

Enterprise Architecting



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Expanding Enterprise Focus

Increasing Total Enterprise Effectiveness

EVOLUTION OF LEAN ENTERPRISE THINKING

Functional lean successes

- Manufacturing
- Product Dev.
- Supplier Network

“Islands” of Success

Success through interaction between functions

Lean applied to enabling processes

- HR
- IT, etc.

Success through enterprise integration

Transition from waste minimization to value creation

Success through total enterprise integration of *all* stakeholders

- Industry
- Government
- Suppliers
- Employees

Success through networked enterprises

Expanding the lean boundaries

- Suppliers
- Customers
- Partners



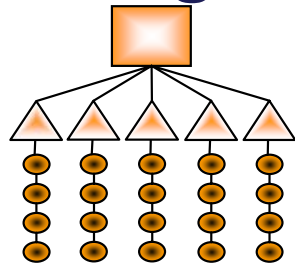


The Challenge of Complex Enterprise Systems

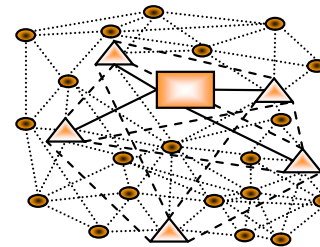
- **Growing complexity of technological systems**
- **Increasing complexity of interactions across the enterprise**
- **Need for a broad view of enterprises as systems**

Emerging Key Challenges

- Managing increasing technological complexity
- Designing collaborative networked enterprises
- Adapting to fast-changing external environment
- Coordinating across multiple interfaces

