



# **The Role of ITS in Contemporary and Future Transportation Systems: A Multidimensional View**

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Intelligent Transportation Systems (ITS) represents fundamental change in transportation, now and in the future on many dimensions.

- Technology
- Investment
- Operating Policies
- Intermodalism
- Performance Measurement
- Institutional Architectures
- Service Quality



ITS: It is Infrastructure and Vehicle *Technologies*  
but so much more

- Shift in investment focus to operations
- Internalizing Externalities
  - Congestion
  - Environment
- Charging for highway services on a differential basis based on service quality
- Regionally-scaled operations and coordinations



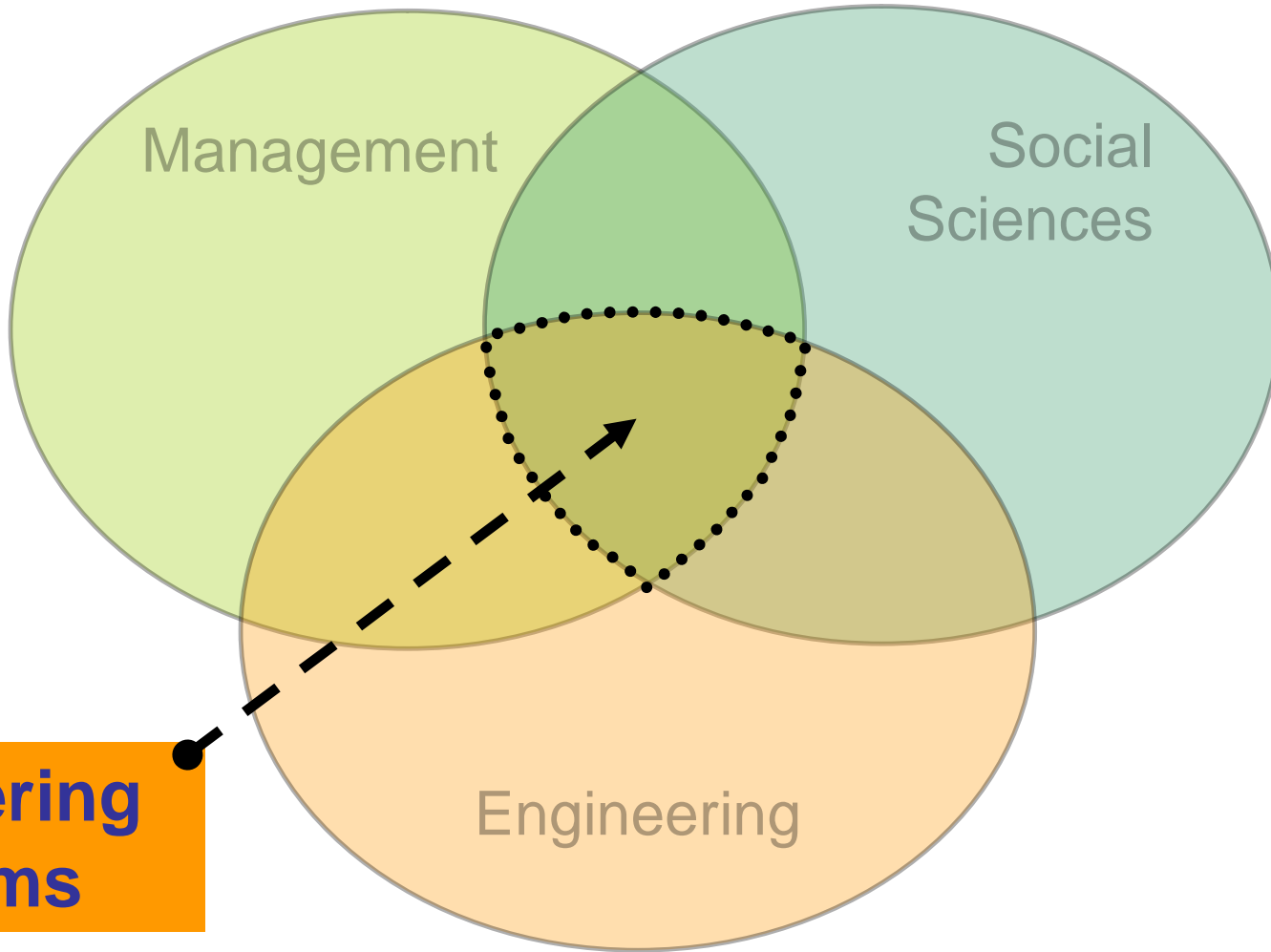
All this implies the need for

- Transportation Professionals with new skills
- New organizational and institutional arrangements
- New participants in the provision of transportation services
- “Beyond infrastructure providers” to new high-tech players
- New voices for various stakeholders



