1.221J/11.527J/ESD.201J *Transportation Systems*

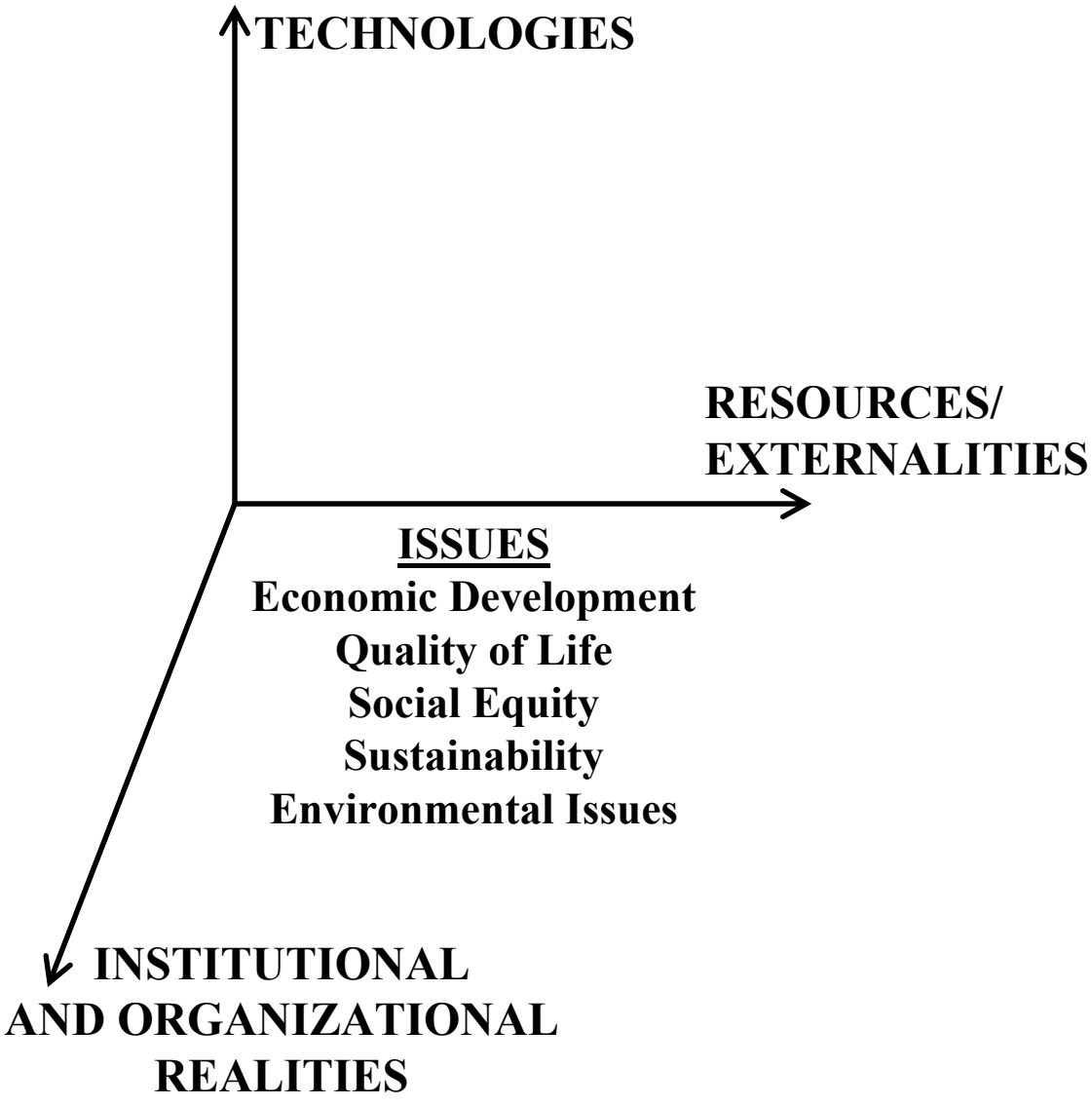
Fall 2004

LECTURE 1

DISPLAYS

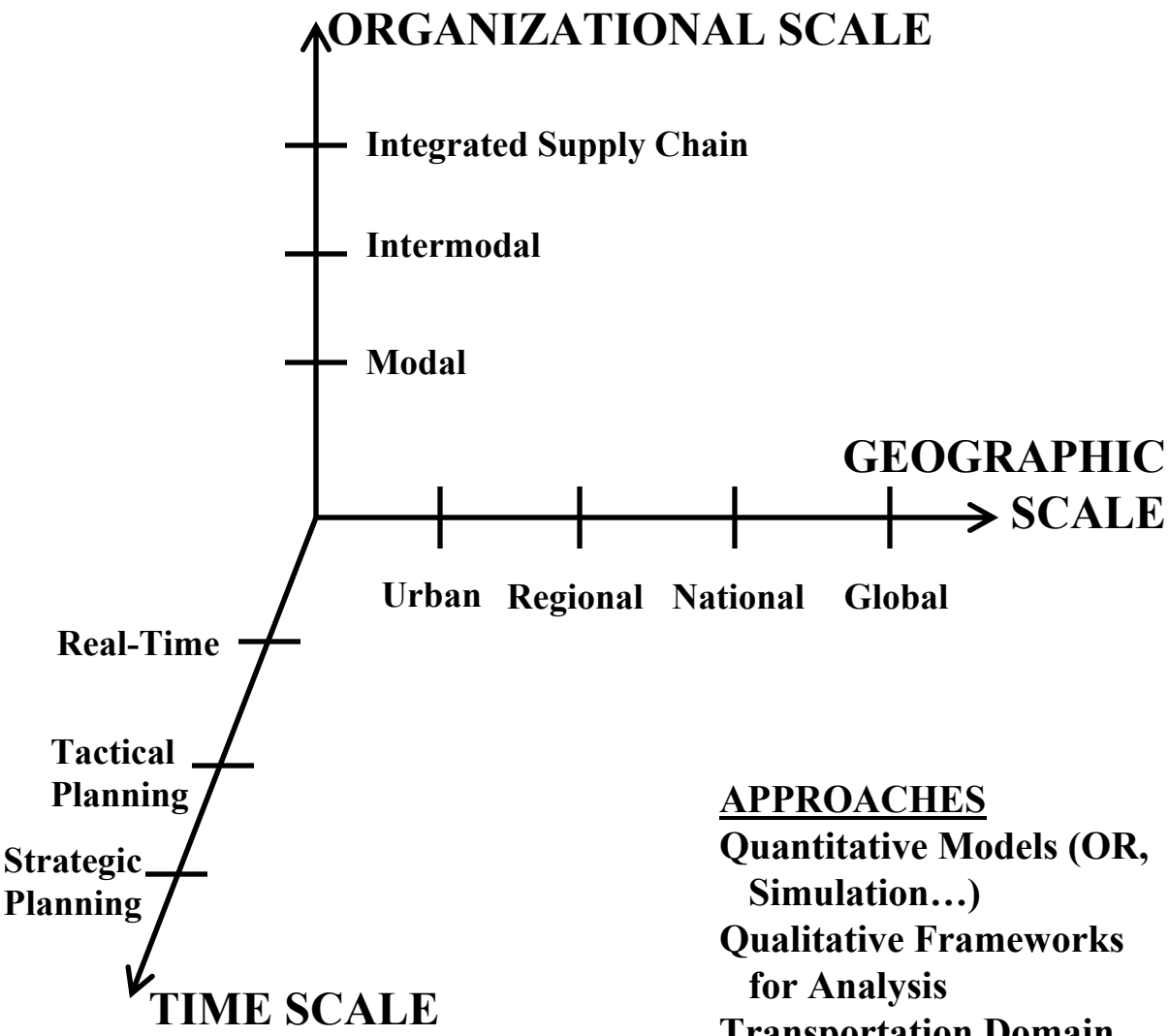
SPEAKER: Joseph M. Sussman
MIT

DRIVING FACTORS IN TRANSPORTATION



Sussman, Joseph M., "The New Transportation Faculty: The Evolution to Engineering Systems", *Transportation Quarterly*, Eno Transportation Foundation, Washington, DC, Summer 1999.

TRANSPORTATION SYSTEM DIMENSIONS



APPROACHES

Quantitative Models (OR, Simulation…)

Qualitative Frameworks for Analysis

Transportation Domain Knowledge

Sussman, Joseph M., "The New Transportation Faculty: The Evolution to Engineering Systems", *Transportation Quarterly*, Eno Transportation Foundation, Washington, DC, Summer 1999.

