LEcTURE 1

DISPLAYS

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CRITICAL CONTEMPORARY ISSUES (CCI)

- Mobility
- Energy
- Global Climate Change
- Urban Form
  - Developing world
  - Developed world
- Population
  - Growth in developing world
  - Shrinkage in parts of developed world
- Economic development/growth
- Environmental issues
- Social equity
- Productivity
  - Manufacturing
- Security
TRANSPORTATION SYSTEM PHASES

- Conceptualization
- Planning
- Construction
- Operations/Maintenance
- Decommissioning
ENGINEERING SYSTEMS
(at the interface of Engineering, Management, & Social Sciences)
CLIOS System

- Complex
- Large-scale
- Interconnected
- Open
- Socio-technical
Complex

- **Structural complexity**
  - The number of components in the system and the network of interconnections between them

- **Behavioral complexity**
  - The type of behavior that emerges due to the manner in which sets of components interact

- **Evaluative complexity**
  - The competing actions of decision makers in the system who have alternate views of “good” system performance

- **Nested Complexity**
  - The interaction between a complex “physical” domain and a complex “institutional” sphere
Nested Complexity

- Physical system “layer”
  - More quantitative principles
  - Engineering & economic models
- Policy system “sphere”
  - More qualitative in nature and often more participatory
  - Stakeholder evaluation and organizational analysis
- Different methodologies are required
  - within the physical system
  - between the policy system and the physical system
  - within the policy system
C L I O S System

TRANSPORTING SPENT NUCLEAR FUEL

Complex
Large-scale

Large-scale in
- Geographic extent, and
- Impact

Yucca Mountain
CLIOS System

TRANSPORTING SPENT NUCLEAR FUEL

Transportation interconnected with:

- Energy
- Global Climate Change
**CLOS System**

TRANSPORTING SPENT NUCLEAR FUEL

- Social Factors
  - Risk
- Political Factors
  - Geopolitics
- Economic Factors
  - Development

Complex
Large-scale
Interconnected
Open
CLIOS System

An Example of a Socio-technical System:

Complex
Large-scale
Interconnected
Open
Socio-technical

TRANSPORTING SPENT NUCLEAR FUEL

◆ Complex Technology
◆ Important Social Impacts
A 3-Stage, 12-step, iterative process used to study CLIOS Systems
Build what “they” want
Focus on physical facilities
Focus on mobility
Focus on economic growth
Largely a modal perspective
- Economics-based framework
  - Supply
  - Demand
  - Equilibrium
  - Networks
- Focus on economic development and environmental concerns
- Focus on both mobility and accessibility
- Recognition of unpriced externalities as causing problems – congestion, air quality, sprawl
- Intermodal Perspective (largely limited to freight)
The Transportation as CLIOS
System Era

Characterized by:

- Advanced Technology and Mathematics
- Institutional Change – the New Concept of Enterprise Architecture
- Transportation Connected to other Sociotechnical Systems
- Expanded Role for Stakeholders and a Broader Definition of Interested Stakeholders
- “Macro-design” Performance Considerations for the Transportation Enterprise – the “ilities”

Focused on transportation as a Complex, Large-scale, Interconnected, Open, Sociotechnical (CLIOS) System
The Transportation as CLIOS System Era is Characterized by:

- Advanced Technology and Mathematics Enabling…
- Operations Focus
- Tailored Customer Service
- A Rich Information Environment
- A Higher and More Effective Level of Intermodalism Extending into Supply Chain Management
- Large-scale Optimization
The Transportation as CLIOS System Era is Characterized by:

Advanced Technology and Mathematics Enabling… (cont.)

◆ Disaggregate Demand Analysis
◆ Real-time Network Control and Provision of Traveler Information
◆ Vehicle Automation and a Crash-Avoidance Safety Perspective
◆ Sophisticated Pricing
  ◆ Yield Management
  ◆ Pricing of Externalities
◆ Regionally-scaled Transportation Operations and Management
The Transportation as CLIOS System Era is Characterized by:

Institutional Change—the New Concept of Enterprise Architecture

- Public Sector Change—among and within levels of government

- Private Sector Change – with new business models and players beyond the traditional ones

- Public/ Private Relationships/ Partnerships
The Transportation as CLIOS System Era is Characterized by:

Institutional Change—the New Concept of Enterprise Architecture (cont.)

◆ An International/Global Perspective
  and
  The Challenge of Operating Regionally and with Advanced Technology

◆ The Relationship of Logistics and Supply Chain Management to Regional Strategic Transportation Planning and the Idea of Transportation Investment and Operations as a Means to Enhance Regional Competitive Advantage
The Transportation as CLIOS System Era is Characterized by:

Transportation Connected to other Sociotechnical Systems

- Environment
- Energy
- Economic
- Global Climate Change
- National Defense/ Geopolitics
- Telecommunications
The Transportation as CLILOS System Era is characterized by:

**Expanded Role for Stakeholders and a Broader Definition of Interested Stakeholders**

- In system definition and representation
- In developing performance metrics
- In developing strategic alternatives
- In considering implementation strategies
- In decision-making
The Transportation as CLIOS System Era is Characterized by:

“Macro-design” Performance Considerations for the Transportation Enterprise---the “ilities”

(in addition to traditional micro-design considerations such as cost, level-of service (LOS) variables such as price, travel time, service reliability, service frequency, safety….)

◆ Flexibility
◆ Adaptability
◆ Robustness
The Transportation as CLIOS System Era is Characterized by:

“Macro-design” Performance Considerations for the Transportation Enterprise---the “ilities”

- Resilience (the opposite of vulnerability)
- Scalability
- Modularity
- Stability …
The Transportation as CLIOS System Era is Characterized by:

“Macro-design” Performance Considerations for the Transportation Enterprise---the “ilities”

... and, perhaps the most important “ility”

◆ SUSTAINABILITY

as an overarching design principle--The 3 Es---Economics, Environment and Social Equity
US DEPARTMENT OF TRANSPORTATION
STRATEGIC PLAN 2003-2008
“Safer, Simpler, Smarter Transportation Solutions”

KEY ISSUES

◆ Safety
◆ Mobility
◆ Global Connectivity
◆ Environmental Stewardship
◆ Security

“Transportation is a strategic investment essential to strengthening the American economy. America needs a fully integrated domestic transportation system as well as safe and efficient connections to the rest of the world.”
THE “T-SHAPED” NEW TRANSPORTATION PROFESSIONAL

Breadth In:
- Transportation fundamentals
- Technology
- Systems
- Institutions

In-depth Knowledge within a Transportation Specialty

Figure by MIT OCW.
DRIVING FACTORS IN TRANSPORTATION

Technologies

Resources/Externalities

Issues
- Economic development
- Quality of life
- Social equity
- Sustainability
- Environmental issues

Institutional & Organizational Realities

Figure by MIT OCW.

TRANSPORTATION SYSTEMS
CHARACTERIZATION

Figure 1.2