



SEARI Short Course Series

Course: PI.26s Epoch-based Thinking: Anticipating System and Enterprise Strategies for Dynamic Futures

Lecture: Lecture 13: Course Summary and Discussions

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This course was taught at PI.26s as a part of the MIT Professional Education Short Programs in July 2010 in Cambridge, MA. The lectures are provided to satisfy demand for learning more about Multi-Attribute Tradespace Exploration, Epoch-Era Analysis, and related SEARI-generated methods. The course is intended for self-study only. The materials are provided without instructor support, exercises or “course notebook” contents. Do not separate this cover sheet from the accompanying lecture pages. The copyright of the short course is retained by the Massachusetts Institute of Technology. Reproduction, reuse, and distribution of the course materials are not permitted without permission.



Systems Engineering Advancement Research Initiative

***[PI.26s] Epoch-Based Thinking: Anticipating System
and Enterprise Strategies for Dynamic Futures***

Course Summary and Discussions

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Systems in a Dynamic World



NEEDS CHANGES

- unanticipated stakeholder needs
- needs related to unique factors (environmental, safety, aesthetic, etc)



POLITICAL and ECONOMIC CHANGES

- changes in multinational agreements
- change in political leadership driving shifts in lifespan or funding profiles



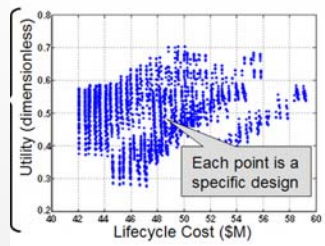
Deere & Company

TECHNOLOGY and MARKET CHANGES

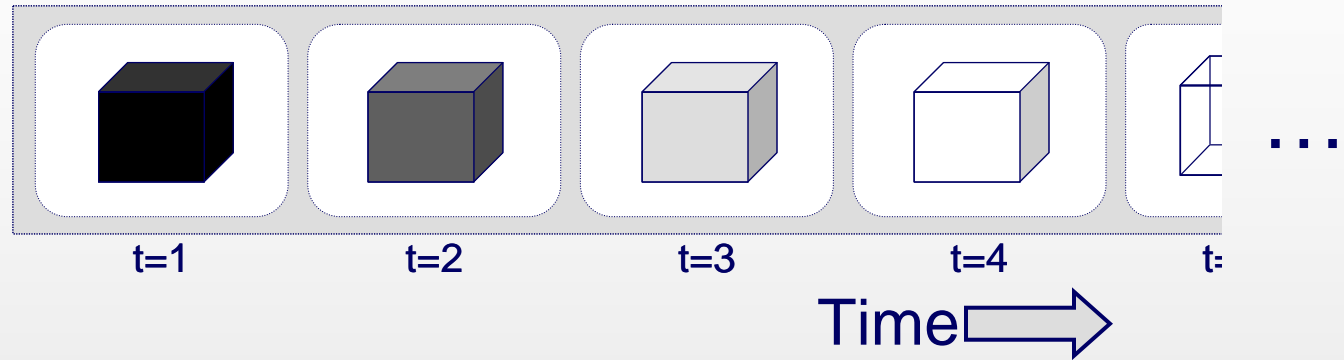
- availability of autonomous vehicles
- new emission standards imposed
- BRIC market escalates

Epoch-based thinking takes more of a “science” based approach to designing systems and enterprises for possible futures

Epochs: Discretizing Contexts and Needs



+



Epoch

Time period with a fixed “context” and needs

Fixed: Constraints, design concepts, available technology, and expectations (attributes and utility function)

One Epoch: short run
Multiple Epochs (System Era): long run

Epoch Purpose

Partition problem into series of short run problems

Legend:

T_i : Duration of Epoch i

$S_{i,b}, S_{i,e}$: System State at beginning, end of Epoch i

Continuity of States: $S_{i,e} = S_{i+1,b}$

An “Epoch” as a Snippet of Time

Definition of Epoch

Time period with a fixed context and needs; characterized by static constraints, concepts, available technologies, and articulated expectations

System success depends on the system meeting *expectations* within a given *context*

↑
can change!

↑
can change!

