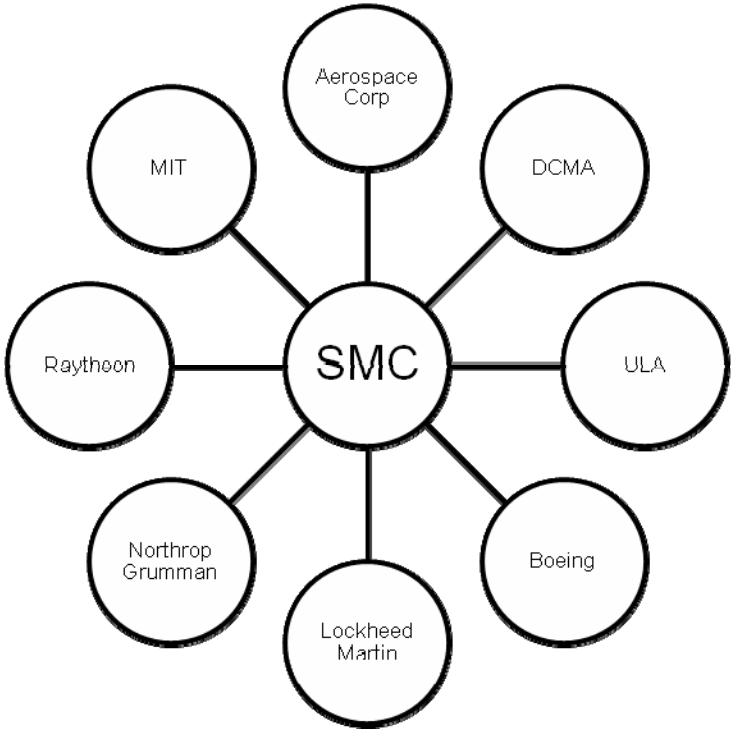
- New strategic systems perspective
- Viewing enterprises as **holistic** and **highly networked** systems
- Integrating leadership processes, lifecycle processes and enabling infrastructure systems
- Balancing needs of multiple stakeholders working across boundaries



MOVING FROM THE PAST
(hierarchical) enterprise

TOWARDS THE FUTURE
(networked) enterprise

Understanding Mission Assurance



Initiation
LAI SMC EVSMA Event

Phase 1 (March 08)
Enterprise View of Government Projects

Phase 2 (April 08)
Integration of Govt. Industry Processes

Outcome
Enterprise View of Mission Assurance 'Big Picture'

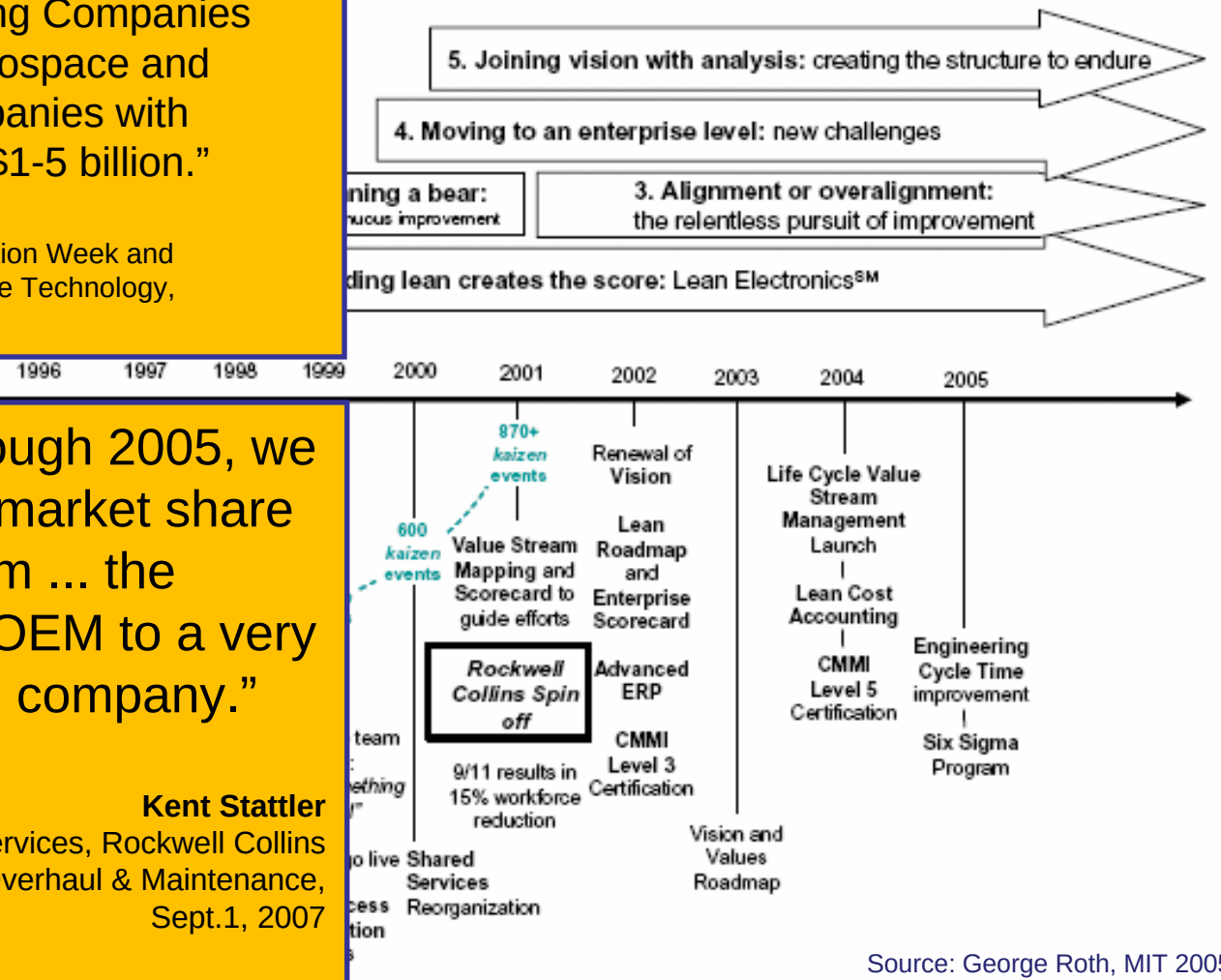
Rockwell Collins Evolution

"Rockwell Collins places first in this year's Top-Performing Companies (TPC) ranking of aerospace and defense (A&D) companies with annual revenues of $1-5 billion."

Source: Aviation Week and Space Technology, 2007

"From 1998 through 2005, we made dramatic market share gains, going from ... the mentality of an OEM to a very service oriented company."

Kent Stattler
EVP of Services, Rockwell Collins Overhaul & Maintenance, Sept.1, 2007



Source: George Roth, MIT 2005

Creating a Holistic Approach to Enterprise Transformation

Implementation Issue	Enterprise Tool
How do I motivate and sustain enterprise transformation?	7 Principles of Lean Enterprise Thinking
How do I transform my enterprise to lean?	Enterprise Transformation Roadmap
	Enterprise Architecting Framework
What analytical tools can I use to support my decision making?	Enterprise Strategic Analysis and Transformation (ESAT)

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7 Principles of Lean Enterprise Thinking

1. Adopt a holistic approach to enterprise transformation.

2. Identify relevant stakeholders and determine their value propositions.

3. Focus on enterprise effectiveness before efficiency.

4. Address internal and external enterprise interdependencies.

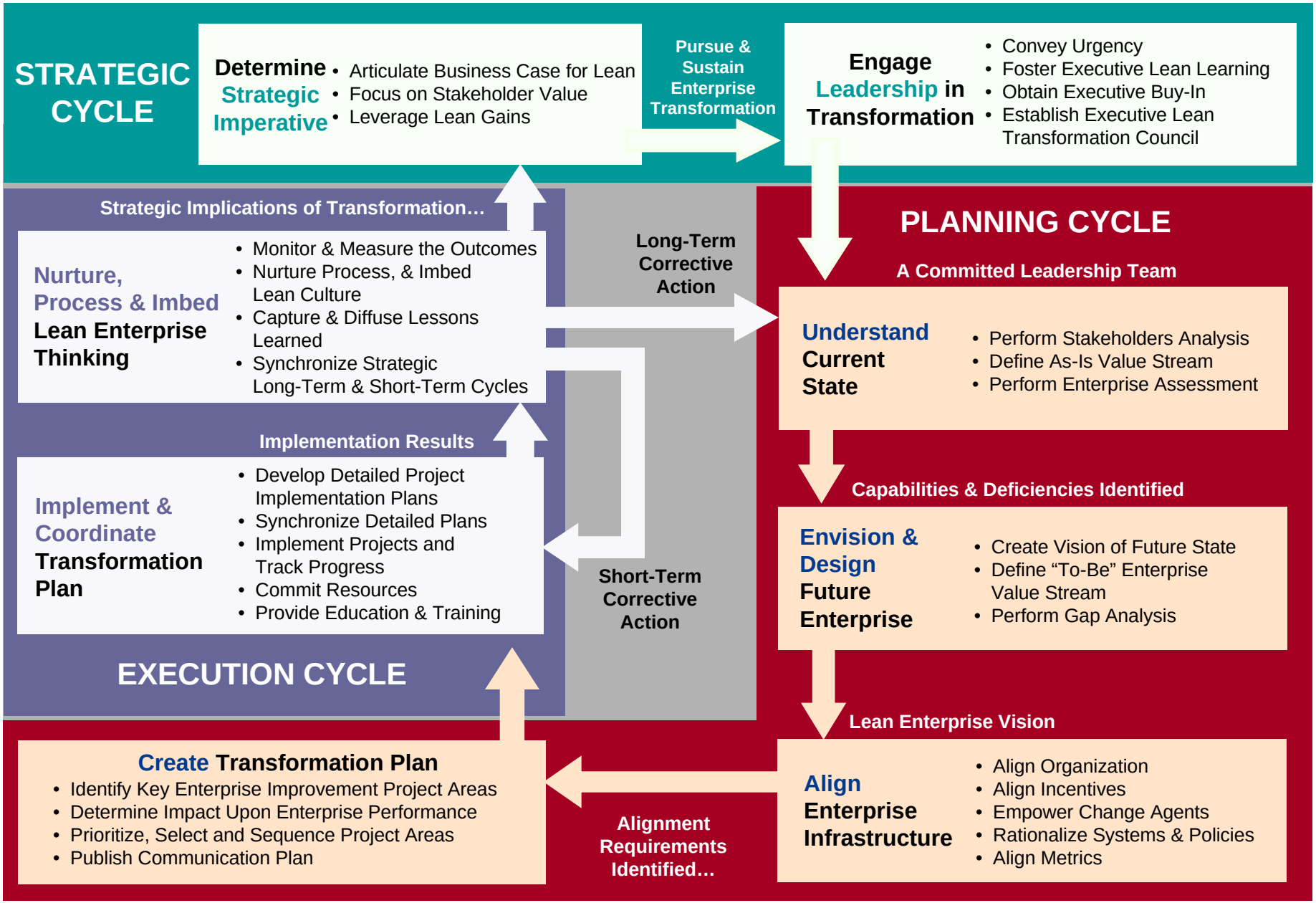
5. Ensure stability and flow within and across the enterprise.

