Enterprise Architecture Modeling, Design and Transformation: Defining the Missing Links

by

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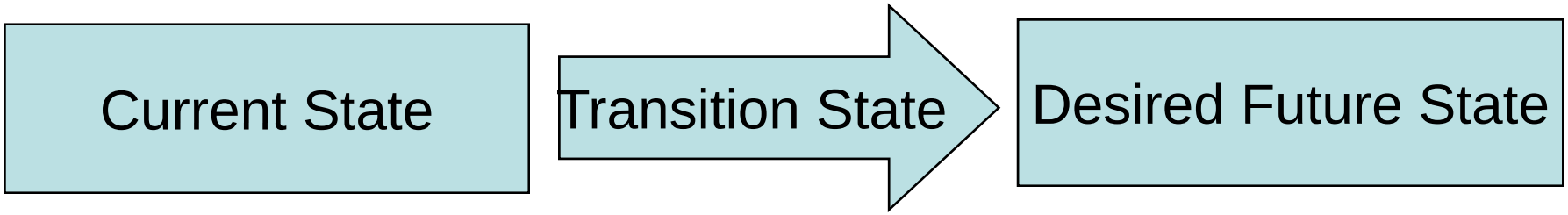
April 18, 2007

Outline

- **Propose a unifying conceptual framework guiding the "front-end" of planned enterprise change (transformation) management process**
  - Enterprise architecture design process (enterprise architecting)
  - Choice of enterprise architecture for emphasis
  - Enterprise architecture modeling strategies
  - Transition moves available for enterprise transformation
- **Show how the framework links together a number of the key design decisions that need to be considered simultaneously, under alternative combinations of major contingency conditions**

Enterprise Transformation --
Typical (Modified) Current Process*



- Short or long jump from *current-state* to a *desired future state*
- *Transition state* -- in-between the current-state and the desired future-state
- *Enterprise change (transformation) management* -- process of steering the enterprise along (through) the transition state, by anticipating and addressing the (predictable) problems & challenges along the way

Modified current process (with "enterprise architecting" emphasis)

- Define current state enterprise architecture (Note: maybe using an enterprise architecture reference framework)

Pursue change management strategies, practices, processes & methods to move from the current state to the desired future state

- Define desired future state enterprise architecture options
- Evaluate options
- Select the best architecture for execution

*For the See David A. Nadler, *et al.*,*Organizational Architecture: Designs for Changing Organizations* (San Francisco: Jossey-Bass, A Wiley Company, 1992), p.64.

A Few Problems with the Model

- **Missing a theory-based conceptual framework driving the analysis & action (atheoretical approach)**
  - Enterprise: how is the enterprise conceptualized? As a closed-system? An open-system? A complex adaptive system? Makes a big difference. More on this later.
  - Environment: What are the external contingency conditions that should be considered? How should they be conceptualized for actionable decisions?
  - Change: rich literature on enterprise change, adaptation, evolution not tapped
- **Unconstrained definition (direction of change, attributes) of the desired future-state (e.g., encompassing design of the future-state enterprise architecture)**
  - Actually, direction of change is strongly constrained by the defined contingency conditions
  - Properties of desired future states, as well, are constrained
- **Time-dynamics (temporal dimension) of change process not considered**
  - Both the enterprise and the external environment are co-evolving over time
  - The desired future-state is a moving target. How to deal with this?
  - The transition path itself is not linear, nor completely predictable
- **Nature, pace & direction of the change process is not directly addressed as part of the up-front "change planning package" [enterprise architecting]**
  - Typically left to be addressed as part of the change management process
  - Needs to be considered as an integral part of the change planning process (involving enterprise architecture design [enterprise architecting] process)

The Design-Science Interface in Thinking about Enterprise Transformation

- **Design (Role model: architecture, engineering)**
  - **Marks the principal difference between the professions and the sciences [Simon 1996]**
  - **Basic orientation:** heavy emphasis on future-oriented "solution-finding"; concerned with "systems that do not yet exist" [Romme 2003]
  - **Value system:** will it work? Is it the best solution for the unique problem at hand?
  - **Mode of thinking:** Normative, stresses synthesis
  - **Nature of knowledge:** pragmatic (heuristics, best practices); draws on *design causality* -- knowledge that leads to action and can be validated [Argyris 1993, p. 266]; intuition & creativity
  - **Methodology:** Practical experimentation & tinkering
- **Science (Role model: natural sciences)**
  - **Basic orientation:** develop an understanding of existing phenomena, by discovering and analyzing existing objects
  - **Value system:** disinterestedness, consensual objectivity
  - **Mode of thinking:** analytical, not normative
  - **Nature of knowledge:** representational (descriptive & explanatory of the world as it is)
  - **Methodology:** scientific method (e.g., controlled experimentation, hypothesis testing, computer simulations to understand cause-effect relationships over time)

Cautionary take-away: Enterprise architecture design (architecting) for transformation needs to be more fully grounded in *design propositions* from research-based knowledge on organizations (enterprises) as complex socio-technical systems [that is, be careful about using traditional "engineering" methods!]

Organizations are Complex Systems

- **Closed-systems view --** Legacy historical perspective [Taylor 1911; Gulick & Urwick 1937; Weber 1947]
  - Grounded in scientific management tradition (even going back to Adam Smith)
  - Primarily concerned with efficiency
  - Static model; "organization as machine metaphor"
- **Open-systems view --** modern perspective [Katz & Kahn 1966;Thompson 1967; Lawrence & Lorsch 1967]
  - Driven by the thinking that organizations are complex open systems interacting with the external environment, where the central problem is coping with uncertainty
  - The primary concern is *adaptation* in a changing environment
  - Dynamic model, one-way causation ("environment is boss")
- **Complex adaptive systems view --** Emerging multilevel co-evolutionary complexity paradigm [Holland 1992; Carley 1997; Dooley 1997; Levinthal & Warglien 1999; Tilebein 2006]
  - Organizations search, adapt & learn in a shifting & complex landscape
  - Landscape complexity depends on the intensity of the web of multilevel interdependencies (internal, external)
  - Main challenge is how to avoid catastrophe of getting stuck in local pockets
  - Dynamic model, two-way causation

Enterprise Transformation as "Enterprise Becoming": Insights from the Academic Literature

- Enterprises change continuously in adaptive response in a complex coevolutionary process with multilevel interdependencies -- ***therefore organizational design [enterprise architecting] should focus on proactively designing & managing ("tuning") interdependencies (internal, external)*** [e.g., Levinthal & Warglien 1999)
- Build-in emergent design (generative properties opening up new possibilities) into the design elements [Garud *et al*. 2006]
- Move from *design* to *designing* as an on-going process [Yoo, Boland & Lyytinen 2006]
- Design organizations that are built to change [Worley & Lawler 2006]
- To cope with environmental complexity and uncertainty organizations should become open learning systems where strategy development and change emerges from the way the company as a whole acquires, interprets and processes information about the environment [Dunphy & Stace 1993]