Epoch-based Thinking

Using the concept of “epoch” to generate and consider a large number of possible future contexts and needs facing a system, along with short term and long term strategies for maintaining a successful system across epochs

Contextual, Temporal and Perceptual Aspects: Essential to Designing for Dynamic Futures

STRUCTURAL	related to form of system components and their interrelationships
BEHAVIORAL	related to function/performance, operations, and reactions to stimuli
CONTEXTUAL	related to circumstances in which the system or enterprise exists
TEMPORAL	related to the dimensions and properties of systems over time
PERCEPTUAL	related to stakeholder preferences, perceptions and cognitive biases

Rhodes, D. and Ross, A., *Five Aspects of Engineering Complex Systems: Emerging Constructs and Methods*, IEEE Systems Conference, April 2010

Dynamic Future -- Approaches

Classical Approaches:

- Anticipated possible futures by “spinning scenarios” (typically 3-4) – output usually graphical or narrative
- Typically used to make ongoing strategic business decisions based on positioning and adaptation strategies should any one of these futures be realized

Epoch-Based Approach:

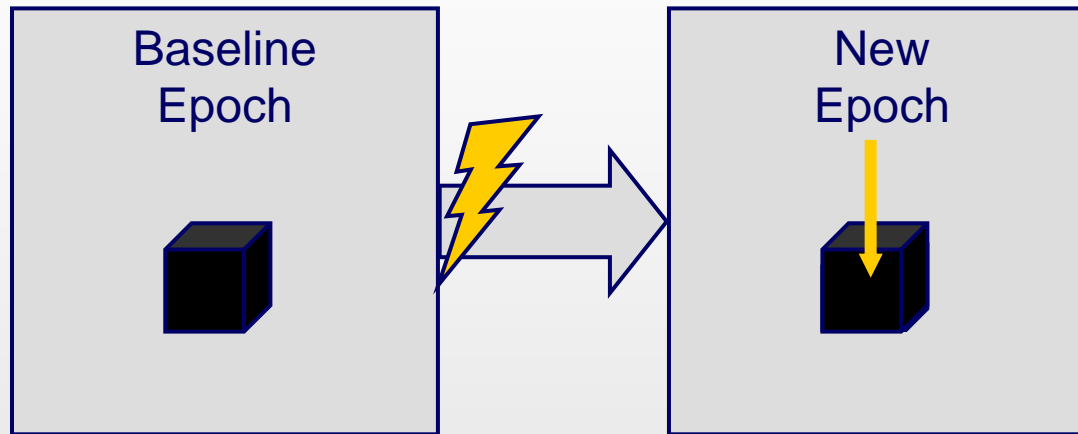
- Epoch variables enumerated for key uncertainties, used to generate possible futures
- Enable better architectural design decision making for systems and enterprises

An “epoch” represents a discrete and natural way of thinking about context, needs, and time

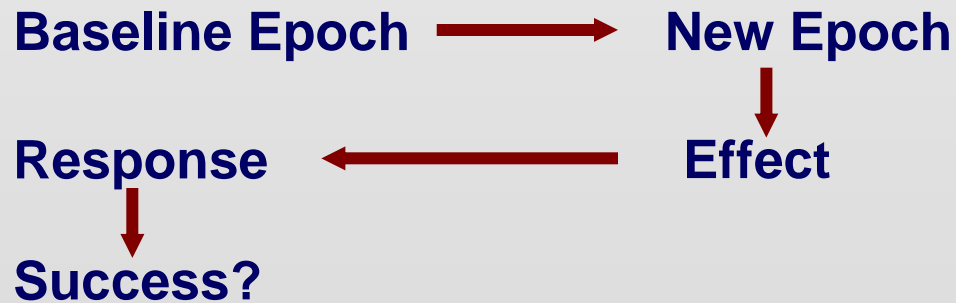
*Discretization of possible future contexts and needs into **epochs** is the basis of Epoch-Based Thinking*

Classical approaches remain useful for strategic thinking in regard to business-oriented decisions, but fall short in supporting architectural design decisions for systems and enterprises
epoch-based approaches fill this gap

Basic Epoch Shift Construct



System Definition



Epoch Characterization

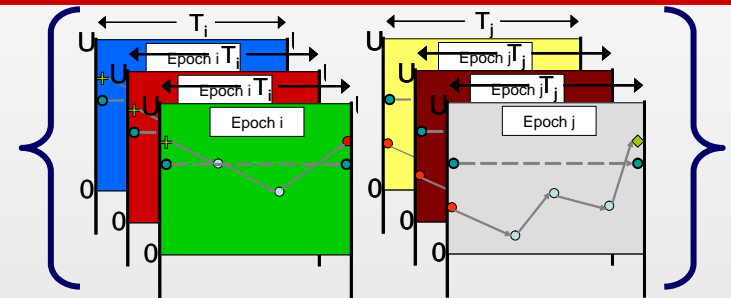
Definition of Epoch:

Time period with a fixed context and needs; characterized by static constraints, concepts, available technologies, and articulated attributes (Ross 2006)

