Level of Service Model for Signalized Intersections for Pedestrians

Submitted: July 31, 2004
Revised: November 10, 2004
Word Count: 5,482 words plus 8 tables/figures = 7,482

By
Theodore A. Petritsch - Corresponding Author
Bruce W. Landis
Peyton S. McLeod
Herman F. Huang
Srikalyan Challa

Sprinkle Consulting Inc.
18115 U.S. Highway 41 North, Suite 600
Lutz, FL 33549
Phone: (813) 949-7449
Fax : (813) 948-1712
E-mails: tap@sprinkleconsulting.com
landis@sprinkleconsulting.com
pmcleod@sprinkleconsulting.com
huang@sprinkleconsulting.com
challa@sprinkleconsulting.com

Martin Guttenplan
Florida Department of Transportation
605 Suwannee Street, MS 19
Tallahassee, Florida 32399-0450
Phone: (850) 414-4900
Fax: (850) 921-6361
E-mail: martin.guttenplan@dot.state.fl.us

ABSTRACT

This paper documents a Florida Department of Transportation sponsored study to develop a Level of Service (LOS) model that accurately represents pedestrians' perceptions of crossings at signalized intersections. This model incorporates perceived safety/comfort (*i.e.*, perceived exposure and conflicts) and operations (*i.e.*, delay, and signalization). Data for the model were obtained from an innovative "Walk for Science" field data collection event and video simulations. The data consist of (1) participants' perceptions of safety/comfort and operations as they walk selected signalized intersections and (2) the design and operational characteristics of these intersections. The resulting model provides a measure of the pedestrian's perspective on how well an intersection's geometric and operational characteristics meets his/her needs.

The Pedestrian LOS model for intersections described in this paper is based upon Pearson correlation analyses and stepwise regression modeling of approximately 800 combined real-time perceptions (observations) from pedestrians walking a course through a typical U.S. metropolitan area's signalized intersections. An additional 800 combined perceptions obtained from the same participants viewing a video simulation (discussed in another paper) were used to refine the model for complex intersections. The study participants represented a cross section of age, gender, walking experience, and residency. Although further hypothesis testing may be conducted in a future study, the resulting general model for the Pedestrian LOS at intersections is highly reliable, has a high correlation coefficient (R^2=0.73) with the average observations, and is transferable to the vast majority of metropolitan areas in the United States. The study reveals that right-turn-on-red volumes for the street being crossed, permissive left turns from the street parallel to the crosswalk, motor vehicle volume on the street being crossed, midblock 85 percentile speed of the vehicles on the street being crossed, the number of lanes being crossed, and the pedestrian's delay, and the presence or absence of right-turn channelization islands are primary factors in the Pedestrian LOS model for intersections.

BACKGROUND

The Highway Capacity Manual (HCM) provides two methodologies for determining the pedestrian LOS at signalized intersections (*1*). One is based upon the signal delay incurred by the pedestrian. The second is based on pedestrian space requirements. While delay and space requirements are easily quantifiable, previous research suggests delay and space do not represent all the factors which determine the level of accommodation perceived by the pedestrian. Sisiopiku (*2),* Khisty (*3*), Crider (*4*), Jaskiewicz (*5*), Landis (*6*), and Chu and Baltes (*7)* have all identified that factors beyond those used in the HCM which influence pedestrians' impressions of how well a road facility serves their needs. The Florida Department of Transportation (FDOT) has adopted, into its Quality/Level of Service Handbook (*8*), the user perception based pedestrian LOS model developed by Landis (6). In addition, the ongoing research project NCHRP 3-70 is exploring using user based measures to define the Level of Service for arterial roadways.

This paper describes the development of a field calibrated, statistically-reliable Pedestrian LOS model for signalized intersections. It details the research design, data analysis and model development performed as part of this important project. It also presents the final model as modified with the results of the video simulation calibration project (a complete description of the video simulation project is provided in a separate paper).

DESIGN OF RESEARCH

Pedestrians typically express their opinions of how well a particular intersection accommodates their travel by referring to the perceived safety or comfort and delay when crossing a signalized intersection. Accordingly, this study placed its participants on actual metropolitan area roadways and through signalized intersections under typical traffic conditions.

A special "Walk for Science" event was created to place a significant number of pedestrians on a roadway course that would take them through various signalized intersections. The purpose was to obtain the pedestrians' real-time responses to the intersection environment stimuli and to create and test a mathematical relationship of measurable factors to reflect the study participants' reactions. The research was designed to elicit responses from participants walking individually, not in pairs or groups.

The Walk for Science collected data for three major studies: an Intersection LOS (this) study, a Roadway Facility LOS study, and a video simulation study. In each study, the participants first watched and scored a video simulation before proceeding to walk and grade an actual walking course under real-life conditions. This paper describes the results of the Intersection LOS study on the actual walking course.

Participants

To ensure a large turnout for data analysis purposes, the study team sought both volunteer and paid participants. The volunteer participants were recruited through newspaper notices and registration displays at public buildings and sporting goods stores. The paid participants were recruited from a local temporary employment agency. The real-time data collection activity was promoted as an event entitled the *Walk for Science 2004.* It was held on Friday, April 30, 2004 in Sarasota, Florida. Approximately 100 people participated in the event.

