Real-Time Human Perceptions
Toward a Bicycle Level of Service

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The primary focus of this study by Sprinkle Consulting Engineers, Inc. is to develop a bicycle-quality, or level-of-service, model for applications in U.S. metropolitan areas. Although there are several model forms being used throughout the United States that attempt to quantify road suitability or the quality of service afforded bicyclists traveling the street and roadway networks of urbanized areas, to date there have been no statistically calibrated models published. The statistically calibrated level-of-service model described here is based on real-time perceptions from bicyclists traveling in actual urban traffic and roadway conditions. The study's participants represented a cross section of age, gender, experience level, and geographic origin of the population of cyclists that use the metropolitan road networks in the United States. The test course is representative of the collector and arterial street systems of North American urban areas. Although further hypothesis testing is being conducted and additional studies are planned to test the need for disaggregate models for central business district streets with high turnover parking, truck routes, and two-lane high-speed rural highways, the general bicycle level-of-service model reported here is highly reliable, has a high correlation coefficient ($R^2 = 0.73$), and is transferable to the vast majority of United States metropolitan areas. The study reveals that pavement-surface conditions and striping of bicycle lanes are important factors in the quality of service.

As reported in Landis (*1*), there exist very few, if any, calibrated and transferable models that estimate bicyclists' perceptions of the quality of service in the on-road cycling environments in U.S. metropolitan areas today. There are many applications for such a calibrated and transferable model. These applications range from annual end-user applications, such as setting priorities for construction projects and bicycle route suitability mapping using supply-side performance measures, to the less frequent travel-demand forecast modeling and logit model refining for alternatives testing in corridor studies.

Currently, the largest of the application needs for a bicycle quality-of-service model is in assessing roads and streets as a criterion for setting bicycle-facility investment priorities and developing a bicycle-suitability network map. Perhaps the most widespread application demand for a statistically valid, mainstream evaluative tool such as a bicycle-quality, or level-of-service, model is for setting priorities for bicycle-facility construction projects. Currently in the United States, the choice between bicycle-facility projects is often made in the absence of an objective supply-side evaluation of the existing roadway facilities. Because competition is fierce among the various transportation modes for project construction funding, a reliable, quantitative supply-side evaluation is needed for bicycle-mode projects.

In the closely related and rapidly growing area of bicycle suitability mapping, the current practice in many areas of the United States is subjectively to evaluate roads to determine their compatibility for bicycle travel. However, consistent evaluation of the roads among the map updates is not possible without involving the same people in every update year. As a result, either inconsistency or inaccuracy results. A statistically calibrated, mathematically based model is thus needed. Such an objective evaluation tool will eliminate a large portion of the uncertainty in suitability mapping and will provide the transportation system users with technically accurate information.

Although less often needed, one of the pressing needs for a quality-of-service model is to overcome one of the current barriers in developing a sequential bicycle travel-demand simulation or forecasting model for urban-area utilitarian bicycling. This barrier is resident in both the trip distribution and assignment steps of the classic four-step transportation system model. Unlike the relatively straightforward trip distribution and assignment algorithms for motorized vehicles, which include only a few impedance factors such as travel distance (or travel time) and (if selected) vehicle-flow capacity constraint, route selection by bicyclists in the United States is influenced by many additional factors (although it is not usually influenced by bicycle flow-capacity constraints). Stated-preference survey work by Axhausen and Smith (*2*), the hypothetical-route choice model by Bovy and Bradley (*3*), and the environmental-preference survey of experienced recreational cyclists by Antonakos (*4*) suggest that bicycle-route selection for utilitarian trip purposes in an urban setting is influenced by several additional factors, which include the perceived hazard of sharing the roadway with motor vehicles and the roadway surface condition, grade, and scenery (possibly for some trip purposes). It is apparent that the first two factors can be combined into a single mathematical function and that the resulting quality-of-service function can be used as a travel impedance in both the trip-distribution and assignment algorithms of system-level travel-simulation models. Thus refined, this mathematical function, or quality-of-service model, can remove one of the barriers to the development of urban-area travel-demand models.