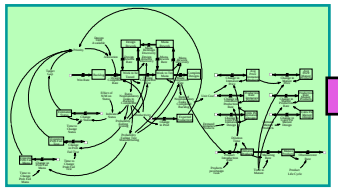
"Organizations rarely do exactly what they are told to do [March 1981]

"The so-called Toyota-style system was not developed all at once by rational strategic decision-making, but gradually evolved during the postwar period (or even since the 1930s)" [Fujimoto 1998]

"Wishing to highlight the pervasiveness of change in organizations, we talk about organizational becoming" [Tsoukas & Chia 2002]

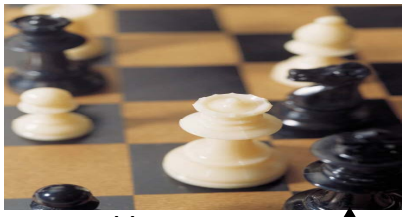
Takeaway: The literature suggests a basic shift emphasis away from a rational, planned, enterprise change process (via enterprise architecting] to one of *guiding* the change process. This, however, is only part of the answer [more on this later]

Proposed Model: Up-front Transformation Planning as a Tightly-Coupled Process



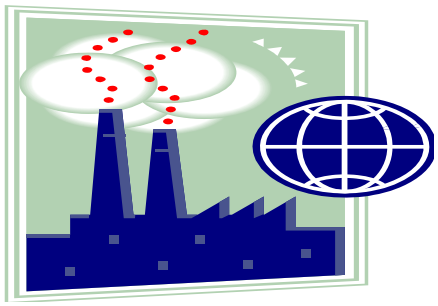
Current Enterprise Architecture

Enterprise Architecture Design

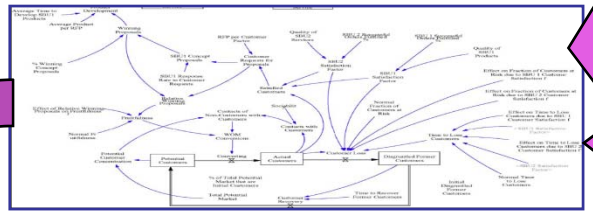


Transition Moves

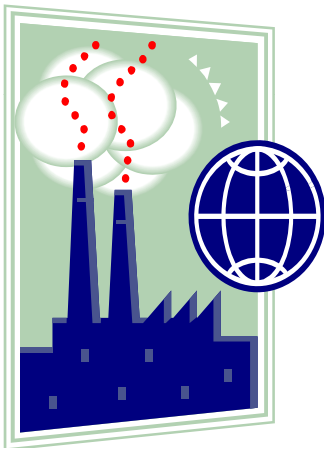
Computational Enterprise Simulation Modeling



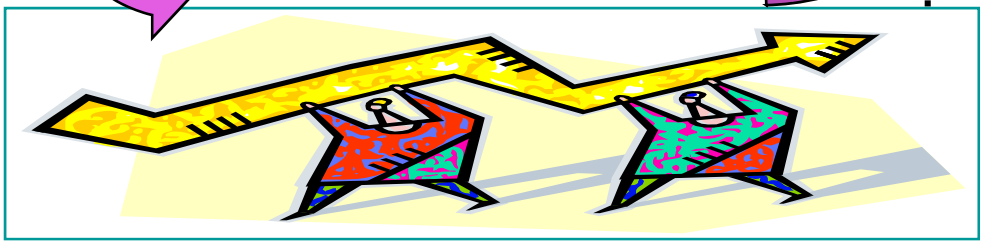
"Real-life" Enterprise (Current State)



New Enterprise Architecture



"Real-life" Enterprise (Future State)



Enterprise Transformation -- Planning & Implementation

Emerging Holistic View of Enterprises as Complex Adaptive Systems

Working definition: Enterprises are goal-directed complex adaptive socio-technical systems organized to create value for their multiple stakeholders by performing their defined missions, functions or businesses

- **Open systems --** Interacting with the external environment
- **Complex interactions --** Both internally and externally
- **Interdependence --** Large number of interconnected parts
- **Dynamic change --** The system changes over time, as environment changes
- **Adaptive behavior (*but with intentionality, strategic choice, foresight, unlike in natural systems)* --** How the system learns and adjusts to external changes shapes its evolution (survival, extinction)
- **Emergence --** Collective behavior at a given level (scale) cannot be understood from studying microstructure and behavior at a lower level (scale)
- **Self-organization --** Interaction between system's structure & emergence can create a new structure

Two footnotes: (1) Primary interest in enterprises serving societal ends (e.g., building, operating, sustaining engineering-intensive, technology-based, systems; **(2)** The terms "organizations" and "enterprises" are used interchangeably; latter draws attention to entities often cross-cutting multiple organizational units (e.g., program enterprise; extended enterprise)

Enterprise Architecture (as a Concept)

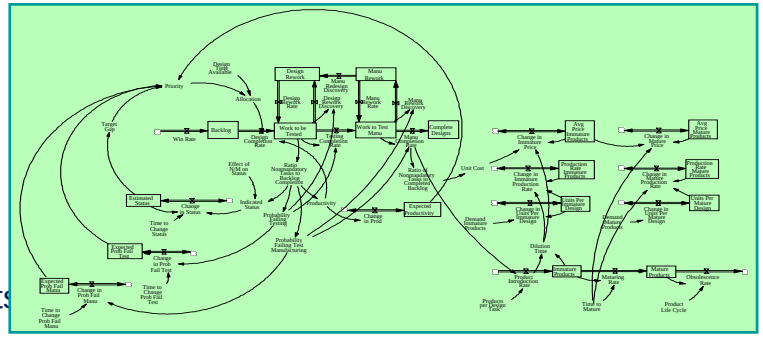
- **Conceptual abstraction and representation of the architecture of a "real-life" enterprise's underlying complexity**
  - Idea of the architecture of complex systems goes back to Simon [1962]; now widely used in designing (architecting) engineering systems
  - Main challenge: how best to adapt the concept to organizational context -- need to capture the architecture of ***dynamic complexity***
- **Outgrowth of the concept of "organizational design," occupying a dominant place in organizational science literature over many decades**
  - Driven by the view that organizational design is the **main** source of an organization's sustained competitive advantage
  - This means one can proactively alter an organization's design (architecture) to improve its performance and shape its evolutionary direction
  - But there is also some evidence that organizations change for other reasons as well
  - Still, organizational design (enterprise architecture) is viewed as the main determinant of an enterprise's sustained competitive success
- **Dynamic concept, not a static "snapshot picture"**
- **Still an evolving concept; "work-in-progress"**
- **Important point: There is no "best" architecture under all circumstances**
- **Still, evidence from literature says there are very limited options facing individual enterprises**
- **Takeaway: Provides a unifying conceptual & analytical framework for thinking about, modeling, managing and changing complex enterprises**