6. Cultivate leadership to support and drive enterprise behaviors.

7. Emphasize organizational learning.

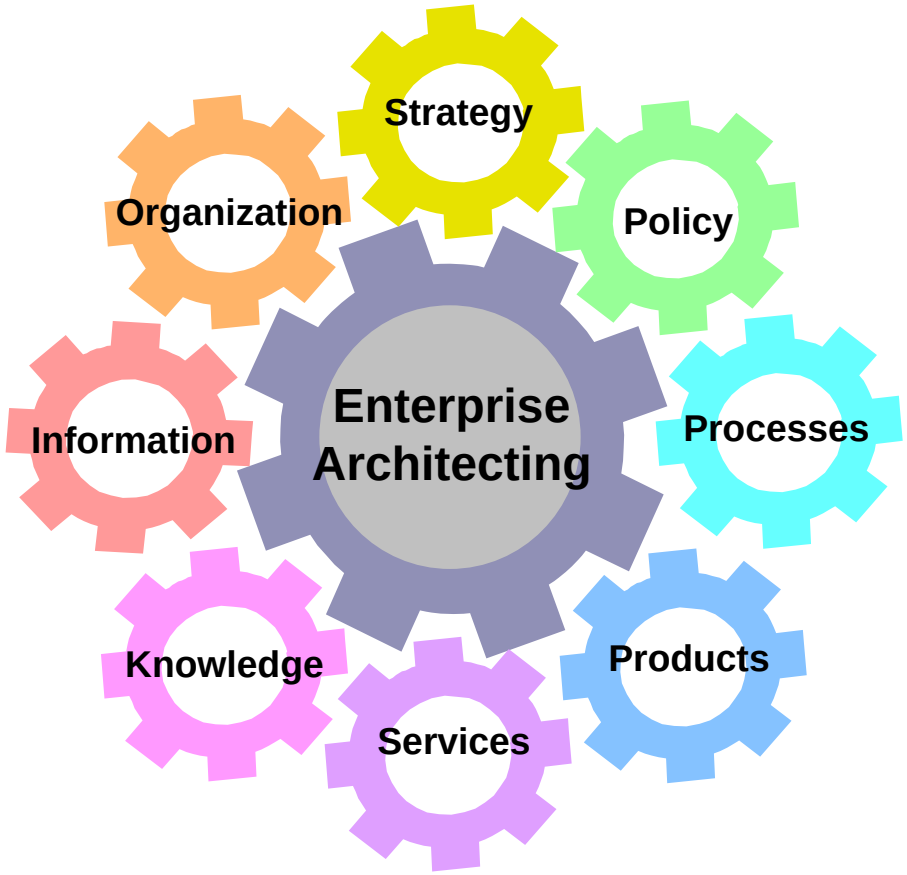
Source: D. Nightingale and J.K Srinivasan, MIT 2008

Enterprise Transformation Roadmap



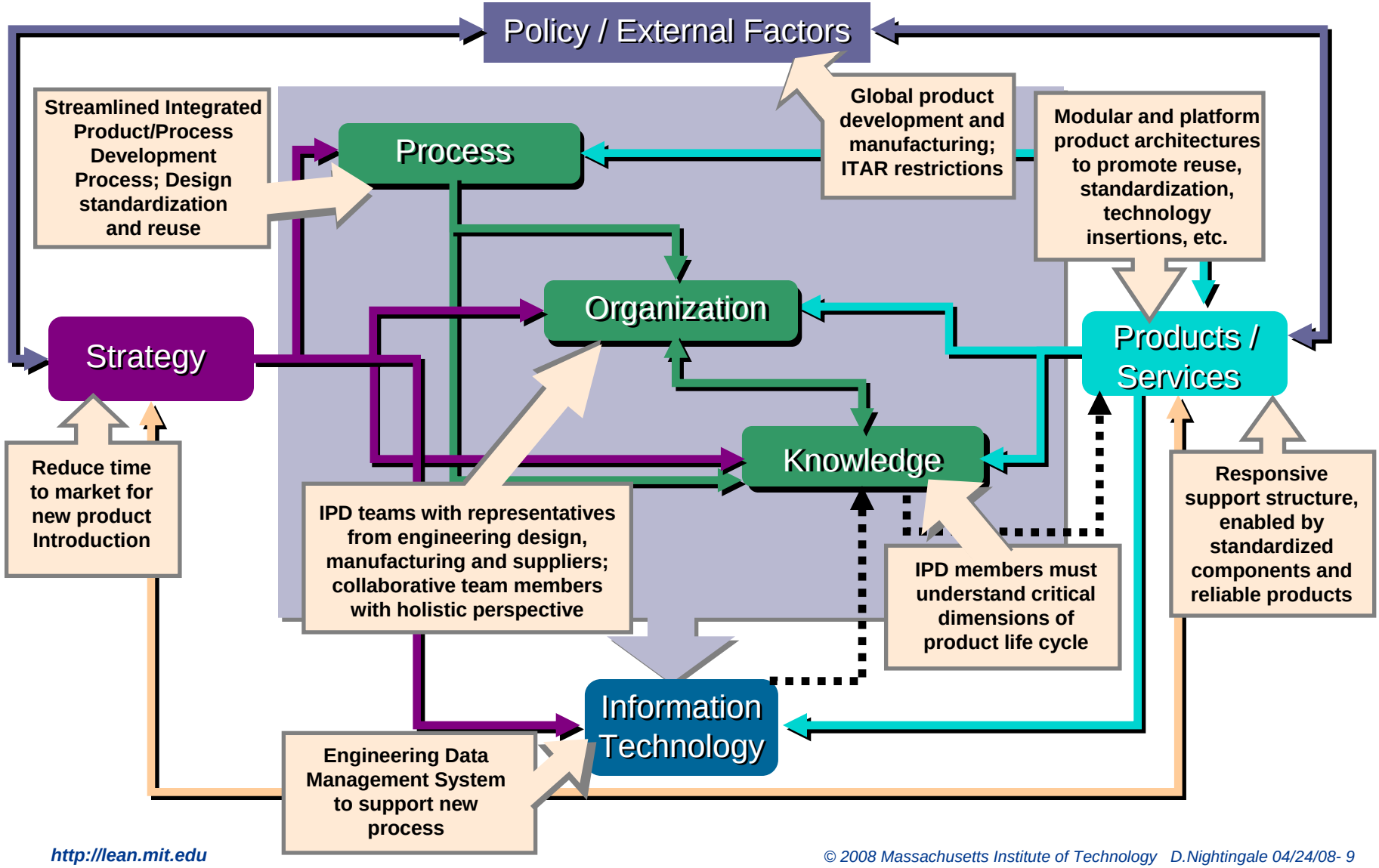
Source: Nightingale, Srinivasan and Mize

Enterprise Architecting – *Enables* Greater Efficiency and Effectiveness

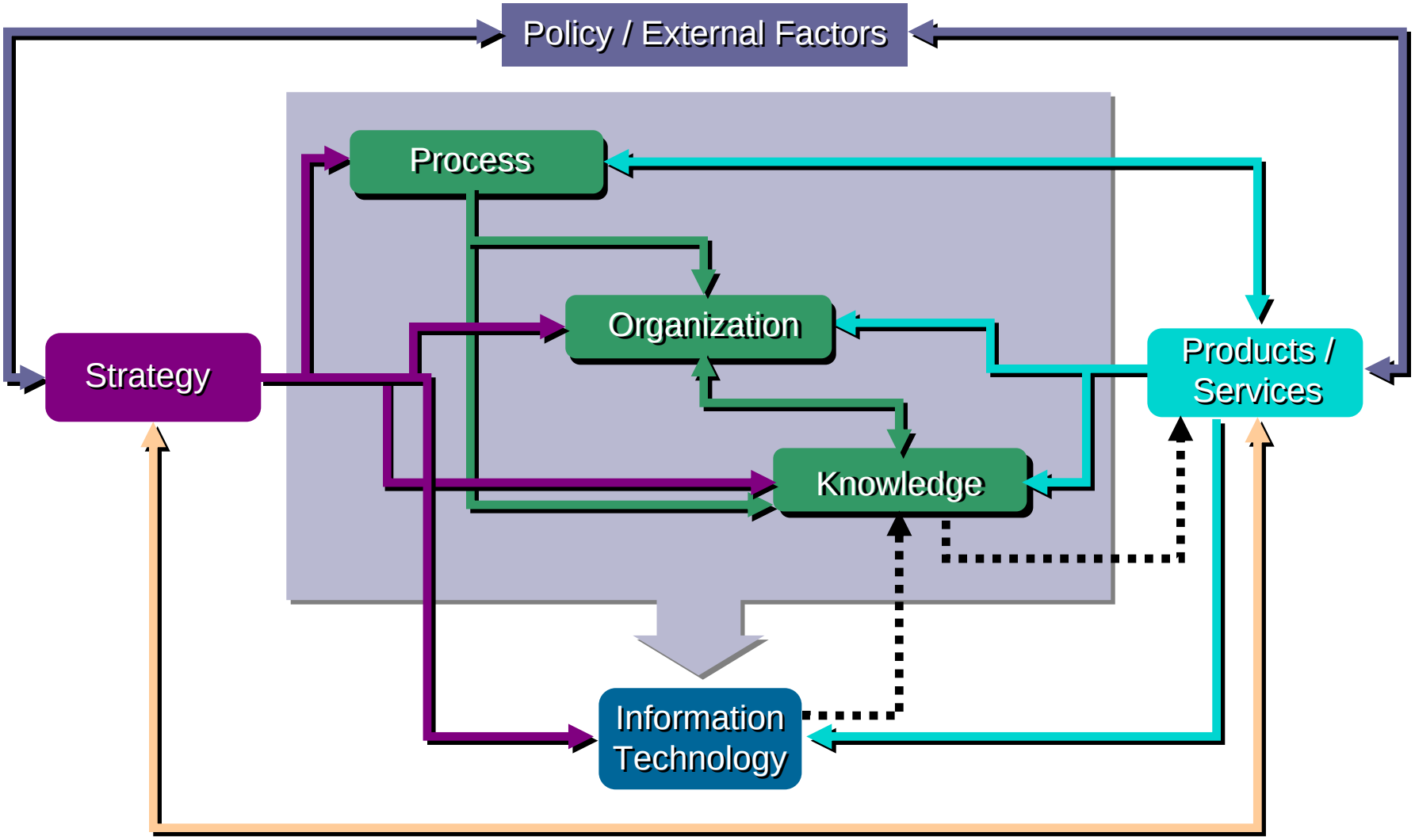


- Effective integration – managing complex interdependencies
- System optimization, not local optimization
- Knowledge-based enterprise capabilities
- Achieving desired future state characteristics
  - Agility
  - Flexibility
  - Reconfigurability

EA Example: Reduce Time to Market Imperative



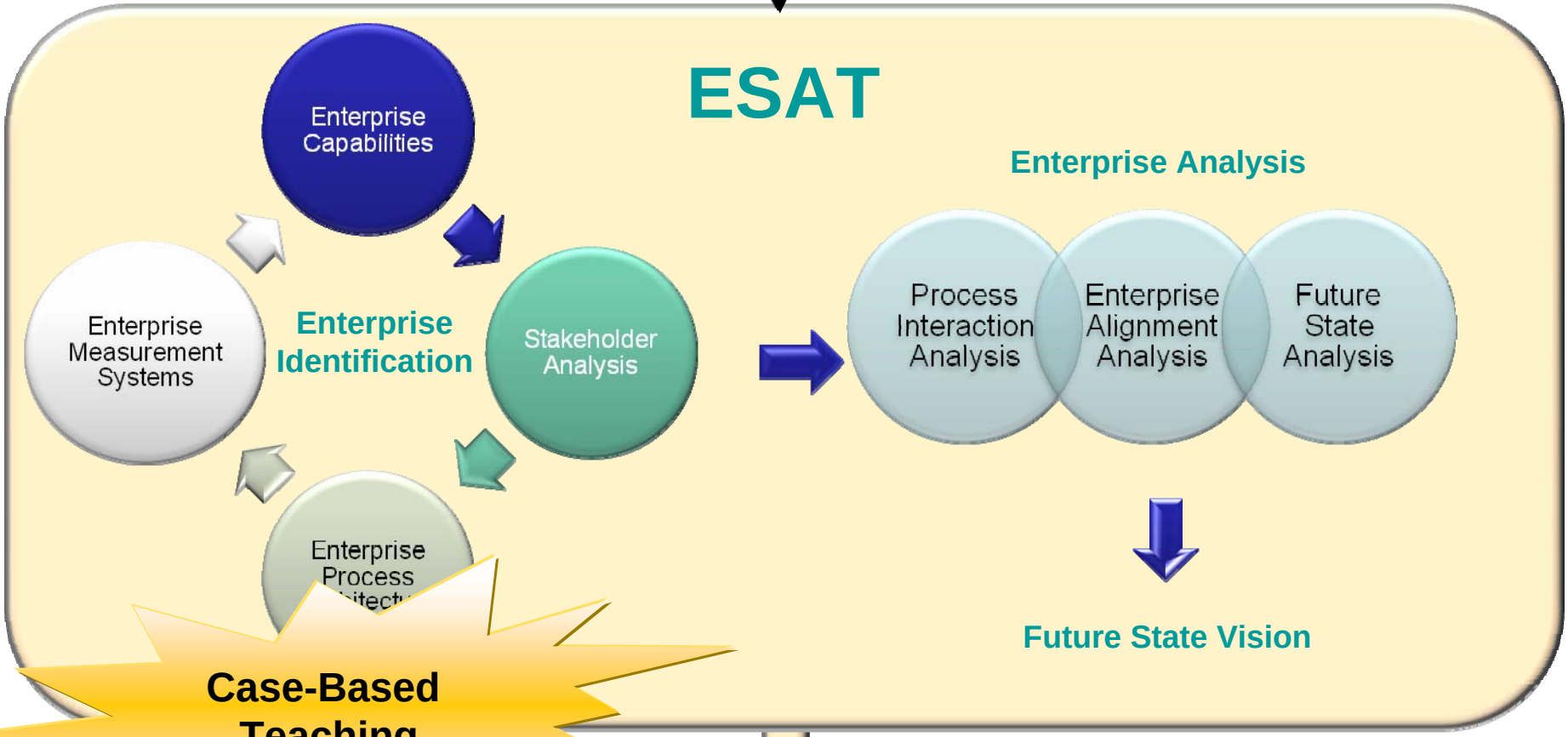
Enterprise Architecture Framework



Enterprise Strategic Analysis and Transformation (ESAT)

