A Methodology for Estimation and Calibration of a City-Wide Micro-simulation Model

TRB ITM 2010

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Outline

• Background
  – Purpose
  – Current Modeling Practice in the GEA
  – State of the Practice

• Project Scope and Objectives
  – Study Area, Modes of Travel, Times of Day
  – Data Input Requirements and Data Collection
  – Methodology

• Methodology
  – Data Collection
  – Model Development
  – Estimation, Calibration, and Validation
  – Future-Year Scenarios
  – Visual Demonstration
Purpose

• To develop a traffic operations model of the Greater Eureka Area (GEA) that would extend and complement existing modeling activities

• To transfer ownership of the model to GEA staff trained in the application, upkeep, and improvement of the model

• To have a visualization tool with which to engage public, stakeholders
Current Modeling Practice in the GEA

- **Systems Planning**
  - GEA Travel Model (GEATM)
  - Traditional 3-step Planning Model
  - Span Humboldt County
  - Multi-agency acceptance

- **Operations**
  - Disparate software platforms
  - Models short-lived
  - No linkage with demand modeling efforts
  - No consistency, cohesion, collaboration = no confidence
## State of the Practice

<table>
<thead>
<tr>
<th>State of the Practice</th>
<th>GEA Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Limited in scale</td>
<td>City-wide</td>
</tr>
<tr>
<td>Sparse network detail</td>
<td>All streets in Eureka included</td>
</tr>
<tr>
<td>Few route choices</td>
<td>Routes innumerable</td>
</tr>
<tr>
<td>Turns/routes prescribed</td>
<td>Route choice a central model component</td>
</tr>
<tr>
<td>Short time periods</td>
<td>2-hour peak periods</td>
</tr>
<tr>
<td>Single-project life span</td>
<td>Model to be maintained indefinitely</td>
</tr>
</tbody>
</table>
Scope

• Scale
  – Eureka City Limits (~16 mi$^2$) + Parts of surrounding Humboldt County
  – 17 miles of US 101 from Spruce Point to North of Bayside Cutoff
  – 417 total origins and destinations (409 TAZ centroids, 8 external stations)

• Modes of Travel
  – Private Auto
  – Truck
  – Eureka Transit Service
  – Pedestrians

• Time Periods
  – AM peak period 7:00 – 8:00 AM
  – PM peak period 4:00 – 6:00 PM
Methodology

- Assemble Existing Data
- Evaluate Data Needs and Conduct Data Collection
- Model Development
- Trip Table and Route Choice Estimation
- Model Calibration & Validation
- Test Future Scenarios
Data Requirements

• Model Inputs
  – Geographic, geometric model of road network
  – Geographic model of transit routes and stops
  – Time-varying origin-to-destination (OD) volumes
  – Signal timings
  – Pedestrian crossing volumes

• Data Requirements
  – Field measurements: traffic & pedestrian counts, travel times, etc.
  – Model-generated data: GEATM OD volumes, network-wide travel times and turning movement delays
  – Other data: signal timing plans, transit schedules
Data Collection

- Turning Movement Counts (47 intersections)
- Directional Counts (70 locations)
- Floating Car Runs with GPS (28 routes)
- Queue Discharge Headways
Model Development

1. Road network model built from the GEATM centerline street geographic file
2. Minor geographic adjustments made
3. Aerial imagery used to make geometric refinements
4. Extremely accurate and detailed in terms of link/storage lengths, lane widths, lane connections (even bicycle lanes)
5. Links divided into segments to accommodate geometric features, but relationships with GEATM that matter still maintained
Trip Table & Route Choice Estimation Methodology

1. Travel Model Subarea Analysis
   - Seed Matrix
2. Analysis of Land Use Data
   - Constraint Matrix
3. Origin-Destination Matrix Estimation
4. Estimated Matrix
5. Simulation-based Dynamic Traffic Simulation
6. Satisfactory Match with Counts?
   - Yes: Finished
   - No: Matrix Adjustment
7. Traffic Counts
Calibration and Validation: Trip Table and Route Choice Estimation

- Objectives
  - Calibration: to match ground counts
  - Validation: to match point-to-point travel times

- Methods:
  - O-D matrix estimation & temporal disaggregation
  - Simulation-based dynamic traffic assignment
  - Targeted trip matrix adjustments

- Goodness-of-fit measures
  - Root mean square error
  - FHWA & Caltrans simulation guidelines
Trip Table in Three Transformations

AM

<table>
<thead>
<tr>
<th>RMSE (%)</th>
<th>ODME</th>
<th>Assignment</th>
<th>Adjustment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>9%</td>
<td>33%</td>
<td>17%</td>
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</tbody>
</table>
Trip Table in Three Transformations

PM

<table>
<thead>
<tr>
<th></th>
<th>RMSE (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ODME</td>
<td>10%</td>
</tr>
<tr>
<td>Assignment</td>
<td>35%</td>
</tr>
<tr>
<td>Adjustment</td>
<td>18%</td>
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</table>
GEH Statistic

AM

![Bar chart showing the percentage of model volumes for different thresholds of GEH. The bars are color-coded to represent different count ranges: All Count Sites, 2-hr Counts >= 100, 2-hr Counts >= 500, and 2-hr Counts >= 1,000. The thresholds for GEH are 5.0 and 10.0.]
GEH Statistic

PM

% of Model Volumes

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

5.0 10.0

Threshold GEH

All Count Sites
2-hr Counts >= 100
2-hr Counts >= 500
2-hr Counts >= 1,000
Results Summary

• Industry-standard calibration on industry non-standard model

• Saturation Flow
  – Average Measured: 1840 vehicles per hour (vph)

• Traffic Demand Calibration
  – Traffic counts satisfy FHWA & Caltrans guidelines in terms of relative error, absolute error, GEH statistic

• Travel Time Validation
  – Travel times satisfy FHWA & Caltrans guidelines in terms of relative and absolute errors on all major corridors and on all but 2 routes driven
Future-Year Scenarios

- Future Years based on GEATM Forecasts
  - 2020 & 2030
  - Future-year subarea analyses & simulation-based dynamic traffic assignments

- Scenarios
  - Broadway widening to 6 lanes
  - Traffic signal optimization
First Application

- Broadway Feasibility Study
Visual Demonstration
2-D Visualization
3-D Visualization