TRANSPORTATION SYSTEMS CHARACTERIZATION

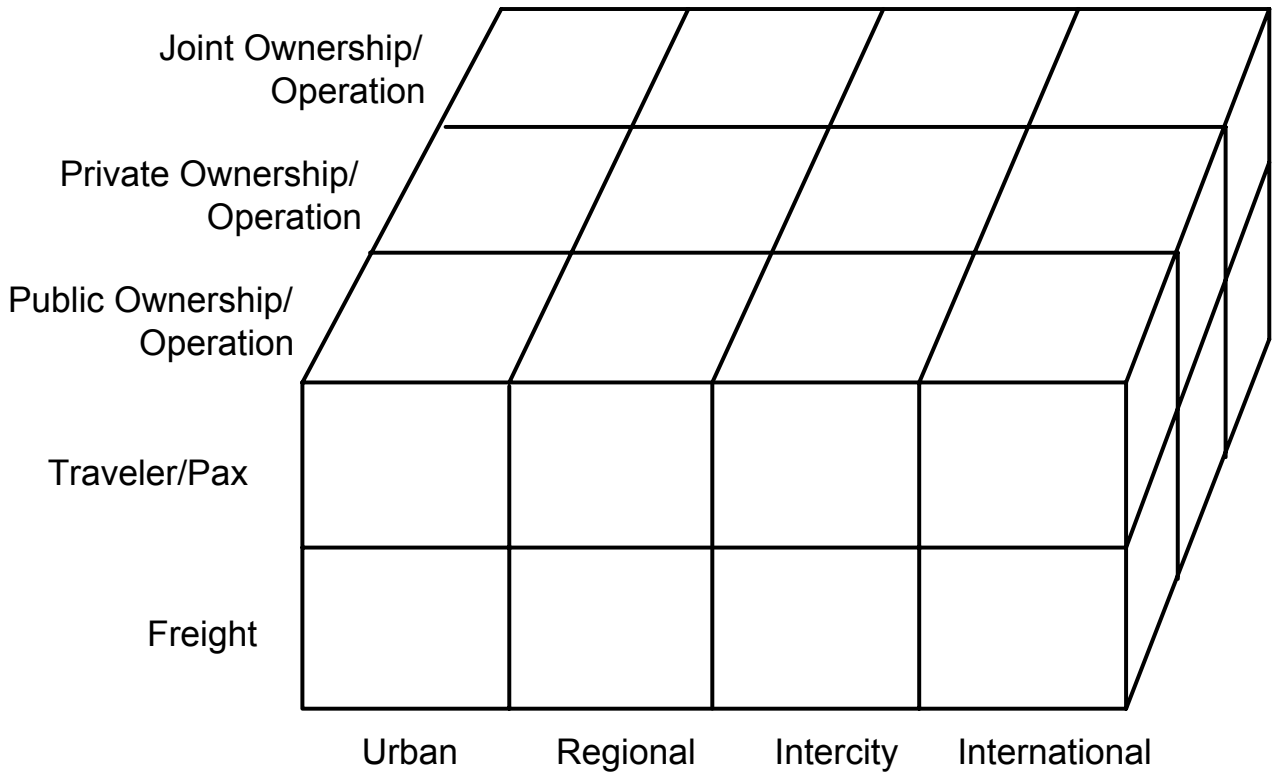


Figure 1.2

Sussman, Joseph M., *Introduction to Transportation Systems,* Artech House Publishers, Boston and London, 2000.