Enterprise Architecture (Definition and Uses)

Working definition: *Enterprise architecture is an abstract representation of a "real-life" enterprise's holistic design (gestalt, configuration, pattern) binding together its structure, strategy, environment and performance, showing its essential elements and the relationships among them, and mapping the interactions between the enterprise and its external environment, as both co-evolve over time*

- **Can be captured by using a variety of methods**
  - Natural language; causal loop diagramming; Integrated Computer Aided Manufacturing Definition -- IDEF)
  - Enterprise modeling using various ontologies -- vocabulary, semantics, axioms, symbology -- (e.g., GEM)
  - Computational enterprise simulation modeling (e.g., system dynamics, agent based modeling)
- **Abstract representation (artifact): "enterprise architecture model" (example below)**
- **Different from, but complementary with, "enterprise architecture reference frameworks" (e.g., Zachman, DODAF, FEA, AFEAF)**
  - (Typically) enterprise information system architecture frameworks supporting business processes
  - Typically based on various enterprise views
- **Serves several important purposes**
  - Descriptive -- defining "current state"
  - Prescriptive -- how enterprise can be better integrated
  - Explanatory -- causal relationships
  - Predictive -- enterprise's future evolution
  - Training & education -- how the enterprise works
  - What-if analysis (via modeling) -- impacts of decisions
  - A new way of doing science (via modeling) -- virtual experiments

System dynamics model of the basic architecture of an engine manufacturing enterprise (Blake, MIT MS Thesis, 2000; on LAI website)



Enterprise Architecture Modeling

- **Modeling enables us to understand and manage enterprise complexity**
  - Involves abstraction of reality
  - Gives insight into critical relationships & behavioral dynamics
  - Serves as a quick diagnostic tool for improvement
  - Provides "what-if" capability
- **There has been a virtual explosion in computational (organizational, enterprise) simulation modeling techniques, tools & methods over the past decade -- (right panel)**
- **Spurred by big "pull" to meet emerging needs as well as "push" from academic world**
  - Enterprise transformation
  - Organizational adaptation
  - Business process improvement
  - Product development
  - Supply chain optimization
  - Intelligent manufacturing systems
  - Defense simulation
- **A new way of doing science -- conducting virtual experiments to test new hypotheses**
- **No all-purpose enterprise model -- must define specific purpose for best application & results**

- System dynamics
- Agent-based modeling
- NK modeling
- Network analysis
- Highly optimized tolerance (HOT)
- Econometric modeling
- Neural networks
- Bayesian networks
- Boolean networks
- Petri-nets
- Evolutionary multi-objective optimization
- Real options
- Optimal control
- Cellular automata
- Genetic algorithms

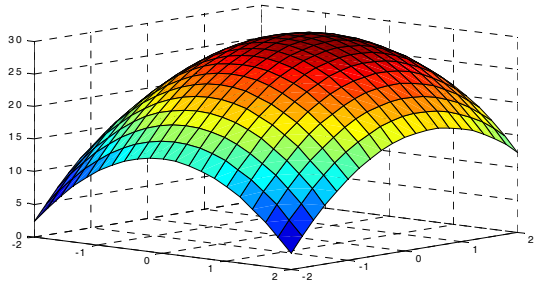
The Concept of Enterprise Architecture

Design [Enterprise Architecting]

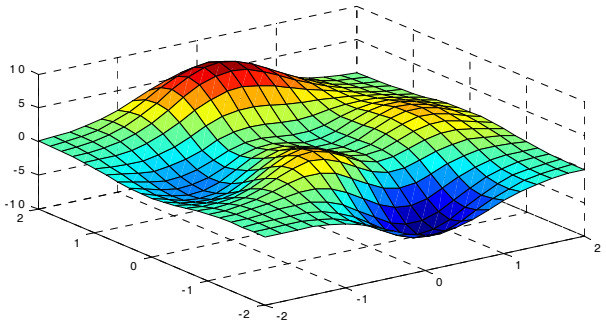
- **Enterprise architecture *design (verb) [enterprise architecting]* is the *PROCESS* of applying holistic thinking to designing an enterprise's going-forward architecture (whose job is delivering desired enterprise attributes)**
  - Define alternative design options (solutions)
  - Evaluate the defined options using evaluation criteria, methods and metrics
  - Select the best one for execution using selection criteria and methods
- **Purpose: serves as the compass guiding the enterprise transformation effort**
  - Defines the end-game, strategic direction, and desired target future enterprise attributes
  - Not a handy AAA-triptik showing how actually to carry out the transformation process
  - The term "architecting" introduces an unnecessary confusion on this point
- **Enabled by enterprise architecture model(ing), but also draws on a lot more (i.e., cumulative enterprise-related knowledge base)**
  - Enterprise science: explicit (formal, codified) research-based knowledge grounded in theory (e.g., causal relationships, principles, methods & tools, design rules)
  - Tacit (experience-based) knowledge (e.g., heuristics, best practices)
  - Creativity, intuition & inspiration
- **Produces actionable knowledge that can be put into practice and that is open to validation (will it work?)**
- **It is a means, not an end -- its function is to deliver the desired "bundle of enterprise attributes" on the other side of the transformation process**

Defining and Modeling the Concept of Enterprise (Fitness) Landscape*

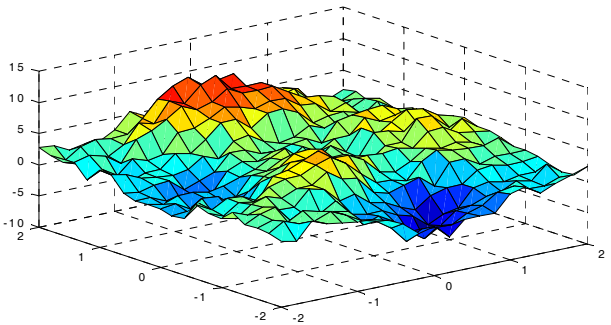
- Enterprise's abstract "payoff surface" -- continuously searching for a higher position (e.g., greater market share)
- ***Smooth*** (relatively stable, with a single peak -- few interactions) or ***rugged*** (relatively unstable or turbulent, with multiple peaks -- dense interactions); evolving over time; shaped the enterprise's internal and external interactions.
- **Main idea: landscape design -- by "tuning" the interdependencies that define the surface (topology) over which adaptation takes place, an enterprise can proactively affect the nature (quality, direction, speed) of its own adaptation process.**
- Payoff to a given choice (element, attribute) (N=1, …, n) depends on its interactions with others (K= 1, …, n-1)
- ***Fitness value function*** measures the sum total of the relative contribution of each element (organizational element or attribute) to the organization's global "fitness" (performance)
- Genesis in evolutionary biology **(Kaufman 1993),** who proposed the NK model as a mathematical tool for modeling the fitness landscape of biological systems, which has natural analogues in social and economic systems
- A companion theoretical paper provides further technical details [Lin & Bozdogan 2007, in-process]
- ***The concept remains abstract and illustrative only at this time; it is being further developed & operationalized***



