Pedestrian LOS For Urban Streets

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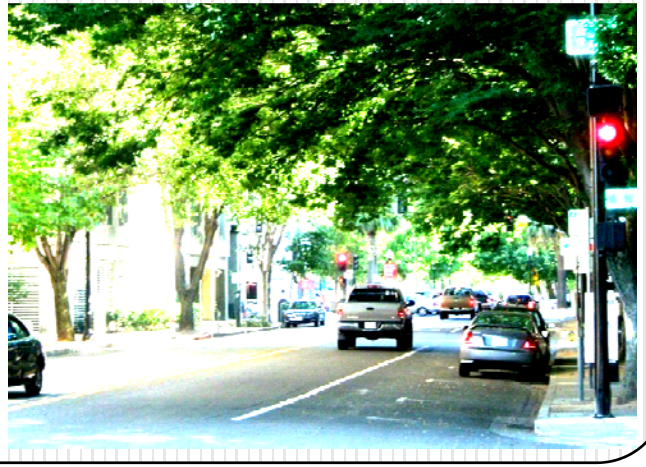


NCHRP 3-70 Research Project

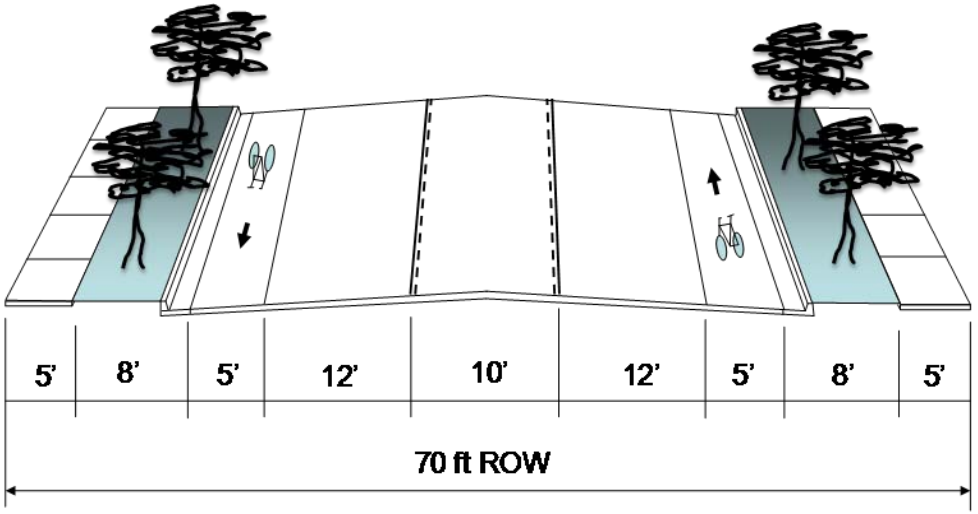
- Objective: To develop a scientific basis for evaluating multimodal LOS on urban streets
- 4-year, $1.1 million project
- U.S. modal experts
  - Dr. Aimee Flannery, George Mason University (Auto)
  - Dr. Nagui Rouphail, North Carolina State University (Auto)
  - Bruce Landis, Sprinkle Consulting (Bicycle)
  - Theo Petritsch, Sprinkle Consulting (Pedestrian)
  - Paul Ryus, Kittelson Associates (Transit)

Data Collection

- Selected and shot video clips of 90 typical street cross sections from point of view of auto driver, bicycle rider, and pedestrian.
- Showed the clips to 120 people in video labs in four cities.
  - College Station, Texas
  - New Haven, Connecticut
  - San Francisco, California
  - Chicago, Illinois
- Asked to rate each clip's trip experience from "best" to "worst."

Multimodal LOS Philosophy

- MMLOS – multimodal level of service
- Each urban street right-of-way is shared by 4 major types of users:
  - Automobile Drivers
  - Transit Passengers
  - Bicyclists
  - Pedestrians



- The urban street should serve all users

Definition of MMLOS

- MMLOS is the degree to which the urban street design and operations meets the traveling needs of each user type.
- Four level of service grades for each street:
  - Auto LOS
  - Transit LOS
  - Bicycle LOS
  - Pedestrian LOS
- MMLOS is a Report Card

Bancroft Avenue Level of Service		
User Type	AM Pk Hr	PM Pk Hr
Auto	C	E
Transit	B	C
Bicycle	D	C
Pedestrian	C	D

Factors Influencing Pedestrian LOS

- Auto Traffic and Speeds, Percent Trucks
- Lateral Separation between Vehicles and Pedestrians
  - Buffers
  - Barriers
- Crossing Difficulty
  - At intersections
  - Mid-block
- Pedestrian Density

Pedestrian LOS Model

- If there is pedestrian/bike shared use path parallel to street:
  - Then go to existing shared use method in HCM Chapter 18
- If bikes and peds do not share sidewalk, then Pedestrian LOS is the worse of:
  - Pedestrian Density LOS
    - See HCM Chapter 18
  - Non-Density LOS
    - The NCHRP 3-70 MMLOS model (FDOT models)

NCHRP 3-70 Pedestrian LOS Model

$$LOS = (0.318\ Segment + 0.220\ Intersection + 1.606) * (RCDF)$$

RCDF = Roadway Crossing Difficulty Factor

LOS Model Outputs	LOS Letter Grade
Model <=2.00	A
2.00 < Model <= 2.75	B
2.75 < Model <= 3.50	C
3.50 < Model <= 4.25	D
4.25 < Model <= 5.00	E
Model > 5.00	F