LEAN ADVANCEMENT INITIATIVE

Strategic Objectives



LAI Research Groups Address 4 Grand Questions

1. How can I understand the way my organization **currently operates** within its larger context?

2. How can I define and evaluate the **future possibilities** for a more efficient and effective enterprise?

3. What are the most **effective strategies** and tactics to achieve these future possibilities for my enterprise?

4. How can I best manage the enterprise **change process**?

EA-ET
Enterprise Architecting - Enterprise Transformation

FOCUS of RESEARCH
- Enterprise Value Analysis
- Enterprise Architecting
- IT as Enterprise Enabler
- Enterprise Cost and Metrics
- Enterprise Modeling

LEPD
Lean Enterprise Product Development

FOCUS of RESEARCH
- Lean Product Development
- Lean Systems Engineering
- Lean Software

ESE
Enterprise Systems Engineering

FOCUS of RESEARCH
- ESE Approaches
- SE Effectiveness Indicators
- Studies of ESE Practices (with MITRE)

ECM
Enterprise Change Management

FOCUS of RESEARCH
- Change Management
- Enterprise Change Philosophy
- Studies of Successful Change
- Distributed Leadership

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The Four Research Groups

	ECM Enterprise Change Management	ET/EA Enterprise Transformation/ Enterprise Architecting	ESE Enterprise Systems Engineering	LEPD Lean Enterprise Product Development
Faculty Lead	**John Carroll**	**Debbie Nightingale & Joe Sussman**	**Warren Seering & Dan Hastings**	**Warren Seering**
Research Areas	**•Change Management •Enterprise Change Philosophy •Studies of Successful Change •Distributed Leadership**	**•Enterprise Value Analysis •Enterprise Architecting •IT as Enterprise Enabler •Enterprise Cost and Metrics •Enterprise Modeling**	**•Enterprise SE Approaches •SE Effectiveness Indicators •Studies of ESE Practices (with MITRE)**	**•Lean Product Development •Lean Systems Engineering •Lean Software**
Communities	**Change Management**	**CIO**	**System Engineering**	**Product Development**
Team Members	**George Roth**	**Kirk Bozdogan Donna Rhodes JK Srinivasan Ricardo Valerdi**	**Donna Rhodes Ricardo Valerdi**	**Eric Rebentisch JK Srinivasan Hugh McManus**
Products & Tools	**Enterprise Change Fieldbook**	**Transformation Roadmap / ESAT / LESAT**	**SE Leading Indicators Guide**	**PDVSM / LEPD/PDTTL**

Enterprise Change Research

George Roth
Massachusetts Institute of Technology
April 24, 2008

Motivation, Issue, question

Enterprise change research has been developed at LAI based on the following observations:

- **Transformation that derives from within "lean" and enterprises approaches differs from traditional notions of managing planned organizational change**

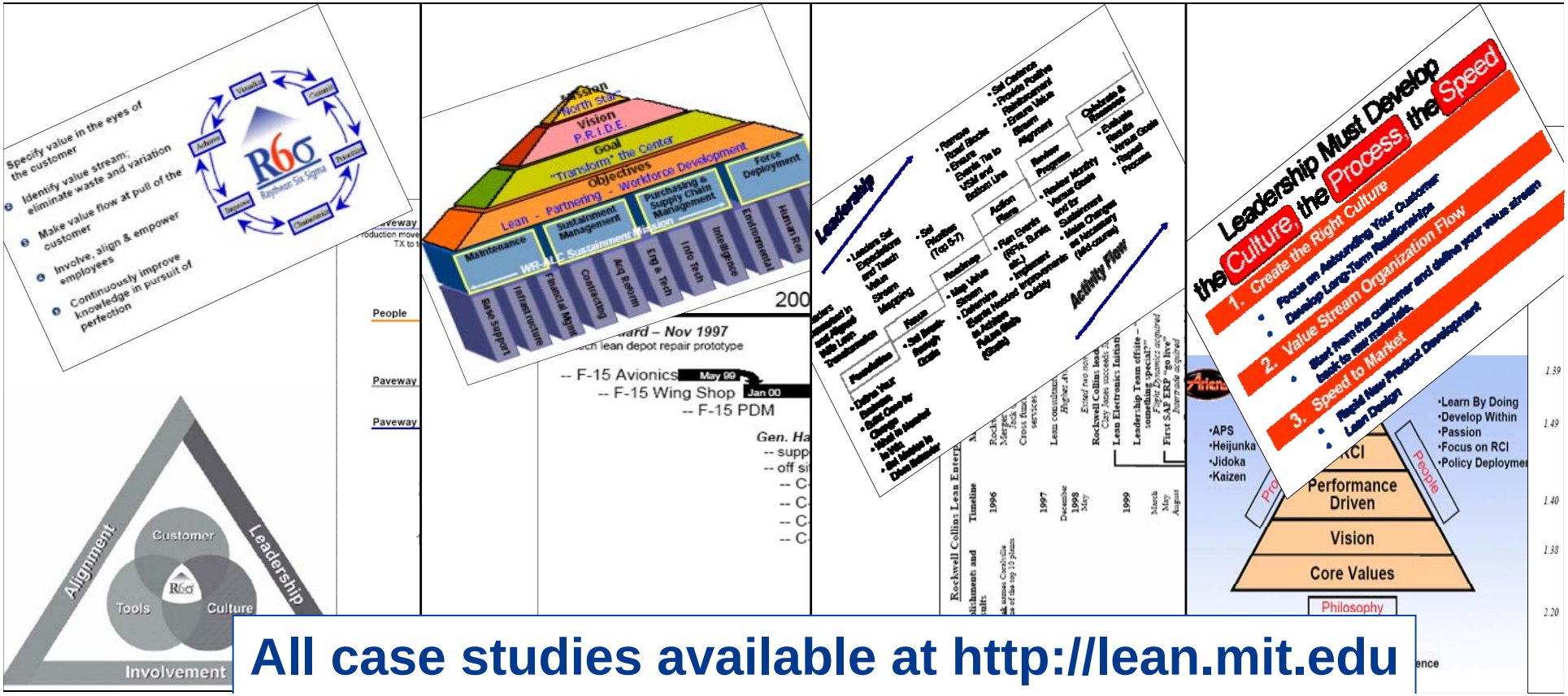
Expected Contributions of Enterprise Change Research

1. ***A comprehensive set of precepts for managing organizational to enterprise change***
2. ***Roadmap for leadership that will help them to initiate, accelerate, and sustain lean enterprise transformation***
3. ***Use of case study observations of change efforts to provide insights into what make for effective lean enterprise cultures and structures***
4. ***Providing references and illustrations for tools and methods that support enterprise transformation***

What happened?

A series of case studies of successful lean enterprise change initiatives has been undertaken

Raytheon | Warner Robins ALC | Rockwell Collins | Ariens



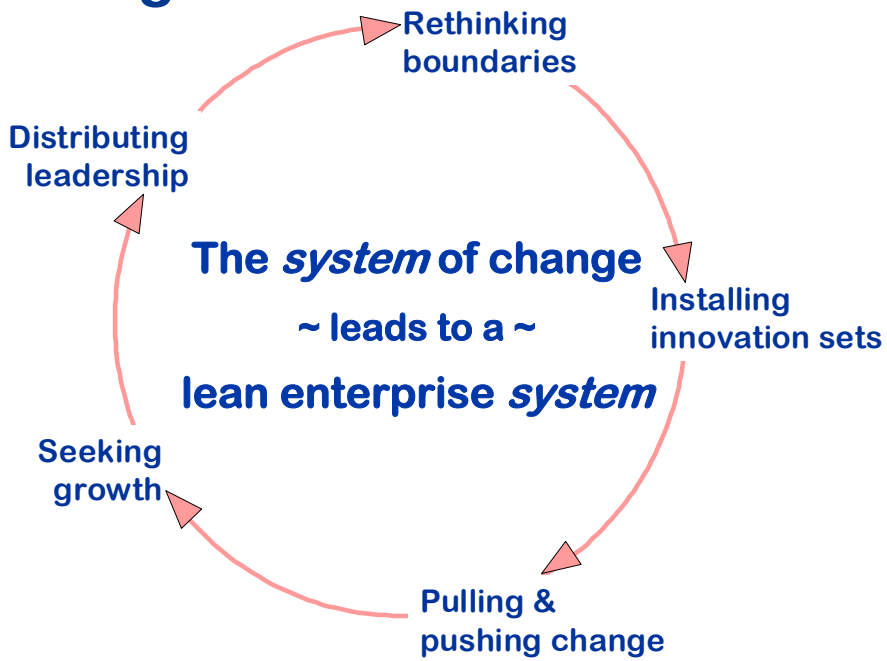
All case studies available at http://lean.mit.edu

Impact on Practice

These studies are:

1) Documented LAI case studies available on the LAI web site

2) Used to illustrate theory and methods for lean enterprise change:



LEAN ADVANCEMENT INITIATIVE ™

Impact on Practice

Systemic change: Europe, Japan and US, 1992-1997

The 3 Dimensions	**Europe**	**Japan**	**US**
Structure (**S**)	30.3%	6.2%	16.5%
Processes (**P**)	74.9%	53.7%	82.3%
Boundaries (**B**)	44.9%	30.7%	57.0%
The 4 Systems			
System 1 (S+P+B)	13.0%	1.2%	8.9%
System 2 (S+P)	25.1%	4.7%	12.7%
System 3 (P+B)	34.2%	18.7%	46.8%
System 4 (S+B)	16.4%	1.6%	11.4%

Very few companies adopting **whole system of change**

* Based on work by Andrew Pettigrew, University of Bath

LEAN ADVANCEMENT INITIATIVE ™

Impact on Practice

Systemic change and performance: Summary of regression results

The 4 Systems	Pooled Sample of Western Firms	UK	US
System 1 (S+P+B)	++	+	+
System 2 (S+P)	-	--	--
System 3 (P+B)	-		
System 4 (S+B)		-	

- **The adoption of a** full set **of changes (System 1) increases the probability of** improving **corporate performance**
- **The adoption of** partial **systems (System 2 and System 3) is likely to** reduce **performance**