Participants completed registration forms, either in advance or on the day of the event. The registration forms included questions to generate background information about the participants – age, gender, years living in Sarasota, and miles walked per week.

Half of the participants participated in the Intersection LOS study. They represented a good cross section of age, gender, and geographic origin. Participants ranged in age from 12 to 76. The gender split of the study was 67 percent females and 33 percent males. Most (85 percent) participants had lived in areas other than the Sarasota region for the majority of their lives. Thirty-five percent of the participants reported walking at least 11 km (7 miles) per week.

Intersection Course

The Walk for Science course ran through a broad spectrum of land use patterns typically found in U.S. metropolitan areas. Held in the areas within and around downtown Sarasota Florida, the course wound through land uses that included downtown offices, shops, and restaurants; neighborhood parks; single-family homes, apartments, and high-rise condominiums; small strip centers; and vacant lots. The course allowed participants to experience a variety of intersection configurations and traffic conditions. Approximately 5 km (3 mi) in length, the course included 23 intersection crossings (of which 21 had pedestrian signals) (Figure 1). Crossing distances ranged from 10.7 to 32.0 m (35 to 105 ft). The narrowest crossings had two lanes (no exclusive right- or left-turn lanes), and the widest crossings had six lanes (including exclusive right- and left-turn lanes). Some crossings had medians and other crossings did not. Fifteen-minute traffic counts on the curbside through lanes of the streets being crossed ranged from 0 to 267 vehicles, depending on the location and the time of day when the participant crossed.

The pavement through the course intersections was in good condition. Additionally, all push buttons were checked to ensure that they were operational (at the study team's request, city staff replaced a non-operational push button).

There was some concern that the quality of the facility along which the pedestrians walked while approaching the study intersections would influence the intersections' scores; and, in fact, if the existing FDOT segment Level of Service Model for Pedestrians would be adequate to describe pedestrians' perceptions of intersections. Consequently, data was collected on the roadway approaches to the crossings along the course. The width of the outside motor vehicle lanes was generally 3.1 to 3.7 m (10 to 12 ft). Sidewalks were present along the entire length of the course. The sidewalk widths ranged from 1.2 to 2.1 m (4 to 7 feet). Most approaches had buffer widths between the sidewalk and the roadway of 0 to 3.1 m (0 to 10 ft); the widest buffer measured 16.8 m (55 ft). Posted speed limits ranged from 40 to 72 km/h (25 to 45 mi/h) and observed 85th percentile speeds ranged from 45 to 71 km/h (28 to 44 mi/h). Fifteen-minute traffic counts for the outside through lane on the intersection approaches ranged from 4 to 225 vehicles, again depending on the specific location and time. These data allow the researchers to determine if the approach roadway segment Level of Service Model for pedestrians would accurately represent the intersection LOS for pedestrians.

Data Collection

Each participant was provided a scorecard to carry during his or her individual walk. On the right side of the scorecard was a map with the numbered study intersections shown; on the left side, each intersection number was listed followed by the letters, A through F. Participants received two briefings before walking: a video simulation (see next section) briefing and a course briefing. At the video simulation briefing, participants were told to "Circle the letter grade that best describes how well you feel the intersection accommodates and serves your needs as a pedestrian" and that "Each section can be graded from "A" to "F" with "A" representing the best and "F" representing the worst. You can change your grades at any time; simply cross through the old grade and circle the new grade." At the course briefing, participants were told that, "The grading process is the same as it was in the video room. Again, you can change your grades at any time."

Participants were also told to obey the traffic signals when crossing the intersections. Specifically they were told:

> *"When crossing intersections you must obey all traffic laws. This means –*
>
> - *Only begin crossing intersections when the pedestrian signal shows a WALK display or the white "walking man" symbol. If there is no pedestrian signal you may cross when the traffic signal is green for the parallel roadway traffic.*
> - *If the pedestrian signal starts flashing "DON'T WALK," or starts flashing a "red hand" at you, and you've already started to cross the street, go ahead and finish. You should still have plenty of time to complete your crossing.*
> - *Do not begin crossing on the flashing DON'T WALK phase or the solid DON'T WALK phase.*
>
> *Failure to comply with these rules will result in your data being considered invalid, and your scores will not be counted as part of this project."*

The sign graphic shown in Figure 2 was provided on the back of each scorecard. Obedience to the traffic control devices was considered critical to the relevance of this project: as the intent of the project was to determine how geometric and operational characteristics of signalized intersections impacted the pedestrians' perceptions, it was important that the participants experienced each intersection as it was designed to operate. Only by requiring that participants obey the traffic signals could the researchers ensure the participants were accurately scoring the intersections' actual operations.