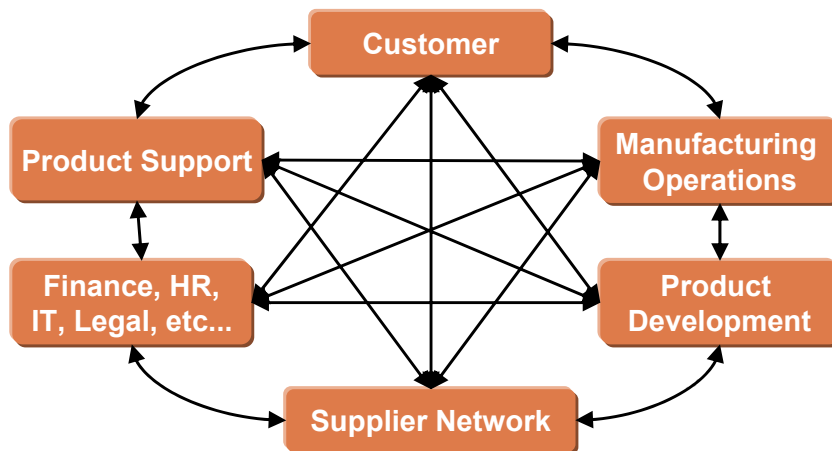


MOVING FROM THE PAST
(vertically integrated) enterprises



TOWARDS THE FUTURE
(networked) enterprises

Integrated Enterprise

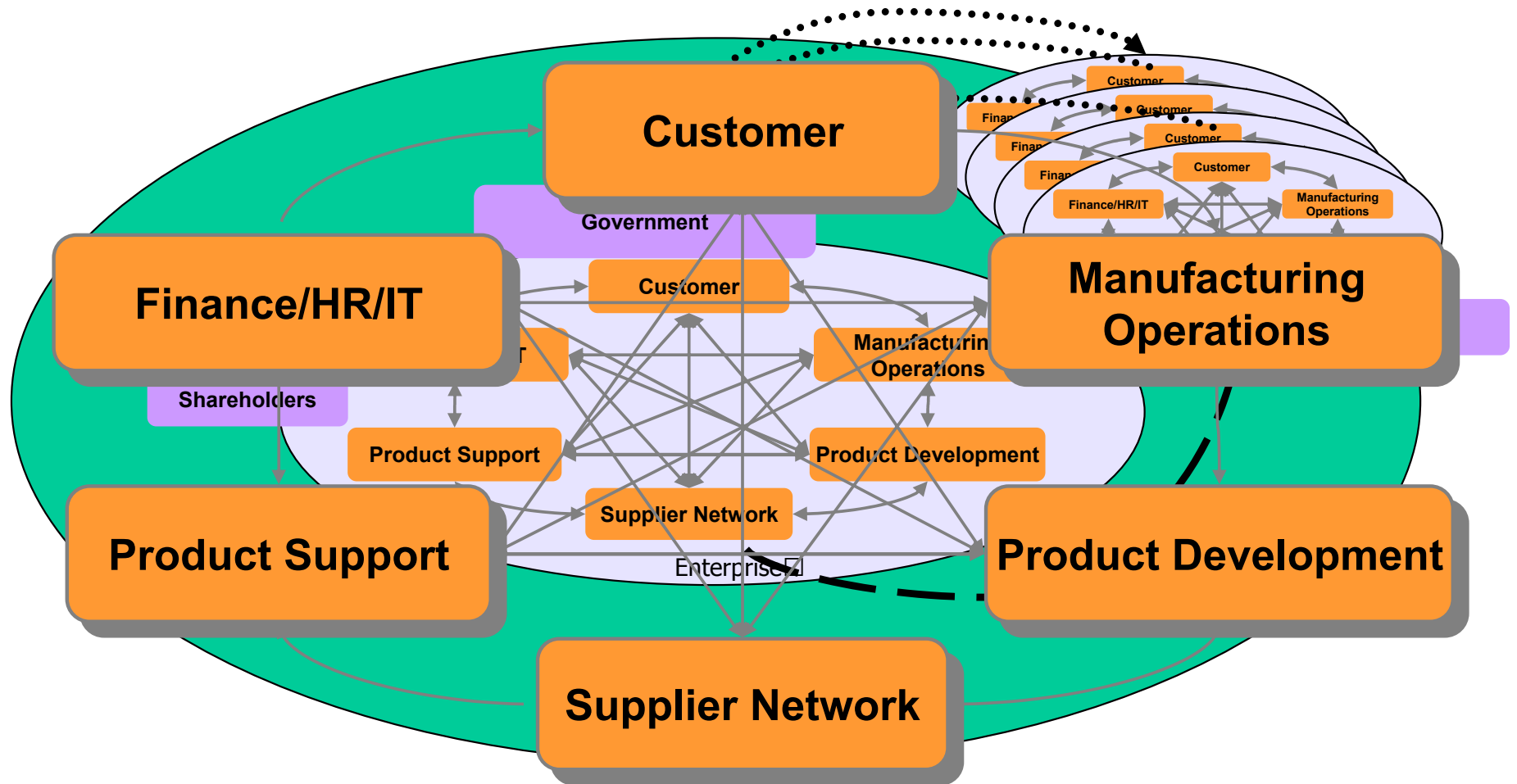


- Organization
- Processes
- Technology
- Information

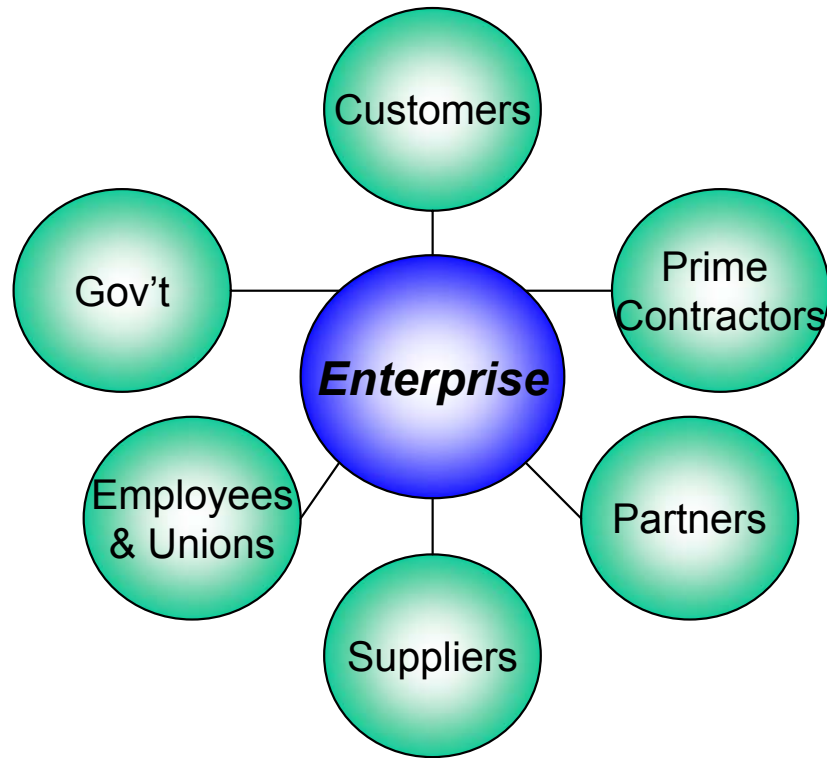
Architecting approaches traditionally only look at a single dimension!