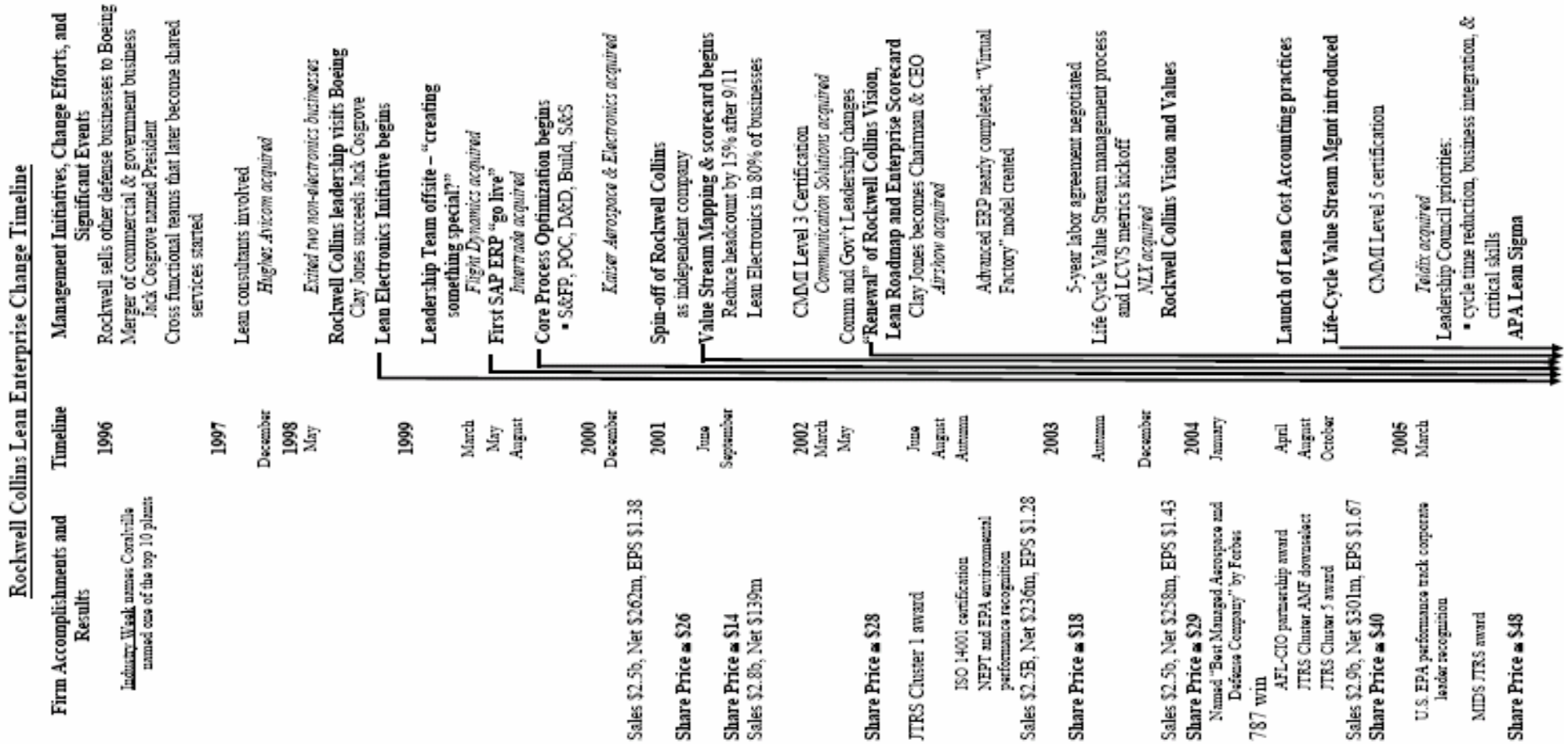
Competitive Advantage Grows Out of a System of Activities as a Whole

* Based on work by Andrew Pettigrew, University of Bath

LEAN ADVANCEMENT INITIATIVE ™

Impact on Practice

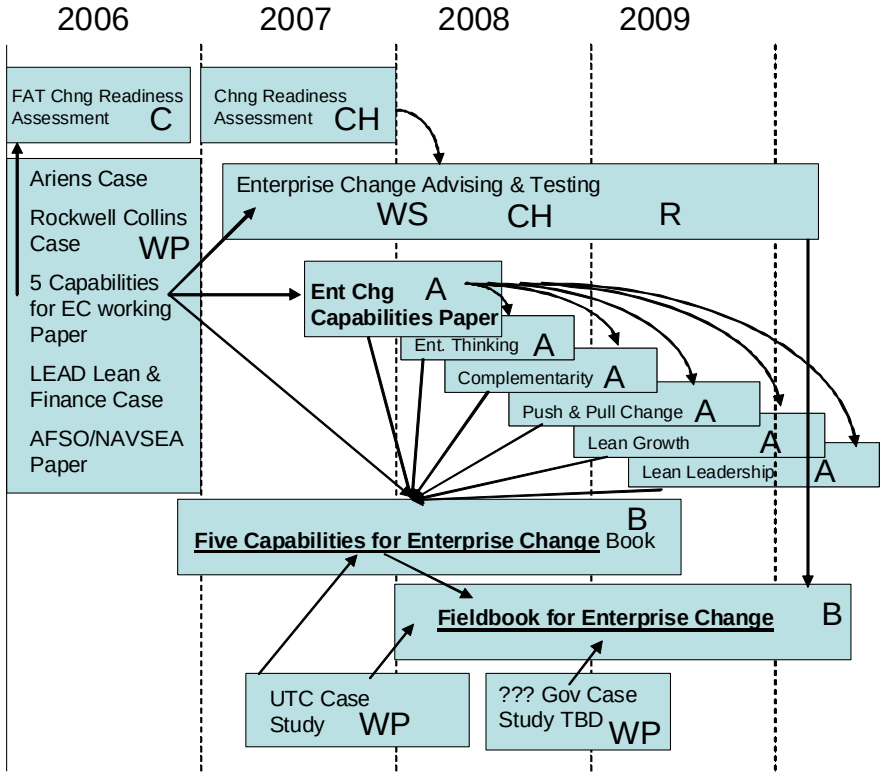
An example of Enterprise Change Capabilities is the complementary and cumulative set of changes as shown in Rockwell Collins' Lean Electronics™



Future direction

UTC ACE Case study – Program, Office, Manufacturing, Engineering and cross-organizational studies

Enterprise Change Theory – KEE, Book, Field Book and journal articles



Enterprise Systems Engineering

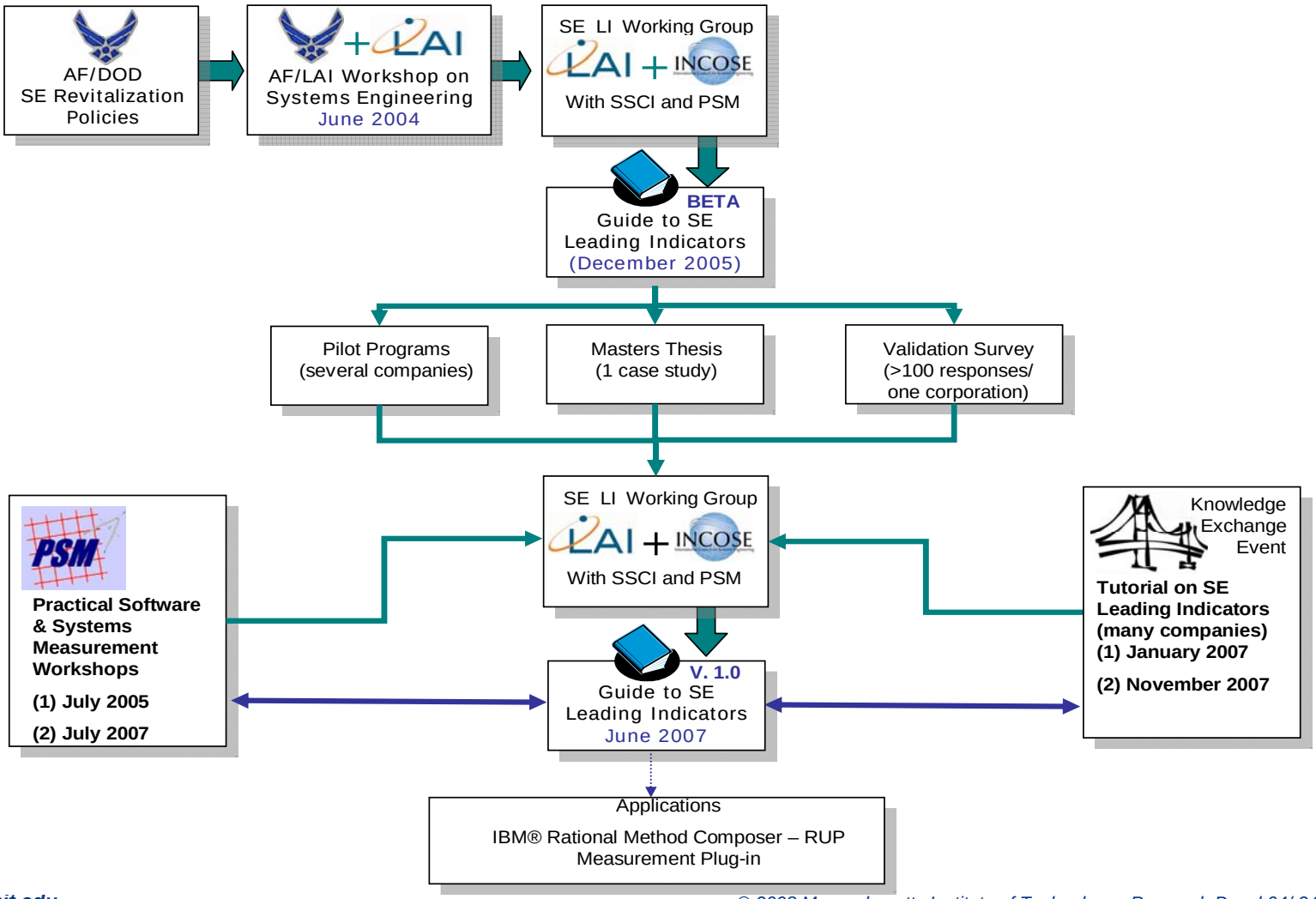
Research on SE Leading Indicators

Dr. Donna H. Rhodes
Massachusetts Institute of Technology
April 24, 2008

Motivation, Issues and Questions

- ***How do I know if a program is performing good systems engineering? -- Dr. Marvin Sambur, 2004***
- ***How can metrics that help me plan new programs also help me manage my current one?***
- ***How can industry, government, and academia collaborate to help make traditional metrics more useful?***
- ***Where can I find good practices on using and interpreting metrics – and by that I mean what real practitioners have discovered?***

History of the Research Effort



Access to Results

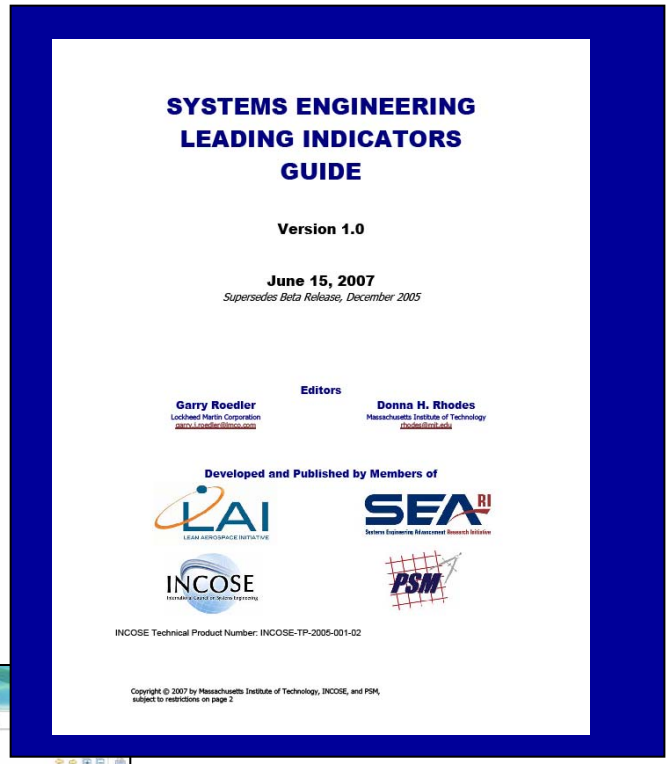
Version 1.0 Guide
- Download http://lean.mit.edu

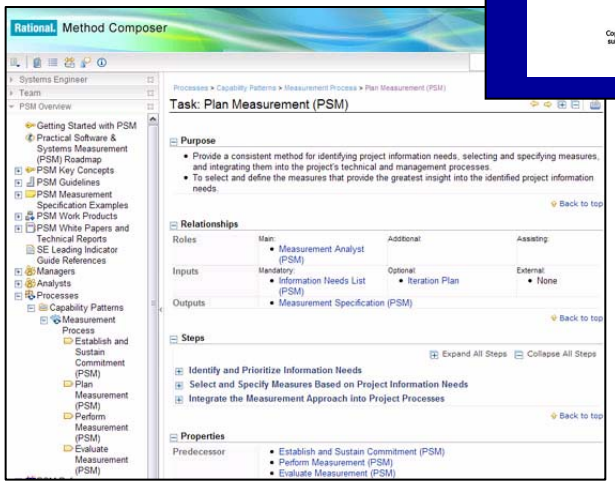
Masters Thesis
- Download http://lean.mit.edu

Journal Paper
- Coming soon on Wiley Systems Engineering journal website

IBM Rational Unified Process PSM Plugin
- http://www.psmsc.com/PSMRMC.asp

Collaboration
- INCOSE Measurement Working Group http://www.incose.org





IBM: *The new release of the RUP for PSM Plug-in (Version 3.0) incorporates measures vital to organizations involved with systems engineering*