Smooth with single peak



Smooth with multiple peaks

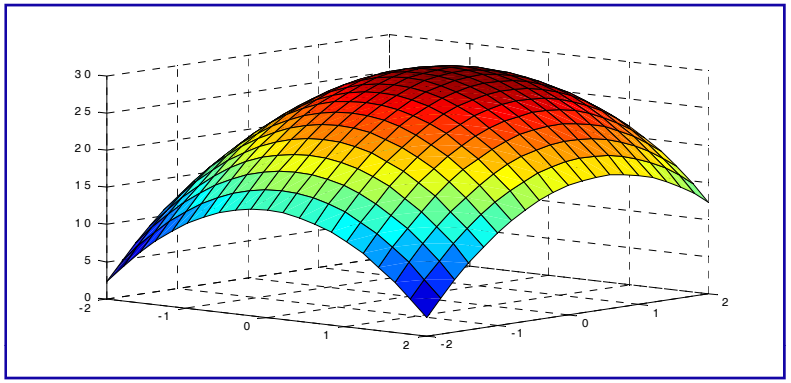


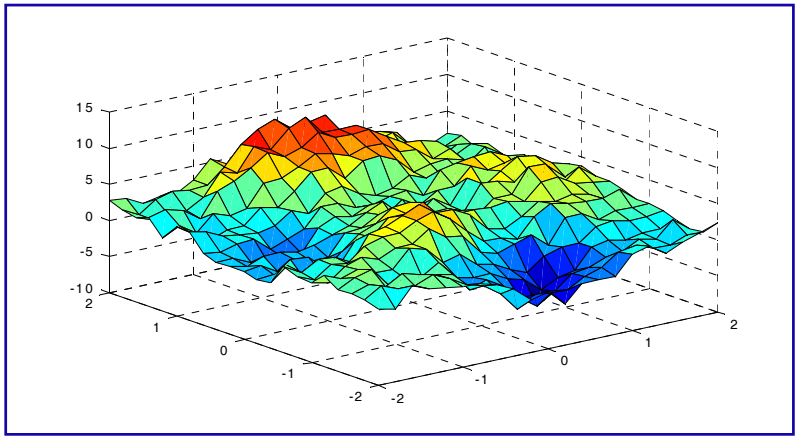
Rugged with multiple peaks

What are the optimal adaptive search (change, transformation) strategies for enterprises over their enterprise fitness landscapes?

*Landscape graphics in this presentation courtesy of Jijun Lin, MIT (2007)

Simplified View of the External Environment*





Relatively Stable (Corresponds to Smooth Landscape)

- **Source of change:** enterprise's task environment (customers, suppliers, competitors directly interacting with the enterprise) or the general environment (technology, regulatory, social)
- **Frequency:** low
- **Amplitude:** small (shallow)
- **Scope (of change):** limited (to specific enterprise domains, functions or processes)
- **Direction:** predictable

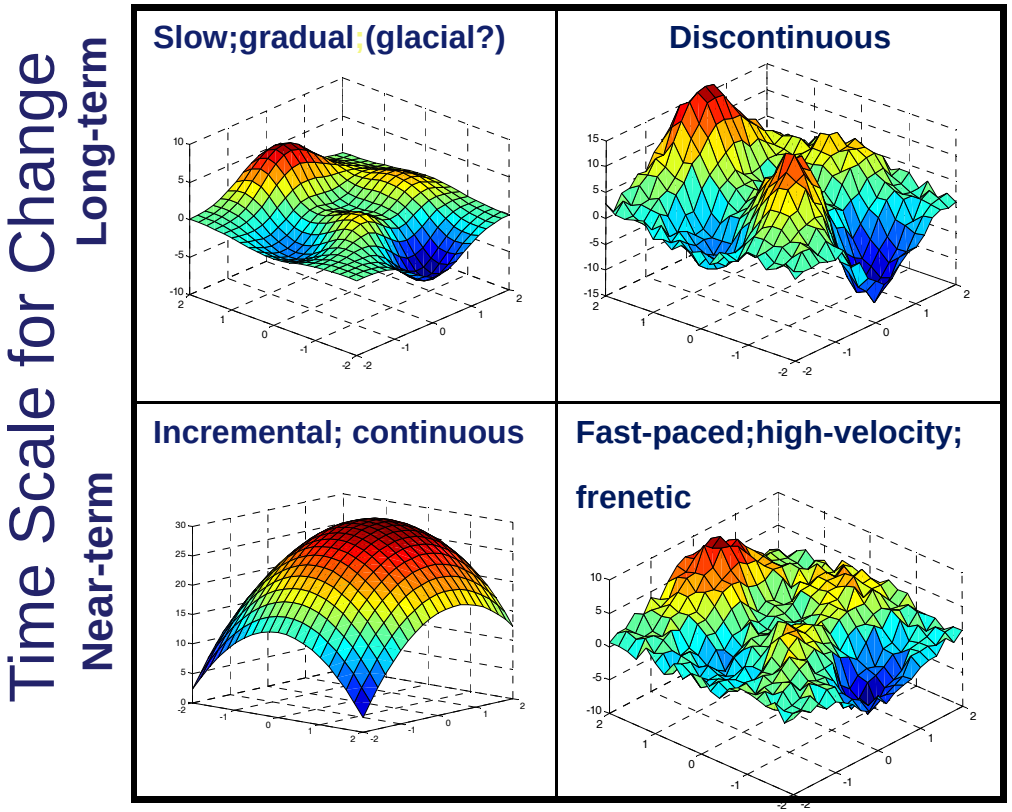
Relatively Unstable (Corresponds to Rugged Landscape)

- **Source of change:** enterprise's task environment or the general environment
- **Frequency:** low or high
- **Amplitude:** small (shallow) or high (deep)
- **Scope:** limited or total (affecting the enterprise's total structure, strategy & behavior)
- **Direction:** very difficult to predict (or unpredictable)

Environment (Corresponds to the Enterprise Fitness Landscape): Conceptualized as having two layers: (1) the direct environment (encompasses customers, suppliers, competitors directly interacting with the enterprise, whose behavior can (might) be influenced or controlled; and (2) the general environment (technology, markets, economy, regulatory, institutional, social), which remain outside the control or influence of the enterprise