Similar to the distinction between segment and intersection analysis in the HCM's level of service determinations (*1*), the study's purpose was to evaluate the quality or level of service of the intersections, not the roadway segments between intersections. Accordingly, participants were instructed to consider only conditions within the intersections and their approach lanes, marked with "BEGIN INTERSECTION" and "END INTERSECTION" signs, when grading the intersections. Participants were also told not to consider any of the following while grading:

- Conditions of the road segment before the intersection start signs or after the intersection end signs
- Aesthetics, neighborhood quality, or condition of adjacent property
- Anything outside the intersection itself or its sidewalks

Extensive data was collected at each intersection with video observations. Elevated wide-angle black-and-white video cameras were linked to traffic signal strain poles. Color video cameras were mounted near the landings to record participants' behavior as they activated pedestrian push buttons. All cameras were connected to VCRs. The video data was subsequently reduced to obtain participant delay at each intersection. Tube counters were used to collect real-time traffic volume data (in 15-minute intervals). Turning movements (also in 15-minute intervals) were obtained from the wide-angle videos.

Event Day

The day of the event, Friday, April 30, 2004, was mostly sunny and warm, with afternoon temperatures around 30 degrees Celsius (86 degrees Fahrenheit). The first participant started walking the course shortly after 10:00 AM; the last participant finished walking the course shortly after 6:00 PM.

After registering, participants were assigned to either the Intersection LOS or the Facility LOS study. Prior to walking, intersection study participants watched and scored an intersection video, and facility participants watched and scored a facilities video. The video simulation results are described in another research paper.

The event personnel included staff from Sprinkle Consulting, Inc., FDOT, the University of South Florida, members of the NCHRP 3-70 project team, and a temporary employment agency. They ensured temporally spaced starts, individual walking and scoring among participants, and made sure that participants kept current completed response cards.

Because there could be no attempt to “control” traffic or influence pedestrian or motorist behavior through placement of law enforcement officials, and because the pedestrians crossed streets with motor vehicles, there was a degree of risk involved. This was explained to the participants in advance through the registration forms and during a pre-walk briefing session.

Participants were also assured that they could stop at any time along the route and be picked up by a support vehicle if they needed to or wanted to leave the course. Proctors were deployed at each of the intersections and all precautions were taken in the event of an emergency, including assistance vehicles that circulated throughout the course. There were no reported incidents that required medical attention. Participants were offered water before starting and after finishing their walk. They were also informed that they could stop at any business along the route if they wanted to purchase something additional to drink.

ANALYSIS OF DATA AND INITIAL HYPOTHESIS TESTING

Considerable data on both participants and course attributes were collected to permit hypothesis testing. The participant responses indicated a well distributed range for the perceived level of accommodation through the study intersections. Figure 3 shows the distribution of intersection scores. The relationship of numerical scores to letter grades is shown in Table 1. (These numerical cutoff points will be tested using a probit model by the project NCHRP 3-70 to determine if they should be adjusted.)

Four major hypotheses were tested prior to the development of a Pedestrian LOS model for intersections. They are:

1. Participants would score the intersections differently according to their demographic characteristics.
2. Pedestrians crossing walking *with* traffic (in the same direction as traffic in the lanes adjacent lanes parallel to the crosswalk) would score the intersections differently than pedestrians crossing walking *against* traffic.
3. The Pedestrian LOS model for *roadway segments* does not adequately predict how well *intersections* serve pedestrians.
4. Paid participants would not score intersections differently than volunteer participants.

The results are described below.

Hypothesis 1 – Participants would score the intersections differently according to their demographic characteristics.
Participants were divided into groups according to several demographic characteristics (Table 2). The T-test was performed to determine if the groups within each characteristic graded the intersections differently. At a significance level of 0.05, the majority of the observed differences were <u>not</u> significant. The results do not support Hypothesis 1.

Hypothesis 2 - Pedestrians crossing walking *with* traffic (in the same direction as traffic in the lanes adjacent lanes parallel to the crosswalk) would score the intersections differently than pedestrians crossing walking *against* traffic.
If this is the case, the model would be direction-dependent. The course was designed so that there were at two instances where pedestrians crossed in the same crosswalk but in opposite directions (Intersections 1 and 23; Intersections 5 and 14). The T-test was performed to compare the scores that participants gave for Intersections 1 and 23, and for Intersections 5 and 14. The differences in the scores were <u>not</u> significant for either pair of intersections. The results do not support Hypothesis 2.

Hypothesis 3 – The Pedestrian LOS model for *roadway segments* does not adequately predict how well *intersections* serve pedestrians.
To test this hypothesis, the existing Pedestrian LOS model for roadway segments (6) was used to calculate the parallel and perpendicular segment LOS for each intersection. The T-test was performed to compare the calculated LOS values with the scores that each participant gave for each intersection. The results showed that there were significant differences in the calculated LOS values for parallel approaches vs. the actual participants' scores (p-value = $1.06X10^{-8}$) and in the calculated LOS for perpendicular approaches vs. the actual scores (p-value = $1.48X10^{-24}$). The results support Hypothesis 3 and suggest that a specific Pedestrian LOS model for signalized intersections needs to be developed.

Hypothesis 4 – Paid participants would not score intersections differently than volunteer participants.
The T-test was performed to determine if volunteer participants and paid participants graded the intersections differently. At a significance level of 0.05, there was no difference in how volunteer and paid participants graded. This result supports Hypothesis 4 and suggests that volunteer participants can be used (instead of paid participants) for pedestrian events, thereby reducing data collection costs for pedestrian model development projects.

