MULTIMODAL LOS IN THE 2010 HCM

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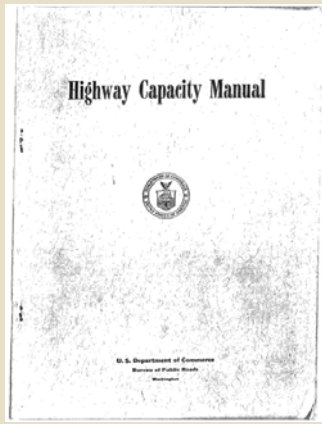
Presentation Overview

- Brief history of multimodal analysis in the HCM
- Issues with the current HCM approach
- 2010 HCM approach
- Examples of multimodal LOS measures for urban street segments

History of Multimodal Analysis in the HCM: 1950 and 1965 Manuals

- 1950 HCM
  - Streetcars and bus impacts on vehicle capacity at traffic signals
  - Pedestrian impacts on vehicle capacity addressed indirectly
- 1965 HCM
  - LOS concept introduced
  - Short (11-page) chapter on bus transit, with little quantitative info



History of Multimodal Analysis in the HCM: 1985 Manual

- New pedestrian chapter
  - Sidewalk and street corner LOS based on space per pedestrian
- New 4-page bicycle chapter
  - Focused mainly on bicycle impacts on vehicular capacity
- Expanded transit chapter
  - Bus capacity methods for bus stops, busways, and terminals
  - LOS based on passenger load and the probability of a queue of buses forming at a bus stop

History of Multimodal Analysis in the HCM: HCM2000

- Expanded pedestrian chapter
  - LOS for more facility types
- Expanded bicycle chapter
  - Provided LOS for off-street paths, bike lanes at traffic signals, and along bike lanes along urban streets
- Revised transit chapter
  - Drew material from the 1999 Transit Capacity & Quality of Service Manual (TCQSM)

History of Multimodal Analysis in the HCM: Issues with Historic Approach

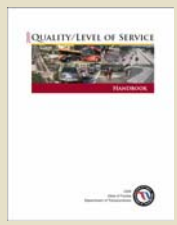
- Generally:
  - Information and analysis tools on non-auto modes are housed in mode-specific chapters that are easy to overlook or ignore
- Bicycle and pedestrian modes:
  - LOS measures generally reflect a traffic engineer perspective
    - Speed, average space, delay
  - Florida & NCHRP 3-70 research suggest these aren't the key factors
- Transit mode:
  - Four transit LOS measures creates comparison difficulties
  - Difficulty keeping HCM in synch with TCQSM updates

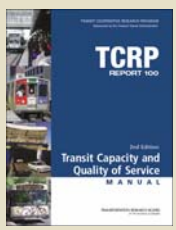
2010 HCM Focus Group Findings

- Many jurisdictions don't require multimodal analyses
  - Therefore, they aren't performed
- Jurisdictions that do want to perform pedestrian & bicycle analyses don't find the current HCM measures useful
  - For example, Maryland & Florida use measures of user comfort
- Most pedestrian and bicycle facilities don't have capacity or speed issues
  - No need to analyze them using HCM procedures
- Users refer to the TCQSM for transit-specific information

Multimodal Research Since HCM2000

- FHWA-sponsored research on off-street path LOS (2006)
- Florida DOT research on on-street ped & bike LOS
  - Florida Quality/Level of Service Handbook (2002 & 2009)
- TCQSM, 2nd Edition (2003)
- NCHRP 3-70, Multimodal Level of Service Analysis for Urban Streets (2008)





2010 HCM Approach (1)

- Integrate multimodal concepts throughout the HCM
  - Encourages HCM users to consider all roadway users in their analysis and decision-making processes
  - Conceptual non-auto material integrated into Volume 1 chapters
  - Methods for determining LOS and other performance measures integrated into facility-specific chapters in Volumes 2 & 3
  - No separate all-inclusive transit, bicycle, pedestrian chapters
- Readers referred to TCQSM for transit-specific info
  - Transit LOS provided for urban streets (multimodal context)
  - Funding approved for a TCQSM 3rd edition (~2013 publication)
  - Technical transit material generally removed from HCM (concepts remain)