Impact on Practice

Industry Example of Use

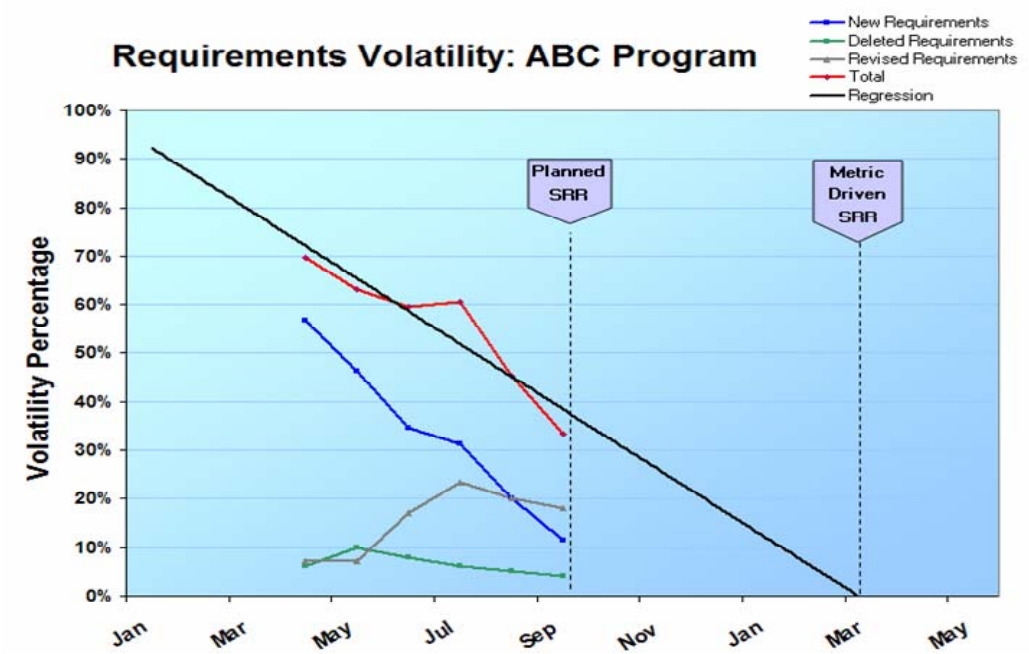
What is an example of how leading indicators have contributed to effective systems engineering on a program?

By monitoring the requirements validation trend, team was able to more effectively predict SRR readiness

Initially the program had selected a calendar date, but in subsequent planning made the decision to have the SRR be event driven, resulting in a new date for review

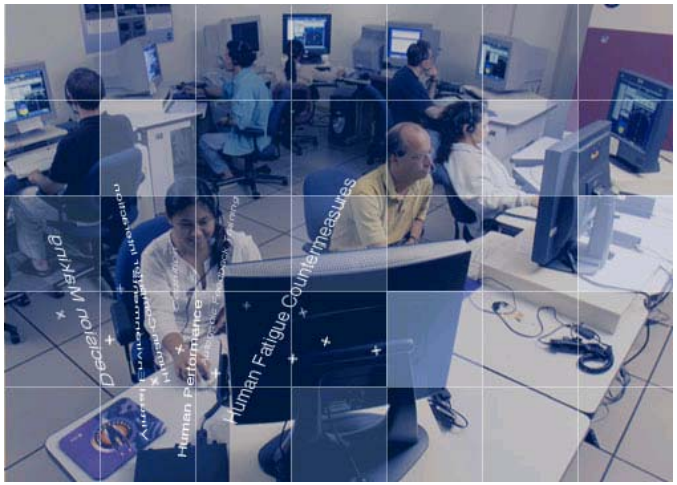
Revised date was set based on an acceptable level of requirements validation in accordance with the leading indicator.

Had original date been used, it is likely that the SRR would not have been successful



Requirements Volatility. The graph illustrates the rate of change of requirements over time. It also provides a profile of the types of change (new, deleted, or revised) which allows root-cause analysis of the change drivers. By monitoring the requirements volatility trend, the program team is able to predict the readiness for the System Requirements Review (SRR) milestone. In this example, the program team initially selected a calendar date to conduct the SRR, but in subsequent planning made the decision to have the SRR be event driven, resulting in a new date for the review wherein there could be a successful review outcome.

Future Direction
SE Leading Indicators Research



- MIT research to extend leading indicators to Human Systems Integration
- Follow-on studies of long term impact of leading indicator triggered program actions
- INCOSE Measurement Working Group – validation and updates
- Knowledge Exchange Event planned for late 2008

Enterprise Systems Engineering Research Portfolio

- **Continue ongoing research in collaborative systems thinking**
- **Evolve systems engineering leading indicators in collaboration with industry/government partners**
- **Extend work in collaborative distributed systems engineering toward development of collaboration assessment instrument**

ESE

Enterprise Systems Engineering

FOCUS of RESEARCH

- ESE Approaches
- SE Effectiveness Indicators
- Collaborative Systems Thinking
- Studies of ESE Practices

Extending Lean Analysis Techniques to Complex Product Development

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April 24, 2008
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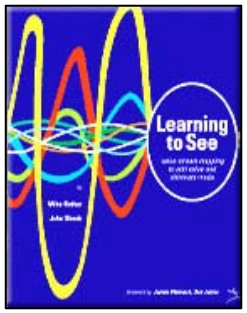
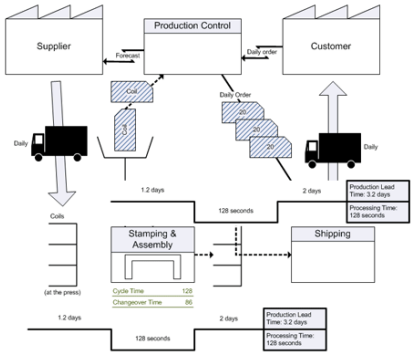
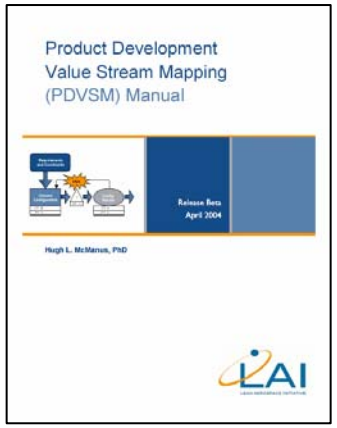
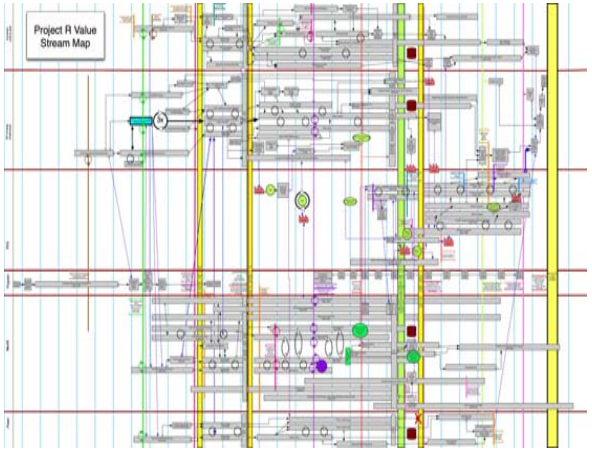
Lean 101 (Waste Reduction and Flow): How to Make it Work in PD?

- Work flow in PD still a challenge
  - inefficient Information transfers across boundaries (~50% pure waste)
  - Information *rot*: 6% of value is lost per month sitting in WIP
  - Developing PD flow is valuable, but hard
- Complex PD systems challenge traditional VSM methods
  - Process iterations, parallel flows
  - Multi-tasked resources
  - Difficult-to-define process and system capacities
  - Inherent risks and uncertainties
- VSMs get even more unruly at enterprise levels
  - Multiple value streams, stakeholders, flows
- Key questions:
  - How must familiar lean tools and methods be adapted for understanding/improving PD systems?
  - How effective are they?
  - What are their limitations?







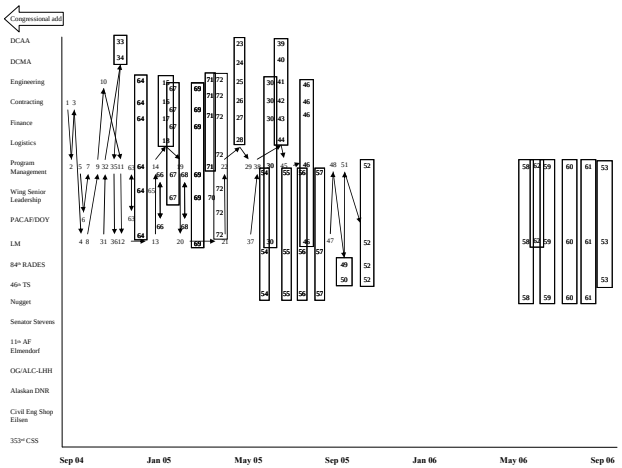


References:

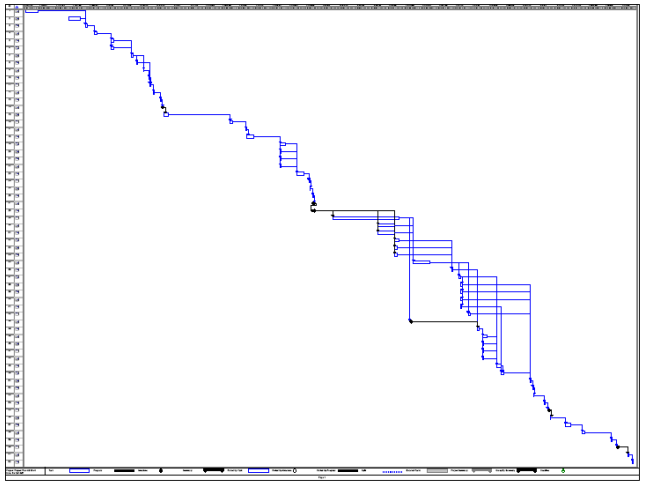
M. Rother and J. Shook, Learning to See, Lean Enterprise Institute, 1998

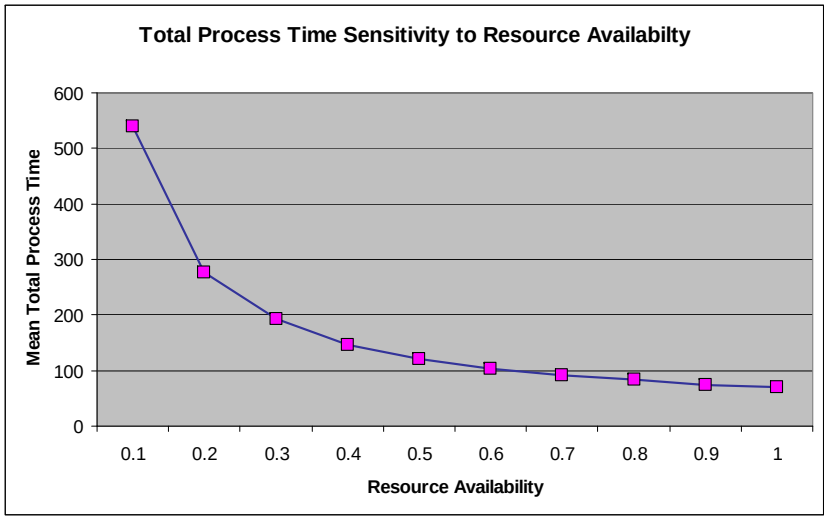
H. McManus, Product Development Value Stream Mapping, LAI, 2005

Traditional Project Management Tools Can Add Analytical Power to VSM at Project Level



- Highly parallel, interdependent, and iterated processes
  - Use value stream map format, or Gantt (or PERT) chart?
  - Info for analysis exists in typical project mgt tools
- Research case: Engineering change process modeled using VSM, MS Project, and MATLAB
- Critical: understanding that multi-tasking makes people availability key to process time reduction
  - Focus on hand-offs and availability, rather than capacity
  - Doubling personnel availability reduces mean process time from 259 to 121 days—more possible
  - Better process and work scheduling, not more people needed