BACKGROUND

There are numerous local governments, metropolitan planning organizations, and state departments of transportation throughout the United States that are applying various methods to describe the quality of service to bicyclists provided by their collector and arterial systems. The majority are basing their methods on either the separate or combined works of Landis, Sorton, Epperson, and Davis (*1,5–7*). Despite having different names for their models, these researchers and other practitioners are generally headed toward developing a model, or group of models, that describe the quality of service afforded bicyclists in the shared-roadway environment. For the most

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part, they all take the approach of quantifying the bicyclists' perception of the magnitude of the hazards (stress, or conversely comfort) of traveling within the shared-roadway environment. Although offering different levels of precision and number of variables, the model forms published by the researchers have one important thing in common: the lack of basis in a statistically robust number of observations (*1*) for model calibration.

The perception of hazard, or alternatively safety or users comfort, within the shared-roadway environment is a performance measure (*8*). Although it has not yet been proved in the United States that the perceptions of safety by transportation system users correlate with actual safety, this perception is a reasonable measure of the quality of service for the bicycle mode of travel and is in keeping with the general guidelines according to the *Highway Capacity Manual* (*9*). As with performance or quality measures for motor-vehicle facilities, gradations in this quality of service are in levels of service. Thus defined, the bicycle level of service (BLOS) is not a measure of vehicular flow or capacity as is the convention for other travel modes. Although methods do exist for quantifying bicycle flow and capacity, such performance measures are generally not relevant for mixed-mode collectors and arterials in the United States, at least in the foreseeable future.

The BLOS is based solely on human responses to measurable roadway and traffic stimuli, similar to the comfort and convenience-type performance measures for other transportation modes. Although motor-vehicle system performance measures are usually based on single parameters such as time (average vehicle delay in seconds for intersections) or speed (average travel speed for road links), their gradations are solely based upon on operators' expectations of performance, that is, human perceptions. For example, the lower-bound level of service of signalized intersections is considered failure F or 60 sec of delay based upon a consensus on the motorists' tolerance threshold of travel delay. Although, the BLOS score is a mathematical function of human perceptions of stimuli, that is, a nondimensional value, it can be described in a similar manner using measurable physical attributes of motor vehicle traffic and roadway conditions. As demonstrated here, this has been done with a high degree of statistical reliability.

DESIGN OF RESEARCH

The common expression of bicyclists concerning how well a particular street or road accommodates their travel is from a perspective of safety. "It's very dangerous" or "it's fairly safe" is the way cyclists articulate their perceptions. Accordingly, this study placed its participants in actual urban traffic and roadway conditions to obtain feedback on real-time perceptions. Although a virtual reality, or simulation, study was first considered by the researchers, due to its advantage of safety to the participants, it was not pursued because of its potential inability to include all response stimuli (i.e., operator and vehicle response factors) present in the on-road bicycling environment.

Participants

The nearly 150 bicyclists who completed the course represented a good cross section of age, gender, experience level, and geographic origin. Figure 1 shows the distribution of age. Due to the potential hazards of riding in urban-area motor vehicle traffic, children younger than age 13 were not allowed to participate in the study. The gender split of the study group was 47 percent female and 53 percent male. The researchers also sought participant diversity in both geographic origins and cycling experience, or skill level. Accordingly, the study test course was located in Tampa, Florida, a metropolitan area with significant in-migration. Nearly half of the study participants had lived in areas other than the Tampa Bay region for the majority of their adult life.

There was a considerable range of cycling experience among the participants. There was a significant number who did very little bicycling and there were some who bicycle virtually every day. Figure 2 shows a histogram of the average annual bicycle distance traveled by the sample population. Nearly 25 percent of the participants ride less than 322 km (200 mi) per year. Despite considerable effort in soliciting participation from nonexperienced Group B cyclists (*10*), the higher response was from the segment of the population who currently bicycle the most often, the club-level riders.