# ENGINEERING SYSTEMS

(at the interface of Engineering, Management, & Social Sciences)



**Engineering  
Systems**





## C L I O S System

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



## C L I O S System

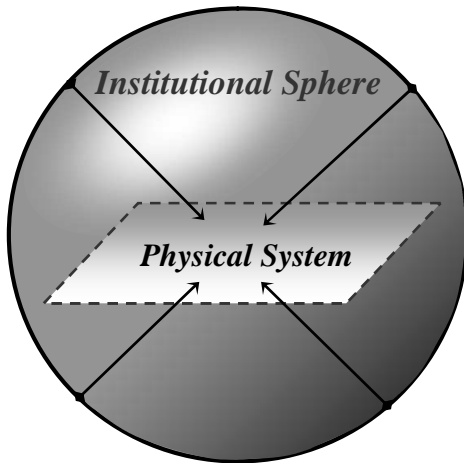
### Complex

- *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 perspectives of stakeholders who have different views of “good” system performance
- *Nested Complexity*
  - The interaction between a complex “physical” domain and a complex “institutional” sphere





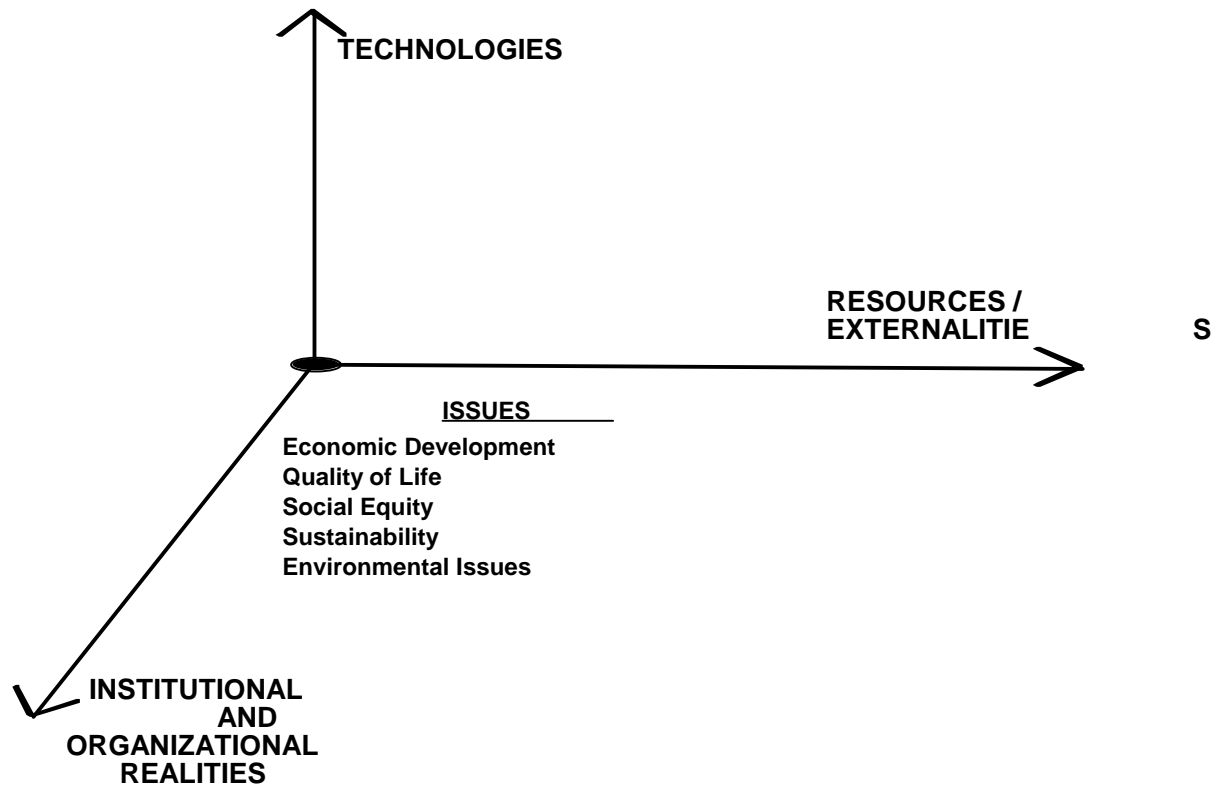
## Nested Complexity



- Physical system
  - More quantitative principles
  - Engineering & economic models
- Institutional “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