MODEL DEVELOPMENT

A fifth hypothesis of this project was as follows:

Hypothesis 5 – A regression model can be developed to mathematically represent pedestrians' perceptions of how well a signalized intersection accommodates pedestrians' needs.

This study sought to mathematically express the geometric, operational, and traffic characteristics that affect pedestrians' perceptions of quality of service, or level of accommodation, through intersections. The following process was applied in developing the preliminary model: (a) identify which variables are relevant (via Pearson Correlations), (b) test for the best configuration of each variable (or combinations/transformations thereof), and (c) establish the coefficients for the variables (or combinations/transformations thereof) that result in the best-fit regression model.

A "long list" of potential primary independent variables influencing pedestrians' sense of safety or comfort within the intersection was generated and then tested (along with numerous other potential factors) in the stepwise regression portion of the model's development. Items that were included on this preliminary list, and issues considered, included but were not limited to the following:

Perceived Conflicts

The researchers expected that pedestrians would perceive conflicts to include not just those vehicles that cross the pedestrians' path (crosswalk), but also those passing so close to the pedestrians as to make them uncomfortable. Consequently, the through volume in the lane adjacent to the crosswalk was considered. Thus potential conflict factors were thought to include the following:

- Right turning motorists from the street parallel to the crosswalk
- Right turn on red motorists from side streets
- Through motorists on the street parallel to the crosswalk
- Left turning motorists approaching from the street parallel to the crosswalk

Perceived Exposure

As stated above, the exposure perceived by the pedestrian was believed to be influenced by more than simply the time the pedestrian is within the roadway. Traffic control devices may also influence a pedestrian's perception of exposure and therefore correlation therewith should be explored. Thus, some of the factors influencing pedestrians' perceived level of exposure were thought to include the following:

- Crossing distance (cross-street width plus a portion of the intersection radii)
- Presence of crosswalk – possibly modified by type of markings
- Other traffic control devices – NO RIGHT TURN ON RED signs, YIELD TO PEDESTRIANS signs, etc.
- Presence of curb and/or sidewalk (at waiting/landing areas)
  Median type (raised, painted, or none)

Delay

For signalized intersections, it was hypothesized that a pedestrian's perception of the intersection is a function of the delay experience: waiting for the green light (or walk phase) to cross the street. The HCM describes methods for calculating pedestrian LOS at intersections based on this approach (*1*). Since pedestrians crossing at signalized intersections are required to obey the traffic control signals, the (theoretical) crossing delay at a signalized intersection is a function of cycle length and the length of the WALK phase for crossings with a pedestrian signal. For crossings without a pedestrian signal, it is a function of the facility's cycle length and g/C. (Although many pedestrians – particularly in suburban areas – do not wait for the appropriate signal phase to cross, it important that the LOS evaluations model only legal movements.) An equation for calculating the delay to pedestrians at a signalized intersection is provided in the HCM. The impact of this delay upon the pedestrian's perception of level of service was expected to be included within our developed model.

Pearson correlation and factor analysis of the extensive array of intersection and traffic variables with respect to the pedestrian level of service model for signalized intersections were employed. Subsequently, the following relevant variables were selected in the second step of the model development process: right-turn-on-red volumes for the street being crossed, permissive left turns approaching from the street parallel to the crosswalk, motor vehicle volume on the street being crossed, speed of the street being crossed, the number of lanes being crossed, and the pedestrian's delay. Other variables were dropped from further consideration because of their poor correlation with the dependent variable, Level of Service score for the pedestrians crossing signalized intersections, or because of their collinearity with more strongly correlated variables. The short list of variables represented the best surrogate measures for some of the more complex operational measures. Initial testing of various transformations yielded the following model format:

$$\text{Pedestrian LOS for Signalized Intersections} = a_1(\text{RTOR+PermLefts}) + a_2(\text{PerpTrafVol*PerpTrafSpeed}) + a_3(\text{LanesCrossed}^{0.514}) + a_4\ln(\text{PedDelay}) + C \quad (1)$$

where

RTOR+PermLefts = sum of the number of right-turn-on-red vehicles and the number of motorists making a permitted left turn in a 15 minute period

PerpTrafVol*PerpTrafSpeed = product of the traffic in the outside through lane of the street being crossed and the midblock 85th percentile speed of traffic on the street being crossed in a 15 minute period

LanesCrossed = the number of lanes being crossed by the pedestrian

PedDelay = average number of seconds the pedestrian is delayed before being able to cross the intersection

C = constant

Stepwise regression analysis was conducted using the combined 800 observations. Table 3 shows the terms, coefficients, and T-statistics for the model. The correlation coefficient (R^2) of the best-fit model is 0.77 based on the averaged observations from the 22 signalized intersection crossings included in the final analysis (one intersection was removed from the analyses because of incomplete data). The coefficients are statistically significant at the 95 percent level.

