Introduction to Travel Forecasting Webcast
July 14th, 2010

Agenda

• Need for Travel Forecasting Methods
• Introduction to Travel Forecasting
  • Trip Generation
  • Trip Distribution
  • Mode Choice
  • Trip Assignment
  • Time of Day
  • External and Commercial Markets
  • Travel Surveys and Model Validation
• Case Study: Travel Forecasting in the Atlanta Region
  • Trip Based Model
  • Activity Based Model
• Questions and Answers

What New Issues Are We Trying To Address?

Then:
  • Highway design (1950’s and 1960’s)
  • Transit design (1970’s)

Now:
  • Congestion management
  • Air quality
  • Title VI/Environmental justice
What New Issues Are We Trying To Address?

- Pricing policies
- New rail starts and other transit projects
- Changing population and household characteristics
- Impacts of transportation accessibility on land-use and economy
- Commercial vehicles

How Analysis Tools Support the Planning Process

- Regional Vision and Goals
- Alternate Improvement Strategies (Operations, Capital)
- Evaluation & Prioritization of Strategies
- Development of Transportation Plan (LTP)
- Development of Transportation Improvement Program (TIP)
- Project Development
- Systems Operations Implementation
- Monitor System Performance (Data)
The Travel Forecasting Process

- Trip Generation
- Trip Distribution
- Mode Choice
- Time-of-Day & Directional Factoring
- Trip Assignment
- Transportation System Performance and Evaluation

Fact Sheet Title/Page Number | Operations Objective
--- | ---
| System Efficiency |
**Extent of Congestion** | • Reduce the percentage of facility miles (highway, arterial, rail, etc.) experiencing recurring congestion during the peak period by X percent by year Y.  
• Maintain the rate of growth in facility miles experiencing recurring congestion as less than the population growth rate (or employment growth rate).  
• Reduce the share of major intersections operating at LOS F by X percent by year Y. |
**Duration of Congestion** | • Reduce the daily hours of recurring congestion on major freeways from X to Y by year Z.  
• Reduce the number of hours per day that the top 20 most congested roadways experience recurring congestion by X percent by year Y. |
**Intensity of Congestion (Travel Time Index)** | • Reduce the regional average travel time index by X percent per year. |
**Travel Time** | • Annual rate of change in regional average commute travel time will not exceed regional rate of population growth through the year Y.  
• Improve average travel time during peak periods by X percent by year Y. |
**Delay** | • Reduce hours of delay per capita by X percent by year Y.  
• Reduce hours of delay per driver by X percent by year Y. |
**Energy Consumption** | • Reduce total energy consumption per capita for transportation by X percent by year Y.  
• Reduce total fuel consumption per capita for transportation by X percent by year Y.  
• Reduce excess fuel consumed due to congestion by X percent by 2020.
Other Planning Methods

- Land Use Models
- Travel Demand Forecasting
  - Traffic Micro-Simulation
  - User Benefits (New Starts)
  - Toll and Revenue Forecasting
  - Air Quality Models

Trip Generation and Distribution

**Trip Generation** defines the size of the flows into or out of a zone

**Trip Distribution** defines the size of the freight flows between zones, constrained by the totals from Trip Generation
Traffic Analysis Zones

Defining Traffic Analysis Zones
Transportation Network File

Trip Generation Models

Trip Rates

Zone Data

Trip Generation

Home-Based Work Productions and Attractions

Home-Based Other Productions and Attractions

Non-Home-Based Productions and Attractions
Zone-Based Model Inputs

Characteristics of “zones”:
- Number of households
- Number of persons
- Income, auto ownership
- Number of jobs by industry
- Density/area-type
- Parking costs
- Percent of zone within transit walk distance

