Engineering Systems Doctoral Seminar ESD.83-- Fall 2011

Class 5

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Guest: Professor Mort Webster (ESD)

Class 5-- Overview

- Welcome, Overview and Introductions (5 min.)
- Dialogue with Professor Webster (55min)--Redaction provided by Xin Zhang
- Break (10 minutes)
- Discussion of ESD.83 faculty-provided theme-related papers led by Josephine Wolff (approximately 40 min)
- Theme and topic integration: Report from the front; Words/Phrases, Quotes, Teaching and Learning Time--Scenarios (Sussman)
- Next Steps -preparation for Class 6 - (10 min.) Magee

Theme and topic integration: Class 5, October 12, 2011

- Report from the front--_____
- Words/ Phrases
- Quotes
- "Teaching and Learning Time"
- Class 6 Plan (Magee)

Words/ Phases

Intuition (and reason)
Equity (as in social equity)

Quotes

When you are not practicing, remember, someone somewhere is practicing, and when you meet him he will win.

-- Ed Macauley

(as quoted by Bill Bradley in John McPhee's "A Sense of Where You Are")

You can't predict but you can anticipate…….

"Teaching and Learning Time"

- Scenarios: Several Views
- Match-up of Class 6 with
  - Framing Questions
  - Learning Objectives

Scenarios

- Introduction to concepts
- The Shell approach
- The RAND approach (already introduced in the discussant segment)

Scenarios

Introductory Concepts

What is a Scenario?

- What is a *scenario* as we will use the term here (at least initially)?
  - It's a narrative informed by information
  - It's a structured, plausible, internally-consistent, comprehensive *story* about the future
  - Based on careful research and quality thinking
  - Informed by "remarkable people" with special insights about the future

Why Scenarios?

- The ESD problem space
  - Uncertainty is everywhere -- deal with it
  - Complexity of various kinds
- Scenarios are a high-level mechanism for understanding uncertainty dealing with fundamental changes in our world
- Different worlds, not just different outcomes in the same world (Wack)
- Scenarios is **not** a forecasting method -- it is a method for conceiving alternative futures, in order to be prepared for them.

Why Scenarios?

- Creatively think about the future -- getting out of the rut of a continuation of the status quo.
- Identify possible discontinuities -- the Bend in the Trend
- Challenge our mental models about the future

Why Scenarios?

- Stretch the minds of decisionmakers -- to think the unthinkable
- Rehearse the future -- "The 2-minute drill -- skip the brain."
- A mechanism for continuous organizational learning

Organizational Learning

- Understand the possible long-term consequences of short-term decisions
- Decisionmakers can begin to identify milestones and leading indicators
  - Identify which scenario pathway they are on
  - Adapt to changing circumstances
- Indicators
  - Reveal shifts from one scenario to another, and prepare an organization for response to these changes

Organizational Information for Complex Policymaking

"Scenarios can effectively organize a variety of seemingly unrelated economic, technological, competitive, political, and societal information and translate it into a framework for judgment -- in a way that no model could do."

-- Wack

- Structure and understand uncertainty
- Identify a few alternative and internally consistent pathways

Linking the "Local" to the "Global"

- Help policymakers link "local" decisions to broader economic, social and political trends
- Scenarios "are not intended to specify the future, rather they aim to draw attention to the major forces underlying potential futures"-- Gakenheimer and Sussman et al, 1999 ("A Scenario Platform for Regional Strategic Transportation Planning")

Why Scenarios?

- Create a test bed against which to check the robustness of *bundles of strategic alternatives* (where robustness is the ability of a particular bundle to perform reasonably well under "plausible" scenarios)

	Scenario 1	*Scenario 2*	*Scenario 3*
Bundle 1	+	-	+
Bundle 2	+	+	+
Bundle 3	0	0	+

The Shell Approach

Perspective on Scenarios

- Scenarios in a corporate environment
  - Assume that corporate strategies do not affect the overall future
- Scenarios in a public-sector environment
  - Assume that strategies do affect the overall future -- indeed, that's what they are intended to do

Scenarios:

- SCHWARTZ --
  THE ART OF THE LONG VIEW

Scenarios: What are the steps? Schwartz Approach

Schwartz (*The Art of the Long View*) proposes an eight-step approach:

1. Identify focal issue or decision
2. Identify key factors in local environment
   --These are the key factors -- locally -- which influence the success or failure of the decision or focal issue identified in Step 1
3. Identify driving forces in macro environment
   -- Social, economic, political, environmental and technological *macro* issues might behind the local forces

Scenarios: What are the steps? Schwartz Approach

4. Rank key factors and driving forces
   -- According to *importance* to key decision and degree of *uncertainty*
5. Select scenario logics
   -- Identifying plots that capture situational dynamics and communicate effectively
6. Flesh out the scenarios
7. Examine implications
   -- How does the focal issue/decision play out in the future?
8. Select leading indicators

Schwartz - The Art of the Long View

- Why scenarios -- "an imaginative leap into the future"
- How can you *see*, most clearly, the environment in which your actions will take place?
- How will those actions relate to prevailing forces, trends, attitudes and influences?
- HOW
  - Invent, and then consider, *in-depth* several stories of plausible futures.
- THE POINT
  - Make strategic decisions that will be sound for all plausible futures.
  - No matter what future takes place, you are more likely to be ready for it if you have thought seriously about scenarios.