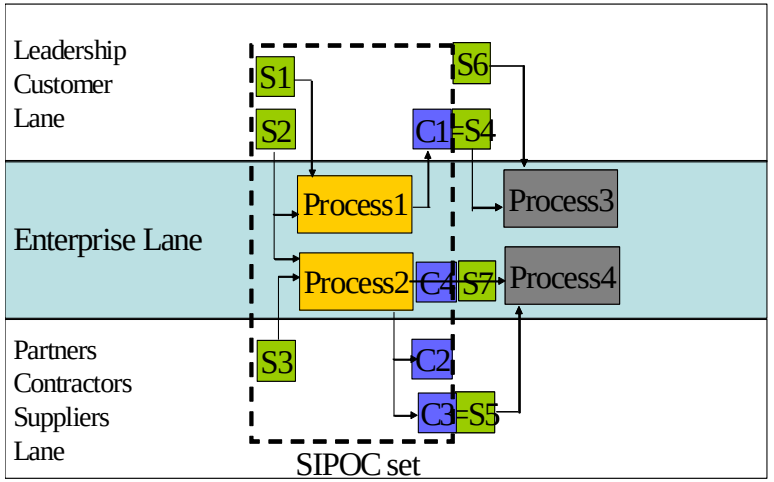


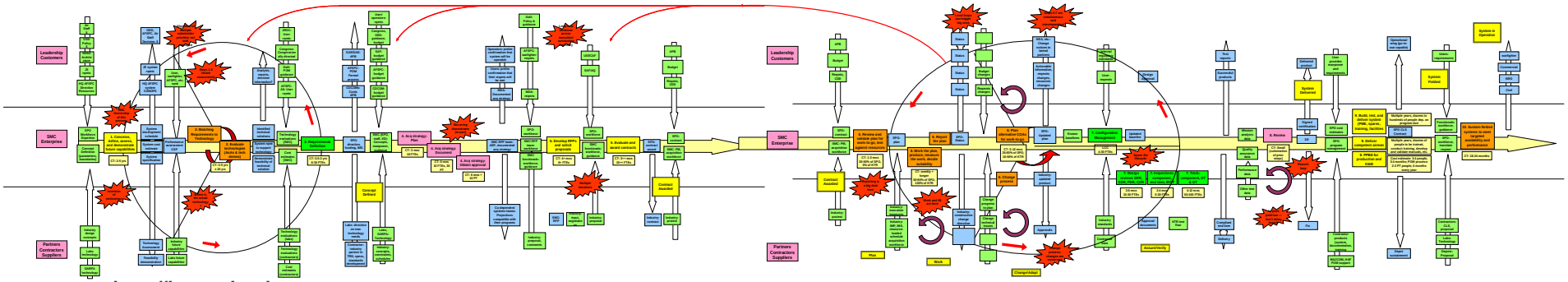


Sources: MacKenzie, 2006; Davis, 2008

Adding SIPOC Helps Reduce Difficulty of Assessing Complex Enterprise VSMs

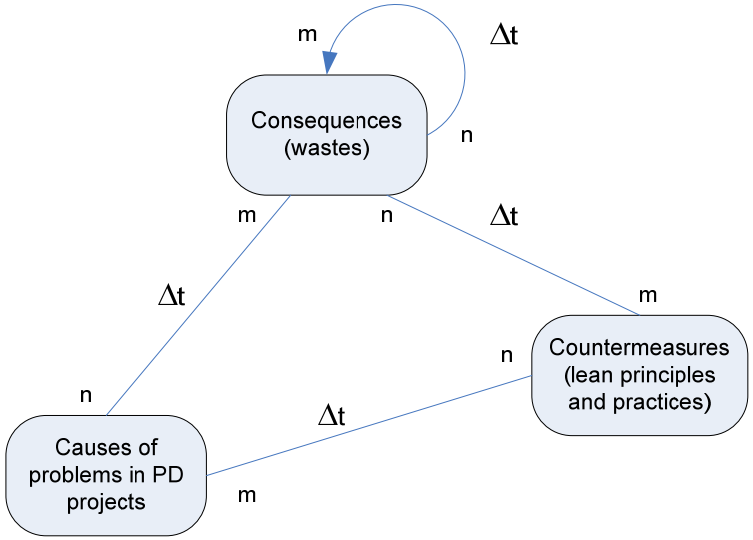
- The enterprise challenge: multiple value streams, multiple processes, multiple outcomes, multiple stakeholders
  - Can't dissect relationships for analytical convenience
- Must capture complexity of relationships and interfaces
  - Combine SIPOC with VSM to accommodate multiple value streams in enterprise processes
- Approach characterizes essential enterprise attributes while remaining manageable in facilitating a large group
  - Identifies macro enterprise behaviors, disconnects at boundaries, long cycle time processes, and unsynchronized processes
  - Mapping work easily distributed among subteams

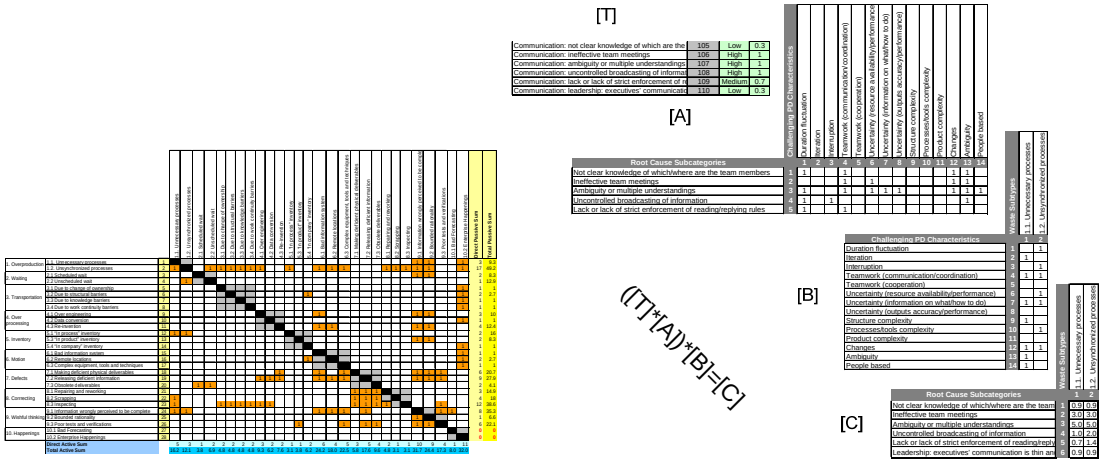


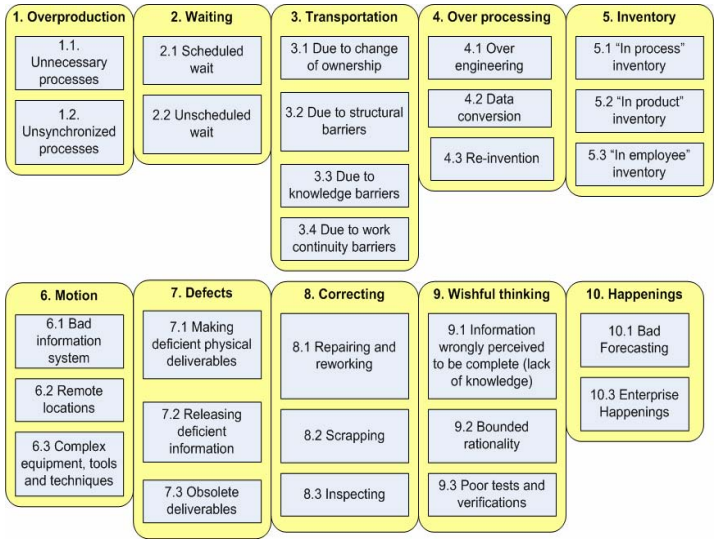


Getting to Root Causes of Waste in Complex PD Systems

- Develop a comprehensive set of PD wastes and root causes descriptions
- Develop a systematic method for prioritizing which wastes to target for elimination
  - Accounting for enterprise system coupling and feedback loops
  - Determine root causes to be corrected
  - Make it usable—simple interface for data entry and reduced data burden
- Foundations for possible future lean enterprise PDSAT developed!







Sources: Bauch, 2004; Kato, 2006, Pessoa, 2008

Turning Research into Training, Tools, and Change

Training

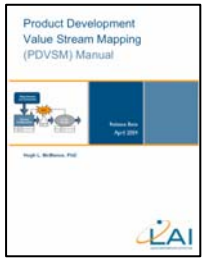
- LEPD KEE (June 24-25, 2008, St Louis)
  - Lean PD principles and PD role in the Lean enterprise
  - PDVSM and related improvement techniques applications producing ~4x cycle time, throughput improvements, ~60% fewer engineering hours, significantly better financials
- MIT PI—LAI Lean Academy® Seminar: Engineering (PI.211s, July 17-18, 2008)
- MIT ESD.60 Lean/Six Sigma Processes (LFM, Summer 2008)
- LAI EdNet Lean PD course curriculum (Fall 2008)
- Related: MIT PI—Value-driven Tradespace Exploration for System Design (PI.27s, June 9-12, 2008)

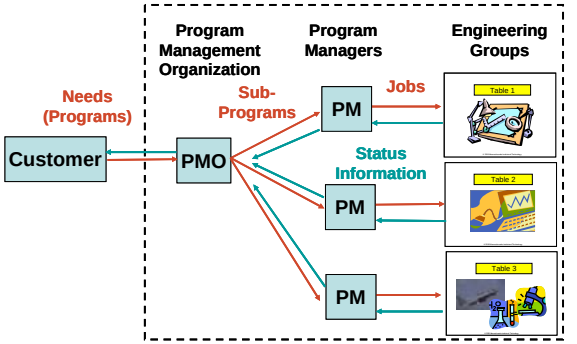
Tools

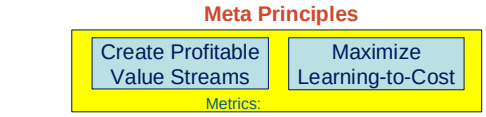
- Lean PDSAT— On-going research, in development
- PDTTL—On-going research, in development

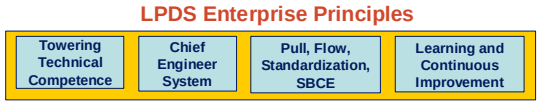
Events

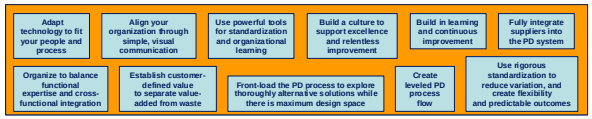
- Lean Now!, EVSMA interventions test tools, generate new insights, stimulate change
- Lean PD Benchmarking events—practitioner knowledge sharing and research cases



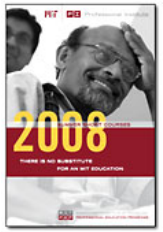


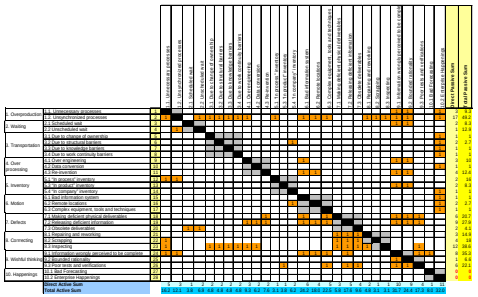


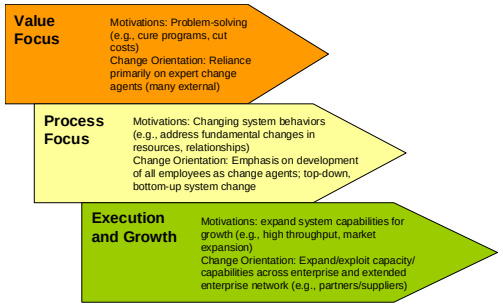




LAI LEAN ACADEMY®







LAI Lean PD Research Portfolio

PD Waste and Value Stream Analysis

- Marcus Pessoa—Diagnosing PD enterprise-level wastes to prioritize improvement actions
- Christian Breigel—Linking PD wastes, root causes to lean countermeasures
- LFM and SDM research projects on related topics

Lean PD Enterprise Process Design

- Sid Rupani—Creating adaptive, efficient PD enterprise process architectures
- João Castro—Coordination/Alignment for flow in PD systems
- Pedzi Makumbe—Sourcing work in globally-distributed PD
- Dan Gillespie—Overcoming enterprise inertia to create innovative new product requirements

Coordinating/Integrating across Multiple Programs

- Dave Long—Defining product family architectures for UAV systems
- Ryan Boas—Managing commonality during product family lifecycle
- Robb Wirthlin—Managing product development portfolios using risk

Furthering our Understanding of the Multiple Elements of the Lean Enterprise/Product System, its Operation, and Improvement

Metrics for Enterprise Transformation

Dr. Ricardo Valerdi
Massachusetts Institute of Technology
April 24, 2008

Links to Grand Questions

A. How can I understand how my organization currently operates within a larger enterprise?

B. How can I understand the possibilities for a more efficient and effective organization and enterprise? In short, what does it mean to be lean, transformed, enterprise-wise?

Key questions

1. How do you measure the (outward-looking) impact of a transforming enterprise?
2. What are the relevant and measurable (inward-looking) attributes of an enterprise undergoing transformation?
3. How do the 8 views of the enterprise motivate metrics?
4. How can synergies and conflicts between metrics be effectively managed in a transforming enterprise?