Techniques for Developing Demographic Forecasts
**Productions and Attractions**

Home-Based Work Trip

Home-Based Other Trip

Non-Home-Based Trip

Households produce trips

Employment attracts trips

Origin is production end

Destination is attraction end

**Production Model**

**Cross-Classification Model**

**Daily Home-Based Work Trip Rates**

<table>
<thead>
<tr>
<th>Purpose</th>
<th>HH Size</th>
<th>Auto Ownership</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Low Income (&lt;$20,000)</td>
<td>1</td>
<td>0.583</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>0.583</td>
</tr>
<tr>
<td></td>
<td>3+</td>
<td>1.393</td>
</tr>
<tr>
<td>Medium Income ($20,000-$45,000)</td>
<td>1</td>
<td>1.062</td>
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<tr>
<td></td>
<td>2</td>
<td>1.488</td>
</tr>
<tr>
<td></td>
<td>3+</td>
<td>1.723</td>
</tr>
<tr>
<td>High Income (&lt;$45,000)</td>
<td>1</td>
<td>1.109</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>1.832</td>
</tr>
<tr>
<td></td>
<td>3+</td>
<td>1.946</td>
</tr>
</tbody>
</table>

Source: Triad Region Travel Demand Models
How many trips per job?
Trip Attractions

Will 10,000 jobs attract 10,000 worker trips?

Trip Attraction Equations

Example Equation for Work Trips:
Source: Amarillo MPO

\[ \text{Total work attractions} = 1.6 \times \text{basic employment} + 1.3 \times \text{retail employment} + 1.4 \times \text{service employment} + 0.08 \times \text{households} \]

Where –
Total work attractions = Total work-based trip ends in a zone

Note: Work attractions are generally lower than total employment

- Impact of telecommuting
- Irregular work patterns
- Absence of traditional “round trip”
Special Generators

The Trip Generation equations will not apply for:
- Airports
- Regional hospitals
- Any use with unusual demand patterns

Treated as “special generators” or “special events”:
- Local data on the number of trips

Trip Distribution

- Distribute trips produced in one TAZ to all other TAZs
- Calibrate to reflect current travel patterns
- Apply to forecast future travel patterns
Home-Based Work Trip Distribution

- Production Zone
- 10,000 households
- Attraction Market 1: 5,000 jobs, 10 miles away
- Attraction Market 2: 5,000 jobs, 10 miles away

Productions and Attractions Allocated to TAZs

- TAZ 1: 1,080 Attractions
- TAZ 2: 531 Attractions
- TAZ 3: 602 Productions, 76 Attractions
- TAZ 4: 47 Attractions
- TAZ 5: 82 Attractions

[Time Distances: 20 Minutes, 7 Minutes, 10 Minutes, 26 Minutes]
Trip Distribution: The Gravity Model

The gravity model distributes person trips based on:

Flow in total passenger travel between two zones is a function of:

the trips produced in the first zone times
the trips attracted in the second zone times
the difficulty of travel between those zones times
adjustment factors to make the outcomes balance

Friction Factors

What are F-factors ??

• F-factors relate the cost of travel to the propensity to travel
• F-factors are higher for zones that are closer together, and lower for zones that are further apart
## Inputs and Outputs

### Trip Generation

**Trip Productions (P_i)**

<table>
<thead>
<tr>
<th>Zone</th>
<th>P_i</th>
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<tbody>
<tr>
<td>1</td>
<td>34</td>
</tr>
<tr>
<td>2</td>
<td>66</td>
</tr>
</tbody>
</table>

**Trip Attractions (A_j)**

<table>
<thead>
<tr>
<th>Zone</th>
<th>A_j</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>82</td>
</tr>
<tr>
<td>2</td>
<td>18</td>
</tr>
</tbody>
</table>

### Trip Table

**From Zone**

<table>
<thead>
<tr>
<th>From Zone</th>
<th>To Zone</th>
<th>Total P_i</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>34</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>66</td>
</tr>
</tbody>
</table>

**Total A_j**

| Total A_j | 82 | 18 | 100 |

### Path Skimming: Level of Service Matrix

<table>
<thead>
<tr>
<th>From Zone</th>
<th>To Zone</th>
<th>Path Skimmed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>20</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>47</td>
</tr>
</tbody>
</table>