- Elements of Scenario Building
  - Determine focal issue/ decision
  - Driving Forces
  - Predetermined Elements
  - Critical Uncertainties
    - How uncertain are we about a particular factor?
    - Impact of that factor on outcomes

Houston Scenario Planning

- The question---- transportation infrastructure investment
  - Light rail through CBD
  - Expanded HOV system
  - Congestion Pricing
  - Construct the Grand Parkway (3rd circumferential)
  - Airport expansion (2)
  - Expansion of Port of Houston
  - Densification/ Growth management and land use controls
  - Intercity HST
  - And so on…….

Houston Scenarios

- The United States of North America
- Earth Day 2020
- The Balkanization of the World

The RAND Approach

- Another way to think about uncertainties through scenarios

The RAND Approach in "Confronting Surprise"

- Why are people surprised?
  - We see the future as an extrapolation of the past-- may be OK for prehistoric humans, but not now
  - We don't anticipate the timing of events
  - We overestimate our abilities to know the future (especially experts!)

The RAND Approach

- Our environment is one of "deep uncertainty" (Simon) and "complexity"
  - Deep uncertainty-- "decision maker does not know…..the system model, the prior probabilities for the uncertain parameter(s) of the system model… and/or the value function"
  - Complexity-- "systems with multiple, nonlinear interactions among components at different levels of aggregation"

The RAND Approach

- Telling stories to gain insight is nothing new and it has helped in the past
- But under conditions of deep uncertainty and complexity, our intuition breaks down
- "It becomes necessary to use mathematics and computers….to trace out causal chains"

The RAND Approach

- "Use simulation models to create a large database of plausible future scenarios where each entry… represents one guess of how the world works and one choice among many alternative strategies …..(for t=0) that we might adopt to influence the world"

The RAND Approach

- A lot of scenarios (thousands perhaps--rather than 2 or 3 in the Shell approach)--quantitative, rather than descriptive
- An computer-based way of generating the scenarios
- Scenarios juxtaposed with hypothesized strategies implemented "now"
- An computer-based way of navigating and learning from the scenarios/strategies

The RAND Approach

- Robust Adaptive Planning--Key Concepts
  - Multiple highly-differential views of the future better than point estimates for understanding the system of interest and its performance
  - Choose robust strategies that perform well over a range of plausible futures. Robustness dominates optimality
  - Robustness "is often achieved by strategies designed to adapt over time to new information"
  - Use human-computer collaboration for decision support

Framing questions for ESD.83 I

- What is a complex system?
- What are our ways of thinking about these complex systems?
- What kinds of research questions do we want to **ask** in the field of Engineering Systems and how do we **answer** them?

Framing questions for ESD.83 II

- What are the historical roots of the field of Engineering Systems and what is their relevance to contemporary engineering systems issues and concepts?
- What does "practicing" Engineering Systems mean?

Framing questions for ESD.83 III

- What are the **design** principles of Engineering Systems?
- What does it mean to advance the field of Engineering Systems and how do we accomplish it?
- How do we integrate engineering, management and social science in Engineering Systems?

Learning Objectives

- **Basic Literacy**: Understanding of core concepts and principles - base level of literacy on the various aspects of engineering systems

- **Interdisciplinary capability**: The capability to reach out to adjacent fields in a respectful and knowledgeable way and the ability to engage with other ES scholars in assessing the importance to ES of new findings in related fields

Learning Objectives

- **Historical Roots**: Understanding of historical/intellectual roots of key concepts and principles in engineering systems

- **ES and observations, data sources and data reduction**: An appreciation of the importance of empirical study to cumulative science and its difficulty in complex socio-technical systems

Learning Objectives

- **Critical Analysis**: Ability to critically assess research and scholarship aimed at furthering knowledge in engineering systems; development of defendable point of view of important contributing disciplines in Engineering Systems Field

- **Links Across Domains and Methods**: Ability to identify links/connections across different fundamental domains and methods relevant to engineering systems

Learning Objectives

- **Scholarly Skills**
  - 1) The ability to write a professional-level critical book review;
  - 2) A beginning level ability to develop and write a research proposal in the ES field;
  - 3) The ability to present and lecture on critical analysis of material that one is not previously familiar with;
  - 4) Developing wider reading skills and habits

THE END

Learning from Scenario Building

- Framework for understanding the scope of the problem and the interactions between these different activities
- Platform for bringing together decisionmakers and analysts from relatively distinct policy arenas such as industry (private sector) and transportation (public sector), in order to examine the implications of an agreed-upon set of future scenarios.