History of the Research Effort

- Events
  - LAI/UK LAI metrics workshop in 2000 (40 attendees)
  - Knowledge Exchange Event in March 2008 (34 attendees)
  - Upcoming Knowledge Exchange Event in June/July 2008
- Research (LAI theses)
  - Metrics thermostat
  - Enterprise metrics system
  - Lean Enterprise Self Assessment
  - Performance measurement system
  - Instability in transforming organizations
- Tools & Frameworks
  - Lean Enterprise Self Assessment Tool (LESAT) & Gov. LESAT
  - EVSMA (X-Matrix)
  - System of metrics, ROIC

Knowledge Exchange Event

March 6, 2008 (LMCO Headquarters, Bethesda, MD)

- **Formation of a "Metrics community of practice" that can share knowledge across industry and government**
- **Benchmarking of best practices across industry and government**
- **Case studies that can serve as useful lessons learned for organizations undergoing lean enterprise transformation**
- **Identification of the most pressing issues facing organizations that wish to define and measure transformation-related metrics**

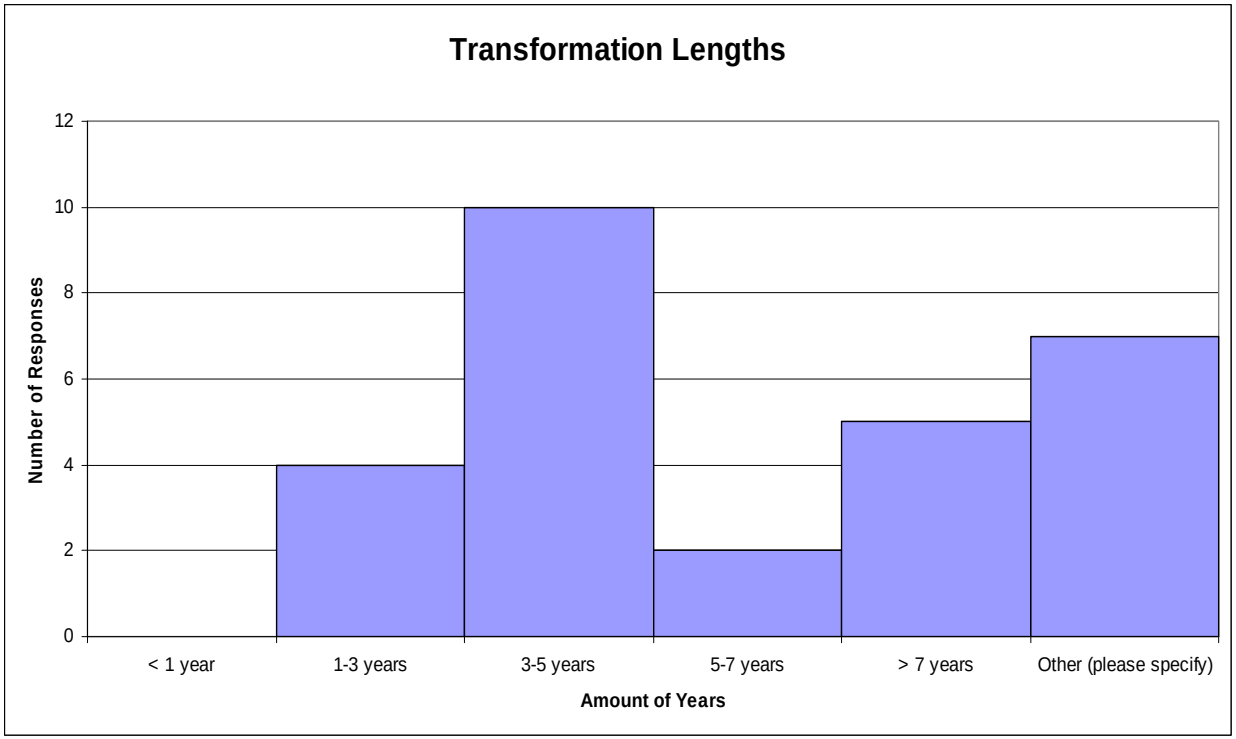
Invited speakers from:

Raytheon and Rockwell Collins

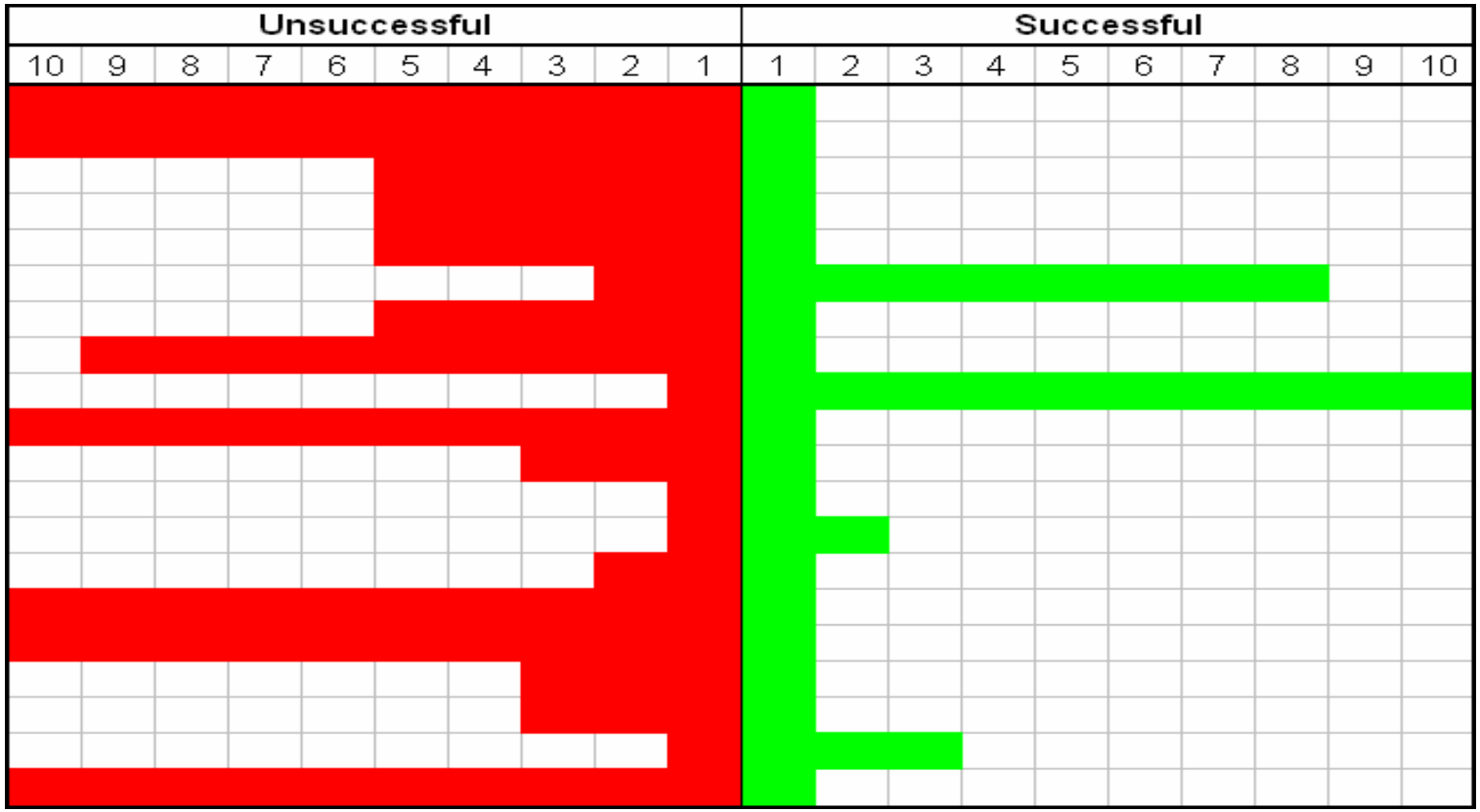
Next Metrics KEE: June/July in Andover, MA

Length of transformation journey (n=27)

1. Transformation takes 4.75 years on average
2. 26% indicated that transformation is never ending



Ratio of successful to unsuccessful enterprise transformations (n=20)



Future Directions

- Understand how often metrics evolve in organizations
- Incorporate the role of context in measuring transformation
- Capture significant “plateaus” that serve as markers of incremental transformation
- Obtain more detailed insight from complementary data sources
  - Case studies
  - Interviews

IT-Enabled Enterprise Transformation

Jayakanth Srinivasan
Massachusetts Institute of Technology
April 24, 2008

Motivation

Industry

- **Aerospace and Defense (A&D) IT budgets for 2007**

2000.

Government

- **DOD systems overly complex and error-prone**

systems

Source: GAO 06-658

- **Fiscal 2007 – DOD request - $16 billion**

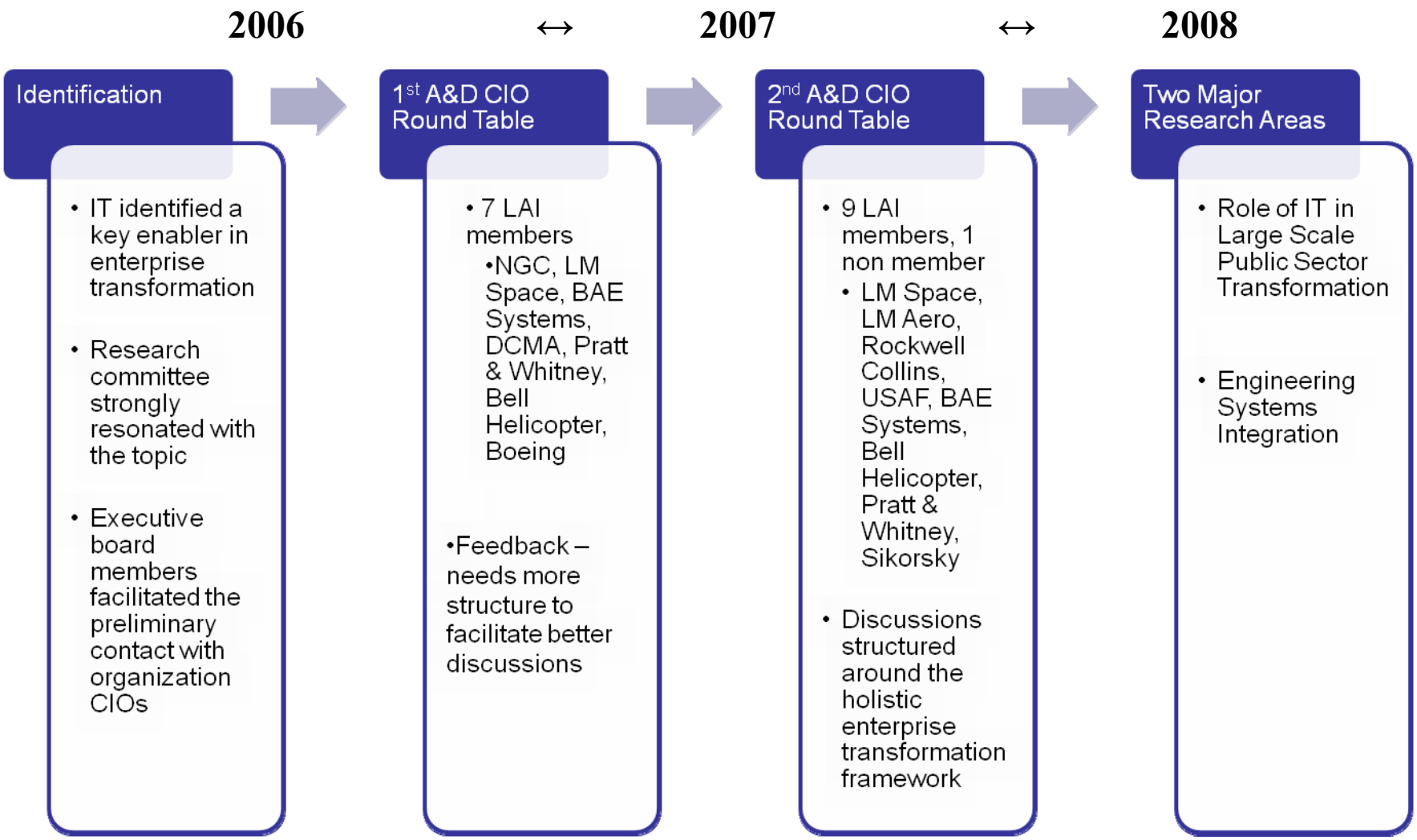
Source: GAO 07-451

How do we design, implement and sustain IT systems to enable lean enterprise transformation?