### Travel Forecasts

**Travel between zones: “trip tables”**

- **“row sums”**: Total trips from each zone
- **“column sums”**: Total trips to each zone
- **“table sum”**: Total trips
## Trip Distribution Calibration: Average Travel Time and Distance Comparisons

Estimated Versus Observed Average Travel Time and Distance

<table>
<thead>
<tr>
<th>Purpose</th>
<th>Obs.</th>
<th>Est.</th>
<th>Diff.</th>
<th>% Diff</th>
<th>Obs.</th>
<th>Est.</th>
<th>Diff.</th>
<th>% Diff</th>
</tr>
</thead>
<tbody>
<tr>
<td>HBWORK</td>
<td>15.24</td>
<td>15.93</td>
<td>0.69</td>
<td>4.5%</td>
<td>8.7</td>
<td>9.31</td>
<td>0.61</td>
<td>7.0%</td>
</tr>
<tr>
<td>HSCHOOL</td>
<td>8.82</td>
<td>9.84</td>
<td>1.02</td>
<td>11.6%</td>
<td>4.48</td>
<td>4.74</td>
<td>0.26</td>
<td>5.8%</td>
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<tr>
<td>HBSHOP</td>
<td>9.35</td>
<td>9.32</td>
<td>-0.03</td>
<td>-0.3%</td>
<td>4.96</td>
<td>5.08</td>
<td>0.12</td>
<td>2.4%</td>
</tr>
<tr>
<td>HBOROTHER</td>
<td>9.86</td>
<td>10.22</td>
<td>0.36</td>
<td>3.7%</td>
<td>5.21</td>
<td>5.33</td>
<td>0.12</td>
<td>2.3%</td>
</tr>
<tr>
<td>NHB</td>
<td>9.88</td>
<td>11.53</td>
<td>1.65</td>
<td>16.7%</td>
<td>5.19</td>
<td>6.24</td>
<td>1.05</td>
<td>20.1%</td>
</tr>
</tbody>
</table>

### District Geography

Pima Association of Governments Travel Demand Model District Map
### District Level Trip Table Comparison

#### Estimated – Observed Home-Based Work Trips

<table>
<thead>
<tr>
<th>Attraction District</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 CityW</td>
<td>3,558</td>
<td>1,808</td>
<td>-481</td>
<td>1,304</td>
<td>-59</td>
<td>505</td>
<td>329</td>
<td>-573</td>
<td>-</td>
<td>-56</td>
<td>299</td>
<td>100</td>
<td>13</td>
<td>0</td>
</tr>
<tr>
<td>2 CityE</td>
<td>4,688</td>
<td>6,529</td>
<td>64</td>
<td>2,164</td>
<td>501</td>
<td>314</td>
<td>4</td>
<td>-853</td>
<td>-</td>
<td>33</td>
<td>-135</td>
<td>-144</td>
<td>-105</td>
<td>0</td>
</tr>
<tr>
<td>3 SubNE</td>
<td>294</td>
<td>619</td>
<td>3,545</td>
<td>4,550</td>
<td>-36</td>
<td>1,054</td>
<td>-26</td>
<td>360</td>
<td>-8</td>
<td>-72</td>
<td>-117</td>
<td>-329</td>
<td>-55</td>
<td>0</td>
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<tr>
<td>4 Abita</td>
<td>1,093</td>
<td>926</td>
<td>105</td>
<td>-333</td>
<td>-105</td>
<td>36</td>
<td>234</td>
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<td>-7</td>
<td>-33</td>
<td>28</td>
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<td>0</td>
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<tr>
<td>5 SW</td>
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<td>89</td>
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<tr>
<td>6 NE</td>
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<td>795</td>
<td>5</td>
<td>500</td>
<td>-</td>
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<tr>
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<td>-45</td>
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<td>212</td>
<td>106</td>
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<td>-</td>
<td>215</td>
<td>-15</td>
<td>47</td>
<td>9</td>
<td>0</td>
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<tr>
<td>8 FarN</td>
<td>3,953</td>
<td>-120</td>
<td>3,103</td>
<td>-561</td>
<td>4,624</td>
<td>38</td>
<td>2,506</td>
<td>-135</td>
<td>2,447</td>
<td>-</td>
<td>10</td>
<td>606</td>
<td>-8</td>
<td>627</td>
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<tr>
<td>9 FarNE</td>
<td>-12</td>
<td>-1</td>
<td>30</td>
<td>-2</td>
<td>2</td>
<td>9</td>
<td>1</td>
<td>-5</td>
<td>-28</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>-</td>
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<tr>
<td>10 FarSW</td>
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<td>-228</td>
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<td>-110</td>
<td>102</td>
<td>14</td>
<td>-154</td>
<td>-54</td>
<td>-3</td>
<td>384</td>
<td>42</td>
<td>-27</td>
<td>6</td>
<td>0</td>
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<tr>
<td>11 FarNW</td>
<td>1,013</td>
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<td>-759</td>
<td>78</td>
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<td>-39</td>
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<td>196</td>
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<td>12 FarSE</td>
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<td>378</td>
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<td>-8</td>
<td>242</td>
<td>-59</td>
<td>-</td>
<td>9</td>
<td>-13</td>
<td>-68</td>
<td>152</td>
<td>0</td>
</tr>
</tbody>
</table>

