Models and Frameworks

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Models and Frameworks

• Model - Mathematical Representation of a System
• Framework - Qualitative Organizing Principle for Analyzing System

ALL MODELS ARE WRONG, SOME MODELS ARE LESS WRONG THAN OTHERS.

• Some Models are Useful

Diamond of Advantage

Example: Porter’s Diamond

• Michael Porter proposes four key determinants of competitiveness, which he calls the ‘Diamond of Advantage,’ based on cases from around the world:

1. factor conditions, such as a specialized labor pool, specialized infrastructure and sometimes selective disadvantages that drive innovation;
2. home demand, or local customers who push companies to innovate, especially if their tastes or needs anticipate global demand;
3. related and supporting industries, specifically internationally competitive local supplier industries, creating a high quality, supportive business infrastructure, and spurring innovation and spin-off industries; and
4. industry strategy/rivalry, involving both intense local rivalry among area industries that is more motivating than foreign competition and as well as a local ‘culture’ which influences individual industries’ attitudes toward innovation and competition.
**Rational Planning Redux**

- Search for Alternatives
- Abstraction into Model/Framework
- Does Model Solution Exist?
- Why Model
- Reconsider MOE
- Insight/Knowledge
- Selection
- Evaluation
- Prediction of Performance

**Why Model**

- gain insight into complex situations by understanding simpler situations resembling them
- optimization
- system operation
- learn from model building process
- modeling as negotiation tool

**Modeling Shapes Your Worldview, And Vice Versa**

- What is a worldview?
  - Your outlook on life, and the world
  - Your internal model of how the world works (i.e., what do you expect, what is a surprise)
  - The result of “Where you stand depends on where you sit”
- Point of View
  - Who are the results for?
    - Subjective advocacy vs. objective analysis

**Types of Models**

- Network analysis
- Linear Programming
- Nonlinear Programming
- Simulation
- Deterministic queueing
- Probabilistic queueing
- Regression
- Neural Nets
- Genetic Algorithm
- Cost/Benefit Analysis
- Life-cycle costing
- System Dynamics
- Control Theory
- Difference Equations
- Differential Equations
- Probabilistic Risk Assessment
- Supply/Demand Equilibrium
- Game Theory
- Statistical Decision Theory
- Markov Models
- Cellular Automata
- Etc.

**Modeling Decisions**

- Hierarchy of Models
- Scale/Detail
- Time Frame
- Spatial Extent
- Boundaries (Boundary Effects)
- Macroscopic vs. Microscopic (Zones, Flows vs. Individuals, Vehicles)
- Static vs. Dynamic
- Stochastic vs. Deterministic
- Linear vs. Nonlinear
- Continuous vs. Discrete
- Numerical Simulation vs. Closed Form Solution
- Behavioral vs. Aggregate Model
- Physical vs. Mathematical Models
- Real Time vs. Offline
- Short Term vs. Long Term (Partial vs. General Equilibrium)
- Proactive vs. Reactive (Predictive vs. Responsive)
- Centralized vs. Decentralized (Optimization (Global) vs. Agent, Local Optimization)
- Equilibrium vs. Disequilibrium

**Solution Techniques**

- Understanding the System
- Approximations and Speed in Optimization (Local Optima) vs. Certainty (Brute Force, Global Optima)
Tradeoffs (Time and resource constraints)
- Money,
- Data,
- Computation,
- Labor,
- Ease of Use,
- Convincing (e.g., Graphic Displays),
- Extendable,
- Evidence of Model Benefits,
- Measuring Model Success

Problem
- The Metropolitan Council of Governments (the region's main transportation planning agency) is examining whether the Twin Cities should build a new Personal Rapid Transit system in downtown Minneapolis, and they have asked you to recommend how it should be analyzed.
- 1. What kind of model should be used? Why?
- 2. What data should be collected.
- Form groups of 3 and take 15 minutes and think about what kinds of models you want to run and what data you want to collect, what questions you would ask, and how it should be collected. Each group should have a note-taker, but all members of the group should be able to present findings to the class.

Monitoring and Data
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Data Inventory
- Traffic Counts
- Travel Behavior Inventory
- Land Use Inventory
- Truck/Freight Demand
- External/Internal Demand (by Vehicle Type)
- Special Generators

Travel Behavior Inventory
- Travel Diary of ~1% sample of population (all trips made on one day) every 10 years
- Socioeconomic/demographic data of survey respondents
- Collection methodology:
  - Phone,
  - Mail,
  - In-Person at Home,
  - In-Person at Work,
  - Roadside
Questions: Denver Regional Council of Governments 2001

- 1. What is/verify home address
- 2. Assigned survey day
- 3. Is your residence a single-family home, duplex/townhome, apartment/condominium, mobile home, or other?
- 4. How many people live in this household?
- 5. How many of the lines are used for voice communication?
- 6. How many motor vehicles are available to your household?
- 7. In total, how many telephone lines come into your home?
- 8. Who owns or leases this vehicle?
- 9. Has telephone service in your home been continuous for the past 12 months?
- 10. What was the combined income from all sources for all members of your household for 1996?