A Look Ahead to the
2010 HCM

2010 HCM Approach (2)

- Analysts should consider modal interactions, trade-offs

Mode Affected	Impacting Mode: Auto	Pedestrian	Bicycle	Transit
Auto	Auto & HV volumes Turning patterns Lane configurations	Minimum green time Turn conflicts Mid-block xings	Turn conflicts Passing delay	Heavy vehicle Blocking delay: stops Signal priority
Pedestrian	Auto & HV volumes Cycle length Driver yielding Turn conflicts Traffic separation	Sidewalk crowding Crosswalk crowding Cross-flows	Shared-path conflicts Bicyclist yielding	Heavy vehicle Transit stop queues Stop cross-flows Vehicle yielding
Bicycle	Auto & HV volumes Auto & HV speed On-street parking Turn conflicts Traffic separation	Shared-path conflicts Min. green time Turn conflicts Mid-block xings	Bike volumes	Heavy vehicle Blocking delay: stops Tracks
Transit	Auto volumes Signal timing	Ped. env. quality Minimum green time Turn conflicts Mid-block xings	Bike env. quality Bike volumes	Bus volumes

2010 HCM Approach (3)

- Greater consideration of the traveler point-of-view through the use of traveler-perception models
  - Models allow more service-quality factors to be considered than traditional HCM measures
  - Models set LOS thresholds based on traveler responses to actual conditions
  - Many non-auto service measures are LOS scores
    - ➢ Predicts the average rating that users of a specific mode would give a specific system element under given conditions
    - ➢ LOS score cannot be measured directly in the field
    - ➢ Modal LOS scores for urban streets can be directly compared to each other (score has same meaning across modes)

Service Measures in the 2010 HCM

System Element	Chapter	Service Measure Provided			
		Auto	Pedestrian	Bicycle	Transit
Freeway Facility	10	✓			
Basic Freeway Segment	11	✓			
Freeway Weaving Segment	12	✓			
Freeway Merge/Diverge Segment	13	✓			
Multilane Highway	14	✓		✓	
Two-Lane Highway	15	✓		✓	
Urban Street Facility	16	✓	✓	✓	✓
Urban Street Segment	17	✓	✓	✓	✓
Signalized Intersection	18	✓	✓	✓	
Two-Way Stop	19	✓	✓		
All-Way Stop	20	✓			
Roundabout	21	✓			
Interchange Ramp Terminal	22	✓			
Off-Street Pedestrian/Bicycle Facility	23		✓	✓	

Pedestrian LOS: Urban Street Segments

- Model incorporates these factors:
  - Outside travel lane width
  - Bicycle lane/shoulder width (acts as buffer from auto traffic)
  - Physical buffer presence (e.g., on-street parking, street trees)
  - Sidewalk presence and width
  - Volume and speed of motor vehicle traffic in outside travel lane
- Pedestrian density considered separately
  - Worse of (density LOS result, perception-based LOS result) determines the segment LOS

Pedestrian LOS: Urban Street Segments

$$\text{Ped Segment LOS} = -1.2276\ln(W_{ol} + W_l + f_p \times \%OSP + f_b \times W_b + f_{sw} \times W_s) + 0.0091(V_{15}/L) + 0.0004\text{SPD}^2 + 6.0468$$

LOS	Ped Segment LOS Score
A	≤2.00
B	>2.00–2.75
C	>2.75–3.50
D	>3.50–4.25
E	>4.25–5.00
F	>5.00

Same LOS scale used for the bike, transit, and auto modes

See NCHRP Report 616 for information on how these were derived

Bicycle LOS: Urban Street Segments

- Model incorporates these factors:
  - Volume and speed of motor vehicle traffic in outside travel lane
  - Heavy vehicle percentage
  - Pavement condition
  - Bicycle lane presence
  - Bicycle lane, shoulder, and outside lane widths
  - On-street parking presence and utilization

Transit LOS: Urban Street Segments

- Model incorporates these factors:
  - Service frequency
  - Average bus speed
  - Bus reliability (excess wait time)
  - Average passenger load
  - Shelter, bench presence
  - Pedestrian LOS score for segment
- "Transit" covers on-street bus, streetcar, light rail
  - Refer to the TCQSM for LOS measures for exclusive transit facilities, routes in general, and transit service areas

Auto LOS: Urban Street Segments

- Perception score model incorporates these factors:
  - Number of stops
  - Left-turn lane presence
- This model had the best fit to the data, but testing around the US found an agency preference for the HCM's current speed-based LOS
- 2010 HCM will present two models:
  - Speed-based (used for determining auto LOS)
  - Perception-based (scores can be used to compare service quality between modes, but no LOS letter attached to them)

Summary

- 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