### Trip Distribution Challenges

Distribution is a complex social behavior with longer-term impacts
- Availability & location of desirable housing
- Employment location based on supply, availability, cost & general preferences
- Destination choice also a function of household-level interactions
- Non-work travel often difficult to represent with gravity-based methods
Travel Patterns for Special Markets

Example: Travel to an Airport

Travel to the regional airport has only one possible destination. Trips come from the entire region.

Mode Choice

Mode choice model parameters

Travel Skims

Zonal data

Trip Generation

Trip Distribution

Trip Tables By Trip Purpose

Mode Choice

Trip Tables By Trip Purpose and Mode

Trip Assignment
The choice of mode is affected by:

- Travel time (in-vehicle, wait, access, etc)
- Cost (parking, tolls, fare, auto operating, etc)
- Other modal characteristics (reliability, safety, comfort, etc)
- Person/Household characteristics (income, autos owned, age, etc)
- Trip purpose characteristics (shopping, number of stops, etc)

Mode Choice Overview

- Mode Characteristics
- Traveler Characteristics
- Trip Characteristics

Mode Choice Model

- % Drive-Alone
- % Shared-Ride
- % Walk/Bike
- % Bus
- % Rail
Mode Share Calculations

TAZ 1  100 Trips  TAZ 3

How many choose auto?
How many choose transit?

\[
\text{Share}_{\text{transit}} = \frac{\text{Attractiveness}_{\text{transit}}}{\text{Attractiveness}_{\text{auto}} + \text{Attractiveness}_{\text{transit}}}
\]

The Logit Model

\[
P_i = \frac{e^{U_i}}{\sum_{i \in I} e^{U_i}}
\]

Describing Mode Attractiveness:
The Utility Expression

\[
\text{Utility}_{\text{transit}} = a \times \text{in-vehicle time} + b \times \text{fare} + c \times \text{access time} + \text{egress time} + d \times \text{wait time} + \text{mode-specific constant}
\]

\[
\text{Utility}_{\text{auto}} = a \times \text{in-vehicle time} + b \times \text{parking cost and operating cost} + c \times \text{access time} + \text{egress time} + \text{mode-specific constant}
\]

- Utility is the weighted sum of the attributes
- \(a, b, c, d\) are the weights, or parameters, in the model
- Parameters are estimated from survey data or borrowed asserted
- They convert the times and costs to utiles
- They are negative if multiplied by time/cost (disutility)
- The mode-specific constant is the value of the “non-included” attributes
### Simplified Mode Choice Model