INCORPORATION OF VIDEO SIMULATION DATA

Concurrent with the Walk for Science field event, a video simulation event was held to obtain additional data for this study. This video simulation involved participant rating of intersections in a controlled environment. Some of the intersections in the video corresponded to intersections on the walking course. The video simulation was created to compare its observations to those from the walking course for common intersections to determine whether people perceive things differently in a controlled environment than while in the actual roadway environment. It was also used to expand the range of variables to which participants were exposed.

It was hypothesized that a significant difference in perception does exist and that a mathematical function is needed to calibrate the video simulation scores before the data can be used to accurately predict responses from the roadway environment itself. This hypothesis proved to be true. Consequently, we were able to expand our research to include more complex intersections the model.

Right Turn Channelization Islands

Based upon further analysis using the video supplemented data, the following function was determined to describe the effect of right turn channelization islands on the perceptions of pedestrians at intersections.

$$\text{Change in Level of Service Score} = -\,\text{RTCI}(0.0027\,\text{PerpTrafVol} - 0.1946)$$

where

RTCI = number of right turn channelization islands on crossing

The incorporation of this term into the original equation resulted into a final R-squared of the overall model based upon the combined 1600 observations to 0.73. See Figure 4 for a plot of predicted Pedestrian LOS for Signalized Intersections versus mean observed values.

DISCUSSION OF FINDINGS

The terms found to be significant and included within the model suggest that the perceived conflicts, perceived exposure and delay, do in fact contribute to pedestrians' perceptions of how well they feel they are accommodated at signalized intersections.

The perceived conflicts term includes only the right turn on red (RTOR) and permitted left turn conflicts. The effects of the through movement parallel to the crosswalk and right turners from the parallel roadway were found to be not significant. The authors believe this may be because pedestrians accept the fact that the motorists on the parallel roadway and motorist with the green light will be turning across the crosswalk. However, RTOR movements and left turns may have been viewed as less predictable and therefore more dangerous conflicts.

Pedestrians' perceptions of exposure are represented by two terms in the equation. The first term includes the volume of the perpendicular street and the speed at which the perpendicular traffic travels. It was found that as the speed of the traffic increased, the impact of volume on the pedestrians' perceptions of level of accommodation increased.

The second term related to exposure is the number of lanes crossed. This term was highly collinear with crossing distance which would include the width of a median island (if present) and additional crossing length within the curb radius areas. However, pedestrians appeared to be affected more by the number of traffic lanes they had to cross than the actual distance crossed.

The pedestrian delay is the final term included in the regression equation developed from the field event data. Because the transformation for this variable is the natural log, as the delay increases, any additional delay has a reduced influence on the pedestrians' perception of level of accommodation.

Using the data from a video simulation event held concurrently with the field event, the presence of right turn channelization islands was found to have an impact on pedestrians' feelings of how well an intersection meets their needs. As can be seen in Figure 5, at low perpendicular approach volumes, the addition of right turn channelization islands has a detrimental effect on the pedestrians' perceptions of level of accommodation. As the perpendicular approach volume increases, the detrimental effect is reduced. Eventually, as the perpendicular approach volume becomes high enough, pedestrians view the addition of right turn channelization islands as improving their accommodation.

Of the variables included within the model, three can be controlled by the traffic engineer designing a signalized intersection's signal plan. Average delay is a function of the length of the WALK signal and the cycle length. It may be possible to use blank-out signs to restrict permissive left turns and right turn on red movements when pedestrians are present or, in some cases, these movements can be eliminated.

A probit model was also developed using these parameters. When using both models on the same set of intersections, the probit model yielded the same Level of Service grades (A through F) as the stepwise linear regression.

APPLICATIONS

The participants in this study represented a broad cross section of the U.S. population of pedestrians, and the course's intersections were typical of those prevalent in the urban and suburban areas of the United States. The initial result of this research is the development of a highly reliable, statistically calibrated Pedestrian LOS model for intersections, suitable for application in the vast majority of U.S. metropolitan areas.

In application, the equation would likely be programmed into a spreadsheet and the input variables would change somewhat. It is likely that the inputs used for motor vehicle analysis would be used as independent variables in a programmed spreadsheet. For example, hourly traffic volumes and peak hour factors would be used instead of 15 minute values. Speed limit (or some transformation thereof) would probably be used as a surrogate for 85th percentile speed. The average delay for pedestrians would be calculated from Equation 18-5 from the Highway Capacity Manual using the cycle length and effective green time for pedestrians as inputs.

The Pedestrian LOS model for *segments* is used by numerous jurisdictions to determine the level of accommodation provided to pedestrians on roadways between intersections (*i.e.*, segments). This Pedestrian LOS model for *intersections* now makes it possible to evaluate the level of accommodation that intersections provide to pedestrians.

It is expected that the Pedestrian LOS model for roadway *facilities* will be based upon the models for segments and for intersections. Work is currently underway on the NCHRP 3-70 project, and an FDOT study, to establish the method for combining the segment and intersection models to develop a facilities model.