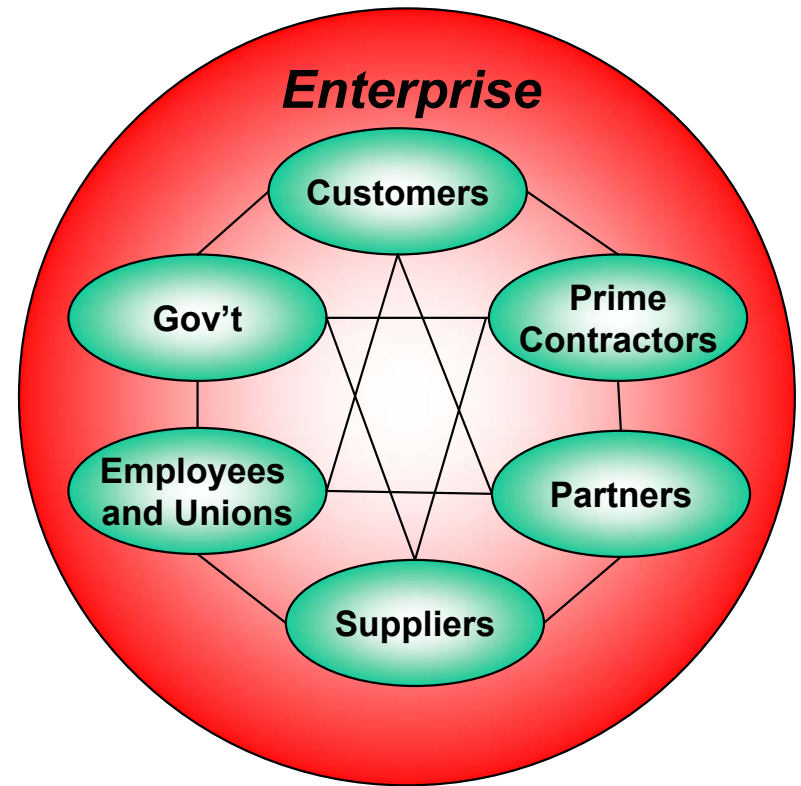
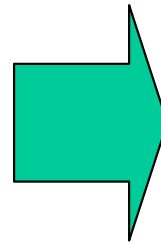
Looking Ahead – We see Evolving Enterprise Scope



Evolution of Lean: Total Integrated Enterprise



Connected Enterprise



Total Integrated Enterprise

New Enterprise Stakeholder Models are Emerging



Systems Approach to Enterprise

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



Motivation for Enterprise Architecting

- In order to transform an enterprise we need to know not only where we are, but more importantly where we want to be (future state)
- In enterprise value analysis how do we define the “future state” of the enterprise?
- Once we define the future “vision” how do we design the enterprise?
- How do we incorporate the multiple dimensions at the enterprise level?