# DRIVING FACTORS IN TRANSPORTATION

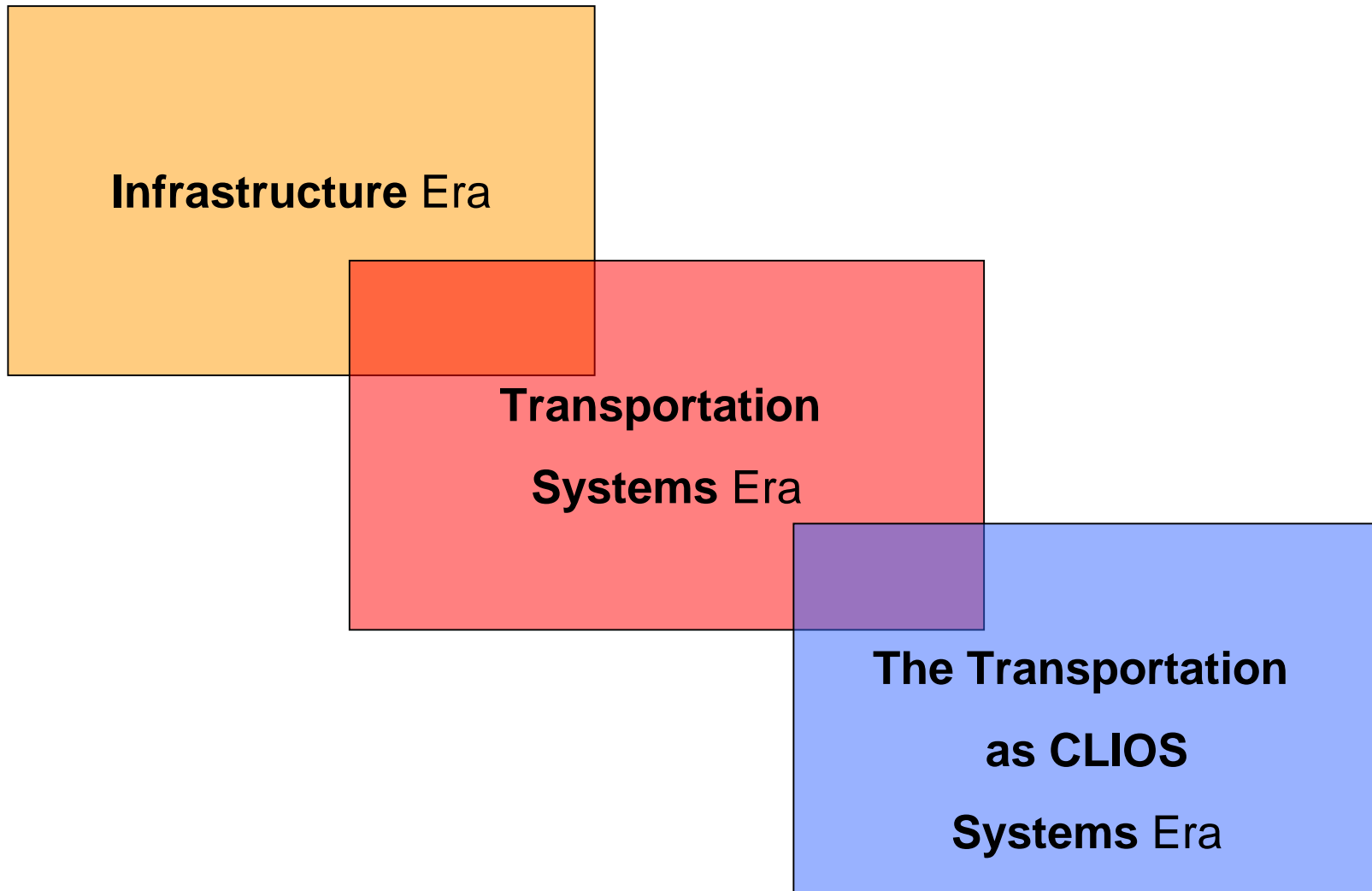


Sussman, Joseph M., "The New Transportation Faculty: The Evolution to Engineering Systems", *Transportation Quarterly*, Eno Transportation Foundation, Washington, DC, Summer 1999.





# Transportation Eras





## Infrastructure Era

- Build what “they” want
- Focus on physical facilities
- Focus on mobility
- Focus on economic growth
- Largely a modal perspective



## Transportation Systems Era

- 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

Focused on transportation as a  
**C**omplex, **L**arge-scale, **I**nterconnected, **O**pen,  
**S**ocio-technical (**CLIOS**) System

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”





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.)**

- 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 CLIOS 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
- 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



To close, we argue that we are now in the  
“Transportation as CLIOS System” Era.  
We must respond to new challenges as we  
try to achieve sustainable transportation.  
ITS - technologically and institutionally -  
must play a central role in this new era -  
now and in the future



**Thanks for your attention!**