*Builds in part on Suarez & Oliva (2005)

Simple Thought Experiment -- Focusing on the External Environment & Time Scale for Planned Change



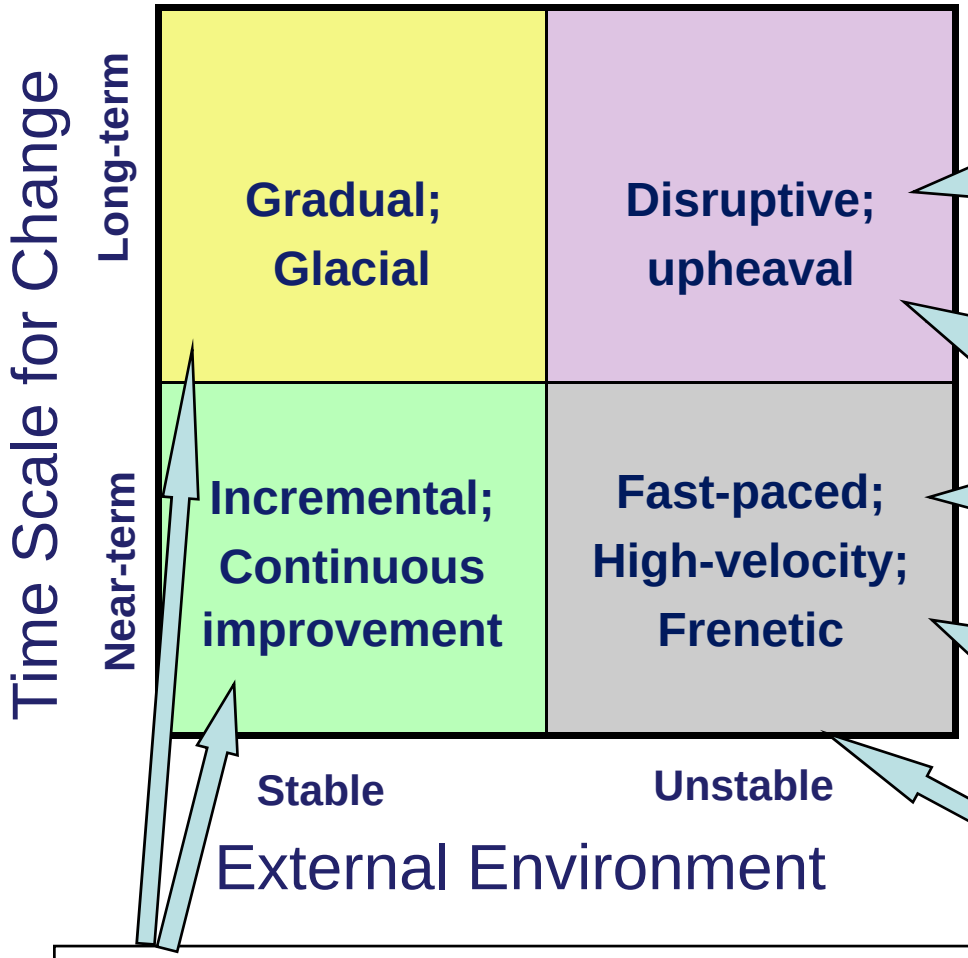
- **Both the environment and the temporal dimensions of planned change do matter (singly & together)**
- **The combination suggests distinctly different *change regimes, defining possible future-state attributes***
- **Planned change (via enterprise architecture design process) would need to take into account these contingency factors**

This is Consistent with the (Dominant) *Punctuated Equilibrium Model* of Organizational Transformation*

Characteristics	Convergent Periods	Reorientation Periods
Duration of periods	Relatively long	Relatively short
Key characteristics	Stability; organizational inertia	Jagged discontinuity; upheaval
Type, frequency and duration of change	Incremental; continuous change via series of small steps over long period	Radical, disruptive; one-time change lasting a relatively brief period
Major direction & cause of change	Internal and external push for higher performance	Major external jolts (technological, market structure & competition, shifts in customer preferences, institutional)
Scale and scope of change	Small improvements within organization's existing design archetype (architecture)	Frame-breaking change; shift to a different design archetype (architecture)
Focus of change	Better organizational alignment; process improvement	Complete transformation of basic concept, structure & behavior
Implications for planned enterprise change	Change can occur typically within the limits of an existing design archetype track; options are few and rather limited	Change occurs as a shift from an existing design archetype to another design archetype (architectural transformation); planned change must anticipate such contingency conditions

*See Tushman & Romanelli (1985, 1994); Romanelli & Tushman (1986, 1994); Tushman, Newman & Romanelli (1986); Gersick (1991); Sastry (1997); Hannan & Freeman (1977, 1984)

Extensions of the Punctuated Equilibrium Model*



Avalanche -- occurs very infrequently but is of high intensity, high speed, and simultaneously affects multiple dimensions of the enterprise; strong, sudden, violent disturbance (e.g., economic reforms in a developing country; radical technological change upsetting entire industrial ecology)

Disruptive change -- occurs infrequently, but is of high intensity; develops gradually; poses high-impact challenge for adaptation (e.g., new technologies)

Hyperturbulence -- high-frequency & high-speed change in one or more dimensions (technology, market); roughly same as "hypercompetition"

Specific shock -- rapid & high-intensity change, occurs rarely & relatively narrow in scope (e.g., deregulation)

Regular change -- low-intensity, gradual change; basically a dominant design industry & market environment

*Draws on Suarez & Oliva (2005)

Thinking about Interactions*

Description		Locus of interactions	
		Internal	**External**
Type of interactions	**Strategic**	• Vision; business model; metrics • R&D strategy; core capabilities • New product development • Investment (plant & equipment) • Organizational form & structure • Decision rights (authority) • Reward & incentive systems • Human resources policies	• Stakeholders; customers; competitors • Joint ventures; acquisitions; technology licensing • Access to capital markets (funding) • Strategic alliances; supplier partnerships; forming virtual enterprises • Institutions (e.g., regulatory)
	Tactical	• Coordination mechanisms • Business processes • Supporting infrastructure systems (e.g., information systems) • Knowledge management • Human resources practices • Training & education	• Logistics (in-bound, out-bound) • External communications (general) • Supplier relationships (certification, quality, process improvement, electronic linkages) • Public relations • Environmental scanning • Technology scouting

*Illustrative; intended only to highlight major decision elements expected to have important interactions with other enterprise domains (e.g., engineering, manufacturing), functions, processes, activities

Why Focus on Managing Interactions?