Architecting vs Engineering

- **The complexity of 21st century systems is driving systems architecting as an important discipline within systems engineering (and sometimes considered to be independent of SE)**
- **Similarly, the complexity of 21st century enterprises is driving the need for enterprise architecting as distinct from enterprise engineering**

Enterprise Architecting defines the desired conceptual properties of an enterprise to be developed (greenfield) or evolved (most typical)

- **Purpose (or function)**
- **Structure (or form)**
- **Top level conceptual design**



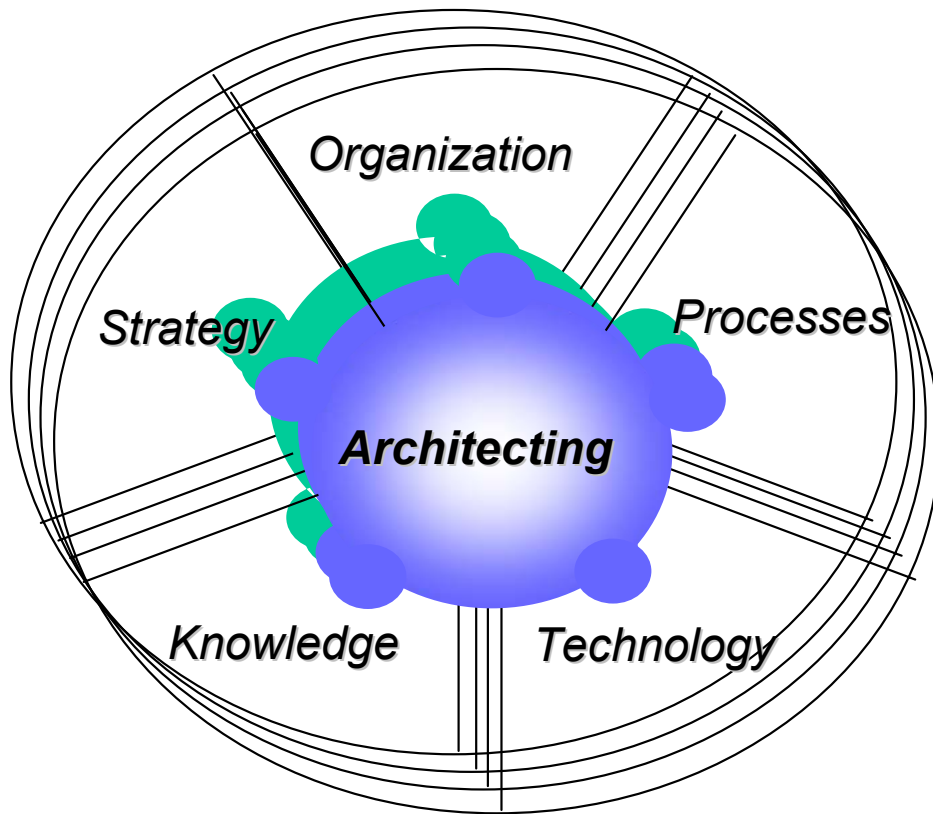
Enterprise Architecting versus Enterprise Engineering

Enterprise Engineering provides the successful strategies and implementation approaches for transformation of an enterprise from 'as is' to a 'to be' state

Enterprise Architecting provides the strategies and modeling approaches to ensure we spend time developing the possible 'could be' states, and evaluating the best alternative given a set of desired properties and criteria for the future enterprise