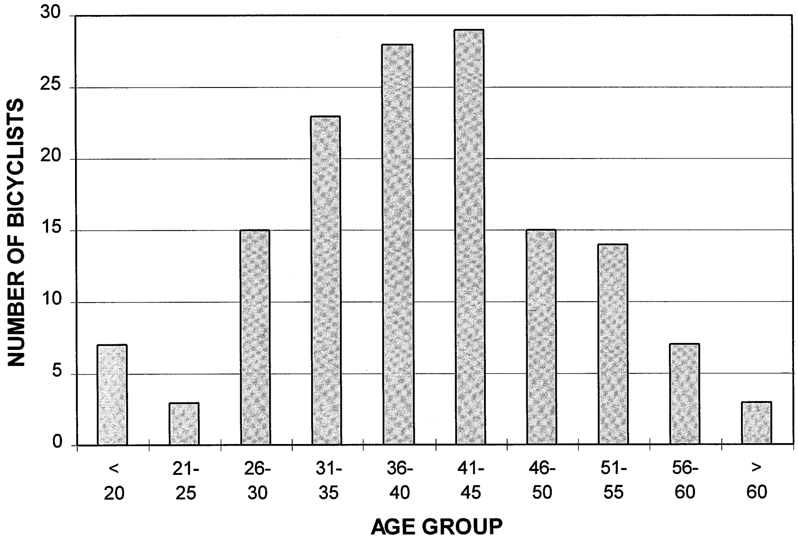

FIGURE 1 Age distribution of participants.

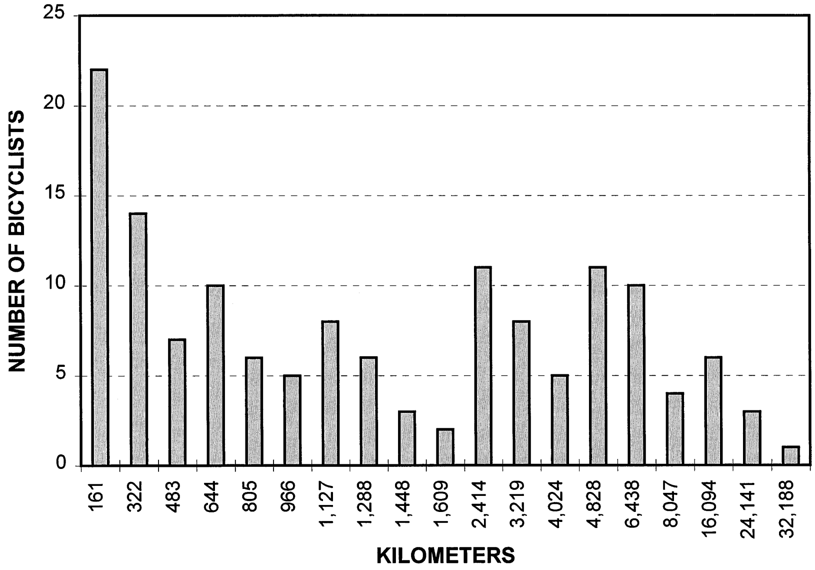

FIGURE 2 **Distribution of annual bicycle kilometers traveled by participants.**

Urban-Area Course

The course included representative traffic and roadway conditions and land development forms present in the urbanized areas of the United States. Approximately 27 km (17 mi) in length, the looped course consisted of 30 road segments with near equal lengths, but varying traffic and roadway conditions. Although the majority of the segments were collectors and arterials, several segments were local streets. During the course run by the participants, traffic volumes ranged from a low of 550 average daily traffic (ADT) to a high of 36,000 ADT, with a mean of 12,000 ADT. The percentage of heavy vehicles (as defined in the *Highway Capacity Manual* [*9*]) ranged from 0 to 2 percent. Posted speeds ranged from 40 to 80 km/hr (25 to 50 mi/hr) with a mode of 72 km/hr (45 mi/hr). The motor vehicle traffic lane configurations included divided, undivided, and continuous left-turn median lanes. The number of lanes ranged from two (undivided) to six (divided). The course included both curb and guttered as well as open shoulder cross-sectioned roadbeds.

There were a myriad of lane widths, bicycle-facility types, and striping conditions (and combinations thereof) present on the course. The width of outside motor vehicle through-lanes ranged from 3.05 to 4.88 m (10 to 16 ft). Striped bike lanes and paved shoulders ranged from nonexistent to 1.83-m (6-ft) wide. Pavement surface conditions ranged from poor to very good [FHWA Highway Performance Monitoring System (*11*) surface quality PAVECON ratings from 2 to 5]. Neither rumble strips nor outside lane reflectors were present on the course.