**TAZ 1**  
100 Trips  
**TAZ 3**

- **Choice**
  - Drive-Alone
  - Shared-Ride
  - Transit

### Example Multinomial Logit Model

### Mode Choice: Computing Mode Shares

**Mode Choice Equation for Transit**

\[
\text{Share(}\text{tran}) = \frac{\text{Mobility(}\text{transit})}{\text{Mobility(}\text{drive}) + \text{Mobility(}\text{carpool}) + \text{Mobility(}\text{tran})}
\]

**Mobility(m) =**

\[
g \ [ \ a \ x \ (\text{in-vehicle time}) \\
+ \ b \ x \ (\text{walk and wait time}) \\
+ \ c \ x \ (\text{tolls/parking costs}) \\
+ \ d \ x \ (\text{number of transfers}) \\
+ \ .......... \\
+ \text{non-quantifiable factors}
\]
**Mode Choice Mathematics**

Example No Build Condition:

\[
\text{Share(Transit)} = \frac{2}{7 + 1 + 2} = 0.20 = 20 \text{ percent}
\]

Example Build Condition:

\[
\text{sum} = 10.0
\]

\[
\text{Share(Transit)} = \frac{2.2}{7 + 1 + 2.2} = 0.216 = 21.6 \text{ percent}
\]

**Mode Choice Inputs:**

**Impedance Tables**

Times and costs between zones: “impedance tables”

- Parking Costs
- Travel Time
- Parking Time
- Fuel Costs
Mode Choice Outputs:
Mode Specific Trip Tables

Trip Tables by Mode:

- Metro trips
- Bus trips
- Carpool trips
- Drive-alone trips

Market Segmentation and Aggregation Error

- The model applied for each zone pair (P to A)
- Market Segments
  - Trip purpose
  - Transit access
  - HH characteristics
    - Income, Autos
    - Time Periods
- Segmentation and aggregation bias
  - Small change in utility can yield unrealistic response

Transit utility - auto utility
Nested Logit Model

Mode Choice: Calibration and Validation

Calibration
- Aggregate mode shares match reasonably well?
- Transit shares in specific markets (e.g. downtown)
- Estimated versus observed number of transfers?

Validation
- Does the model make logical predictions in forecasting?
Accounting for Time of Travel

First generation models:

- Provided traffic projections for geometric and pavement design

Now:

- Evaluating policy and project design alternatives
- Understanding future congestion and its affects on travel
- Evaluation of pricing and ‘managed lane’ policies
- Alternatives to single-occupant vehicles (HOV lanes, transit)
- Air quality analysis

Time-of-Day Modeling

- Trip Generation
- Trip Distribution
- Mode Choice
- Daily Trip Tables (by trip purpose and by mode)
- Time-of-Day Factors (by trip purpose and by mode)
- Time-of-Day Modeling
- Directional Split Factors (e.g., home-to-work vs. work-to-home)
- AM Peak Period or Peak Hour Trip Tables
- Midday Period Trip Tables
- PM Peak Period or Peak Hour Trip Tables
- Overnight Period Trip Tables
- Trip Assignments (AM, Midday, PM, Overnight)
Trip Assignment

Assignment Approaches

- All-or-nothing Assignment
- Equilibrium Assignment
- Stochastic Assignment

Inputs and Outputs

Inputs
- O&D trip table
- Coded network

Outputs
- Link flows as per coded network
- Link travel times/speeds
- Vehicle-miles of travel (VMT)
- Vehicle hours of travel (VHT)
- Delay
- Turning Movements
- Boardings and Alightings (Transit)

