



SEARI Short Course Series

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

Lecture: Lecture 1: Challenges of the Dynamic World

Author: Adam Ross and Donna Rhodes

Lecture Number: **SC-2010-PI26s-1-1**

Revision Date: July 24, 2010

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***

**Lecture 1
Challenges of the Dynamic World**

Dr. Donna H. Rhodes
rhodes@mit.edu

Dr. Adam M. Ross
adamross@mit.edu



Massachusetts Institute of Technology



Outline

- Motivation for Long Run Perspective
- Examples of Systems in Dynamic World
- Facets of Dynamic World

Motivation

Designers* do an adequate job of understanding value perceptions in the short run...but to do so in the long run requires:

- effectively anticipating what the future will bring
- incorporating this knowledge into present decision

Designers can not predict the future in its entirety, but they can anticipate possible and probable scenarios for the future, and predict sequential orderings for these scenarios in order to design value robust systems

* “Designer” is used in a general way to mean system designer or enterprise designer – or a person making choices regarding socio-technical systems

*The complexities of
21st century systems
and system enterprises
are driving changes in
how we perform
engineering and evolve
our enterprises*

Systems and enterprises are more complex than ever before, and must be able to adapt to changes in environment and technologies

Systems need to be expandable, scalable, and designed to accommodate growth in capability

Advances in computing technology and advanced methods provide engineers with ability to do things previously not possible

System-of-Systems * Family of Systems * Product Families * Network Centric Systems



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

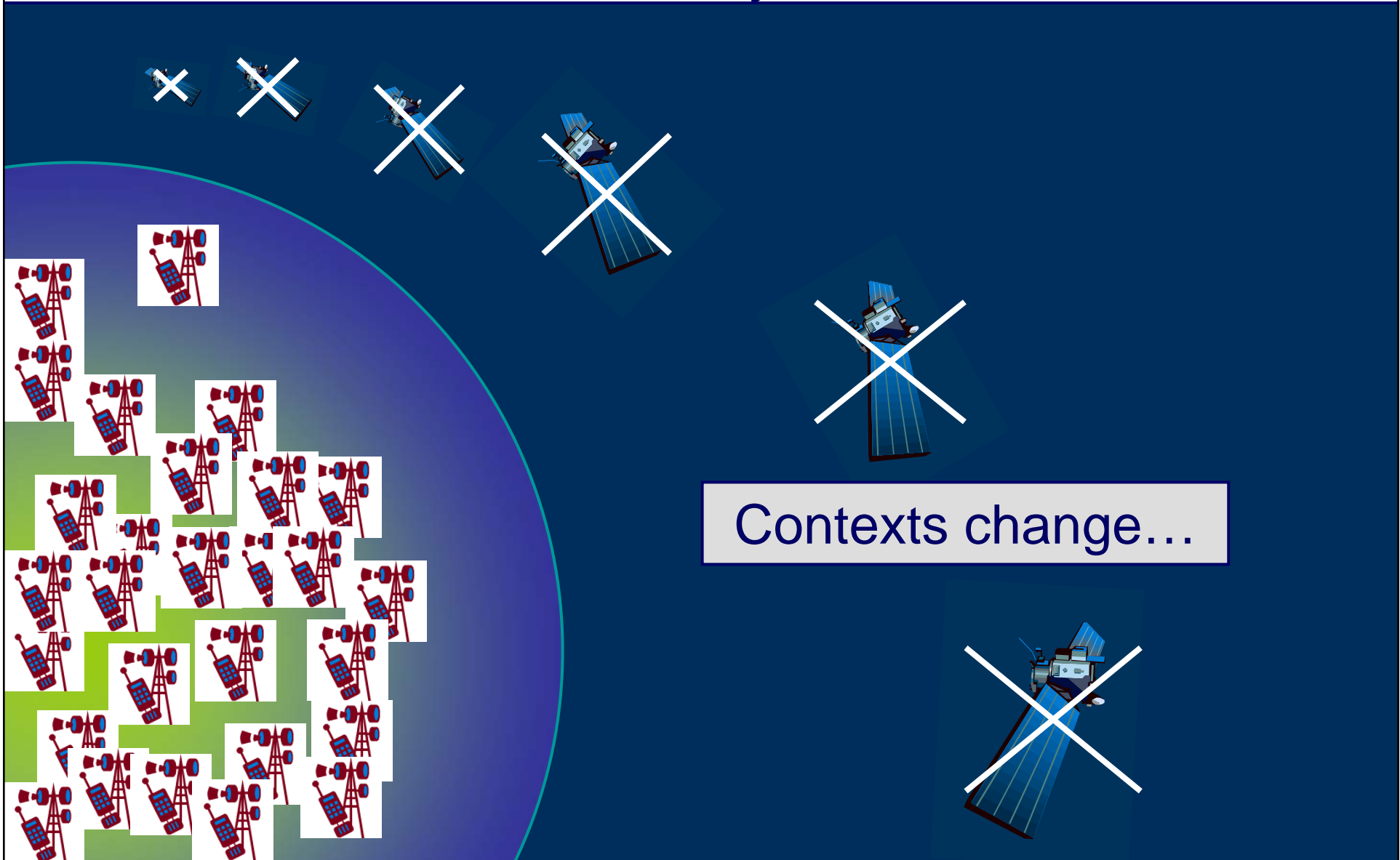
- availability of autonomous vehicles
- new emission standards imposed
- BRIC market escalates