The course ran through the entire spectrum of land development forms and street network patterns found in U.S. metropolitan areas. Retail commercial development forms ranged from regional shopping malls (with several high-volume driveways) to small convenience strip centers (with numerous curb cuts). Modern community- and neighborhood-scaled centers were prevalent; 1950s and 1960s small retail-neighborhood centers with limited on-street parking were also represented. Some segments had office buildings fronting them, others were fronted with hospitals and medical complexes. Some segments passed by modern sports stadiums and museums. Several segments passed by elementary schools, a college, and a large state university. Other land uses included churches, convenience stores, sit-down and fast-food restaurants with drive-throughs, professional and personal care businesses, laundromats, car repair shops, a salvage yard, fire stations, city public works departments, golf courses, a national-scale theme park, a neighborhood park, a natural forest, and light industrial areas. The age of the development forms ranged from the 1940s to the present day.

In the residential areas, there was also an extensive variety of development forms directly adjoining the course. Residential dwellings included high-rise apartment and condominium units housing people from students to the managed-care elderly. Mid- and low-rise apartments were present, as were townhomes and other forms of attached dwelling units. Some course segments had single-family homes directly fronting them and intersecting traditional grid-pattern local streets. Others had entrance-drive connections from curvilinear street-form (planned-development) residential subdivisions. The age of the residential land forms ranged from the 1940s to the present day. Neighborhoods represented a balanced mix of upper, middle, and low household income levels. In summary, the majority of the nearly 1,000 land uses documented in the ITE trip generation manual (*12*) directly adjoined the study course.

Participant Response

Participants in the study were solicited using a broad-based, area-wide, multimedia approach that included newspaper notices and articles, radio announcements, direct mailings by numerous organizations and businesses, and brochure-registration form distribution. Displays with registration forms were deployed at retail sports outlets, colleges and universities, public schools, museums, government office lobbies, major employers, and bicycle shops. The real-time data collection activity of the study was promoted as an event entitled the Fun Ride for Science, with prize drawings and gifts as incentives for participation. The need to ensure a large number of volunteer bicyclists (*1*) mandated a weekend testing period. To ensure that uniform motor vehicle traffic volumes were experienced by all participants, the event was run during a single time block. The course run (the event) was scheduled for the morning of one of the busiest (from a traffic-volume standpoint) Saturdays of the year, April 27.

Approximately 150 people participated in the event. They first completed registration forms that included a battery of questions to generate individual profiles of the participants. Although the participants were being briefed on course configuration, instructions for completing the response cards, and logistical matters, course proctors were deployed. Consisting of staff from the Hillsborough County (Tampa) metropolitan planning organization, the Center for Urban Transportation Research, and Sprinkle Consulting Engineers Inc., over 20 proctors were strategically located throughout the course. The proctors ensured temporally spaced starts, individual riding, independent response scoring among the participants, and current completed response cards (participants were encouraged to reflect on their accumulating experience and hence re-grade as they proceeded through the course).

Similar to the separation between link and intersection analyses in highway capacity and level-of-service determinations, the study's purpose was to evaluate the quality, or level of service, of the roadway links, not the intersections. Accordingly, the participants were instructed to disregard the conditions at the termini of the segments. They were instructed to exclude from their consideration the aesthetics of the segments. They were to include only conditions within, or directly adjoining, their right-of-way. The participants evaluated on a 6-point (A to F) scale how well they were served (how safe or how comfortable they felt) as they traveled each segment. Level A was considered the most safe or comfortable (or least hazardous); Level F was considered the most unsafe or most uncomfortable (or most hazardous).

