



Introduction to Engineering Systems, ESD.00

Lecture 1

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Motivation I

- ❑ Society faces many large-scale problems-- we call them critical contemporary issues (CCIs)
- ❑ They aren't simply CEE problems or ME problems or economics problems or physics problems or management problems
- ❑ Approaching them requires an integrative, interdisciplinary perspective
- ❑ They are “systems” problems

Motivation II

- Are we going to solve these problems this semester? Of course not
- Can we give you a sense of the nature of these problems and the kind of approaches that can lead to answers? Yes, we can

Critical Contemporary Issues (CCI) I

- Mobility
- Energy
- Environmental Issues (clean air, clean water, land use, habitat preservation)
- Global Climate Change
- Urbanization

Critical Contemporary Issues (CCI) II

- Population
 - Growth in developing world
 - Shrinkage in parts of developed world and an aging society in many nations
- Economic development/ growth and the global economy
- Security (individual and national)
- Social Equity

Critical Contemporary Issues (CCI) II.

- Sustainable Development-- the 3 Es
 - Economic Development
 - Environmental Protection
 - Social Equity

Connections

- Lady Bird Johnson found that in dealing with highway beautification it was like "picking up a tangled skein of wool; all the threads are interwoven - recreation and pollution and mental health. and the crime rate, and rapid transit and the war on poverty, and parks....everything leads to something else."
- Lady Bird Johnson's Obituary in the Economist, July 21, 2007

Complex Sociotechnical System (CSS)

- “Complexity” of many types
- “Sociotechnical” suggests that systems we are interested in
 - have important social impacts
 - have a vital technical component

ESD.00 Content

- Core Engineering Systems Concepts and Methods
 - System Dynamics
 - Dealing with Uncertainty
 - Networks

ESD.00 Content II

□ Projects

- Air/HSR and the Environment
- Energy/Water Nexus: Masdar City
- Internet Governance: The Digital Divide
- The Stroke Care Chain

Each project

is illustrative of one or more CCI

is a CSS

will use the three core methods and concepts plus other techniques relevant to the particular application

ESD.00 Philosophy

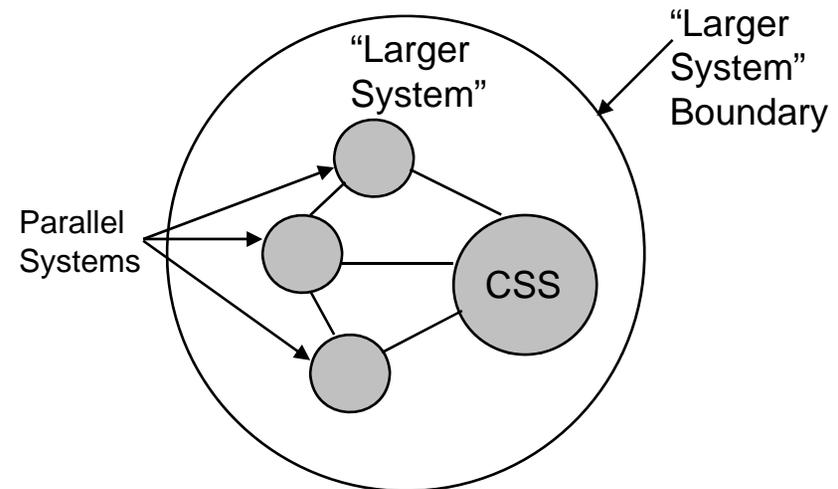
- ❑ Integrative approach
- ❑ Recognize complexity and try to deal with it
- ❑ Engineering approach: we need to make a decision on what to do, often with information that is incomplete and with a future that is uncertain. We are not simply observers

CSS Example

- *We now introduce a number of CSS concepts. We will use the Boston/Cambridge transportation system as a CSS example to illustrate some of the concepts.*

Systems Parallel to our CSS I

- *Our CSS has various parallel systems. These might include:*
 - *the air quality in Boston/Cambridge,*
 - *MIT itself, whose behavior will affect the Boston/Cambridge transportation system: when MIT is on spring break, the loads on the transportation system are certainly lower (and further our CSS affects MIT as well)*



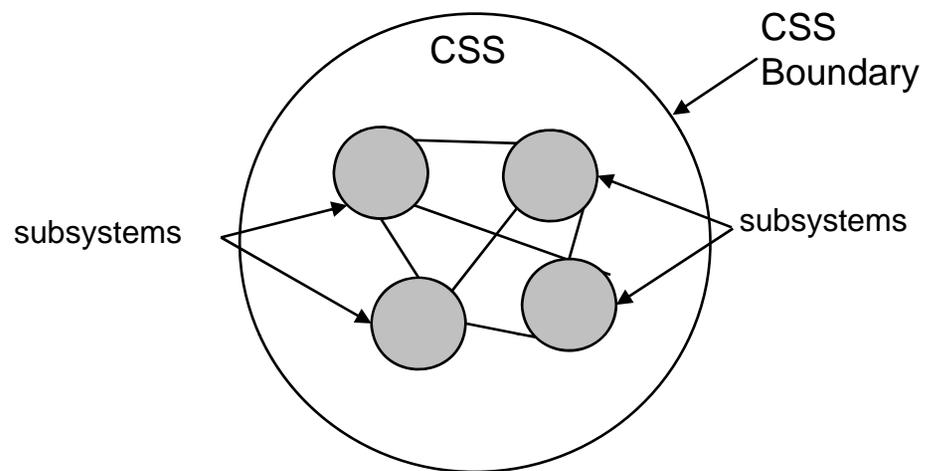
Systems Parallel to our CSS II

- *the commuter rail system which provides service from the outlying suburbs to Boston/Cambridge (commuter trains provide service to both North and South Stations)*
- *the economic system in Boston/Cambridge, clearly affected by the effective delivery of goods, the ability of people to get to work or school and the vibrancy of the economy clearly relates to the loads on the transportation system*

Systems Parallel to our CSS II.

- The real estate market in Boston/Cambridge, will relate to accessibility of a residence to job opportunities

Subsystems of our CSS I



Subsystems of our CSS II

- Subsystems of our CSS include:
 - The highway network
 - The MBTA system, which would in turn include vehicles buses and trains, and the infrastructure needed for the MBTA to operate which includes the rail network, the highway network on which the MBTA's buses operate, fare collection systems, operating staffs

Subsystems of our CSS III

- *Travelers who will make a choice of what mode to use: driving, taking public transportation of one sort or another, traveling intermodally (bike to the station and take the train from there)*

The Micro-Macro Question

- *In our CSS, do we need to know how an internal combustion engine works? Probably not. Do we have to know if a street has bike lanes? Probably. But it depends upon the questions we want to answer about our CSS.*

Other CSS characteristics

- Nonlinearity
- Feedback
- Uncertainty
- Emergent properties

The Teaching Note discusses these and others.

The Projects

- You'll now hear about the four projects we have designed– let's put some meat on the bones!

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