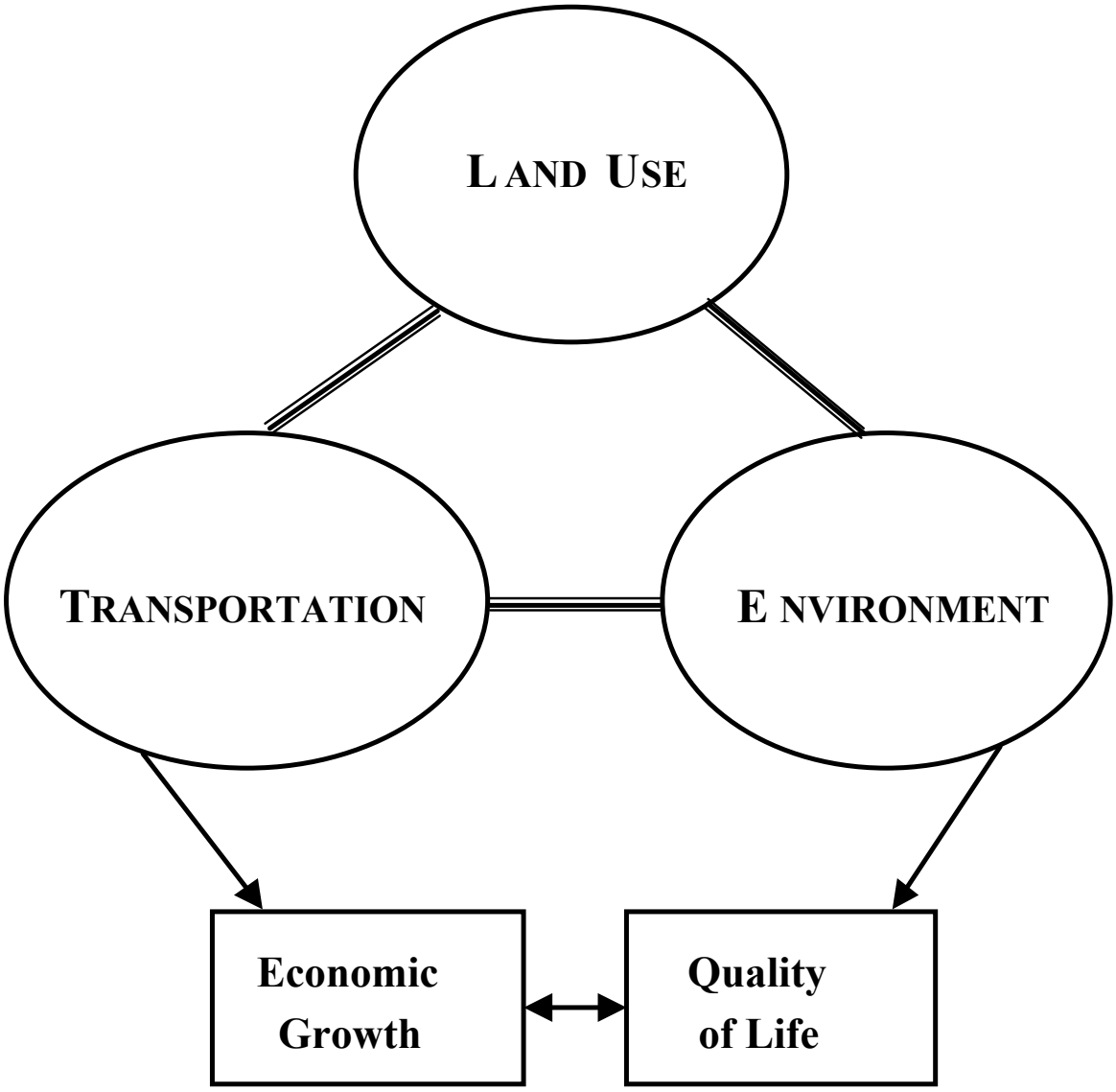
TRANSPORTATION SYSTEM PHASES

- Conceptualization
- Planning
- Construction
- Operations/Maintenance
- Decommissioning

MODES OF ANALYSIS

- ***QUANTITATIVE*** **ANALYSIS -- MODELS**
- ***QUALITATIVE*** **ANALYSIS -- FRAMEWORKS**
- **HYBRID ANALYSIS -- USING BOTH OF THE ABOVE IN TANDEM -- E.G., INTEGRATED ASSESSMENT**

IRON TRIANGLE



CLIOS

- We introduce CLIOS (Complex, Large-Scale, Integrated, Open Systems), defined as follows:
- A system is *complex* when it is composed of a group of related units (subsystems), for which the degree and nature of the relationships is imperfectly known. Its overall behavior is difficult to predict, even when subsystem behavior is readily predictable. Further, the time-scales of various subsystems may be very different (as we can see in transportation -- land-use changes, for example, vs. operating decisions).
- CLIOS have impacts that are *large* in magnitude, and often *long-lived* and of *large-scale* geographical extent.
- Subsystems within CLIOS are *integrated*, closely coupled through feedback loops.
- By "*open"* we mean that CLIOS explicitly include social, political and economic aspects.
- Often CLIOS are counterintuitive in their behavior. At the least, developing models that will predict their performance can be very difficult to do. Often the performance measures for CLIOS are difficult to define and, perhaps, even difficult to agree about, depending upon your viewpoint. In CLIOS there is often human agency involved.