ANALYSIS OF DATA AND INITIAL HYPOTHESIS TESTING

Considerable data on both the participants and the course attributes were collected to permit extensive hypotheses testing. Although further hypothesis testing is ongoing, two tests have been performed in addition to the initial model development. First, a standard pooled error statistical comparison was made between the mean bicycle quality-of-service scores for females versus that of males. The means, standard errors, and sample size were, respectively, 3.33, 0.83, and 68 for female cyclists and 3.17, 0.72, and 77 for male cyclists. The computed *t*-test (1.23) was not significant at $\alpha = 0.05$. The second initial hypothesis test was for perception differences associated with bicycle experience level. Using annual bicycle kilometers (miles) traveled [BKT (BMT)] as a measure of experience, incremental standard pooled error tests were conducted beginning at the tails of the BKT (BMT) frequency histogram (Figure 2) and working toward the middle of the distribution until a statistically significant difference was encountered. Not surprisingly, a quality-of-service score difference was encountered between the riders who traveled less than 322 km (200 mi) per year and those with more than 322 annual BKT (200 annual BMT). What was surprising was that for the less-experienced riders, their average perception of the hazards of bicycling in a shared-roadway environment was less than that for the more experienced riders (2.75, a high C, versus 3.14, a middle C). Although further testing of perception differences among groups or subgroups is currently underway, the initial results suggest that once they are traveling on a road segment (i.e., after overcoming any impediment to traveling on an on-street network), the less-experienced bicyclists are not perhaps as aware of the potential hazards of traveling in a shared-roadway environment.

MODEL DEVELOPMENT

This study sought to mathematically express, for road or street links, the roadway and traffic conditions that affect bicyclists' perceptions of the quality of service, or level of accommodation. The following process in developing the preliminary model was applied: (*a*) identify which variables are relevant, (*b*) test for the best configuration of each variable (or combinations thereof), and (*c*) establish the coefficients for the variables (or combinations thereof) that result in the best-fit regression model.

The perceived quality of service (BLOS) in a shared-roadway environment was first hypothesized as a function of a set of variables, which takes the general form:

$$BLOS = f(X_1, X_2, X_3, X_4 \ldots) \tag{1}$$

Building upon the works of Landis, Sorton, Epperson, and Davis (*1,5–7*), a comprehensive Pearson correlation analysis of the extensive array of roadway and traffic variables with respect to BLOS was employed. Subsequently, the following relevant variables were selected for consideration in the second step of the model-development process, per-lane traffic volume, traffic speed, traffic mix, cross-traffic generation (traffic flow turbulence), pavement surface condition, and available roadway width for bicycling. The variables that were dropped from further consideration because of their poor correlation with the dependent variable (BLOS) or their colinearity with the more strongly correlated variables listed above included presence of curbing, controlled intersections (average through-movement green time to cycle-length ratio was 0.69), and number of directional lanes. Accordingly, Equation 1 can be rewritten as:

$$BLOS = f(V, S, M, X, P, W) \tag{2}$$

where

V = per-lane motor vehicle traffic volume,
S = speed of motor vehicles,
M = traffic mix,
X = potential cross-traffic generation,
P = pavement surface condition, and
W = width for bicycling.

Using a linear regression analysis technique, the model form would be:

$$\begin{aligned} BLOS = b &+ a_1(V) + a_2(S) + a_3(M) + a_4(X) \\ &+ a_5(P) + a_6(W) \end{aligned} \tag{3}$$

Because testing of variations in the construction of some variables was planned prior to any transformations or combination of variables, it would be more accurate to describe Equation 3 as:

$$\begin{aligned} BLOS = b &+ a_1[f(V)] + a_2[f(S)] + a_3[f(M)] \\ &+ a_4[f(X)] + a_5[f(P)] + a_6[f(W)] \end{aligned} \tag{4}$$

The stepwise regression analysis was conducted using the approximately 4,300 observations from the real-time course runs by the study participants. Numerous variable transformations and combinations were tested. Table 1 shows just three of the many model forms that were tested and the coefficients and *t*-tests. Model A does not include a potential cross-traffic variable, and it has only the total outside lane width as the "width for bicycling" variable. Model B also does not have the potential cross-traffic variable, but it does have a more comprehensive construction of the "width for bicycling" variable. The correlation coefficient (R^2) of the best-fit model (Model C) is 0.73. (See Figure 3 for a plot of predicted versus mean observed BLOS values and Figure 4 for the residuals plot.) The coefficients are all statistically significant at more than the 95 percent level except for the curb-cut, on-street parking (cross-traffic) term. Thus, the following model was developed for the total population of bicyclists and roads and streets in U.S. metropolitan areas:

$$BLOS = a_1 \ln(Vol_{15}/L) + a_2 \ln[SPD_p(1 + \%HV)] + a_3 \ln(COM15 * NCA) + a_4(PC_5)^{-2} + a_5(W_e)^2 + C \qquad (5)$$

