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.
[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

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

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

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

Baseline Epoch → New Epoch

Response → Effect

Success?
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*

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**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

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**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”

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?
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Thank you for your participation

Feedback on the course is encouraged!
Please contact: seari@mit.edu