More importantly

How do we do it in a lean manner?

IT-Enabled Enterprise Transformation Knowledge Area Evolution



Results

- **Aligning IT Strategy to Enterprise Strategy**

  "We are currently undergoing a paradigm/culture shift , where we are going to a space in which we haven't played before … We are now expected to add value – internal to the organization as well as on the customer side" – Industry CIO

  "Our strategy has not changed a lick in the last three years" – Government CIO

- **Driving Successful Execution**

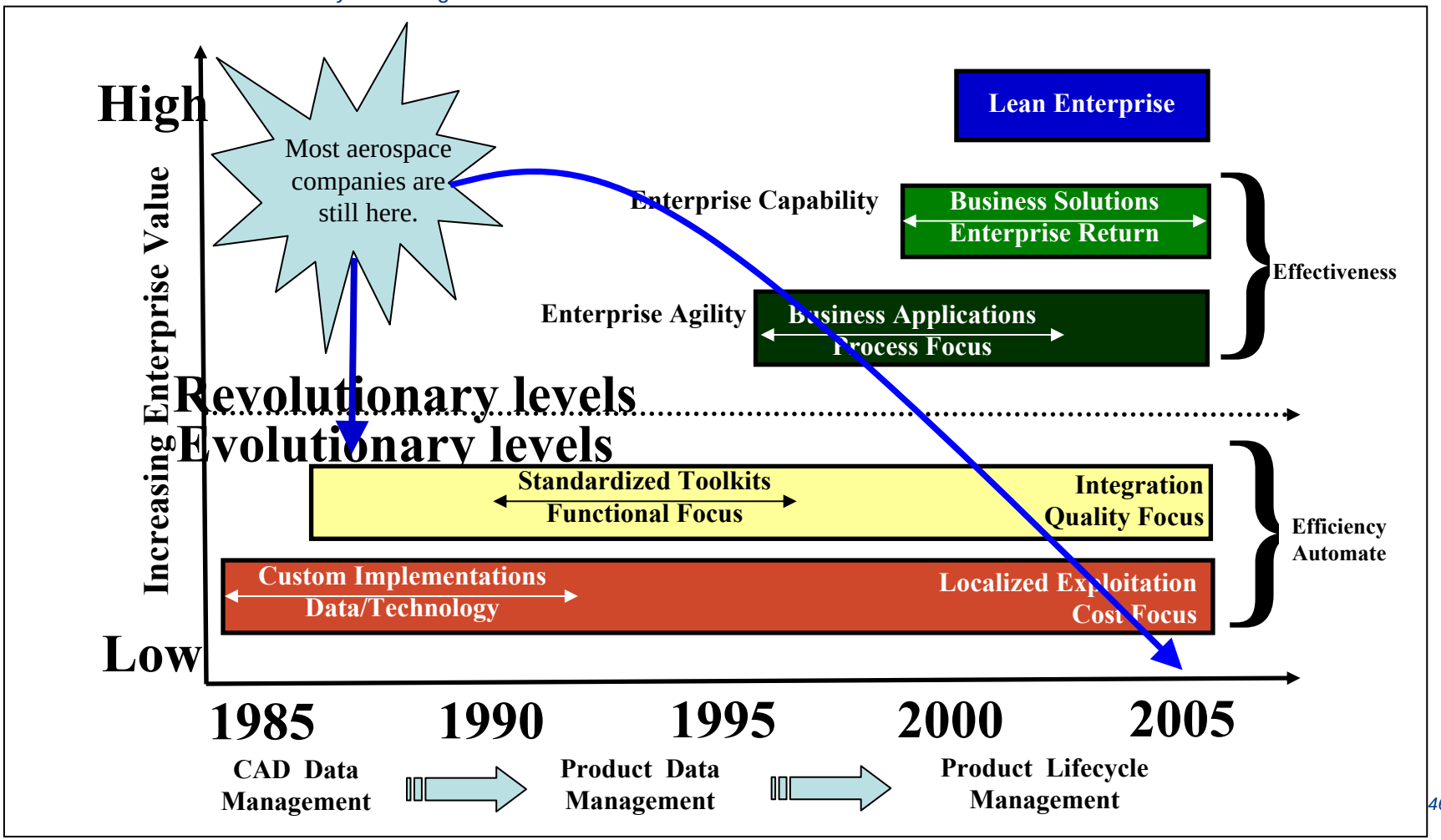
  Once we delivered the first module, then all of a sudden it went from - "this is never going to happen" to "Oh! Oh! this is going to happen and we many need to get involved"

  We are "fighting" with the customer on a daily basis to say this is what the systems does, work with it.. Our customers are like fighter pilots – they want it done their way – we are still listening to comments like "the screen doesn't look the way it used to" and "I don't do it that way"

Product Lifecycle Management

"A strategic business approach that applies a consistent set of business solutions in the support of the collaborative creation, management, dissemination, and use of product definition information across the extended enterprise from concept to end of life – integrating people, process, business systems and information (emphasis added)"

– CIMdata definition of Product Lifecycle Management



LEAN ADVANCEMENT INITIATIVE ™

Framework for Enterprise Agility in Software Development

Focus	Idea Phase	Production Phase
Problem	Wicked	Complex/Complicated
Process	Defined/Fluid	Rigid
Team Size	Small	Large
Search Strategy	Exploration	Exploitation
Knowledge Management	Tacit	Explicit
Nature of Innovation	Architectural and Incremental	Incremental
Capabilities	Dynamic	Routines
Expectation	Curiosity/ WOW! Factor	System Works Every Time
Responsibility, Authority, Accountability	Team	Organization

Source: Jayakanth Srinivasan, Balancing Agility and Discipline in Software Organizations, 2008

LEAN ADVANCEMENT INITIATIVE ™

Going Forward

"Everyone has a system, so WHAT?"

Align IT Strategy to the Enterprise Strategy	• Extend ESAT process to include IT architecture mapping and analysis
Managing the Change Process	• Case studies at LAI member sites to understand the challenges associated with implementing a new IT System
Value of IT	• Extend heuristics into metrics that can be used to guide enterprise transformation
Lean Software Development	• Framework for Enterprise Agility in Software Development

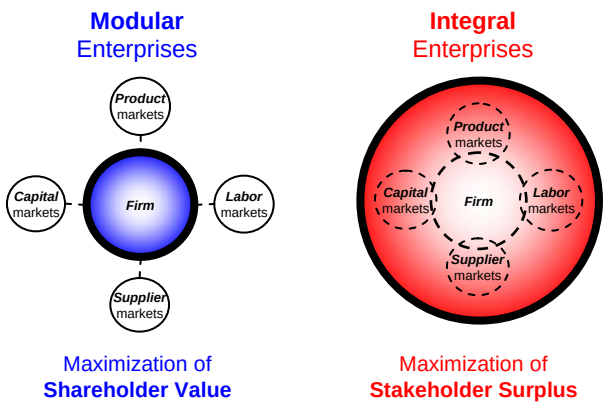
Enterprise Architecting/ Enterprise Transformation

Debbie Nightingale
Massachusetts Institute of Technology
April 24, 2008

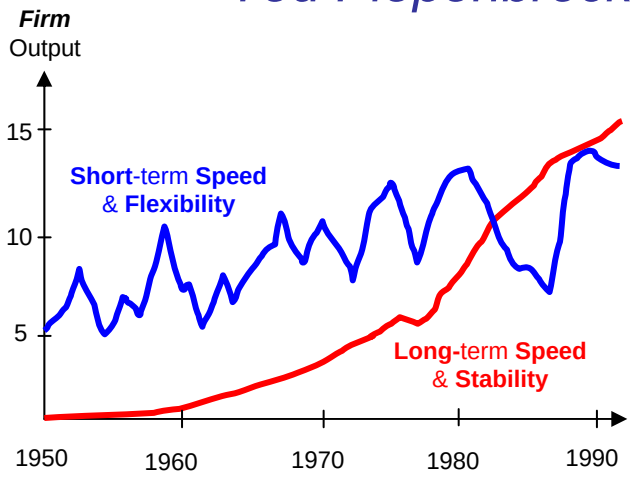
The Evolution of Business Ecosystems: Enterprise Architecture Drives Performance

Ted Piepenbrock

LEAN ADVANCEMENT INITIATIVE ™

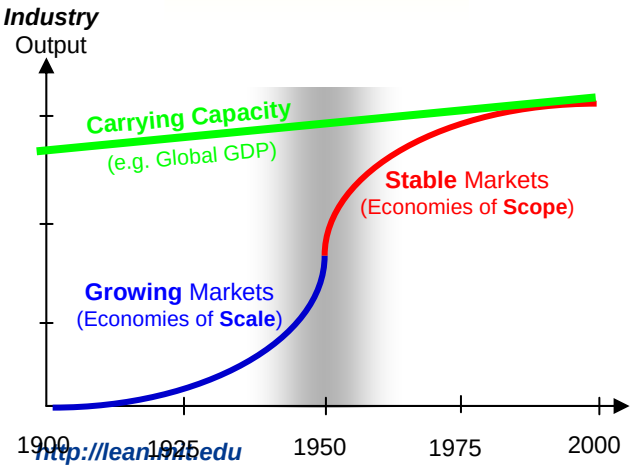


Competitive ***Dynamics***

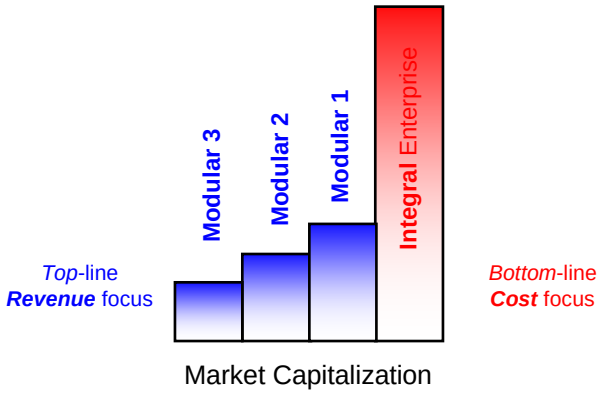


Enterprise ***Architectures***

Firm ***Performance***



Industrial ***Evolution***



LAI EA/ET Research Portfolio

Enterprise Architecting

- LTC Doug Matty – *Analytical and Empirical Methods for Enterprise Management*
- Ted Piepenbrock - *The Evolution of Business Ecosystems*
- Jorge Oliveira – *Designing Hospital Enterprise Architectures to Attain High Performance*
- Chris Roberts - *Dynamic Engineering System Design Strategies*

Enterprise Modeling

- Chris Glazner - *Understanding and Modeling Enterprise Behavior using a Hybrid Modeling Approach*
- John Dickman - *Dynamics of Enterprise System Architecture: Design and Evolution of Flexibility*
- Marc Haddad - *Knowledge Integration in the Development of Complex Aerospace Systems*

IT as an Enterprise Enabler

- Danny Gagne - *Architecting IT Enabled Enterprise Integration*

Enterprise Metrics

- Craig Blackburn - *Metrics for Enterprise Transformation*

LAI Research Groups Address 4 Grand Questions

1. How can I understand the way my organization **currently operates** within its larger context?

2. How can I define and evaluate the **future possibilities** for a more efficient and effective enterprise?

3. What are the most **effective strategies** and tactics to achieve these future possibilities for my enterprise?

4. How can I best manage the enterprise **change process**?

EA-ET
Enterprise Architecting - Enterprise Transformation

FOCUS of RESEARCH
- Enterprise Value Analysis
- Enterprise Architecting
- IT as Enterprise Enabler
- Enterprise Cost and Metrics
- Enterprise Modeling

LEPD
Lean Enterprise Product Development

FOCUS of RESEARCH
- Lean Product Development
- Lean Systems Engineering
- Lean Software

ESE
Enterprise Systems Engineering

FOCUS of RESEARCH
- ESE Approaches
- SE Effectiveness Indicators
- Studies of ESE Practices (with MITRE)

ECM
Enterprise Change Management

FOCUS of RESEARCH
- Change Management
- Enterprise Change Philosophy
- Studies of Successful Change
- Distributed Leadership

Vision Going Forward

Research Shapes Deployment

Enterprise Research

We study Enterprises to identify best practices, transformation strategies and future Enterprise design.

Transformation Knowledge Deployment

We transform research-based knowledge into education, products, knowledge exchange events and transformation events.

Deployment Shapes Research

- **Insight into research**
- **Participate in projects, collaborate with researchers and support projects**
- **Find value in being part of LAI**

