Introduction to Transportation Systems

PART I:

CONTEXT, CONCEPTS AND CHARACTERIZATION

Chapter 10:

Models and Frameworks

Models and Frameworks: An Introduction

◆ Models are mathematical representations of a system.

◆ Frameworks are qualitative organizing principles for analyzing a system.

◆ We can use both models and frameworks to do *analysis.*

What is our function as transportation professionals?

- ◆ Designing better transportation systems
- ◆ Using resources, financial and otherwise, effectively in a transportation context
- ◆ Operating transportation systems optimally
- ◆ Maintaining transportation systems efficiently

Value-laden words:

- better
- effectively
- optimally
- efficiently

These depend on your point of view.

A Structure for Transportation System Analysis

A Systems Analysis Framework: A First Look
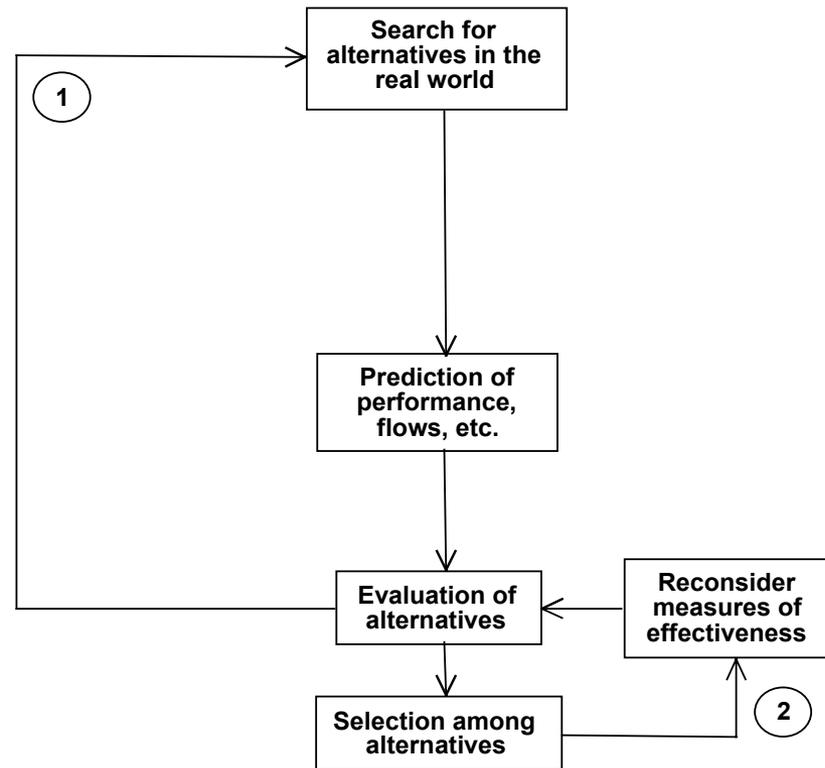
LOOP 1: Does the evaluation suggest other alternatives?

LOOP 2: Are the measures of effectiveness appropriate?