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

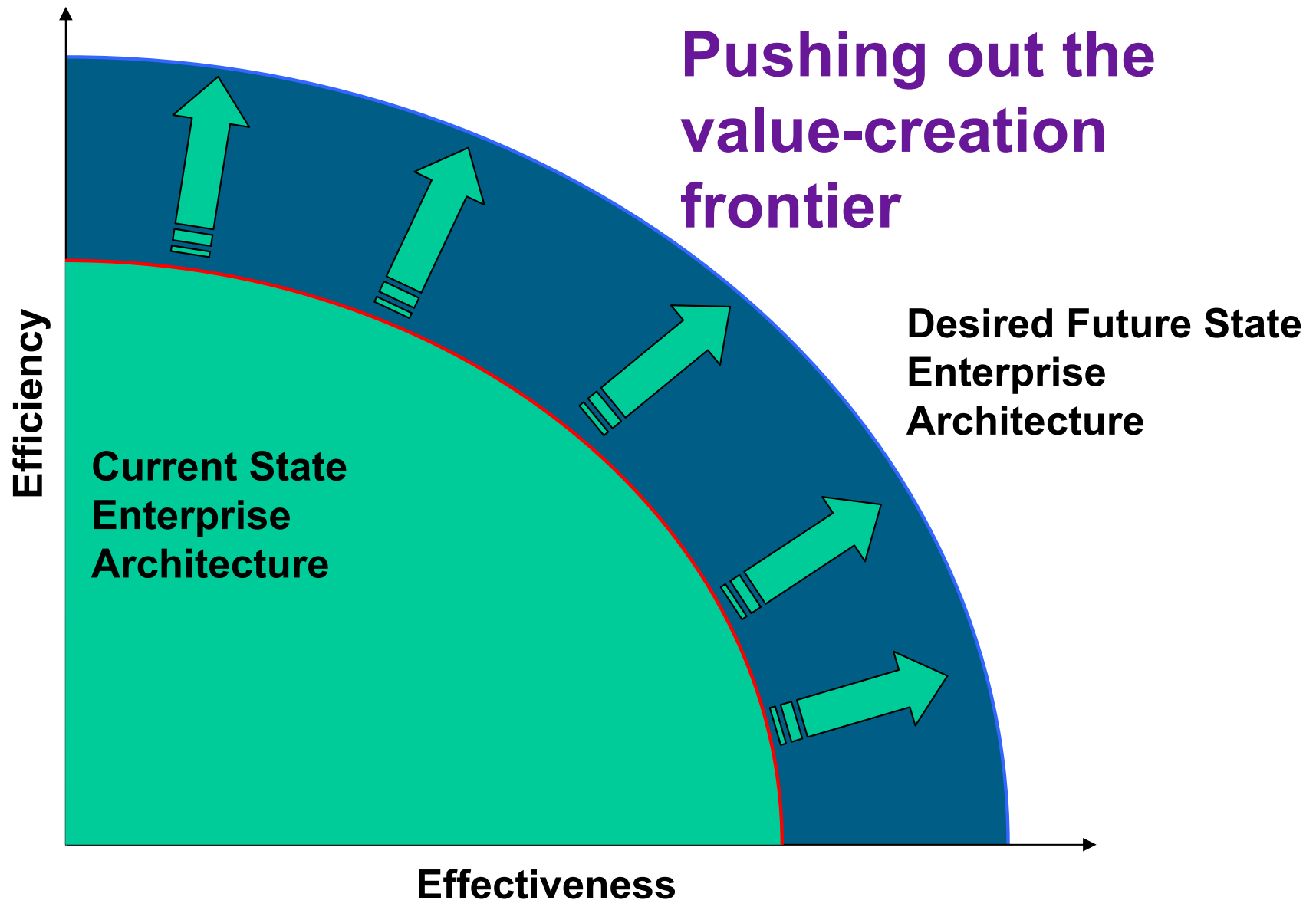
Networked Lean Enterprises



Delivering Effects-based On-demand Value



Enterprise Architecting – Achieving Greater Efficiency & Effectiveness





Some Questions...

- **What Systems Engineering/Systems Architecting tools/methodologies be applied at the enterprise level?**
- **What new methodologies do we need at the enterprise level to address organization, process, product, information, and technology issues?**
- **What new intellectual underpinnings/constructs can we contribute?**
- **What new research is required?**