where

$BLOS$ = perceived hazard of the shared-roadway environment,
Vol_{15} = volume of directional traffic in 15-min time period,
L = total number of through lanes,
SPD_p = posted speed limit (a surrogate for average running speed),
HV = percentage of heavy vehicles (as defined in the *Highway Capacity Manual*),
$COM15$ = trip generation intensity of the land use adjoining the road segment (stratified to a commercial trip generation of 15, multiplied by the percentage of the segment with adjoining commercial land development),
NCA = effective frequency per mile of noncontrolled vehicular access (e.g., driveways and on-street parking spaces),
PC_5 = FHWA's 5-point pavement surface condition rating, and
W_e = average effective width of outside through lane ($W_e = W_t + W_l - \Sigma W_r$, where W_t = total width of outside lane (and shoulder) pavement, W_l = width of paving between the outside lane stripe and the edge of pavement, and W_r = effective width (reduction) due to encroachments in the outside lane.

(W_r has not been statistically calibrated during this first phase of the study.)

The cross-traffic *COM15NCA* term has been retained (in Model C) for institutional reasons. Although the course had an excellent variety and range of the roadway and traffic variables typically encountered by cyclists in metropolitan areas, only two segments had substantial high turnover on-street parking. Thus, it is postulated that the transverse turbulence created by on-street parking activity (i.e., motor vehicle and pedestrian ingress-egress to the parking spaces) may be a factor in the bicyclists' perception of safety. Although it is estimated that fewer than 1 percent of the total mileage of U.S. metropolitan areas' collector and arterial roadways have high turnover on-street parking, it may be beneficial to some urban areas to use BLOS Model C with this factor.

TABLE 1 Model Coefficients and Statistics

	Coefficients			T-Statistics		
Model Terms: form	Model A	Model B	Model C	Model A	Model B	Model C
Outside Lane Volume:						
$\ln(Vol_{15}/L)$	0.649	0.607	0.589	6.351	7.256	6.657
Motor Vehicle and Speed:						
$\ln(SPD_p(1+HV))$	0.436	0.901	0.826	1.185	2.825	2.419
Access from Adjoining Land Use:						
Potential cross-traffic generation:						
ln(COM15NCA)	---	---	0.019	---	---	0.647
Pavement Surface Condition:						
("Pavecon" rating)$^{-2}$	5.457	6.510	6.406	2.970	4.052	4.014
Width of Outside MV Lane and (any) paved shoulder:						
$(Wt)^2$	-0.009	---	---	-5.896	---	---
$(We)^2$	---	-0.005	-0.005	---	-8.680	-8.147
Constant	0.146	-1.833	-1.579	0.130	-1.841	-1.468
Model Correlation (R^2)	0.61	0.73	0.73			

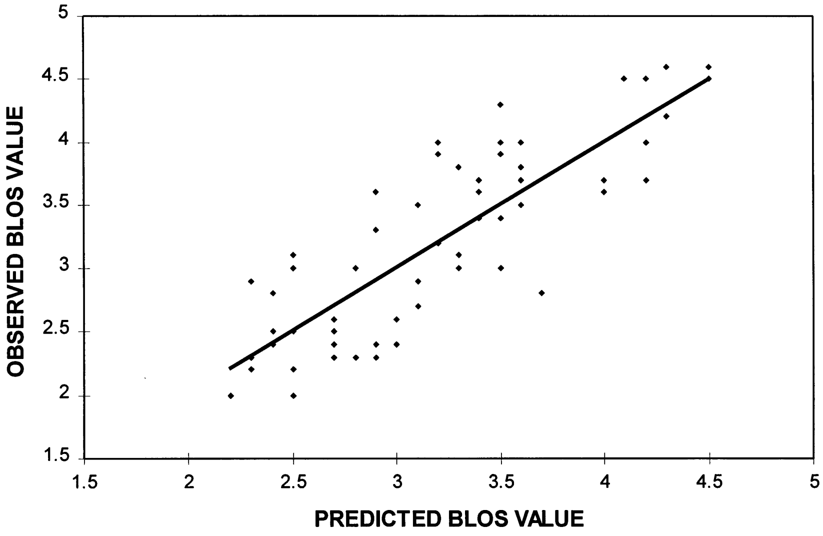

FIGURE 3 Regression plot of predicted and observed BLOS values.