- **The cost (total, average, marginal) of managing external interactions exceeds the cost of managing internal interactions --** extensive literature on this subject (e.g., Coase [1937 classic -- why firms exist], Williamson [1975, 1979, 1981, 1998 -- transaction cost economics]
- Argument (1) When the external environment is *relatively stable*, organizations (enterprises) will generally place relatively greater emphasis on managing *internal* interactions, since the net returns (benefits minus costs) associated with managing internal interactions will exceed the net returns from managing external interactions
- Argument (2): When the external environment is *relatively unstable*, organizations (enterprises) will place relatively greater emphasis on managing *external* interactions, since the net returns from managing external interactions will exceed the net returns from managing internal interactions (*strong conjecture*)

Definition: Net returns from managing external interactions = opportunity cost of *not* managing external interactions (i.e., foregone benefits) *minus* the actual transaction costs associated with managing external interactions.

Note: Traditional theory is generally concerned only with the cost side of managing internal vs. external interactions, not with the benefits side.

Thinking about Interactions*-- Enterprise Architecture Partitioning - 1

Description		Locus of interactions	
		Internal	**External**
Type of interactions	**Strategic**	• Vision; business model • R&D st • Decis • Reward & • Human resources policies	ers: competitors gy y)
	Tactical	• Coordin mechanisms • Business • S • Hu • Training & ed	bound, out bound) al) y

Macro-architecture

Micro-architecture

*Illustrative; intended only to highlight major decision elements expected to have important interactions with other enterprise domains (e.g., engineering, manufacturing), functions, processes, activities

Thinking about Interactions*-- Enterprise Architecture Partitioning - 2

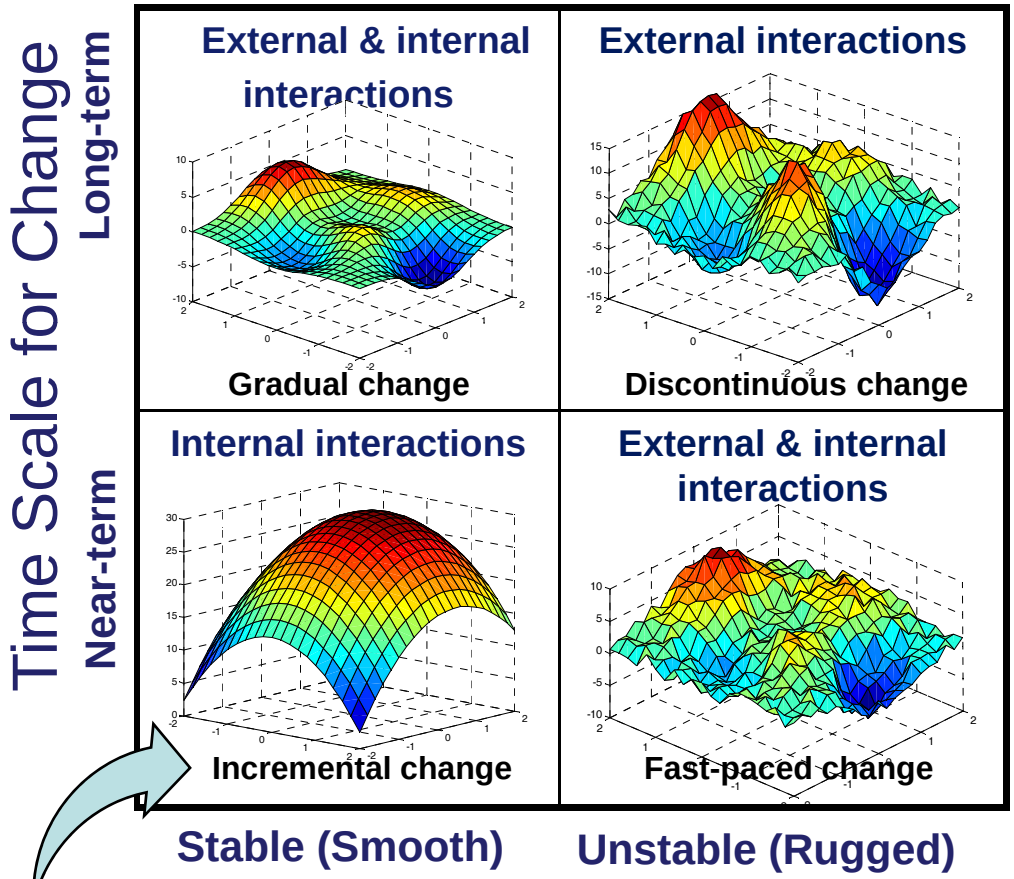
Description		Locus of interactions	
		Internal	**External**
Type of interactions	**Strategic**	• Vision; bu… metrics • R&D …ities • Ne… • I… • …	• Stakeholders: … petitors • J… ventu… …logy lic… … • Acces… • Strat… …; form… • Inst…
	Tactical	• … (… • Kn… • Hum… • Training	• Log… • Exte… • Supp… …y, proc… …es) • Pub… En…onme… • Technology s…

Internal architecture

External architecture

*Illustrative; intended only to highlight major decision elements expected to have important interactions with other enterprise domains (e.g., engineering, manufacturing), functions, processes, activities

Propositions -- Managing Interactions



- **Proposition 1.1:** If the time-horizon is closer to the present (near-term, e.g., 1-3 yrs.), place relatively greater emphasis on managing *internal (strategic and/or tactical)* interactions
- **Proposition 1.2:** If the time-horizon is further away from the present (longer-term, e.g., 3-10 yrs.), place relatively greater emphasis on managing *external* interactions
- **Proposition 1.3:** If the external environment is relatively stable, place relatively greater emphasis on managing *internal* interactions
- **Proposition 1.4:** If the external environment is relatively unstable, place relatively greater emphasis on managing *external* interactions

