Evaluation of Safety, Design, and Operation of Shared-Use Paths

Pedestrian and Bicycle Safety

The Pedestrian and Bicycle Safety Research Program focuses on identifying problem areas for pedestrians and bicycles, developing analysis tools that allow planners and engineers to better understand and target these problem areas, and evaluating countermeasures to reduce the number of crashes involving pedestrians and bicycles.

U.S. Department of Transportation
Federal Highway Administration

Introduction

This TechBrief is a summary of *Evaluation of Safety, Design, and Operation of Shared-Use Paths: Final Report,* FHWA-HRT-05-137.

Shared-use paths are paved, off-street travelways that serve bicyclists, pedestrians, and other nonmotorized modes of travel, as shown in figure 1. The Federal Highway Administration (FHWA) has developed a new method to estimate the level of service (LOS) on a shared-use path, using a team of researchers led by the North Carolina State University Department of Civil, Construction, and Environmental Engineering.

Answering Key Questions

During the planning or design of every shared-use path, someone eventually asks, "How wide should this pathway be?" That question almost always raises even more questions: "What types of users can we reasonably expect? When will we need to widen

Figure 1. Hikers, bicyclists, and skaters often share the same pathways.

the path? Do we need to separate different types of users from each other?" Before this project, these key questions were difficult to answer. The American Association of State Highway and Transportation Officials (AASHTO) *Guide for the Development of Bicycle Facilities* (1999) provides general guidance regarding path width (3.0 meters (m) (10 feet (ft)), or 3.7 to 4.2 m (12 to 14 ft) with substantial mixed use), but no specifics.(1) The Transportation Research Board (TRB) *Highway Capacity Manual* (2000) provides a method to calculate the LOS (A through F rating) for a path; however, this method has several important limitations, such as only including certain types of passing movements, assuming that path users never impede each other, including only pedestrians and bicyclists, and using fixed values for pedestrian and bicycle speeds.(2)

Objectives

The project's purpose was to develop a service model that professionals could use to assist with the planning, design, and management of shared-use paths and to answer the key questions posed above. In particular, the project was to produce a tool that would overcome the limitations in the current LOS procedure. The new service model would:

- Be calibrated and validated.
- Be based on U.S. data.
- Have LOS criteria based on user input for a typical mix of trip purposes.
- Include more modes than just pedestrians and bicycles.
- Include the ability to change key parameters, such as mean speeds.
- Account for delayed passing.
- Analyze the full range of existing and possible path widths.
- Be in a form ready for use by path designers.

The four major work items needed to achieve the project objectives were:

1. Develop an additional theoretical framework.
2. Collect information on path operations to increase the predictive ability of the framework, so that theoretical predictions match reasonably well with field observations.
3. Collect path-user perception data to establish LOS criteria.
4. Develop a new LOS estimation tool.

New Theory

To achieve these objectives, the project team had to develop two important new aspects of the theory of traffic flow on shared-use paths. First, the team had to develop improved methods to estimate the number of meetings (opposite direction encounters) and passes (same direction encounters) for a wide variety of path users. Second, the team had to find a way to calculate the number of delayed passes (i.e., the number of times that a bicyclist arrives behind a slower path user and is not able to pass because of the lack of an adequate-sized gap in the lane to the left). Obviously, delayed passes are undesirable for bicyclists, and they are critical because they are so highly related to path width. Delayed passes were not included in the *Highway Capacity Manual* procedure.(2)

Coast-to-Coast Data Collection

To calibrate and validate the new service model and the LOS procedure, the main variables that needed to be collected were meetings and passes by path users. Other necessary data included the speeds of different types of path users. Most of the data was collected by using a camera mounted on the helmet of a test bicyclist. The data collection sites were

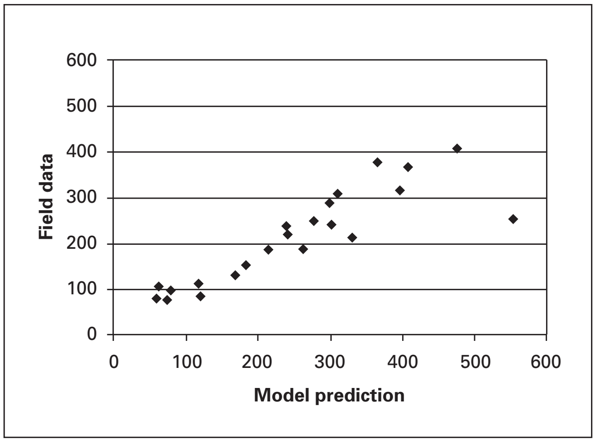

Figure 2. The number of meetings on a path segment as observed in the field and as predicted by the new model.

some of the busiest and best-known trails in the United States, such as:

- Pinellas Trail near St. Petersburg, FL.
- South Bay Trail in Santa Monica, CA.
- Sammamish River Trail near Seattle, WA.
- Forest Park Trail in St. Louis, MO.
- Lakefront Trail in Chicago, IL.
- Dr. Paul Dudley White Bike Path near Boston, MA.

