HC M’S FREEWAY FACILITIES METHODOLOGY
THE RIGHT-SIZED TOOL FOR PLANNING AND OPERATIONS

16 JULY 2020

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AGENDA

- HCM Freeway Analysis Options
- HCM Approach for Freeway Facilities
- The FREEVAL Tool
- HCM Freeway Facilities Analysis “Scope”
- Traffic Analysis Tradeoffs
- Case study: Freeway Express Lanes
- Other Opportunities for Freeway Facilities Analysis
HCM 6th Edition Uninterrupted Flow Chapters

- Chapter 10: Freeway Facilities
- Chapter 11: Freeway Reliability Analysis
- Chapter 12: Basic Freeway and Multilane Highway Segments
- Chapter 13: Freeway Weaving Segments
- Chapter 14: Freeway Merge and Diverge Segments
- Chapter 25: Freeway Facilities Supplemental
- Chapter 26: Freeway and Highway Segments Supplemental
- Chapter 27: Freeway Weaving Supplemental
- Chapter 28: Freeway Merges and Diverges Supplemental

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HCM Freeway Analysis Options
HCM ANALYSIS ELEMENTS

- Generally Independent Segments
  - Basic Freeway Segments
  - Weaving Segments
  - On-Ramp and Off-Ramp Segments
  - Overlapping Segments
  - Managed Lane Segments
- Single Time Period
- Defined Demand
  - Peak hour
  - Modifications (e.g., Peak Hour Factor, trucks)

HCM Freeway Analysis Options
HCM’S FREEWAY FACILITY ANALYSIS IS MUCH MORE SOPHISTICATED

- Combines the analysis of multiple segments along an extended length of a freeway (up to 15 miles).
- Considers oversaturated conditions including queue spillback and effects on upstream and downstream flows.
- Can model queue propagation between segments and over multiple time periods.
- Considers operations over multiple (15-minute) contiguous analysis periods up to 24 hours.
- Considers interaction of parallel facilities (e.g., managed lanes).
- Allows for multiple days (reliability analysis).
MULTIDIMENSIONAL FREEWAY FACILITIES ANALYSIS

HCM Approach for Freeway Facilities

One segment, one time period, one day
MULTIDIMENSIONAL FREEWAY FACILITIES ANALYSIS

One segment, one time period, one day

HCM Approach for Freeway Facilities

Multiple Days

Interacting Segments

Time Periods
SEGMENT INTERACTION ANALYSIS IS MOST CRITICAL FOR CONGESTED FREEWAYS
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Real-life LOS

HCM Approach for Freeway Facilities
SEGMENT INTERACTION ANALYSIS IS MOST CRITICAL FOR CONGESTED FREEWAYS

HCM Approach for Freeway Facilities
SEGMENT INTERACTION ANALYSIS IS MOST CRITICAL FOR CONGESTED FREeways

HCM Approach for Freeway Facilities

Real-life LOS

HCM Segment LOS

Freeway Facilities
MULTI-DAY ANALYSIS CAPTURES REAL-LIFE VARIATION

- Daily “noise”
- Incidents
- Weather
- Seasonal effects
FREEWAY FACILITIES SOFTWARE

- Accounting exercise
  - Track each segment and time period
  - Determine HCM-based results
  - Adjust for upstream queues and downstream queue starvation

- Options:
  - Spreadsheets (bad idea)
  - Bundled with HCS
  - FREEVAL
FREEVAL SOFTWARE

- http://freeval.org
  - Developed by North Carolina State University
  - Free software
  - User guide, videos, links, Q&A

- TL;DR: Enter data on each segment and time period
- Instant results
FREEWAY FACILITIES ANALYSIS FOLLOWS THE SAME APPROACH AS OTHER STUDIES

- Determine study area, scenarios, time periods
- Gather data for existing conditions
- Code, test, and validate baseline model
- Calibrate using performance measures and the eye test
- Determine future demands and alternatives
- Code and “run” future scenarios
- Extract data and develop reports
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HCM Freeway Facilities Analysis “Scope”
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EXAMPLE PROJECT

- Congested California freeway
- HOV lanes (current)
- Alternatives include:
  - Widening (additional managed lanes)
  - Tolling
  - Occupancy changes
BASELINE FUTURE ANALYSIS - G P

Existing GP

2035 No Build GP

Case Study - Freeway Express Lanes
BASELINE FUTURE ANALYSIS - HOV

Case Study - Freeway Express Lanes
Case Study - Freeway Express Lanes
ALTERNATIVES ANALYSIS - EXPRESS LANES