Highway Network Files

Speed Table

<table>
<thead>
<tr>
<th>Facility Type</th>
<th>CBD</th>
<th>Urban</th>
<th>Suburb</th>
<th>Rural</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freeway</td>
<td>--</td>
<td>26</td>
<td>38</td>
<td>28</td>
</tr>
<tr>
<td>Rural Arterial</td>
<td>--</td>
<td>--</td>
<td>32</td>
<td>34</td>
</tr>
<tr>
<td>Collector</td>
<td>20</td>
<td>11</td>
<td>18</td>
<td>19</td>
</tr>
<tr>
<td>Ramp</td>
<td>--</td>
<td>--</td>
<td>34</td>
<td>32</td>
</tr>
<tr>
<td>Major Arterial</td>
<td>12</td>
<td>13</td>
<td>19</td>
<td>21</td>
</tr>
<tr>
<td>Local</td>
<td>10</td>
<td>16</td>
<td>27</td>
<td>20</td>
</tr>
<tr>
<td>Minor Arterial</td>
<td>10</td>
<td>12</td>
<td>22</td>
<td>12</td>
</tr>
</tbody>
</table>

Regional network with localized detail for corridor study.

Detailed network for regional analysis.
Frank-Wolfe Assignment Algorithm

1. Compute time on all links using flows from current solution
2. Find shortest paths between zone pairs.
3. Assign all demand between zone pairs to the shortest paths.
4. Make a weighted average of current and previous solutions (lambda search).
5. Stop if converged; otherwise back to 1.
   • Equilibrium is achieved when no individual trip maker can reduce path costs by switching routes.

Volume Delay Functions

Volume-Delay Curve Comparison: BPR, Conical, and Akcelik
Assignment Stability

Tighter equilibrium closure criteria does improve link assignment stability... eventually

"Loaded" Highway Network

Highway Assignment Bandwidth Plot
Overview of Travel Demand Forecasting
Transit Assignments

Complex interchange patterns associated with passenger movements

- Some paths offer more than one parallel service with complex associated choices
- Network coding can reflect several access modes
- Allocation of trips to paths for route level boardings

External and Commercial Vehicle Trips
Internal to External Travel

External stations produce non-resident trips and attract resident trips.
Internal TAZs produce resident IE trips and attract non-resident IE trips.

Data and Methods for Internal-External Travel

Data on external trips can be collected with origin destination (roadside) surveys at external stations.
Internal-external trips modeled using production-attraction format:
- Gravity model
External-external trips left in origin-destination format:
- Matrix fitting (Fratar)
Commercial Vehicles

Trip tables can be developed by:

• Factor an existing trip table
• Apply a simple ‘quick response truck model’
• ‘Synthesize’ matrices via truck counts, using truck matrices as a ‘seed’
• Develop and apply a more sophisticated commodity flow model

Data Sources

• Vehicle Classification Counts
• National data products (FAF/3)
• Establishment Surveys
• Intercept Surveys

Model Validation and Reasonableness Checking
Error Propagation

Trip Generation

<table>
<thead>
<tr>
<th>Zone</th>
<th>Trip Productions (Pi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>34</td>
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<tr>
<td>2</td>
<td>66</td>
</tr>
</tbody>
</table>

Trip Attraction (A)

<table>
<thead>
<tr>
<th>Zone</th>
<th>Trip Attractions (Aj)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>82</td>
</tr>
<tr>
<td>2</td>
<td>18</td>
</tr>
</tbody>
</table>

Trip Distribution

<table>
<thead>
<tr>
<th>From Zone</th>
<th>To Zone</th>
<th>Total</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>7</td>
<td>34</td>
</tr>
<tr>
<td>2</td>
<td>55</td>
<td>11</td>
<td>66</td>
</tr>
<tr>
<td>Total</td>
<td>62</td>
<td>18</td>
<td>100</td>
</tr>
</tbody>
</table>

Mode Choice

<table>
<thead>
<tr>
<th>Mode</th>
<th>Trips (Tmr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auto</td>
<td>30</td>
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<tr>
<td>Transit</td>
<td>25</td>
</tr>
</tbody>
</table>

Trip Assignment

<table>
<thead>
<tr>
<th>Route</th>
<th>Trips (Tmr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Route A</td>
<td>18</td>
</tr>
<tr>
<td>Route B</td>
<td>7</td>
</tr>
</tbody>
</table>

Model Application Steps

1. Forecast household and employment data for each TAZ
2. Apply trip generation model
3. Forecast and code future year networks
4. Apply trip distribution model
5. Apply mode choice model
6. Apply time-of-day and directional factoring
7. Apply trip assignment model
Evaluating Forecasts: Do they look reasonable?

