The 2010 Highway Capacity Manual

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Outline

- Overview of HCM 2010
- Multi-modal Level of Service
- Summary of Updates to HCM Procedures
- Traffic Simulation/ Alternative Tools
- Planning and Preliminary Engineering Applications
- Conclusion
Overview of HCM 2010

- Comprehensive Discussion of Issues Related to the Capacity of Highway Facilities
- Widely Used in the United States and Worldwide
- Previous Editions
  - 1950
  - 1965
  - 1985 (Major Updates in 1994, and 1997)
  - 2000
- Transit Capacity Discussed in Transit Capacity Manual
The HCM 2010 consists of four volumes
- Volume 1: Concepts
- Volume 2: Uninterrupted Flow
- Volume 3: Interrupted Flow
Multi-Modal Level of Service

- Alternative modes will be integrated into the 2010 HCM far better than before
- Urban street LOS methods will facilitate “complete streets” evaluations
  - Relative service quality provided to each mode’s travelers can be determined
  - Trade-offs of different improvement alternatives or future demand scenarios can be evaluated
  - Toolbox of possible LOS improvement measures will include much more than just traditional auto capacity enhancements
Summary of Updates to HCM Procedures

- Urban Street Facilities
- Urban Street Segments
- Signalized Intersections
- Two-Way Stop-Controlled Intersections
- All-Way Stop-Controlled Intersections
- Roundabouts
- Interchange Ramp Terminals
- Freeway Weaving Segments
- Freeway Merging and Diverging Segments
- Multilane Highways
- Two-Lane Highways
- Freeway Facilities
Chapter 16
Urban Street Facilities

› Scope
  – Facility (= two or more segments)
    - 0.75 to 2.0 miles long in urbanized downtown areas
    - 1.5 to 5.0 miles long in other areas
  – Separate methodology for auto, ped, bike, and transit modes
  – Emphasizes combined evaluation of auto, ped, bike, and transit

› Methodology
  – Aggregates key segment performance measures

› Example Problems
  – Demonstrate integrated multimodal evaluation process
Chapter 17
Urban Street Segments

Scope

- Segment (= link + boundary intersections)
- Signal, TWSC, AWSC, or roundabout boundary intersections
- Models signal coordination
- Separate methodology for auto, ped, bike, and transit modes
Chapter 18
Signalized Intersections

- **Automobile Methodology**
  - *Actuated phase duration prediction*
    - Controller operation inputs
      - Simultaneous gap-out
      - Flashing-yellow-arrow operation
    - Controller phase inputs
      - Passage time
      - Minimum green
      - Recall
      - Dual entry
    - Detector design
      - Detector length
    - Based on HCM 2000 Chapter 16 - Appendix B
Chapter 18
Signalized Intersections

› Automobile Methodology
  - *Procedure for estimating uniform delay*
    - Computes delay by integrating queue polygon
    - Works for all movements and lane assignments
      - Permissive-only left turns from shared lane

\[ d_{1b} = \frac{0.5 \sum_{i=1}^{n} (Q_{i-1} + Q_i) t_{t,i}}{qC} \]
Chapter 18
Signalized Intersections

- **Automobile Methodology**
  - *Performance measures*
    - Automobile control delay
    - Queue storage ratio
      - Percentile queue procedure
    - Volume-to-capacity (v/c) ratio
    - Level of service is based on control delay and v/c ratio
Chapter 19
Two-Way Stop-Controlled Intersections

- Gap acceptance parameters for six-lane streets added
- Interface with urban street segment methodology for upstream signal effects
Chapter 19
TWSC Intersections (cont.)

- Analysis of major street U-turns on 4-lane and 6-lane streets
- Improved analysis of shared/short lanes
- Updated procedure for analyzing unsignalized pedestrian crossings
Chapter 20
All-Way Stop-Controlled Intersections

- Restructure of chapter to make procedure clearer
- Explicit incorporation of details to calculate AWSC with three-lane approaches (details in Volume 4)
- Queuing model added
Chapter 21
Roundabouts

- Incorporates NCHRP Report 572 methodologies (with enhancements and extensions)
- Lane-by-lane analysis of multilane roundabouts
LOS table for roundabouts

- Consistent with TWSC and AWSC due to similar delay formulation and lack of guaranteed service (unlike signals)
- Recognized need for additional research