ACKNOWLEDGMENTS

This study was co-sponsored by District 1 of the Florida Department of Transportation. The authors wish to thank the FDOT District 1 advisory committee members – Michael Tako Nicolaisen, Jim Baxter, Sean Masters, and Steve Browne, for their support and input on this important project. Additionally, we would like to express our appreciation to members of the panel and consulting team for NCHRP 3-70: Doug McLeod, Rick Dowling, Nagui Rouphail, Aimee Flannery, and Paul Ryus. We also wish to thank Felicia Leonard and those individuals from the FDOT Central Office, North Central Florida Regional Planning Council, and the University of South Florida. Their input contributed to the success of the Walk for Science event. Finally, we would like to thank the many participants and event personnel, who made the Walk for Science a success.

REFERENCES

1. *Highway Capacity Manual*, Transportation Research Board, Washington, DC, 2000.
2. Sisiopiku, Virginia P., X. Zhang, M. R. Virkler, Pedestrian Level of Service and Quality of Operations Assessment Methods, Preprint, Transportation Research Board Annual Meeting, Washington, DC, 2002.
3. Khisty, C. J. Evaluation of Pedestrian Facilities: Beyond the Level-of-Service Concept. *Transportation Research Record 1438*, Transportation Research Board, National Research Council, Washington, DC, 1994, pp. 45-50.
4. Crider, L.B., J. Burden, and F. Han. *Multimodal LOS "Point" Level of Service Project, Final Report*. University of Florida, Gainesville, FL, 2001, 59 pp.
5. Jaskiewicz, F. Pedestrian Level of Service Based Upon Trip Quality. *Urban Street Symposium Conference Proceedings*, Dallas, TX, 1999, pp G1/1-G1/144.
6. Landis, B.W., V.R. Vattikitti, R.M. Ottenberg, D.S. McLeod, M. Guttenplan, Modeling the Roadside Walking Environment: Pedestrian LOS*, Transportation Research Record 1773*, Transportation Research Board, National Research Council, Washington, DC, 2001.
7. Chu, X. and M.R. Baltes. *Pedestrian Mid-block Crossing Difficulty, Final Report.* National Center for Transit Research, University of South Florida, Tampa, FL, 2001, 79 pp.
8. FDOT, 2002 Quality / Level of Service Handbook, Florida Department of Transportation (2002), pp.20-21.