Meeting Customer Needs



- Goal of design is to create value (profits, usefulness, voice of the customer, etc...)
- Requirements capture a mapping of needs to specifications to guide design

Deploying a “Valuable” System...



Contexts change...

Meeting Customer Needs (cont.)



- Goal of design is to create value (profits, usefulness, voice of the customer, etc...)
- Contexts change... People change their minds...
- To continue to deliver value, a successful system must dynamically overcome changing contexts and needs...

Where Can Uncertainties Come About?

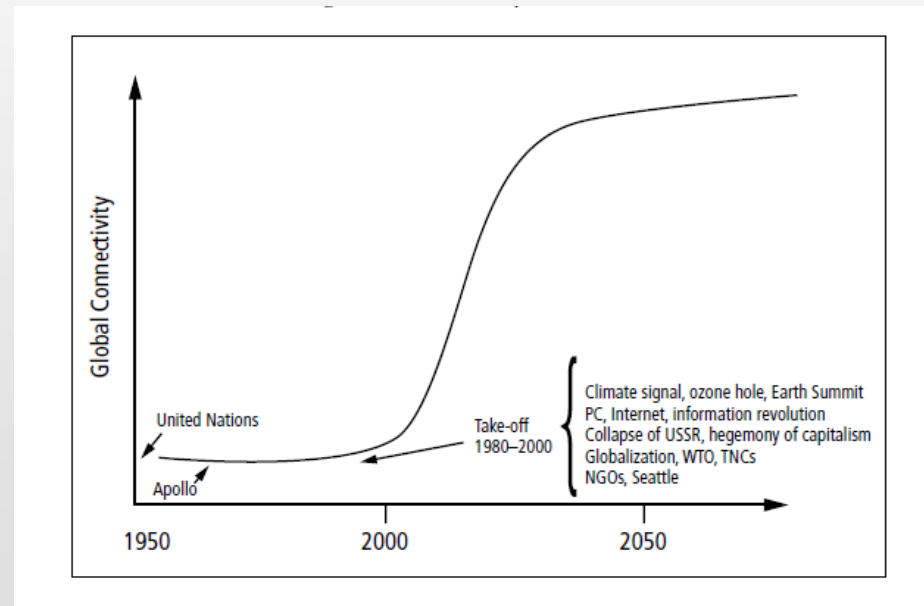
- Technology
 - (e.g., new type of material)
- Policy
 - (e.g., change in safety standard)
- Economy
 - (e.g., economic downturn)
- Resources
 - (e.g., level of investment)
- Markets
 - (e.g., new competitor)
- End Uses
 - (e.g., emergent use of product)
- Natural Environment
 - (e.g., change due to global warming)

Many uncertainties stem from soft factors that are even more difficult to anticipate

- Demographics
- Cultural
- Social factors

Technology

- Innovation in technology type/purpose
- Availability of new materials
- Miniaturization
- Interoperability
- IP rights
- Connectivity



source,: Raskin et al., Great Transition, Tellus Institute, 2002

Economics

- Economic conditions in region/nation
- Funding profiles on long-life projects
- Shifts in spending profile (e.g., defense spending increases/decreases)
- Inter-nation agreements and sanctions
- Availability of venture funding
- Opening or closure of markets

Governance/Policy

- Policy constraints and implications
- Intellectual property rights
- Centralization/decentralization of authorities
- Shifts in public/private ownership
- Formal or influential authority
 - e.g., how Internet is controlled
- Balance in state/regional/national governance

Demographics

- Populations growth and aging
- Locations of population growth
 - Example (cited 2002): *Additional population growth will be in developing countries*
- Trends in rural vs. urban dwellers
 - Example (cited 2002): *By 2032 over 2 billion new city dwellers*
- Complex relationships
 - Impacts of population growth with socio-economics relate to population average age
 - Urbanization aggravating environmental pressures