<table>
<thead>
<tr>
<th>Control Delay (s/veh)</th>
<th>Level of Service by Volume-to-Capacity Ratio*</th>
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<td></td>
<td>v/c ≤ 1.0</td>
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<tr>
<td>0 – 10</td>
<td>A</td>
</tr>
<tr>
<td>&gt;10 – 15</td>
<td>B</td>
</tr>
<tr>
<td>&gt;15 – 25</td>
<td>C</td>
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<tr>
<td>&gt;25 – 35</td>
<td>D</td>
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<tr>
<td>&gt;35 – 50</td>
<td>E</td>
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<tr>
<td>&gt;50</td>
<td>F</td>
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</table>
Chapter 22
Interchange Ramp Terminals

Scope
- Operational evaluation of signalized ramp-crossroad Intersection
- Quick estimation method for interchange type selection
- Methodology addresses auto mode only

Methodology
- Signalized intersection methodology in Chapter 18
- Roundabout methodology in Chapter 22

Elements
- Additional saturation flow rate factors
  - Lane utilization factor
  - Traffic pressure factor
  - Turn radius factor
- Additional lost time procedure
Additional Lost Time Procedure
  - Reduction in effective green period
  - Two causes for reduction
    - Queue spillback
    - Demand starvation

Lost Time Due to Queue Spillback

Northbound incurs additional lost time
Chapter 22
Interchange Ramp Terminals

- Additional Lost Time Procedure
  - Reduction in effective green period
  - Two causes for reduction
    - Queue spillback
    - Demand starvation
- Due to Demand Starvation

Southbound incurs additional lost time
Performance Measures

- Automobile control delay
  - By lane group and movement
  - By origin-destination
- Queue storage ratio
- Volume-to-capacity (v/c) ratio
- Level of service is based on control delay, queue storage ratio, and v/c ratio
CH 12: FREEWAY WEAVING SEGMENTS

› New ways to consider length, width, and configuration.
› New speed-prediction algorithms.
› New approach to weaving capacity.
No significant changes to HCM 2000.
“Reasonableness Check” added to initial predictions of flow in Lanes 1 and 2.
Two minor changes in predictive equations for $v_{12}$ to avoid discrepancies in extreme cases.
No major changes in base methodology.
Like basic freeway segments, no interpolation between free flow curves.
Added analysis procedure for bicycles on multilane highways.
CH 15: TWO-LANE HIGHWAYS

- Two-way analysis methodology deleted.
- Some basic characteristic curves and tables were revised and updated.
- Third class of two-lane highway added as an alternative procedure: Two-Lane Highways in Built-Up Areas. FDOT procedure used.
- Procedure added for bicycles on two-lane highways.
HCM2010 Updates
Chapter 10: Freeway Facilities

› Incorporates all Freeway Chapter Changes, plus

› Definition of Average Facility Density

› LOS Measure and Table

› Increased Emphasis on Impacts of Weather and Work Zones
### Facility and Segments

<table>
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<th>Segment Number</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>
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<td>Segment Type</td>
<td>B</td>
<td>ONR</td>
<td>B</td>
<td>OFR</td>
<td>B</td>
<td>B or W</td>
<td>B</td>
<td>ONR</td>
<td>R</td>
<td>OFR</td>
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<td>2280</td>
<td>1500</td>
<td>5280</td>
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<td>5280</td>
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<td>3</td>
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</table>

**Directional Facility**
Traffic Simulation / Alternative Tools

- New Guidance Based on NCHRP 3-85 and FHWA Research
- Excellent Discussion of the State of the Art of Traffic Simulation
- Gaps in HCM Procedures
- Comparisons of Traffic Simulation Results to HCM Results
- Guidance on How to Use (and Not Use) Traffic Simulation
General Guidance for Volume 1

Ch 6: Analysis Tools

Ch 7: Interpreting and Presenting Results

- Traffic Modeling Concepts,
- Selection Criteria
- Application Framework and Guidelines
- Performance Measures
- Trajectory Analysis
- Stochastic Aspects
Use of Vehicle Trajectory Analysis in Comparing Performance Measures

- Onset of queue
- Holding time for vehicles denied entry to link
- Beginning of stop
- End of stop
- Return to running speed
- Release from queue

2010 Highway Capacity Manual
Planning and Preliminary Engineering Applications

- Improved Guidance on Default Values
- Use of V/C and Similar Measures for LOS F Conditions
Conclusion

› HCM 2010 Has Arrived
› Software Available
› Courses Available Through ITE and TRB