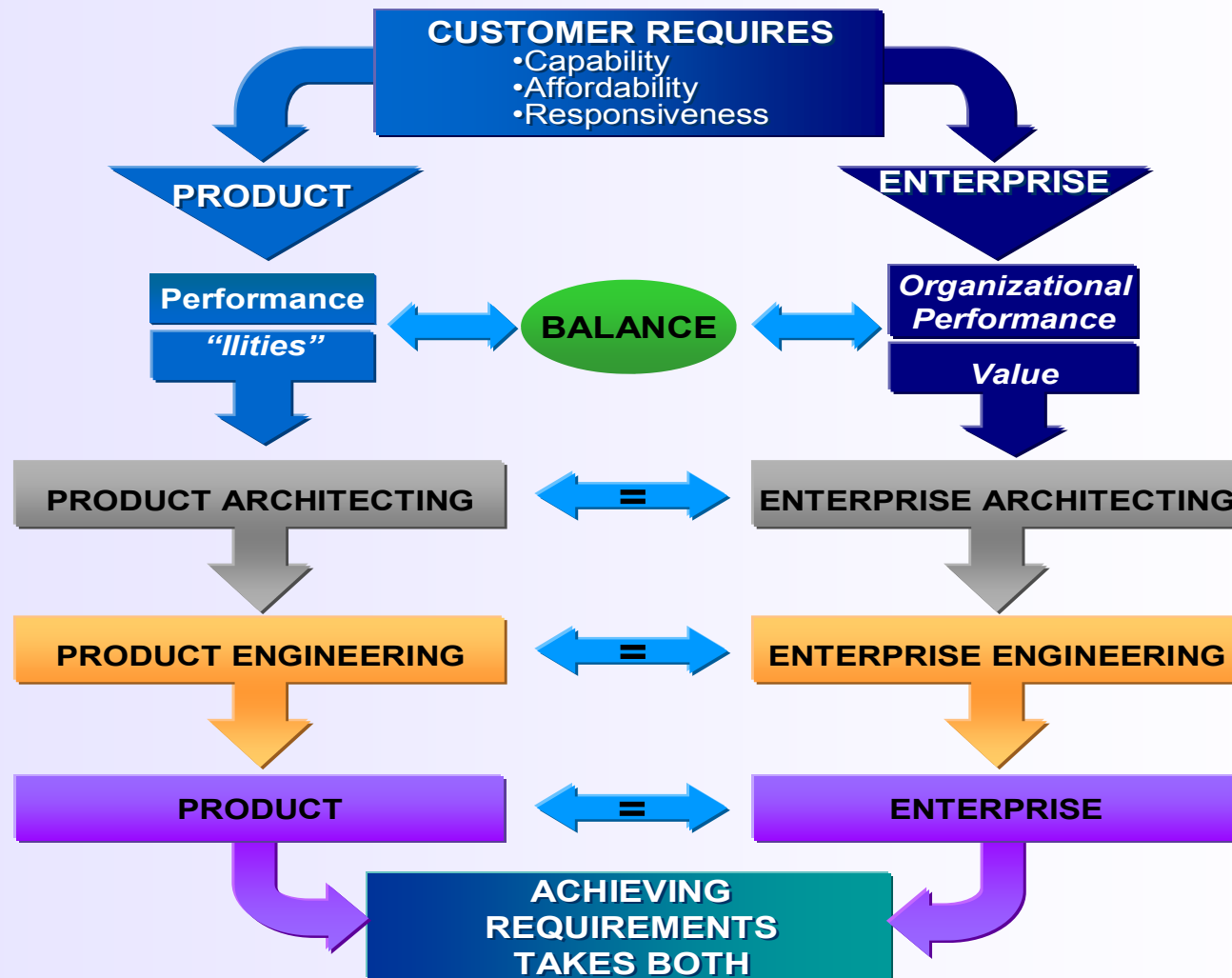


Current Systems Engineering Research Topics

- **Developing Future Systems Workforce**
- **Evolvable Systems and “ilities”**
- **Evolvable Systems Architectures**
- **Architecting for Dynamic Stakeholder Utility**
- **Multi-attribute Trade Space Exploration**
- **Capabilities versus Value-based Approaches**



Parallels in Creating Products and Enterprises





Enterprise Systems Architecting As An Emerging Art And Science

Architecting looks not just at transition from an 'as is' to the 'to be' state, but also at the underlying decision analysis related to various alternative 'could be' states

Architecting enriches the thinking about the enterprise through a deeper exploration of each enterprise view, and at the interconnections and interrelationships between these views

Decisions are made about the alternatives in context of the business model, technology, strategy, culture, purpose, and other factors

Architecting is both art and science, and the current state of systems architecting is probably more of the former

- The 'art' uses qualitative and heuristic techniques including lessons learned, value judgments, and soft measures
- Increasingly, architecting is a science using quantitative analytic techniques - math, modeling, measurement



Enterprise Architecting – What are the Key Questions?