Define Epochs

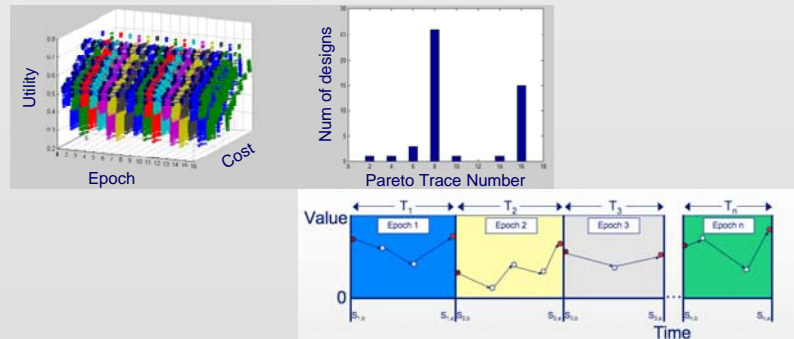
Potential Contexts

Potential Needs



Multi-Epoch Analysis

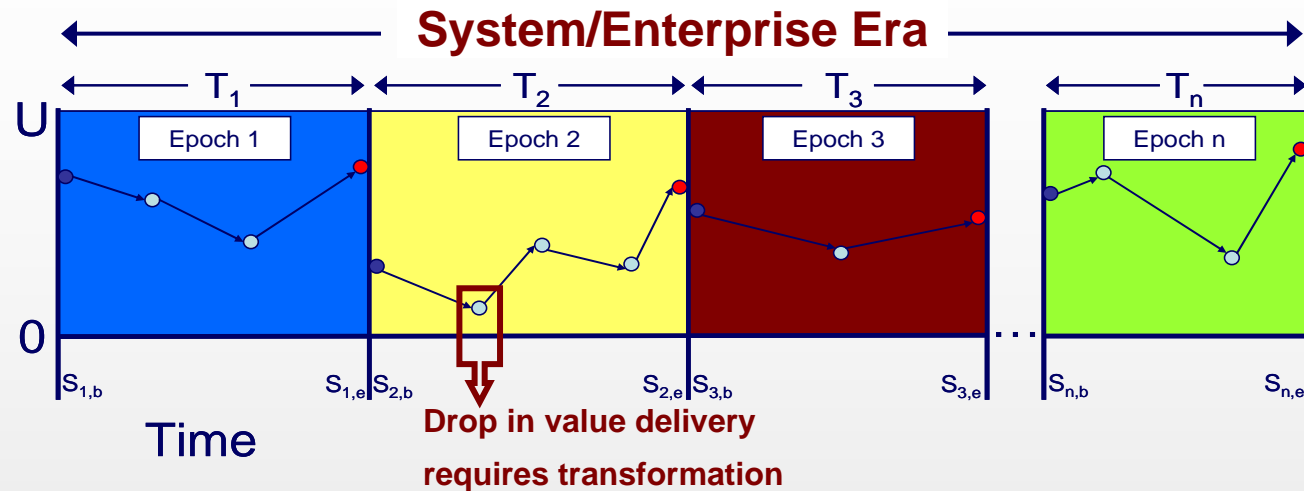
Era Construction



Parameterize future contexts for generating and sampling scenarios

Value Delivery Across Epoch Shifts

Epoch is a time period for which context and expectations are fixed



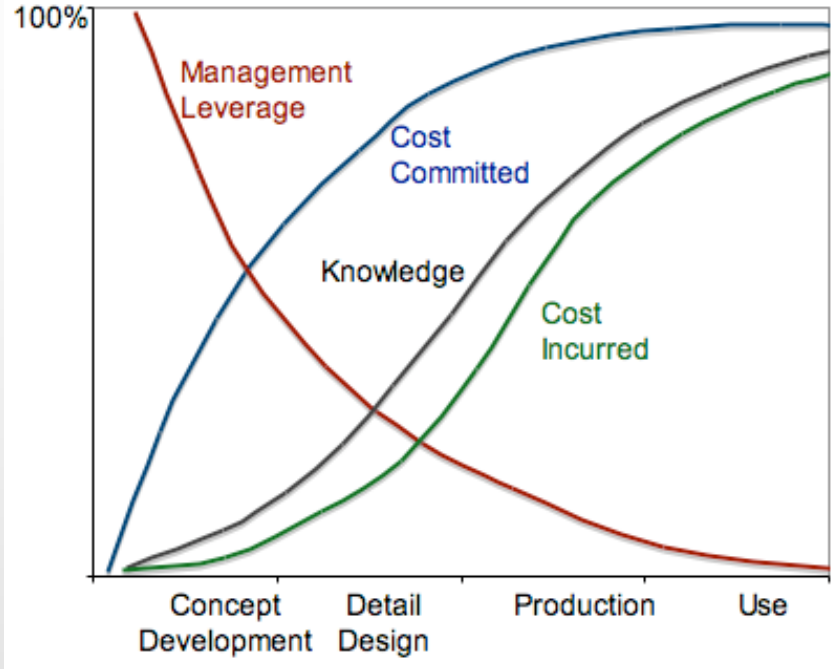
Example triggers for epoch shift impacting system/enterprise