Figure 10.1

8

The Subtlety in Choosing Measures of Effectiveness

Be sure your measures of effectiveness are good

An Urban Area
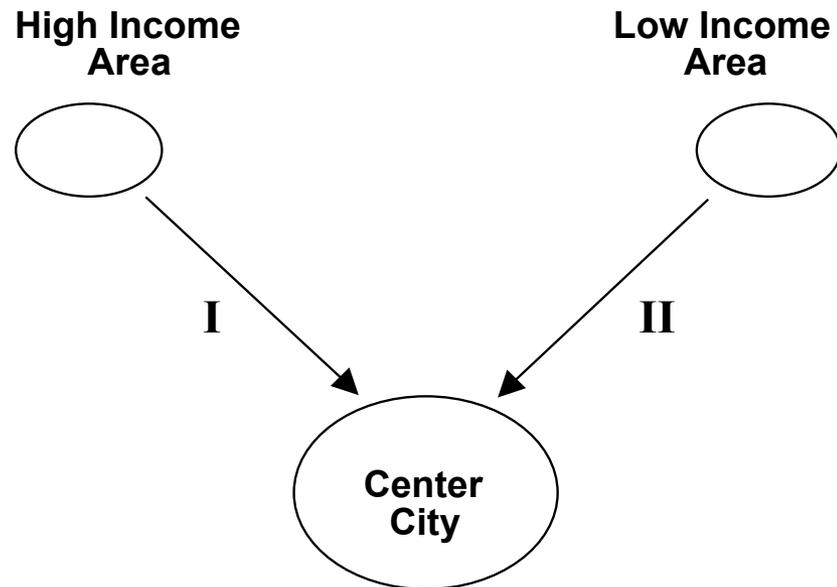
Figure 10.2

A Systems Analysis Framework: A Second Look
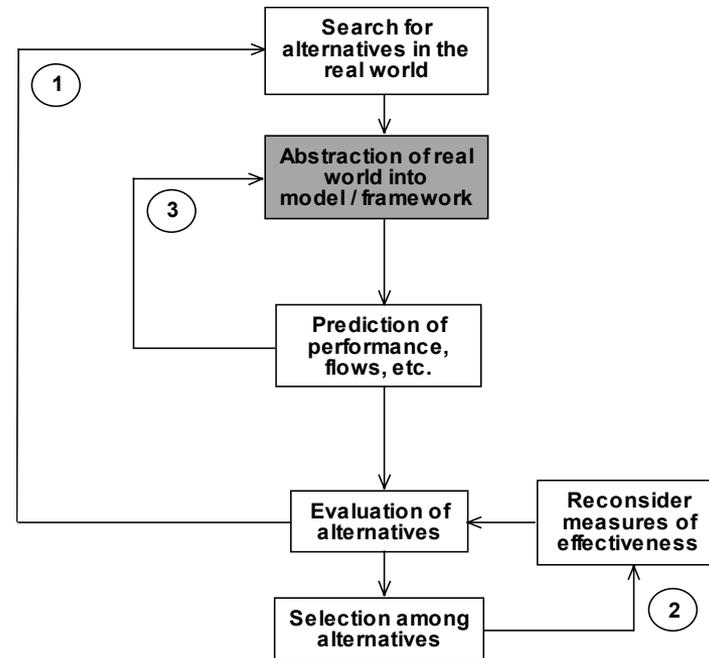

LOOP 1: Does the evaluation suggest other alternatives?

LOOP 2: Are the measures of effectiveness appropriate?

LOOP 3: Is the "abstraction" good at predicting?

We need to ask, "Is the abstraction any good?"