LEAN AEROSPACE INITIATIVE

LOCAL SEARCH MODEL

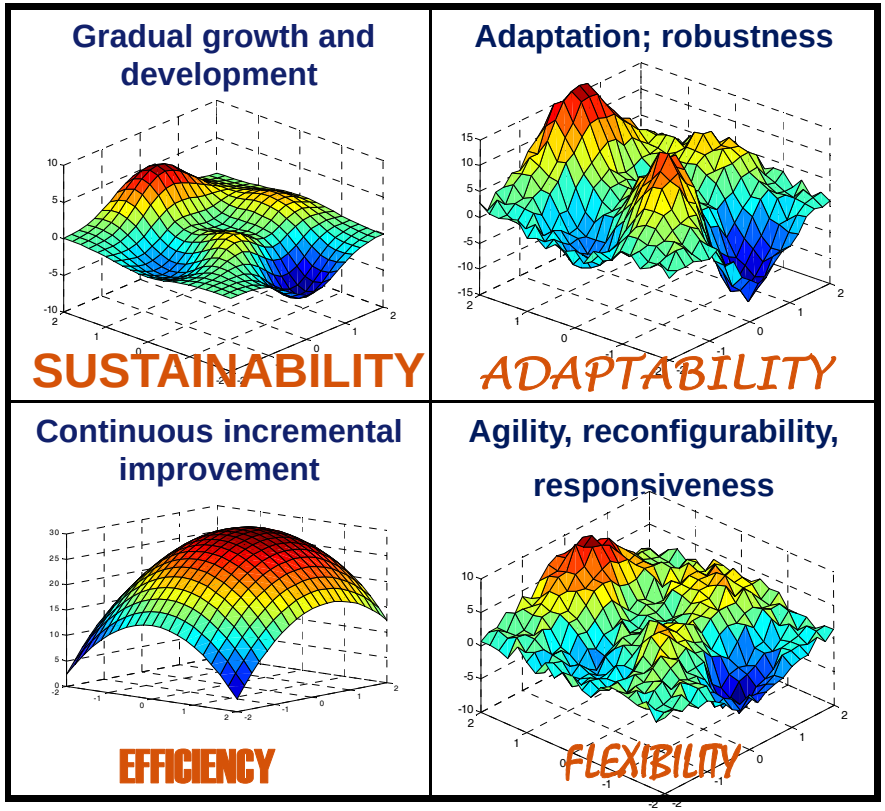
Transformation to What ?

What the Enterprise Architecture Design Process Should Deliver ("bull's eye" targets)

Time Scale for Change

Long-term

Near-term



Stable (Smooth) Unstable (Rugged)

External Environment (Landscape)

- **ASSUMPTION: (Myopic) local search -- staying put within each defined generic "terrain" over defined time-horizons**
- **EFFICIENCY:** Achieving greater efficiency gains (product, process) through relatively greater emphasis on managing **internal interactions**, concentrating on tactical/operational interdependencies (Propositions 1.1 & 1.3)
- **SUSTAINABILITY:** Achieving sustained growth and development by placing emphasis on managing **both external and internal strategic interactions** (value stream integration), concentrating on consolidation, alignment, congruence, competitiveness differentiators (Propositions 1.2 & 1.3)
- *ADAPTABILITY:* Relatively greater emphasis on managing **external interactions**, concentrating on managing uncertainty & risk (Propositions 1.2 & 1.4)
- FLEXIBILITY: Emphasis on **both internal and external interactions**, focusing on creation of agile "sense-and-respond" capabilities (Propositions 1.1 & 1.4)

LEAN AEROSPACE INITIATIVE

LOCAL SEARCH MODEL

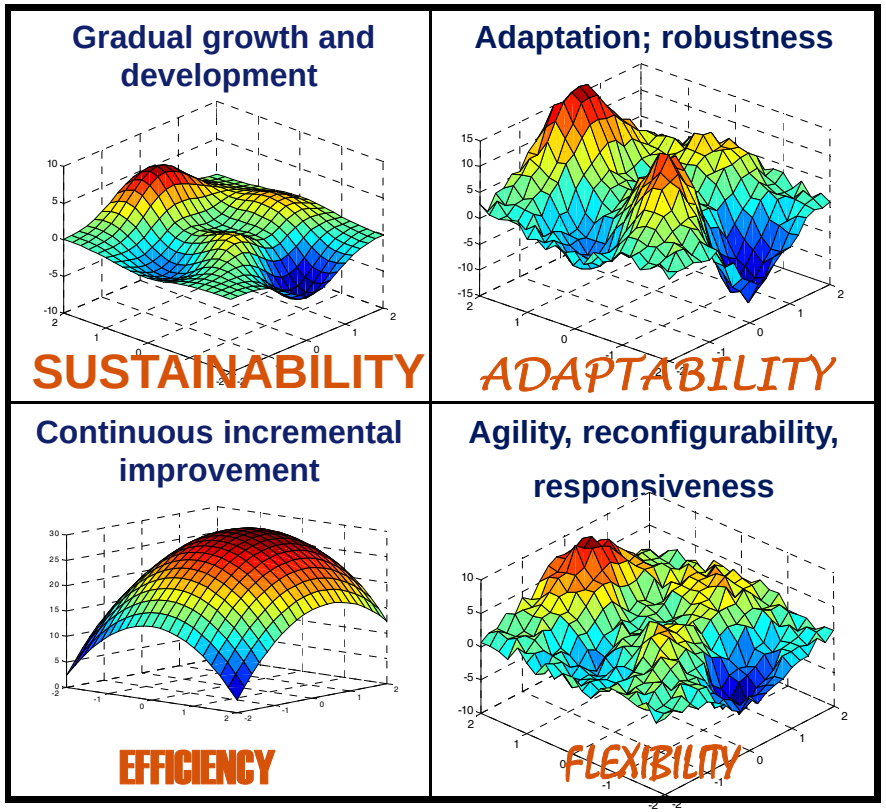
Transformation How?

Enterprise Architecture Definition (Choice)

Time Scale for Change

Long-term

Near-term



Stable (Smooth) Unstable (Rugged)

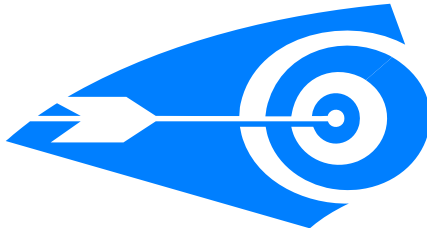
External Environment (Landscape)

- ***ASSUMPTION:*** **(Myopic) local search -- staying put within each defined generic "terrain" [quadrant] over the defined time-horizon**
- ***PROPOSITION:*** **Enterprise architecture definition (choice) is a function of the interactions requiring greater management emphasis**
- **EFFICIENCY:** Relatively greater emphasis on managing internal interactions **-- Internal architecture** (Propositions 1.1 & 1.3)
- **SUSTAINABILITY:** Emphasis on managing both external and internal interactions **-- Total enterprise architecture (external & internal; macro & micro)** (Propositions 1.2 & 1.3)
- *ADAPTABILITY:* Relatively greater emphasis on managing external interactions -- **external architecture** (Propositions 1.2 & 1.4)
- FLEXIBILITY: Emphasis on managing both internal and external interactions -- **Total enterprise architecture (external & internal; macro & micro)** (Propositions 1.1 & 1.4)

Transformation How?