New ***Business Models***
& ***Value-Creation***
Frameworks

Designing
Future
Lean Enterprises

Evolving
Adaptive
Lean Enterprises

- How do we construct robust **value propositions**?
- What are the emerging **new business models**?
- What are the key characteristics of **emerging networked enterprises**?
- How can **knowledge** be transformed for competitive advantage?
- How do you create both **efficient and effective** lean enterprises?
- How do you **organize** to deliver best value to stakeholders?
- How do you build **virtual lean enterprise networks**?
- What **measures & incentives** drive high-performing enterprises?
- How do you architect an enterprise that can most **effectively produce a desired product system**?



Integrated Research Agenda

- **Theoretical foundations** -- Make progress towards defining & evolving *Enterprise Science* fundamentals supporting *Enterprise Architecting*
 - Integrate multiple domains of existing theory-based knowledge
 - Define meaningful constructs, abstraction levels & linkages
 - Create complementary new knowledge in priority areas
- **Methods and techniques** -- Define & evolve an integrated analytical portfolio
 - Define design strategies & techniques
 - Identify applicable modeling & simulation methods
 - Develop heuristics, analytical engines & algorithms
- **Implementation practices** -- Define & develop an integrated implementation toolset
 - Capture and codify lessons learned from field research
 - Identify effective approaches & practices
 - Co-develop implementation tools (jointly with LAI stakeholders)



Enterprise Architecture -- Focus

- **Enterprise integration**
 - Leadership, lifecycle and infrastructure support processes
 - Modeling enterprise interactions
- **Emerging enterprise architectures**
 - Emerging new stakeholder value propositions
 - Business models
 - Structure & behavior
 - Alignment; complementarity
- **Definition and evaluation of current-state and desired future-state enterprise architectures**
 - Enterprise dynamics modeling -- co-evolutionary dynamics of system and enterprise architectures, enterprise-environment interactions, multiscale behavioral dynamics
 - Future state enterprise architecture attributes (flexibility, evolvability, adaptability, robustness, reconfigurability, etc.)
 - Tradespace analyses
- **Navigation of transition process (transformation)**
 - Transition trajectory
 - Adaptive steering
 - Decision-support systems to manage uncertainty



Enterprise Architecting -- Research Projects Currently Under Way

- Enterprise performance measurement systems
- Multi-platform thinking: Integrating knowledge in the lean enterprise
- Dynamic evolution of enterprise and system
- Language, models and architectures
- Integration strategies across enterprise networks guiding principles for enterprise architecting
- Impact of enterprise architectures on innovation
- Architecting large project enterprises
- Engineering an X-enterprise
- Enterprise design for dynamic complexity



ESD.38J - Enterprise Architecting

MIT Course - Learning Objectives

- **Have an appreciation for the emerging field of Enterprise Architecting and its importance in the field of Engineering Systems**
- **Understand how strategic drivers (business model, strategic focus, enterprise performance objectives, etc) and desired enterprise “ilities” (flexibility, scalability, agility, etc.) influence the enterprise architecture**
- **Describe the different views (policy, organizational structure, processes, knowledge, product system, enabling technologies) that comprise an enterprise architecture**
- **Understand the enterprise architecture frameworks, models, and toolsets currently being applied in practice and research**
- **Understand how enterprise architecting is being applied in real world engineering systems**
- **Gain insight into dimensions of current enterprise architecting research**
- **Recognize the challenges, barriers, and enablers in enterprise architecting and define future research opportunities**
- **Contribute to defining enterprise architecting heuristics**



Summary

- Enterprises, much like products, must be **architected as complex integrated systems**
- In the past decade, we've seen the **evolution of enterprise architecting** which has led to development of architecture frameworks, standards, modeling languages and tools
- We see the current field as too limited, and that **a more holistic systems approach to architecting enterprises** is needed
- Complex enterprises exhibit **systems properties**, as well as **unique emergent qualities/values** rooted in the human dimension
- There is **significant research ongoing** at MIT and other leading universities to evolve this art and science, and more is needed to address challenging research questions
- Further work is beginning on **how to educate the future systems leaders** who will architect, build, and transform complex enterprise systems