Figure 10.3

A Systems Analysis Framework: A Third Look
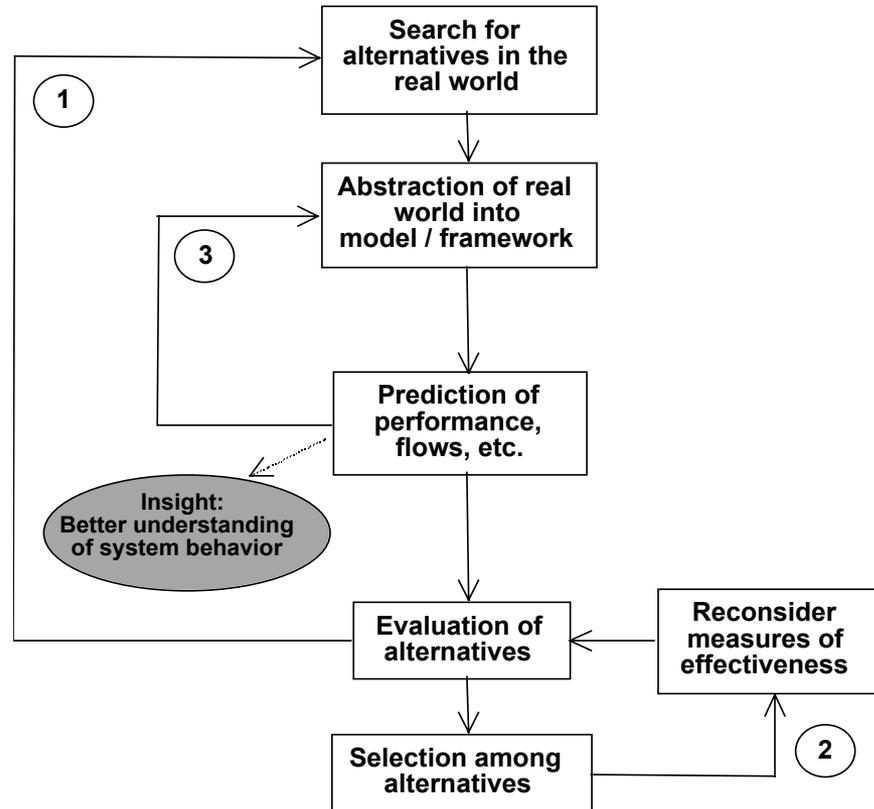
Search for alternatives in the real world

① 1

Abstraction of real world into model / framework

③ 3

Prediction of performance, flows, etc.

Insight: Better understanding of system behavior

Evaluation of alternatives

Reconsider measures of effectiveness

Selection among alternatives

② 2

LOOP 1: Does the evaluation suggest other alternatives?
LOOP 2: Are the measures of effectiveness appropriate?
LOOP 3: Is the "abstraction" good at predicting?

Figure 10.4

Why Are We Modeling?

◆ Choosing the Best Alternative -- Optimization

◆ System Operation

◆ Learn from Model Building Processes

◆ Insight

"We may gain insight into complex situations by first understanding simpler situations resembling them."

Modeling for Negotiation

- ◆ Prodyut Dutt, in "A Standards-Based Methodology for Urban Transportation Planning in Developing Countries", focused on how planners work in developing countries versus the way urban planners work in the developed world. The essence of his research looked at the differences in planning methodologies necessary in the two environments.

- ◆ Dutt developed "models for negotiation" -- the idea of *transparent* models, where rather than shielding the outside world from what was going on within that "black box" model, planners could look into the model and clearly see the assumptions driving the trade-off about location of corridors in urban areas.

13

The Model Is a Shaper of Your World View

◆ A hammer is a fine tool, but it is not very good for washing windows.

Modeling Approaches

◆ Network Analysis

◆ Linear Programming

◆ Non-linear Programming

◆ Simulation

◆ Deterministic Queuing

◆ Probabilistic Queuing

◆ Regression

◆ Neural Networks

◆ Genetic Algorithms

◆ Cost/Benefit Analysis

◆ Life-cycle Costing

Modeling Approaches (continued)

- ◆ System Dynamics
- ◆ Control Theory
- ◆ Difference Equations
- ◆ Differential Equations
- ◆ Probabilistic Risk Assessment
- ◆ Supply/Demand/Equilibrium
- ◆ Game Theory
- ◆ Statistical Decision Theory
- ◆ Markov Models