FINDINGS AND APPLICATIONS

Bicycle Lane Striping: Does It Really Matter?

One of the secondary goals of this initial stage of the research was to determine the effect of striping in conjunction with a bicycle lane or a paved shoulder. It was expected and confirmed that extra pavement width to accommodate bicycle travel affects the roadway's quality of service to bicyclists. However, preliminary analysis of the data indicated that there might also be a relationship between the presence of a stripe separating the areas designated for the two travel modes and the perception of a safer condition.

For example, 30th Street had two segments in the course that were similar in virtually all aspects (including paved width) except that one had a striped bike lane and the other an unstriped, wide outside curb lane. However, the difference between their average quality-of-service scores was nearly 50 percent (2.45 and 3.65, respectively) even though the segment with the striped lane had nearly double the traffic volume of the other. Other segments with striped bike lanes or paved shoulders were perceived as being better (i.e., safer or less hazardous) than those without, all other traffic and roadway geometrics being the same.

Accordingly, a variable width of striped bicycling cross section (W_l) was introduced (Model B of Table 1) and transformations were tested within its range. The final form resulted in the variable W_l being a factor in the effective width W_e term, and its inclusion substantially increased the Model's correlation coefficient (R^2) from 0.61 to 0.73. As an example, Table 2 shows the effect of various lane widths and striping configurations using a 3.66-m (12-ft) lane width as a baseline. Notice that for a 4.88-m (16-ft) wide outside lane, the BLOS score decreases only 13 percent. However, with striping added, the quality of service is improved by 31 percent.

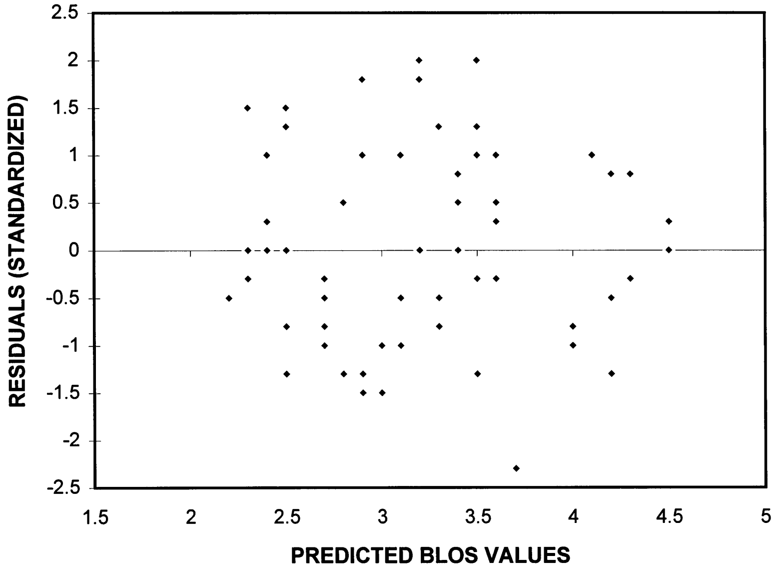

FIGURE 4 Residual plot of predicted and standardized residuals.

TABLE 2 Sensitivity Analysis for Lane Width, Striping, and Pavement Condition

$$BLOS = a_1\ln(Vol_{15}) + a_2\ln(S(1+HV)) + a_3\ln(COM15NCA) + a_4PC_5^{-2} - a_5W_e^{2} - C$$

a_1: 0.589 a_2: 0.826 a_3: 0.019 a_4: 6.406 a_5: 0.005 C: 1.579

Baseline inputs:
ADT = 12,000 vpd
L = 2 lanes
W_e = 3.66 m (12 ft)
S = 64.4 kmph (40 mph)
% HV = 1
PC = 4 (good condition pavement)
%COM = 40 (Trip Rate = 15)
CCF = 26 per km (42 per mile)