- Change in political environment
- Entrance of new competitor in market
- Emergence of significant new/changed stakeholder need
- Policy mandate impacting product line, services or operations

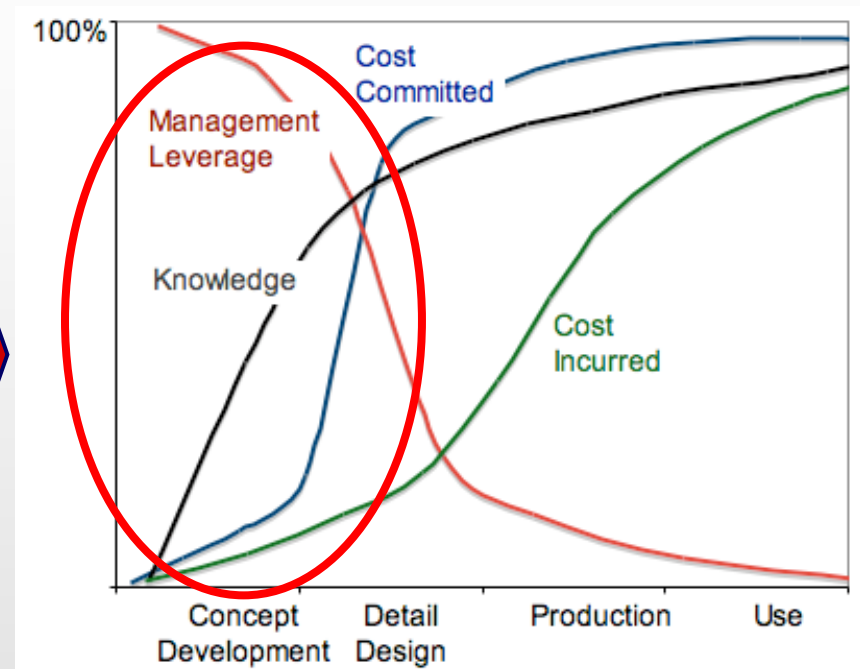
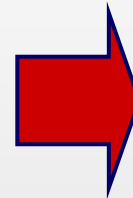
Categories of epoch variables can aid in thinking about key changing factors

E.g. Resources, Policy, Infrastructure, Technology, End Uses ("Markets"), Competition, etc.

Our Research Seeks to “Change the Picture”



Classic paradigm



New paradigm

1. Existence of appropriate **competencies** in workforce
2. Advanced **methods** for performing anticipatory thinking, analysis, and decision making in design of systems
3. Enterprises with enabling strategies and model-based **environments**

Closing Thoughts

What dynamic world factors are you facing in developing systems or enterprises?

Do the engineering methods you use today accommodate thinking about time and context?

How might epoch-based thinking be used in your organization?

Resources for Learning More about Our Research

Access to Research
SUMMIT

Access to Research
WEBSITE

SEARI Research Summit
October 19, 2010
Cambridge, MA



The screenshot shows the SEARI website homepage. At the top left is the SEARI logo and name. A navigation menu on the left includes links for Home, About, People, Research, Related Courses, Documents, Events, Economics, Community, and Contact. The main content area features a large image of a construction site with orange rebar. To the right of the image are two boxes: one for 'Systems Engineering Leading Indicators Guide' with a 'Download PDF >>' link, and another titled 'What is Systems Engineering?' with a 'more' link. Below the image is a 'Login Form' with fields for Username and Password, and a 'Remember me' checkbox. The main heading is 'SEARI at MIT', followed by a paragraph describing the initiative as a consortium of systems engineering leaders from industry, government, and academia. A 'News' section below mentions the availability of the 'Systems Engineering Leading Indicators Guide, Version 1.0' with links for 'Full Announcement (PDF)' and 'Downloadable Guide (PDF)'. A '[Back]' link is at the bottom.

<http://seari.mit.edu>



Thank you for your participation

Feedback on the course is
encouraged!

Please contact: seari@mit.edu