Getting Answers from Models

Developing a model -- an abstraction -- and getting results from it are two different things.
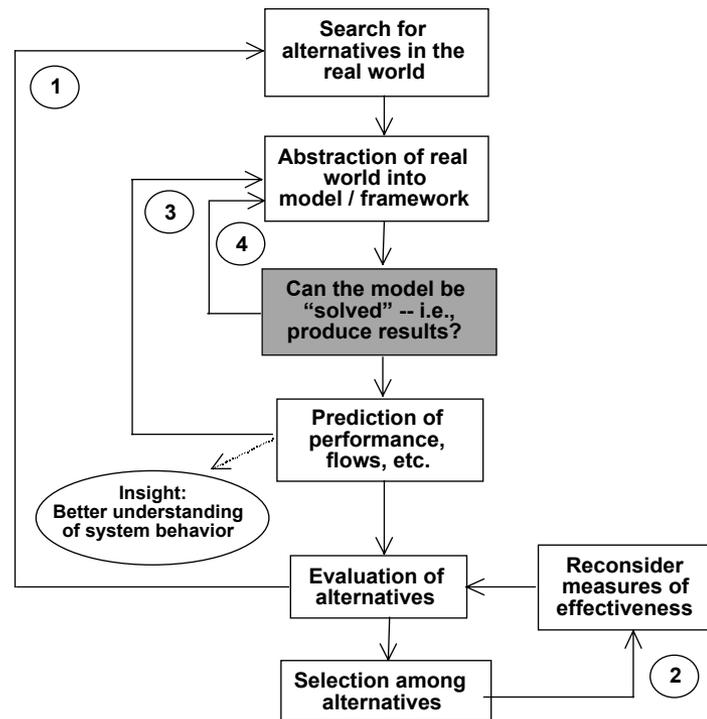
LOOP 1: Does the evaluation suggest other alternatives?
LOOP 2: Are the measures of effectiveness appropriate?
LOOP 3: Is the "abstraction" good at predicting?
LOOP 4: Develop new abstraction.

Figure 10.5

Models vs. Frameworks

◆ Models
  ◆ Models are a mathematical representation of reality -- quantitative in nature.

◆ Frameworks
  ◆ When we talk about a *framework*, we are generally talking about a qualitative view of a complex system. It is "a way of thinking" -- a way of *organizing* our thinking about a complex system.

Here is a framework we discussed earlier:

Figure 10.6

19
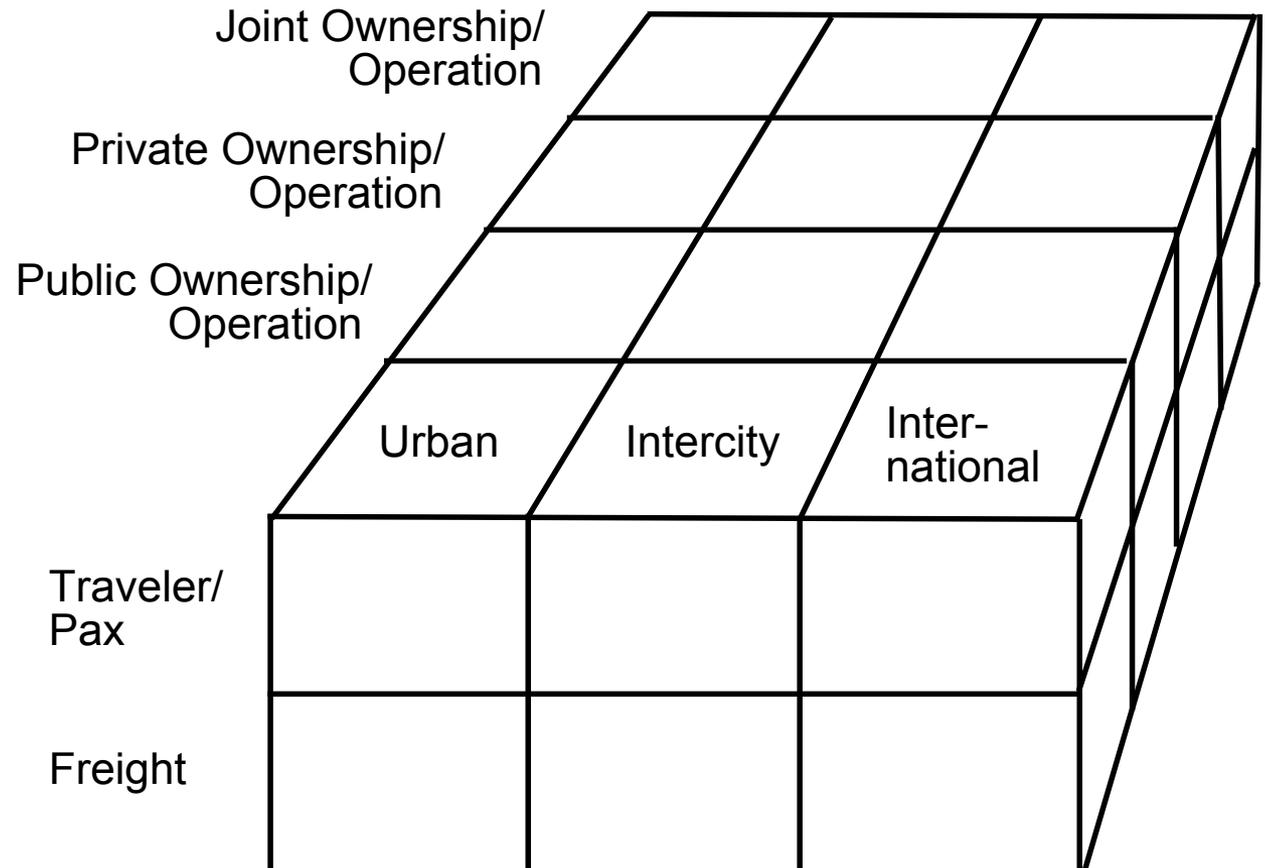
Simple vs. Complex Models and Frameworks

