Travel Forecasting Tutorial
Travel Demand Modeling/Forecasting

Process by which relationships among causal factors and travel decisions are analyzed and mathematically modeled. Decisions include:

- Travel frequency and timing
- Destination choice
- Mode choice
- Path choice
What information is used?

Four types of input parameters:
- Urban Activities, Land use
- Trip Maker
- Trips and Travel
- Transport System
Urban Activities/Land Use

• Macro-Scale
  – What kind of activity/land use?
  – Where?
  – How much?

• Site Plan Scale
  – Lay-out of various uses
  – Pedestrian environment
Urban Activities/Land Use

Or?
Trip-maker Characteristics

- Household
  - Size
  - Income
  - Auto ownership
  - Phase of life cycle
  - # of workers, students
- #'s of households of different types
Trip and Travel Characteristics

• Purpose: Recurring trips or occasional?
• Isolated trip or linked to other ones in a “tour?”
• Time-of-day: Peak periods or late at night?
• Day of week: Work day or weekend?
• Number of people in traveling group: Alone or with family?
• Origin, destination: e.g., trip distance, origin and destination land use?
Transportation System: Quantifiable Attributes

- **Times**
  - On-board vehicle
  - Initial waiting
  - Transfer waiting
  - Walking
- Transfer requirements
- Out of pocket costs
Other, Hard To Quantify System Characteristics

- Amenities
- Reliability
- Sense of safety and security
- Ease of Use
  - Availability of quality passenger Information
  - Convenient schedules
  - Fare payment
- Comfort
- Identity, image
Amenities, Image, Security
Demand Forecasting Process

- Land Use, Urban Activities
- Transport System
- Travel Demand Analysis and Modeling
One Common Structure: Four-Step Travel Model

- Trip Generation (Trip Frequency)
- Distribution (Destination Choice)
- Mode Choice
- Highway Assignment (Path Choice)

Network Description
- P.T.
- Highway

Land Use
- Urban Activity
- Demographics

Trip-ends by Zone

O/D Volumes

Path Choice

Link, Line Volumes

Link Volumes
One Common Structure: Four-Step Travel Model

1. Trip generation: Models trip frequency
2. Trip Distribution: Models destination choice
3. Modal Demand: Models mode choice
4. Assignment: Models path choice
Travel Analysis Zone Structure: Consistency Rules!!
One Common Structure: Four-Step Travel Model

- Trip Generation (Trip Frequency)
  - Trip-ends by Zone

- Distribution (Destination Choice)
  - O/D Volumes

- Mode Choice

- Network Description
  - P.T.
  - Highway

- Pub. Transport Assignment (Path Choice)
  - Link, Line Volumes

- Highway Assignment (Path Choice)
  - Link Volumes

- Land Use
- Urban Activity
- Demographics
Trip Generation

• Major causal factors/inputs: Number and types of households and employment by travel analysis zone
• Output = number of trips by travel analysis zone
• Most common model form:
  – Cross-classification on home end
  – Regression on non-home end
One Common Structure: Four-Step Travel Model

Trip Generation (Trip Frequency)
Trip-ends by Zone

Distribution (Destination Choice)
O/D Volumes

Mode Choice

Pub. Transport Assignment (Path Choice)
Link, Line Volumes

Highway Assignment (Path Choice)
Link Volumes

Network Description
• P.T.
• Highway

• Land Use
• Urban Activity
• Demographics
Trip Distribution

• Inputs: Origin to destination times and costs, trip ends at both origin and destination

• Output: Matrix of travel volumes between every origin and every destination

• Most Common Model Form: “Gravity Model”
Most Commonly Used Trip Distribution Model: Gravity Model

\[ \text{Trips}_{ij} = P_i \cdot A_j \cdot \varepsilon^{\alpha F(I_{ij})} \]

- \( P_i \) = “Production trip ends at \( i \)
- \( A_j \) = “Attraction trip ends at \( j \)
- \( I_{ij} \) = Travel “impedance (linear combination of time and cost) between \( i \) and \( j \)
- \( \varepsilon \) = universal logarithmic base
- \( \alpha \) = constant
One Common Structure: Four-Step Travel Model

- Trip Generation (Trip Frequency)
  - Trip-ends by Zone

- Distribution (Destination Choice)
  - O/D Volumes

- Mode Choice

- Pub. Transport Assignment (Path Choice)
  - Link, Line Volumes

- Highway Assignment (Path Choice)
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Mode Choice???
Mode Choice Model

- **Inputs:** Times and costs for competing modes, between each pair of zones
- **Outputs:** Share of trips between each pair of zones on each mode
- **Most common model form:** Logit Model
Logit: Most Common Mode Choice Model

\[ \%M_{ij} = \left( \frac{\epsilon \alpha' F'(tt_{ij}, S_{ij})}{\sum_{m} \epsilon \alpha' F'(tt_{ij}, S_{ij})} \right)_M \]

- \( tt \) = travel time between \( i \) and \( j \)
- \( S \) = travel cost between \( i \) and \( j \)
- \( \epsilon \) = universal logarithmic base
- \( \alpha \) = constant
One Common Structure: Four-Step Travel Model

Trip Generation (Trip Frequency)
Trip-ends by Zone

Distribution (Destination Choice)
O/D Volumes

Mode Choice

Pub. Transport Assignment (Path Choice)
Link, Line Volumes

Highway Assignment (Path Choice)
Link Volumes

Network Description
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Assignment

• Inputs: Travel matrix, trips between all zone pairs; network description
• Output:
  – Highway
    • Travel on each link in network
    • Turning movements at nodes
  – Transit
    • Travel on each link and line
    • Transfers
    • Boardings, alightings by stop
• Most Common Models forms: Multi-path stochastic, capacity constrained
Four-Step Model Development

- Surveyed Parameters
  - Land Use
  - Trip-makers
  - Trips/travel
  - System

- Statistical Estimation Techniques

- Models
  - TG Trip Rates
  - TD, MS Equations
  - Network Representation
Four-Step Model Validation

Current Year Inputs
- Land Use
- Trip-makers
- System

Apply Models
- T.G. Trip Rates
- T.D., M.S. Equations
- Networks

Adjust Model Parameters as Necessary

Compare To Actual, Measured Values

Transit, Hwy.
- Trips
- Trip Lengths
- Volumes
- Transfers
- Speeds
Four-Step Model Application

Horizon Year Year Inputs
- Land Use (Alternatives to be tested)
- Trip-makers
- System (Alternatives to be tested)

Users Of Forecasts

Models
- TG Trip Rates
- TD, MS Equations
- Network Rep.

QA/QC

Transit, Hwy.
- Trips
- Trip Lengths
- Volumes
- Transfers
- Speeds
Model Application

- Travel times and costs reflect investments and management/operations strategies that are being analyzed
- Land-use (population, employment distribution by sub-area) may reflect “status quo” or result of new growth and urban development policies