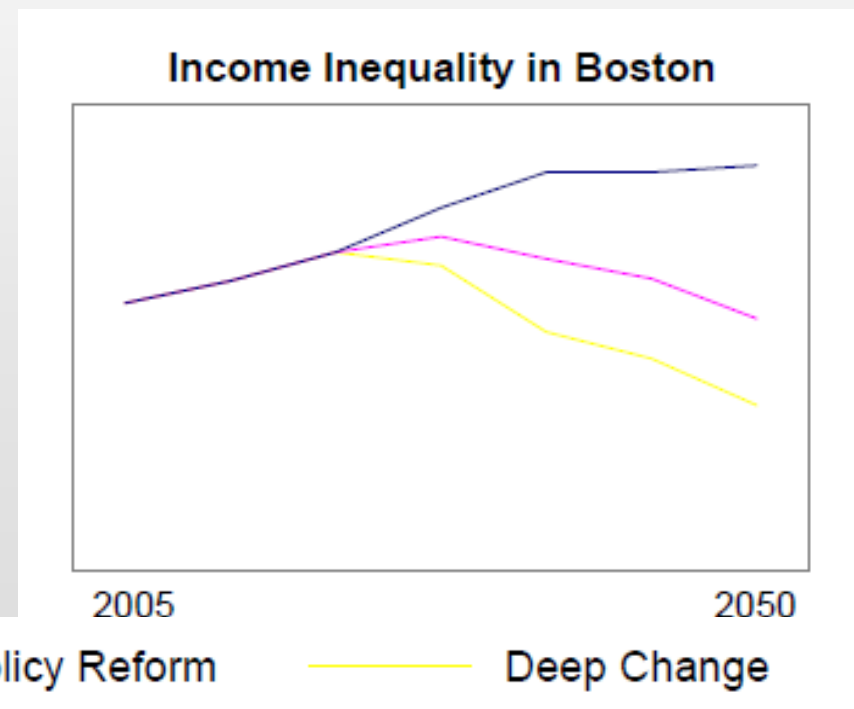
Source: Global Environmental Outlook Scenario Framework, Tellus Institute, March 2002

Social

- Distribution of wealth in societies
- Impact of diseases in nations
- Economic inequities within regions and between nations

Impact of three possible futures on income inequity

Source: Contours of the Future: Alternative Scenarios for the Boston Region, Tellus Institute, April 2008



Environment

- Degradation of global environment
- Depletion of natural resources
- Resulting worldview shifts (e.g., “green” starts to influence buying habits)
- Impacts of environmental factors

Car Industry Plans Shift to Low-Impact Refrigerant in A/C Systems

Popular Mechanics, Nov 2009

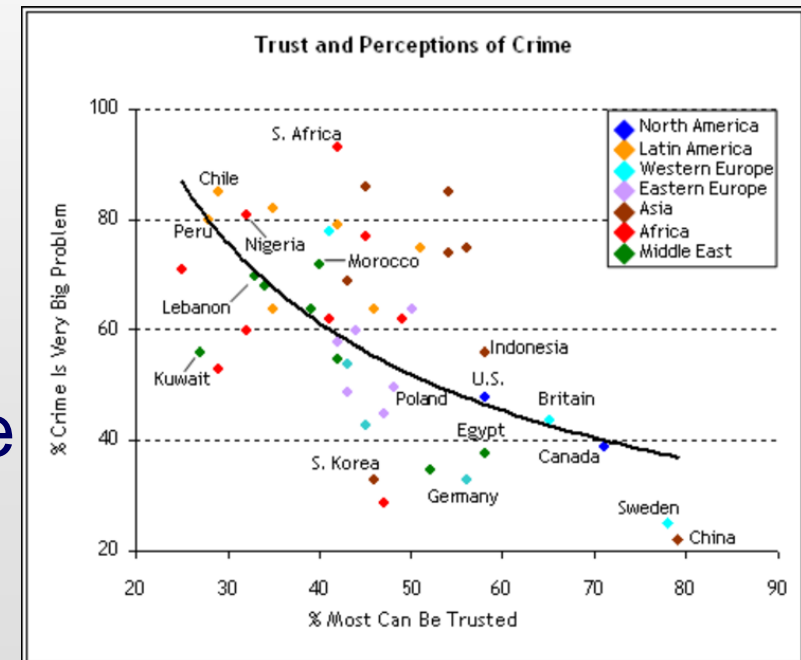


Soft Factors

Many uncertainties rooted in soft factors that are even more difficult to anticipate...

Examples:

- Demographic influences/power shifts
- Worldview shifts (e.g., “green” starts to influence buying habits)
- Trust profiles



Source: Pew Research Center 2008

Impact of Disruptive Events

What if Category 5 Hurricane Hits New York?

Based on scenario sketched by Risk Management Solutions

- RMS ranks New York the world's second-most-expensive hurricane target, after Miami, with an estimated cost of a Cat 5 direct hit of \$320 billion
- Cost escalates to \$2.2 trillion by 2070 if sea levels rise as expected



Source: Fisher and Helman, If you think the Oil Spill is Bad, Forbes, June 28, 2010

Summary

- Systems and enterprises exist in changing world
- Many facets and factors challenge designers
- Ranges from more “predictable” to disruptive

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?