TRANSPORTATION SYSTEMS

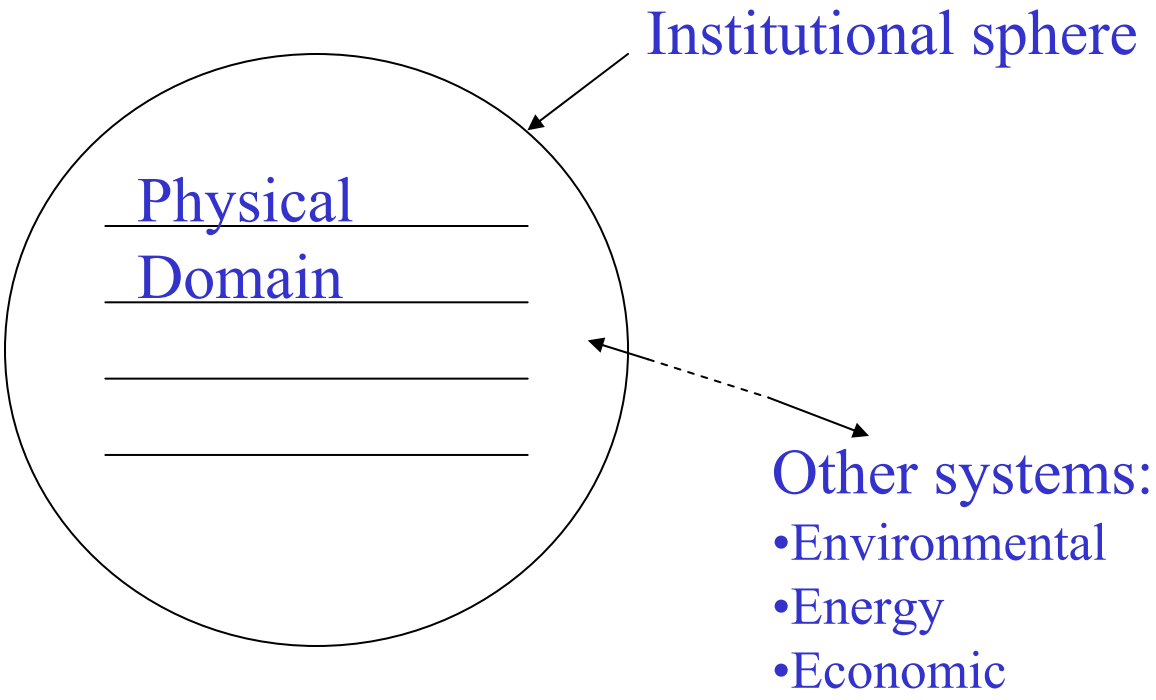
- Transportation systems are complex, dynamic and internally interconnected, as well as interconnected with other complex dynamic systems (e.g., the environment, the economy).
- They vary in space and time (at different time scales for different components). Service is provided on complex networks. The systems are stochastic in nature.
- Human decision-makers with complex decision calculi make choices that shape the transportation system.
- Modeling the entire system is almost inconceivable. Our challenge is to choose relevant subsystems and model them appropriately for the intended purpose, mindfully reflecting the boundary effects of the unmodeled components.

"All Models Are Wrong;
However, Some Are Useful."

CRITICAL CONTEMPORARY ISSUES (CCI)