	MODEL (Quantitative)	FRAMEWORK (Qualitative)
SIMPLE	Useful / Not Useful	Useful / Not Useful
COMPLEX	Useful / Not Useful	Useful / Not Useful
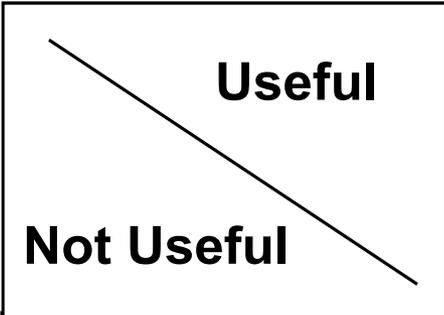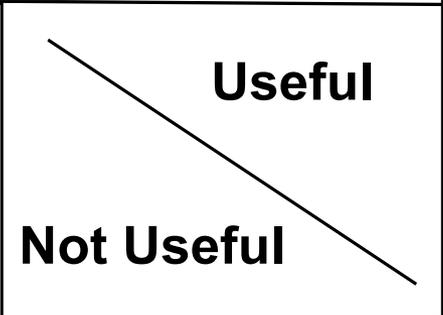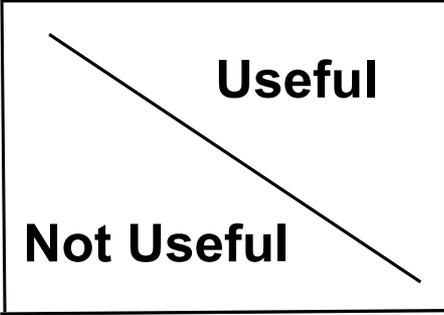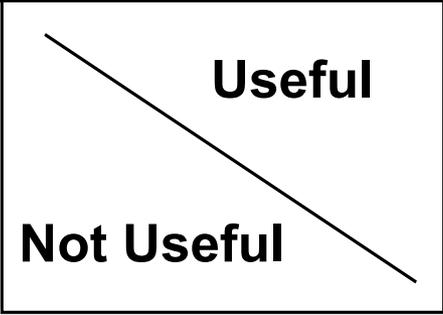
Figure 10.7

Points for Class Discussion

◆ Public Transportation

◆ National Transportation Plan

◆ Traffic Light Coordination

What kinds of models and frameworks would you use in each of these cases?