2035 No Build HOV

2035 Express Lanes
## Sample Performance Summary

### Case Study – Freeway Express Lanes

<table>
<thead>
<tr>
<th>Density Based Level of Service (Period Distribution)</th>
<th>%</th>
<th>%</th>
<th>%</th>
<th>%</th>
<th>%</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOS A</td>
<td>0%</td>
<td>19%</td>
<td>52%</td>
<td>20%</td>
<td>4%</td>
<td>4%</td>
</tr>
<tr>
<td>LOS B</td>
<td>0%</td>
<td>5%</td>
<td>29%</td>
<td>19%</td>
<td>16%</td>
<td>30%</td>
</tr>
<tr>
<td>LOS C</td>
<td>0%</td>
<td>44%</td>
<td>34%</td>
<td>9%</td>
<td>0%</td>
<td>12%</td>
</tr>
<tr>
<td>LOS D</td>
<td>5%</td>
<td>22%</td>
<td>29%</td>
<td>10%</td>
<td>1%</td>
<td>33%</td>
</tr>
<tr>
<td>LOS E</td>
<td>6%</td>
<td>40%</td>
<td>36%</td>
<td>7%</td>
<td>1%</td>
<td>9%</td>
</tr>
<tr>
<td>LOS F</td>
<td>26%</td>
<td>27%</td>
<td>13%</td>
<td>1%</td>
<td>1%</td>
<td>33%</td>
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</table>

<table>
<thead>
<tr>
<th>Average Travel Time (Minutes)</th>
<th>Vehicle Miles Traveled (Veh-Miles)</th>
<th>Passenger Miles Traveled (Pass-Miles)</th>
<th>Vehicle Hours Traveled (Hours)</th>
<th>Passenger Hours Traveled (Pass-Hours)</th>
<th>Average Speed (MPH)</th>
<th>Vehicle Hours of Delay (Hours)</th>
<th>Passenger Hours of Delay (Pass-Hours)</th>
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<tbody>
<tr>
<td>GP AM</td>
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<td>505,704</td>
<td>7,974</td>
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<td>167,257</td>
<td>1,273</td>
<td>2,700</td>
<td>62</td>
<td>222</td>
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</tbody>
</table>

### Total

| GP                      | 1,950,792 | 2,145,871 | 53,540 | 58,894 | 27,530 | 30,283 |
| HOT                     | 376,298   | 798,459   | 10,047 | 21,318 | 5,030  | 10,672 |

| Total                   | 2,327,090 | 2,944,330 | 63,587 | 80,213 | 32,559 | 40,955 |

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**Case Study – Freeway Express Lanes**
RELIA BILITY ASSESSM EN T

How Traffic Conditions Have Been Communicated

Travel Times

Annual Average

Jan July Dec

Travel Times Vary Greatly Day-to-Day!
(What travelers experience ....)

What People Remember!

Jan July Dec

Case Study – Freeway Express Lanes
## Reliability Assessment

### Case Study – Freeway Express Lanes

- **144 scenarios**
  - Demand variations (PeMS)
  - Incidents (range)
  - Weather (local)
- **Performance metric:** travel time reliability index
  - % of trips with Travel Time Index (TTI) < 3.0 (3x free flow)
  - Introduced as one of the ways of assessing alternatives
    - Travel time, delay, LOS, reliability

### Build Alternative vs Travel Time Reliability Index

<table>
<thead>
<tr>
<th>Build Alternative</th>
<th>Travel Time Reliability Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>1A (No Build)</td>
<td>11%</td>
</tr>
<tr>
<td>1B</td>
<td>7%</td>
</tr>
<tr>
<td>2D</td>
<td>16%</td>
</tr>
<tr>
<td>3A</td>
<td>16%</td>
</tr>
<tr>
<td>3C</td>
<td>45%</td>
</tr>
<tr>
<td>3D</td>
<td>41%</td>
</tr>
<tr>
<td>4D</td>
<td>43%</td>
</tr>
</tbody>
</table>
OVERALL ASSESSMENT (PM AND TECHNICAL)

- Better than simulation
  - Much faster (at least twice as fast)
  - Flexibility as alternatives changed
  - Easy output processing (spreadsheet-based)
  - HCM base
  - New reliability “toy”

- Limitations
  - No animation
  - Simplistic model for weaving at access points
  - Straight pipe only
  - No intersections (Synchro)
OTHER OPPORTUNITIES

- Work Zones - Lane Closure Scenarios
- Demand Variations (COVID Recovery)
- Active Traffic Management/Dynamic Lane Control
- Effects of Incidents/Incident Management
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