Vehicle Questions

- 1. Vehicle model year
- 2. Vehicle make
- 3. Vehicle model
- 4. Body type
- 5. Fuel type
- 6. Who owns or leases this vehicle?
- 7. Prior to the survey day, when was the last day it (the vehicle) was used?
- 8. Odometer reading (milege) at the start of the survey day
- 9. Odometer reading (milege) at the end of the survey day

Person Questions

- 1. Person’s first name (used for identification purposes only; during the survey, we saved an anonymous number for each person)
- 2. Relationship of household
- 3. Sex
- 4. Age
- 5. Marital status?
- 6. Student status (student, part-time, full-time, etc.)
- 7. Grade level
- 8. Employment status
- 9. Primary job description (not, sales, teacher)
- 10. Primary employer’s name
- 11. Primary employer’s address
- 12. Primary employer’s business type (hospital, retail, etc.)
- 13. Does your primary employer offer flextime?
- 14. If vehicle offered (primary employer), type of deviation allowed at start
- 15. If vehicle offered (primary employer), type of deviation allowed at end
- 16. Number of other jobs or employers
- 17. Do you have a transit pass?
- 18. Monthly cost of transit pass to you
- 19. Did you make trips on the survey day?
- 20. If trips were made, did you use the HOV lanes on the travel day?
- 21. Did you work at your workplace on the survey day?

Environment Questions

Using a 1 to 10 scale, with 10 the best, how would you describe the walking and bicycling environment around your:
- 23. home
- 24. work
- 25. school
- 26. Was the person interviewed by the surveyor?
- 27. Based on responses and the survey, did the person appear to use the activity diary?

Travel Diary Questions

- 1. This place is my home, my regular workplace, or another place
- 2. What kind of place is this (bank, grocery, park, etc.)?
- 3. Place address
- 4. At what time did you arrive at this place?
- 5. What did you do at this place (main activity)?
- 6. What else did you do at this place (up to eight secondary activities)?
- 7. Was this your last place for the 24-hour day?
- 8. At what time did you leave this place to go to the next place?

Travel Method

- 1. Travel method used to make this trip and related travel details
Auto Trip Questions

1. Which household vehicle was used if a household vehicle was used?
2. Total number of people in the vehicle
3. Total number of household members in the vehicle
4. If more than one person was in the vehicle, is this a formal carpool/vanpool?
5. Were HOV lanes used on this trip?
6. Was E-470 used for this trip?
7. Was the parking cost fully or partly reimbursed?
8. What was the parking cost paid at the end of this trip?
9. What period is covered by the parking cost paid?
10. Was the parking cost fully or partly reimbursed?
11. What was the parking location (cross streets, lot name, if applicable, and city)

Transit Trip Questions

The following four questions were asked if the travel method was transit

12. What was the transit route number?
13. What was your wait time for transit?
14. What was the transit fare paid?
15. How did you pay the transit fare?
16. What was the bicycle or walk time?
17. Was a bike path used?
18. Where did you store this vehicle?
19. Was a walk path used?

Behavioral Data Paradigms: Revealed Preference

• Revealed Preference - data that have been obtained by direct observation of the choice that individuals make with respect to travel behavior.
  - Travel Cost Analysis uses the prices of market goods to evaluate the value of goods that are not traded in the market
  - Hedonic Pricing uses the market price of a traded good and measures of its component attributes to calculate value.
• ADVANTAGES, DISADVANTAGES

Stated Preference:

• Stated Preference - a group of techniques used to calculate the utility functions of transport options based on the response of an individual decision-maker to certain given options. The options generally are based on descriptions of the transport scenarios or are constructed by the researcher.
  - Contingent Valuation - is based on the assumption that the best way to find out the value that an individual places on something is known by asking.
    - Compensating Variation is the compensating payment that leaves an individual as well-off or before the economic change.
    - Equivalent variation for a benefit is the minimum amount of money one would have to be compensated to leave the person as well-off.
  - Conjoint Analysis refers to the application of the design of experiments to obtain the preferences of the individual, breaking the task into a list of choices or ratings that enable us to compute the relative importance of each of the attributes studied.
• ADVANTAGES, DISADVANTAGES

Sampling Issues (Statistics)

Issues:
• Sample Size
• Population of Interest
• Sampling Method
• Error: Measurement, Sampling, Computational, Specification, Transfer, Aggregation
• Bias
• Oversampling
• Extent of Collection
  - Spatial
  - Temporal
• Cross-section, Time Series, and Panel

Assignment:

• Develop a Proposal Topic (1 page discussion/outline) and identify sources of data (and ensure its availability) that you will use in your analysis of a transportation system. State any hypothesis you wish to test.
Minute Paper