Test: Back-casting
- After base-year calibration, run model for a past year and validate

Step-wise build-up of travel forecasts
- Run model holding various steps constant between baseline and build to determine effect of each on forecast

Risk and uncertainty analysis
- Run model multiple times, varying the assumption and inputs, to determine effect on results – produce range of forecasts

Home Interview Surveys

- Activity and travel information for 24-hour weekday period
- Provide up-to-date travel information
- Provide information about household and travel characteristics
- Provide a basis for future projections
- Considerations for survey design and implementation
- Coverage Bias
- Response Bias

TRB Data Collection Manual
- http://tmip.fhwa.dot.gov/resources/clearinghouse/browse/list/25/1378
Trip Tables from Home Interviews

<table>
<thead>
<tr>
<th>Origin Destination</th>
<th>Central</th>
<th>North City</th>
<th>South Suburban</th>
<th>East Suburban</th>
<th>North County West</th>
<th>North County East</th>
<th>East County</th>
<th>Out of Area</th>
<th>Unknown</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central</td>
<td>43.3%</td>
<td>26.1%</td>
<td>11.5%</td>
<td>12.1%</td>
<td>1.3%</td>
<td>1.7%</td>
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<td>0%</td>
<td>3.3%</td>
<td>100.0%</td>
</tr>
<tr>
<td>North City</td>
<td>14.6%</td>
<td>60.3%</td>
<td>3.6%</td>
<td>5.5%</td>
<td>5.1%</td>
<td>3.1%</td>
<td>1%</td>
<td>0%</td>
<td>2.6%</td>
<td>100.0%</td>
</tr>
<tr>
<td>South Suburban</td>
<td>21.4%</td>
<td>13.8%</td>
<td>53.6%</td>
<td>0.1%</td>
<td>0%</td>
<td>0%</td>
<td>3.6%</td>
<td>0%</td>
<td>3.5%</td>
<td>100.0%</td>
</tr>
<tr>
<td>East Suburban</td>
<td>18.0%</td>
<td>21.3%</td>
<td>5.4%</td>
<td>52.4%</td>
<td>1.7%</td>
<td>1.4%</td>
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</tr>
<tr>
<td>North County West</td>
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<td>4%</td>
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<td>100.0%</td>
</tr>
<tr>
<td>North County East</td>
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<td>11.1%</td>
<td>5%</td>
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<td>58.0%</td>
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<td>6.3%</td>
<td>0%</td>
<td>6.3%</td>
<td>100.0%</td>
</tr>
<tr>
<td>East County</td>
<td>3.8%</td>
<td>7.3%</td>
<td>5%</td>
<td>11.4%</td>
<td>0%</td>
<td>0%</td>
<td>71.2%</td>
<td>0%</td>
<td>5.4%</td>
<td>100.0%</td>
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<tr>
<td>Out of Area</td>
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<td>3%</td>
<td>5%</td>
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<tr>
<td>Unknown</td>
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<td>28.0%</td>
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</tr>
</tbody>
</table>

Source: San Diego HH Survey, NuStats, 2006

On Board Survey Questionnaire

2004 Customer Survey
Encuesta de Ciente 2004

Thank you for participating in the 2004 Customer Survey. Your opinion is valuable to us.

2004 Customer Survey
Encuesta de Ciente 2004

Thank you for participating in the 2004 Customer Survey. Your opinion is valuable to us.
Model ready for prime time?

Base year model results compared to observed travel
Judgment as to model suitability
  • Reasonably match base year conditions?
  • Logical response to changes in inputs?
Once validated, model available for forecasting

Questions?

Thank You!

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