LIST OF TABLES AND FIGURES

Walk for Science Sarasota Route

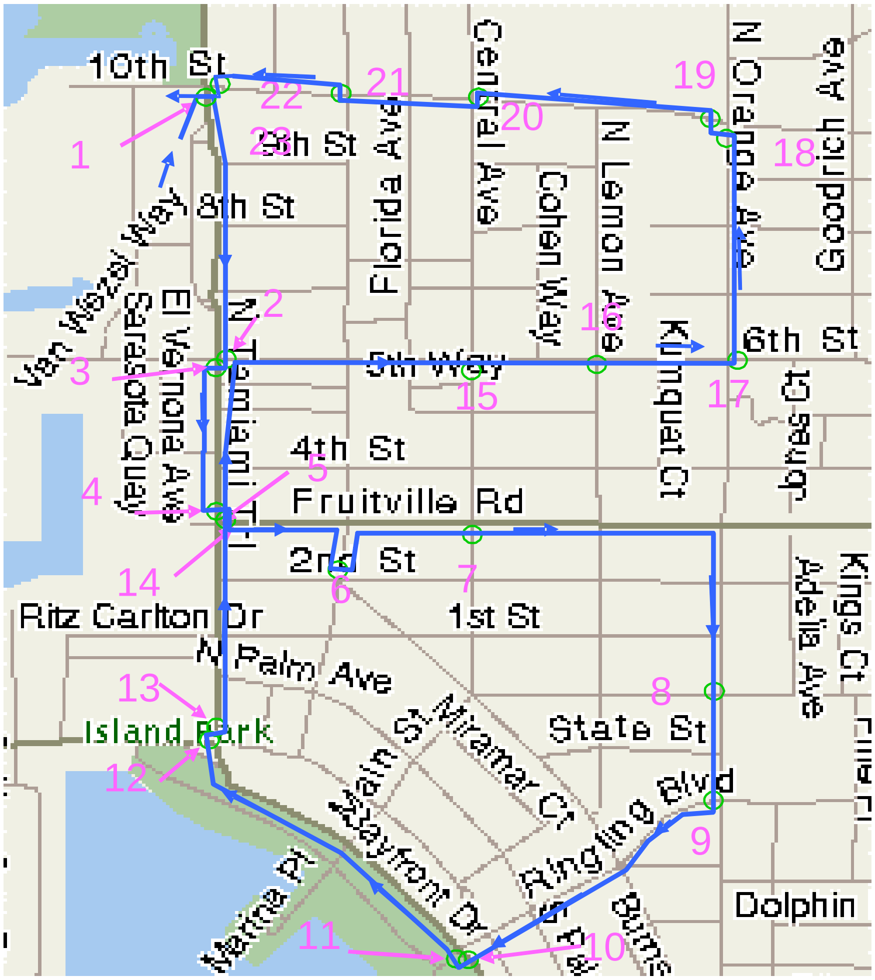

FIGURE 1 Walk for Science course

FIGURE 2 Sign provided on the back of each scorecard

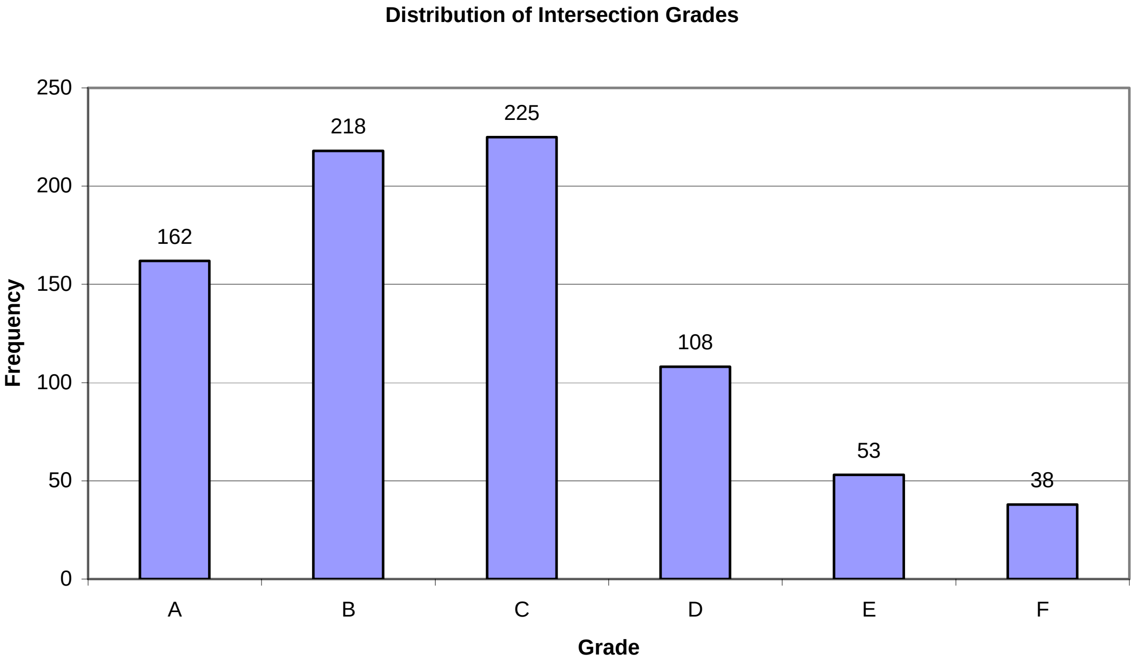

FIGURE 3 Grade distribution for intersections

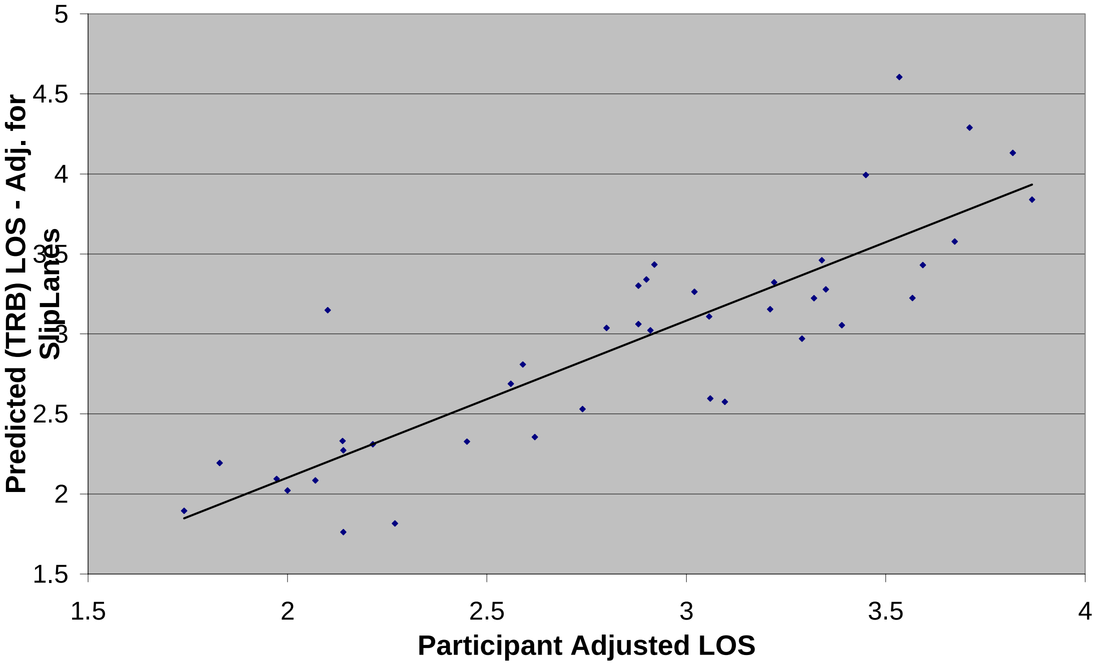

FIGURE 4 Plot of predicted and observed signalized intersection LOS for pedestrians

