SHRP2 Project C05: Final Report to TCC

Understanding the Contribution of Operations, Technology, and Design to Meeting Highway Capacity Needs

Wayne Kittelson & Brandon Nevers

TCC Meeting at The Beckman Center
April 26, 2010
Presentation Overview

- Project Scope, Objectives, and Timeline
- Key Findings
- Key Products
- Response to TCC Feedback of Spring 2009
- Schedule for Completion
Project Scope and Objectives

- Quantify capacity benefits of improvements at the network level
- Provide information and tools to analyze operational improvements as an alternative to traditional construction
- Develop guidelines for “sustainable service rates” to be used in planning networks
## Non-Lane Widening Strategies to Improve Capacity

<table>
<thead>
<tr>
<th>Freeway</th>
<th>Arterial</th>
<th>Both</th>
</tr>
</thead>
<tbody>
<tr>
<td>HOV Lanes</td>
<td>Signal Retiming</td>
<td>Narrow Lanes</td>
</tr>
<tr>
<td>Ramp Metering</td>
<td>Signal Coordination</td>
<td>Reversible Lanes</td>
</tr>
<tr>
<td>Ramp Closures</td>
<td>Adaptive Signals</td>
<td>Variable Lanes</td>
</tr>
<tr>
<td>Congestion Pricing</td>
<td>Queue Management</td>
<td>Truck Only Lanes</td>
</tr>
<tr>
<td>Pricing by Distance</td>
<td>Raised Medians</td>
<td>Truck Restrictions</td>
</tr>
<tr>
<td>HOT Lanes</td>
<td>Access Points</td>
<td>Pre-Trip Information</td>
</tr>
<tr>
<td>Weaving Section</td>
<td>Right/Left Turn Channelization</td>
<td>In-Vehicle Info</td>
</tr>
<tr>
<td>Frontage Road</td>
<td>Alt LT Treatments</td>
<td>VMS/DMS</td>
</tr>
<tr>
<td>Interchange Modifications</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Insights on Strategy Effectiveness

- Effectiveness needs to be tested in network context
  - Requires the use of a travel demand/DTA model
  - Cannot be done with static look-up tables

- Impacts most pronounced at the link and corridor levels, and often difficult to see at the network level
  - Demand-side issues are best viewed from an O-D perspective
  - Supply-side issues are best viewed at the link and corridor level

- Pre-trip information can reduce buffer time
  - En-route information may create instabilities
Key Products

- Traffic Model Enhancements
- Diagnostic Tools
- Strategy Evaluation Results
- Spreadsheet-Based Model
- Final Report
- Guidebook
Traffic Model Enhancements: Stochastic Capacity for Freeway Bottlenecks
Traffic Model Enhancements: Stochastic Capacity for Arterials
Traffic Model Enhancements: Day-to-Day Traveler Learning

- Traveler’s route choice is based on experiences remembered from the past two weeks
- Limits applied to number of travelers who will adjust their trip each day
- Expected to be important in the evaluation of non-recurring congestion
Traffic Model Enhancements: Improved Bottleneck Representation

Merges
Short Turn Pockets
Diagnostic Tools: Active Bottleneck Identification
Diagnostic Tools:
Movement-Specific Intersection Delay Display
Diagnostic Tools:
Stochastic Link Performance and Breakdown Probability

- Visual representation currently being developed
- Breakdown probabilities estimated from recorded simulated experience
Overview of Strategy Testing Plan

- Testing plan developed for 25 strategies
  - Location within the DFW network
  - Geometric, volume, and operational inputs
  - Selection of performance evaluation MOE’s

- Test Protocol
  - I: Baseline stabilization
  - II: Strategy stabilization
  - III: 20-day results comparison period

Network-Wide Simulation Results
Strategy Evaluation Results:
Equivalent Capacity Gain Concept

Effect of Non-Construction Improvements on Network Travel Time

Network Travel Time
Added Network Lane Miles
Equivalent Capacity Gain
# Capacity Addition Scenarios
(Southbound Freeway Corridor)

<table>
<thead>
<tr>
<th>Baseline # of Lanes</th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.9 miles</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.9 miles</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.7 miles</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Lane-Mile Addition**

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Lane-Mile Addition</th>
<th>Capacity Addition</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>+7.6 (+22%)</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>+8.5 (+24%)</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>+16.0 (+46%)</td>
<td></td>
</tr>
</tbody>
</table>
20-Day Average Results

Travel Times

* Effects in peak direction with lane addition for one hour
20-Day Average Results

Travel Time Index

- Baseline
- ATIS Pre-trip
- ATIS En-route
- Narrow Lanes
- Reversible Lane
- A (+22%)
- B (+24%)
- C (+46%)

Travel time index
20-Day Average Results

Buffer Index

Baseline: +22%
ATIS Pre-trip
ATIS En-route
Narrow Lanes
Reversible Lane
A (+22%)
B (+24%)
C (+46%)
Primary OD: 1→2 (Southbound)

Spreadsheet Application: Network Simplification is Required
Spreadsheet Application: Uses Simplified Travel Time Profiles

D: Good day on freeway
E: Bad day on freeway
A: Arterial street (we do not have randomized capacity on arterial street yet)
100 random scenarios (i.e. days) using calibrated stochastic capacity model from C05

- Deterministic demand
- Two corridors
  - Route A: 2 lanes, free-flow travel time: 20 min
  - Route B: 3 lanes, free-flow travel time: 40 min
Validation on a bona fide network will increase comfort and add credibility

Ability to model nonrecurrent congestion will make the tool substantially more useful to users and decision-makers
### Portland Network Statistics

<table>
<thead>
<tr>
<th></th>
<th>Entire Network</th>
<th>Subarea Network</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic Analysis Zones</td>
<td>2,013</td>
<td>208</td>
</tr>
<tr>
<td>Nodes</td>
<td>9,905</td>
<td>857</td>
</tr>
<tr>
<td>Links</td>
<td>22,748</td>
<td>1,999</td>
</tr>
<tr>
<td>Vehicles</td>
<td>1.2 M</td>
<td>212 K</td>
</tr>
<tr>
<td>Average Travel Time</td>
<td>22 min</td>
<td>14 min</td>
</tr>
</tbody>
</table>

Demand Horizon: 4 hours *(15:00-19:00)*
DTA modeling enhancements have been coded into two separate DTA models
  – Dynasmart-P v. 1.2(E)
  – DTA Lite

Method:
  – Calibrate the entire network using DTA Lite
  – Apply DSP to the smaller subarea

Current status:
  – DTA Lite network calibration is complete
  – DSP has recreated subarea base condition results
  – Diagnosis and evaluation of treatment options underway
Portland Subarea: Identified Active Bottlenecks
Adding Non-Recurrent Congestion Capability

- Develop strategy to represent effects of nonrecurring congestion
- Produce necessary software code
- Apply enhanced model to Portland network
- Summarize/document findings
## Final Report Outline

1. Executive Summary
2. Introduction
3. Improved Methods for Modeling Network Performance
   - Measurement and Modeling of Network Performance
   - Uninterrupted Flow Facilities
   - Interrupted Flow Facilities
4. Strategies for Enhancing Sustainable Service Rate on Freeways and Arterials
5. Prototype Application of Methods, Metrics, and Strategies
<table>
<thead>
<tr>
<th>Schedule for Completion</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Portland Network</strong></td>
</tr>
<tr>
<td><strong>Draft Final Report</strong></td>
</tr>
<tr>
<td><strong>Draft Guidebook</strong></td>
</tr>
<tr>
<td><strong>Project Completion</strong></td>
</tr>
</tbody>
</table>