	BLOS	% Change
Baseline BLOS Score (BLOS)	4.1	N/A
Lane Width and Lane striping changes		
W_t = 3.05 m (10 ft)	4.4	5% increase
W_t = 3.36 m (11 ft)	4.3	3% increase
W_t = 3.66 m (12 ft) - - (baseline average) - - - -	4.1 - - - - -	no change
W_t = 3.97 m (13 ft)	4.0	3% reduction
W_t = 4.27 m (14 ft)	3.9	6% reduction
W_t = 4.58 m (15 ft) (W_l = 0.92 m (3 ft))	3.7 (3.2)	9% (22%) reduction
W_t = 4.88 m (16 ft) (W_l = 1.22 m (4 ft))	3.6 (2.9)	13% (31%) reduction
W_t = 5.19 m (17 ft) (W_l = 1.53 m (5 ft))	3.4 (2.5)	17% (41%) reduction
W_t = 5.49 m (18 ft) (W_l = 2.14 m (6 ft))	3.2 (2.0)	21% (52%) reduction[a]
Pavement Surface Conditions		
PC_5 = 1 Very Poor	10.2	145% increase[a]
PC_5 = 2 Poor	5.3	29% increase
PC_5 = 3 Fair	4.5	7% reduction
PC_5 = 4 - - Good - (baseline average) - - - - - -	4.5 - - - - -	no change
PC_5 = 5 Very Good	4.0	3% reduction

[a] Outside the variable's range present on the Course
1 Km = 0.62 miles
1 meter = 3.28 feet

Pavement Condition: Does It Have An Effect?

Although identified as being statistically significant in the stated-preference survey work by Axhausen and Smith (*2*), the hypothetical route-choice models of Bovy and Bradley (*3*), and the environmental-preference survey of experienced recreational cyclists by Antonakos (*4*), pavement condition is frequently dismissed by some practitioners as being insignificant. However, the response to real-time stimuli captured in this study does confirm that pavement condition plays an important role in bicyclists' assessment of the shared-roadway environment. This study proves conclusively that there is a statistically significant inverse mathematical relationship between pavement condition and the dependent variable BLOS (see Table 1). Poor surface conditions tended to strongly affect the level of service; good surface conditions played a lesser role (Table 2). This finding suggests that virtual reality or other environment simulation techniques used for estimating bicyclists' perceptions of the on-road environment would, in some cases, miss a significant factor in actual roadway conditions. Epperson (*6*) was wrong in suggesting that a video simulation (alone) could be used to calibrate a quality, or level-of-service model. The data clearly reveal that only through placing bicyclists in actual conditions, with real-time consequences of their interactions with motor vehicle traffic and their bicycle's response to the roadway pavement surface condition, can a bicycle quality-of-service model be ascertained with confidence. Videocamera simulation may prove to be an option, provided that it is calibrated with real-time observations. It might be used with caution to estimate perceptions in extreme traffic conditions where study bicyclists might refuse to participate (e.g., high-speed facilities with high-truck volumes).

Applications

The participants in this study represent a broad cross section of the U.S. population of bicyclists, and the course's segments are typical of the collectors and arterials 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 model suitable for application in the vast majority of U.S. metropolitan areas. For individual validation, Table 3 may be used as a basis for stratifying the BLOS scores into bicycle level-of-service classes. Even as further hypothesis testing of the data set is under way, additional studies are being planned to test the need for separate models for central business district streets with high turnover parking, truck route segments, and two-lane high-speed rural highways.

ACKNOWLEDGMENTS

The authors would like to thank Sprinkle Consulting Engineers, Inc., and the Hillsborough County (Tampa) Metropolitan Planning Organization (MPO) for funding assistance; Tampa's Museum of Science

TABLE 3 Level of Service Categories

Level-of-Service	BLOS 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	> 5.5

and Industry, the Tampa Bay Freewheelers, and other corporate sponsors for promotional and facility support; the staff of the Center for Urban Transportation Research at the University of South Florida and the MPO and other individuals in data collection, event registration, and test course proctoring. The authors would also like to thank Bruce Epperson of the MetroDade (Miami) MPO and Timothy Trabold of the Niagara Frontier Transportation Committee (the Buffalo, New York, Regional MPO) for their assistance in the initial analysis and sensitivity testing of the bicycle level-of-service model. And finally, the authors would like to express their gratitude to the nearly 150 people who volunteered their time to participate in the study for the sole purpose of advancing applied science.

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All findings and conclusions are solely those of the authors.

Publication of this paper sponsored by Committee on Bicycling.