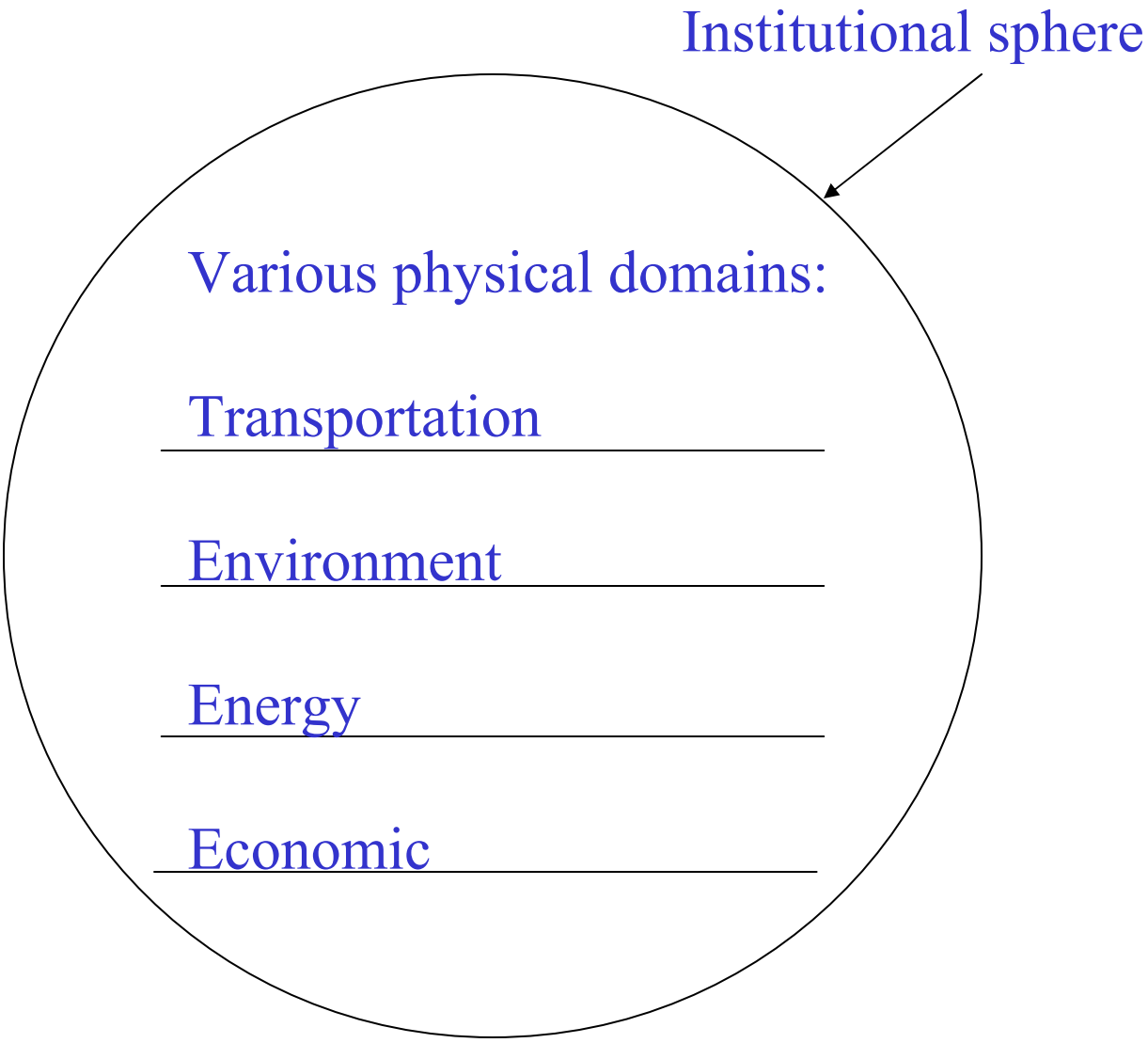
- Mobility
- Energy
- Global Climate Change
- Urban Form
  - Developing world
  - Developed world
- Population
  - Growth in developing world
  - Shrinkage in parts of developed world
- Economic development/growth
- Environmental issues
- Social equity
- Productivity
  - Manufacturing
- Security

THE TRANSPORTATION SYSTEM WITH PHYSICAL DOMAIN AND INSTITUTIONAL SPHERE



- Physical Domain
  - Network
  - Infrastructure
  - Vehicles
  - Technology
- Institutional Sphere
  - Organizations
    - Formal
    - Informal

ALTERNATE FORMULATION



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."

CRITICAL ISSUES IN TRANSPORTATION -- TRB (1)

- The transportation system is vulnerable to attacks by terrorists and saboteurs.
- The demand for passenger travel and freight movement is straining the capacity of the U.S. transportation system.

CRITICAL ISSUES IN TRANSPORTATION -- TRB (2)

- Current institutional arrangements constrain the orderly development, operation, and coordination of the U.S. transportation system, including facilities, modes, and services.
- Worthy environmental goals and values pose serious challenges to the operation and expansion of transportation facilities to meet growing demand.

CRITICAL ISSUES IN TRANSPORTATION -- TRB (3)

- The aging transportation infrastructure must be rebuilt, but the costs involved exceed revenues.
- Transportation organizations are having difficulty attracting and retaining the technically diverse personnel needed in the 21st century.

CRITICAL ISSUES IN TRANSPORTATION -- TRB (4)

- Consumer benefits from deregulation are threatened by industry consolidation.
- The burden of owning and operating vehicles is increasing for the lowest-income families.

CRITICAL ISSUES IN TRANSPORTATION -- TRB (5)

- Telecommunications and information technologies are likely to have significant but uncertain consequences.
- Transportation faces formidable barriers to innovation, which are compounded by growing constraints on research investments.

THE "T-SHAPED" NEW TRANSPORTATION PROFESSIONAL