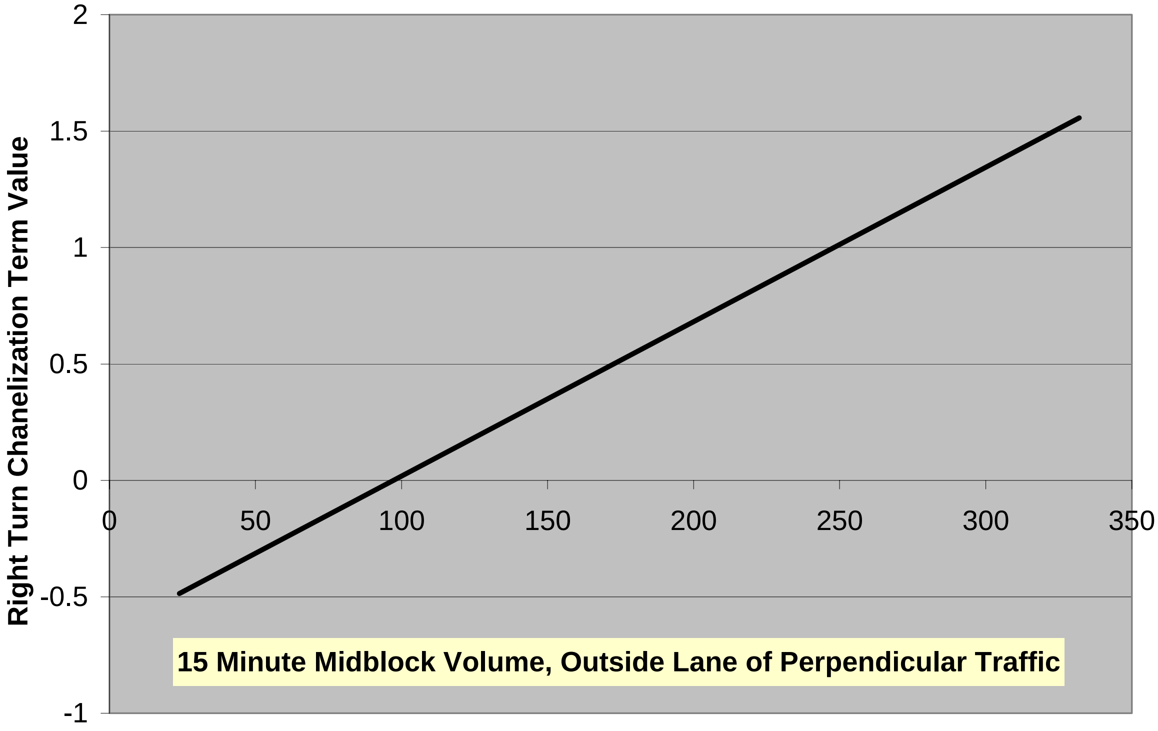

FIGURE 5 The influence of right turn channelization islands on signalized intersection LOS for pedestrians

Table 1 Pedestrian LOS for Signalized Intersection Categories

Ped LOS for Signalized Intersections	Model Score
A	≤ 1.5
B	> 1.5 and ≤2.5
C	> 2.5 and ≤3.5
D	> 3.5 and ≤4.5
E	> 4.5 and ≤5.5
F	> 5

TABLE 2 Participants' responses by demographic characteristics

CHARACTERISTIC	GROUP 1	GROUP 2	T TEST RESULTS
Gender	Male (N=16)	Female (N=30)	Not significant
Age[1]	12 to 24 (N=8)	Everyone (N=46)	Not significant
	25 to 44 (N=11)	Everyone (N=46)	Not significant
	45 to 64 (N=18)	Everyone (N=46)	Not significant
	65 and over (N=5)	Everyone (N=46)	Not significant
Residency in Sarasota	At least half of their life in Sarasota (N=8)	Less than half of their life in Sarasota (N=36)	Not significant
Paid vs. Volunteer	Paid (N=11)	Volunteer (N=25)	Not significant
Transportation Professionals vs. Others	Transportation Professional (N=7)	Other (N=39)	Not significant
Walking Experience[1]	0 km/week[2] (N=26)	Everyone (N=46)	Not significant
	1.6-11.3 km/week (N=6)	Everyone (N=46)	Significant[3]
	12.1-22.5 km/week (N=3)	Everyone (N=46)	Not significant
	23.3 km/week or more (N=10)	Everyone (N=46)	Not significant

[1] With respect to age and walking experience, the participants were stratified into four groups. The scores for each group were compared with the scores for everyone. The group sample sizes do not sum to 46 because age and walking experience were not available for some participants.
[2] 1 km = 0.62 mi.
[3] Significance level = 0.05.

TABLE 3 Model coefficients and statistics

Model Terms	Coefficients	T-statistics
SUMRTOR_PermLefts	5.689E-03	8.474
PRODPerpTrafVol_PerpTrafSpeed	1.274E-04	27.955
LanesCrossed$^{0.514}$	0.6810	17.579
Ln(PedDelay)	4.011E-02	7.527
Constant	0.5997	6.756
Model Correlation (R^2)	0.770	