Implications for Enterprise Architecture Modeling Strategies

LOCAL SEARCH MODEL



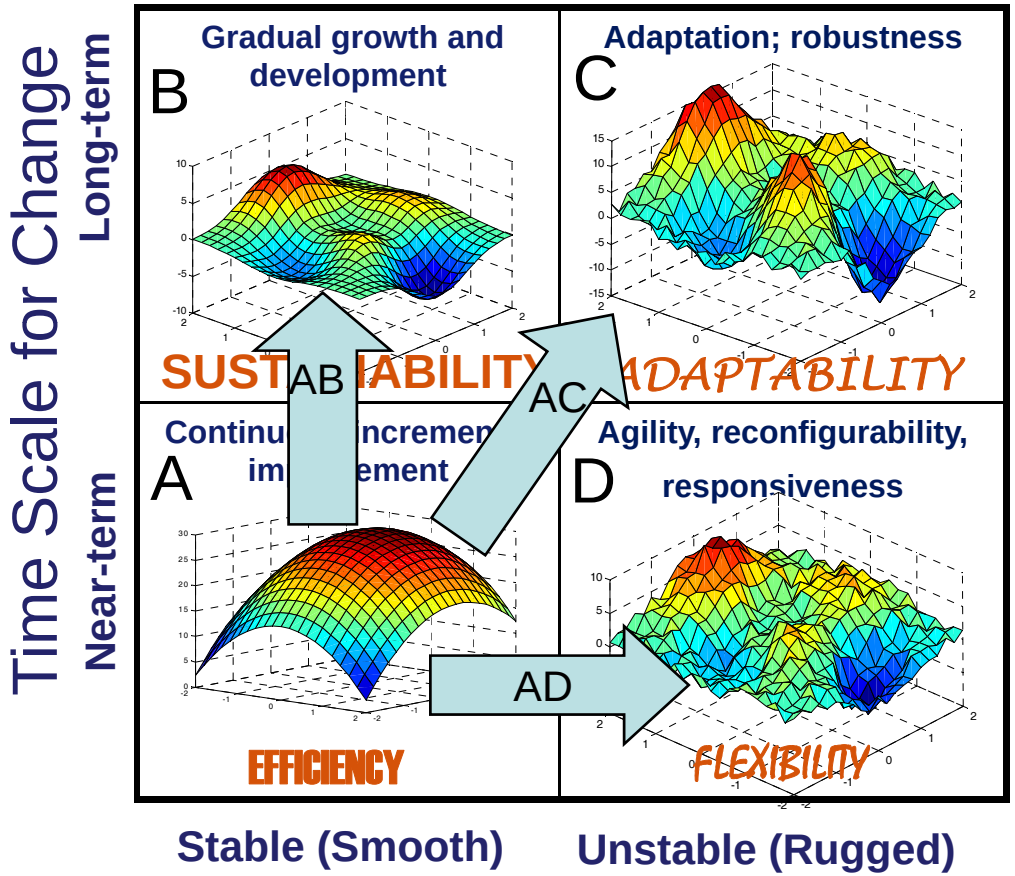
Time Scale for Change	Stable (Smooth) External Environment (Landscape)	Unstable (Rugged) External Environment (Landscape)
Long-term	**Internal & external (macro & micro) architecture)** • Linked system dynamics & agent based modeling (e.g., studying longer-term co-evolution of linked macro & micro architectures) • Evolutionary multiobjective optimization (e.g., designing product platforms) **SUSTAINABILITY**	**External architecture** • NK modeling (e.g., external interactions) • Real options (e.g., response strategies) • Genetic algorithms (e.g., selecting among a large number of design options) • Agent based modeling (e.g., survivability of supplier networks) *ADAPTABILITY*
Near-term	**Internal architecture** • Linked system dynamics & agent based modeling (e.g., enterprise integration) • Discrete event simulation (e.g., processes) • Petri-nets modeling (e.g., workflow) • Boolean networks (e.g., modeling enterprise interactions) **EFFICIENCY**	**External & internal (macro & micro) architecture)** • NK modeling (e.g., changes in enterprise fitness landscape topology) • Network analysis (e.g., unanticipated disruptions in supply chains) • Agent based modeling (e.g., emergent behavior in fast-response environments) *FLEXIBILITY*

LEAN AEROSPACE INITIATIVE

GLOBAL SEARCH MODEL (Illustration)

Transformation to What & How?

What/How the Enterprise Architecture Design Process Should Deliver



ASSUMPTION: Global search (with foresight; example: A➔B; A➔C; A➔D)

- **Current State: EFFICIENCY --** Achieving greater efficiency gains (product, process) through relatively greater emphasis on managing internal interactions, concentrating on tactical/operational interdependencies
- **Transition Move AB:** Toward sustainability (consolidate efficiency gains) -- from internal to linked external & internal (macro & micro) architecture)
- **Transition Move AC:** Toward adaptability (balance efficiency & adaptability)-- from internal to external architecture
- **Transition Move AD:** Toward flexibility (balance efficiency & flexibility) -- from internal architecture to linked external & internal (macro & micro) architecture

RESULTS:

- **Global search (transition) moves suggest quite different mix of objectives**
- **Architecting must explicitly consider alternative available transition moves (limited in number)**
- **Architecture definitions (choices) & modeling strategies depend on not only on what interactions to emphasize but also on "from-to" transition moves**

Main Conclusions - 1

- **Proposed a unifying contingency-theory-based conceptual framework guiding up-front enterprise transformation planning process, resulting in a number of important results:**
  - Definition of alternative generic *enterprise change regimes*, each suggesting a different relative emphasis in terms of managing enterprise interactions (internal, external)
  - Definition of alternative "bull's eye" desirable future-state enterprise attributes (efficiency, sustainability, adaptability, flexibility) that the enterprise architecture design process, in general, should deliver (transformation to what?)
  - Identification of enterprise architecture choices for emphasis in the enterprise architecture design process (transformation how?)
  - Identification of enterprise modeling strategies to serve specific defined transformation-related purposes (transformation how, enabled by enterprise architecture modeling)
- **Enterprise architecture design [enterprise architecting] for transformation involves a tightly-coupled process where key design decisions, enterprise modeling strategies, and transition moves need to be addressed simultaneously**
  - Expanding the framework from "local search" to "global search" suggests important balancing & tradeoff decisions on desirable future-state enterprise attributes (e.g., efficiency vs. flexibility, etc.)
  - Also suggests quite different enterprise architecture design strategies, enterprise architecture choices, and enterprise architecture modeling approaches

Main Conclusions -- 2

- **Propose a two-track enterprise transformation strategy (governing enterprise architecture design, enterprise architecture choice, and enterprise modeling approaches)**
  - **Planned change:** well-suited for the relatively stable environment case; performed over regular time periods (e.g., reset near-term every year; reset longer-term every 3-5 yrs.) -- lean enterprise thinking (and six sigma, etc.) represent good fit here
  - **Emergent (guided) change:** well-suited for the relatively unstable environment case; performed on an on-going basis (more in tune with "the organizational becoming" idea); near-term & longer-term linked on a rolling basis; need to consider alternative change strategies with "generative properties" (opening up new future improvement possibilities), stressing greater agility, flexibility, responsiveness, reconfigurability of capabilities as well as longer-term adaptability properties

BACKUP REFERENCE SLIDES