Origins and Evolution of Scenario Planning

- Corporate Roots
  - Royal Dutch/Shell (30 years)
  - Initially utilized in high-level corporate strategy to improve business decisions in an uncertain environment
  - Needed to move away from forecasts
- Evolution within Shell
  - 1970s
    - Challenged prevailing assumptions of stable oil prices
    - Six scenarios before the oil shocks– one suggested a disruption to oil supply and a sharp rise in prices

Origins and Evolution of Scenario Planning

- Evolution within Shell (cont.)
  - 1980s
    - Broadened perspective to socio-political developments and energy market dynamics
    - Recession, sharp rises and collapses in oil prices, longevity of the USSR and the Cold War
  - 1990s to today
    - Addressing more complex issues and being used more widely throughout the company as well as outside the company

Origins and Evolution of Scenario Planning

- Scenarios for corporate strategy or "civic change"?
  - Not only was scenario planning increasingly adopted by other leading companies, but....
  - Scenario planning began to be used for applications in more complex issues, involving multiple stakeholders and normative approaches--how do we want things to be and how do we get there?
    - The Mont Fleur Scenarios in South Africa
    - Stability in South Africa in the Post-Apartheid era was seen as key to Shell's decision to stay in South Africa

Perspective on Scenarios

- Scenarios should be
  - Few in number--- perhaps 2 or 3
  - Plausible
  - Recognizable
  - Challenging
  - Internally consistent
  - Consequential

  -- Patag - Shell - 8/30/02
- Scenarios as a neutral environment for negotiation

Shell Scenarios: Energy Needs, Choices and Possibilities I

- Two Diverging Scenarios
  - The Spirit of the Coming Age
    - Energy choices
      - consumer perspective
      - revolutionary
  - Dynamics as Usual
    - Energy choices
      - citizen perspective
      - evolutionary

The Process

- Time Frame
- Research
- Driving Forces
  - Some are predetermined
  - Some are "critical uncertainties"
  - These are often linked--question your assumptions about what is predetermined and a critical uncertainty may appear
- Rehearse the implications -- act out your options (decisions) in each future world and refine your understanding of the plausible futures *and* your options.

- "… the precise definition of 'scenario' is: a tool for ordering one's perceptions about alternative future environments in which one's decisions might be played out."
- "… scenarios are vehicles for helping people learn. Unlike traditional business forecasting or market research, they present alternative images of the future; they do not merely extrapolate the trends of the present."
- "The purpose of scenarios is to help yourself change your view of reality -- to match it up more closely with reality as it is, and reality as it is going to be.

- *The end result, however, is not an accurate picture of tomorrow, but better decisions about the future.* The planner and the executive are partners in taking a long view."
- "… too many people react to uncertainty with denial. They take an unconsciously deterministic view of events. They take it for granted that some things just can't and won't happen; for example, 'oil prices won't collapse,' or 'the Cold War can't ever end.' Not having tried to foresee surprising events, they are at a loss for ways to act when upheaval continues. They create blind spots for themselves."

Creating Scenarios

- Driving Forces: What moves the plot of a scenario? -- think about what these are in the context of the decisions you have to make -- *brainstorming in groups*.
- "Familiar litany of categories (of driving forces)
  - Society
  - Technology
  - Economics
  - Politics
  - Environment"

- Critical Uncertainties: Dwelling-place of our "hopes and fears".
- *Critical uncertainties are intimately related to predetermined elements. You find them by questioning your assumptions about predetermined elements*

- Predetermined elements: What we know we know -- Strategies for looking for predetermined elements
  - Slow-changing phenomenon
  - Constrained situations
  - In the pipeline (e.g., demographics)
  - Inevitable collision

Composing a Plot

- "The scenario-planner looks at converging forces and tries to understand how and why they might intersect -- then extends that imagination into coherent pictures of alternative futures. That's what gives texture to scenarios."
- "Your goal is to select plot lines that lead to different choices for the original decision. What plots might make you do something different?"

Combining Driver States and Selecting Scenario Plots

- Choose some combinations of macro-drivers to serve as the basis for the scenario plots
- Internally consistent
  - Connections between the states of the different drivers
- Range of possible outcomes
- Include not only the "most likely" but also incorporate big events

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