Pedestrian Segment LOS

- FDOT Model, function of:
  - Lateral separation between vehicles and pedestrians
    - Barriers (trees, bushes, barricades)
    - On-Street parking
  - Presence of sidewalk
  - Width of sidewalk
  - Vehicle volumes
  - Vehicle speeds

FDOT Pedestrian Segment LOS

$$\textbf{Ped Seg LOS} = -1.2276 \ln (W_{ol} + W_l + f_p \times \%OSP + f_b \times W_b + f_{sw} \times Ws) + 0.0091(Vol_{15}/L) + 0.0004\, SPD^2 + 6.0468$$

Ped Seg LOS	= Pedestrian level of service score for a segment (≤ 2.0 = A, > 5.0 = F)
ln	= Natural log
W_{ol}	= Width of outside lane
W_l	= Width of shoulder or bicycle lane
f_p	= On-street parking effect coefficient (= 0.20)
%OSP	= Percent of segment with on-street parking
f_b	= Buffer area coefficient (= 5.37 for trees spaced 20 feet on center)
W_b	= Buffer width (distance between edge of pavement and sidewalk, in feet)
f_{sw}	= Sidewalk presence coefficient (= 6 - 0.3W_s)
W_s	= Width of sidewalk
Vol_{15}	= Volume of motorized vehicles in the peak 15 minute period
L	= Total number of directional through lanes
SPD	= Average running speed of motorized vehicle traffic (mi/h)

Pedestrian Intersection LOS

- FDOT Signalized Intersection Model, Function of:
  - Right turns on red
  - Left turns during "Walk" phase
  - Cross-street vehicle traffic
  - Cross-street vehicle speeds
  - Lanes on the cross-street
  - Vehicle volumes
  - Vehicle speeds
  - Delay waiting to cross at signal
- Only for signalized intersections

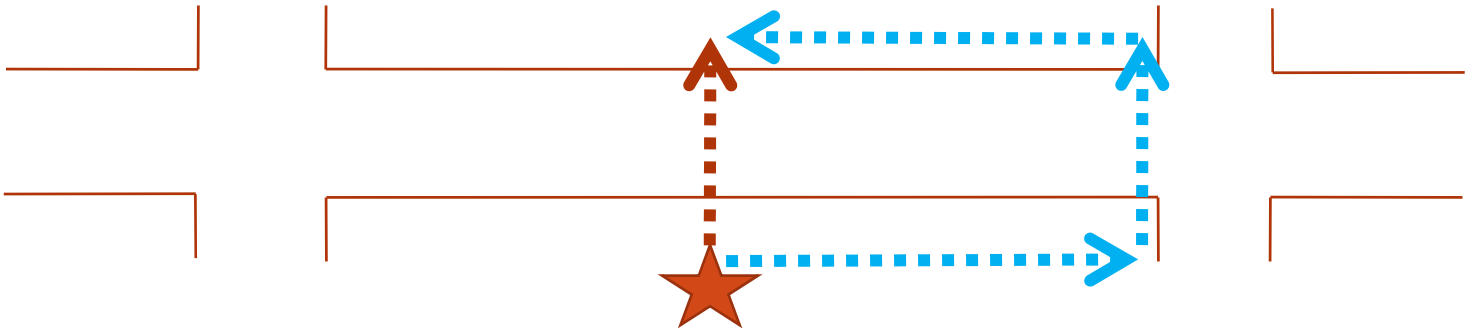
FDOT Pedestrian Intersection LOS

Ped Int LOS = 0.00569(RTOR+PermLefts) + 0.00013(PerpTrafVol*PerpTrafSpeed)
+ 0.0681(LanesCrossed$^{0.514}$) + 0.0401ln(PedDelay at signal)
- RTCI(0.0027PerpTrafVol – 0.1946) + 1.7806

- RTCI = right turn channel islands (0, 1, 2)
- Ped Int LOS ≤ 2.0 then LOS "A"
- Ped Int LOS > 5.0 then LOS "F"

Ped. Midblock Crossing Difficulty

- Can increase or decrease pedestrian LOS by up to 20%.
- Factor is related to the minimum of:
  - Delay waiting for gap in traffic
  - Delay walking to nearest signalized intersection
- Can turn off this computation, if desired.



Roadway Crossing Difficulty Factor

$$RCDF = (XLOS-NXLOS)/7.5 + 1.00$$

Subject to: $0.80 \leq RCDF \leq 1.20$

Minimum of Wait or Divert Delay (Seconds)	XLOS
10	1
20	2
30	3
40	4
60	5
> 60	6

- XLOS = roadway crossing LOS
- NXLOS = pedestrian LOS without crossing roadway

NXLOS – Non-Crossing LOS

$$LOS = 0.318\ Segment + 0.220\ Intersection + 1.606$$

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Software Implementations

- Research grade spreadsheet
  - Unsupported, no cost
- If/When incorporated in HCM 2010
  - May be incorporated in commercially available software (HCS)
  - Post June 2010

To Learn More

- Final Report: NCHRP Report #616
  - *http://onlinepubs.trb.org/onlinepubs/**nchrp**/**nchrp**_rpt_**616**.pdf*
- User's Guide: NCHRP Web document 128
  - *http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_w128.pdf*
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