Overall, the 15 data collection trails in 10 cities represented a wide range of shared-use path conditions, including trail widths ranging from 2.4 to 6.1 m (8 to 20 ft).

The researchers made nearly 800 data collection rides of 0.8 kilometer (0.5 mile) each on the 15 trails. Most rides were on weekends in good weather. Some of the most important findings were:

- Five travel modes were used by almost all of the users of the studied trails. Average mode splits were 56 percent adult bicyclists, 3 percent child bicyclists, 18 percent pedestrians, 13 percent runners, and 10 percent inline skaters.
- The average trail had 430 users per hour.
- The average bicycle speed was 20.6 kilometers per hour (12.8 miles per hour).

Overall, the field data matched the theoretical predictions very well, as figure 2 shows for the case of the number of meetings.

Asking the Users

The research team surveyed 105 trail users (primarily bicyclists) to determine what factors they found to be significant in their evaluation of comfort and freedom to maneuver on shared-use paths. The respondents viewed

LOS Equation

Shared-Use Path Level of Service Score = 5.45 - 0.00809(E) - 15.9(RW) - 0.287(CL) - (DPF)

where:

E = Events = Meetings per minute + 10(Active passes per minute)
RW = Reciprocal of path width (i.e., 1/path width, in feet)
CL = 1 if trail has a centerline, 0 if trail has no centerline
DPF = Delayed pass factor

LOS Scale

Score	Grade	Score	Grade
X ≥ 4.0	A	2.5 ≤ X < 3.0	D
3.5 ≤ X < 4.0	B	2.0 ≤ X < 2.5	E
3.0 ≤ X < 3.5	C	X < 2.0	F

For a complete explanation of the derivation of the equation and scale, see the *Evaluation of Safety, Design and Operation of Shared-Use Paths: Final Report (Final Report).*[3]

Figure 3. LOS equation.

Table 1. Example of LOS predictions.

Trail users per hour in each direction	Trail width (feet)			
	8	12	16	20
25	B	B	A	A
50	D	B	A	A
75	D	B	B	A
100	D	B	B	A
150	E	C	B	B
200	F	D	C	B
250	F	D	C	C
300	F	E	D	C
400	F	F	E	E
500	F	F	F	F

1 foot=0.305 meters

and rated 60-second video clips of shared path operations; these clips were filmed by the researchers using the helmet camera during field data collection. The researchers tested a wide variety of factors to determine their overall influence on survey responses. The primary factors found to affect trail users' perceived LOS included:

- Path width.
- Active passes by the bicyclists of slower path users.
- Meetings.
- The presence of a centerline.

The researchers added an adjustment for the number of delayed passes and produced the LOS equation and scale shown in figure 3.

A New Procedure

Combining the new theory, the field data, and the user survey, the researchers produced an improved LOS estimation procedure for shared-use paths. Table 1 shows a few examples of service predictions. However, readers must use this table cautiously because it is based on many assumptions, including assumptions about user speed and mode splits. *The Final Report* and *Shared-Use Path Level of Service Calculator: A User's Guide,* FHWA-HRT-05-138, contains many more examples like this.[3,4]

Users of the service estimation procedure need to remember that its scope is limited to uninterrupted segments of paved, off-street paths, from 2.4 to 6.1 m (8 to 20 ft) wide, and that the LOS is presented from the bicyclist's viewpoint only.

SUPLOS Calculator

The Shared-Use Path Level of Service (SUPLOS) calculator is a spreadsheet developed during this research that quickly and accurately executes the new LOS estimation procedure. Professionals can use the calculator to guide planning, design, and/or management decisions regarding path width and user mix on shared-use paths. Input is simple, requiring only four variables:

- One-way path users per hour.
- Mode split.
- Path width.
- Presence or absence of a centerline.

Table 2. Sample SUPLOS calculator spreadsheet.

Segment Name	Path Width	Centerline	Volume (users per hour in 1 direction) and Mode Split							Trail Level of Service	
	Closest 0.5 ft.	0=No Centerline	*Volume*	*Mode Split (%)**							
Name	Width (ft.)	1=Centerline	One-Way (per hour)	Adult Bicyclists	Pedestrians	Runners	Inline Skaters	Child Bicyclists	All Modes	LOS Score	LOS Grade
Example Trail	11.0	1	160.0	55.0%	20.0%	10.0%	10.0%	5.0%	100.0%	3.12	C

Analysts may elect to use the default mode split provided in the calculator if reliable mode split data are not available.

The SUPLOS calculator example depicted in table 2 shows how easy it is to use the tool. The *User's Guide* provides detailed instructions for the calculator, offers case studies in which it is employed, and describes a variety of applications for which the calculator can be used.(4)

For More Information

Ann Do
Federal Highway Administration
202–493–3319
ann.do@fhwa.dot.gov

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Research, Development, and Technology

Turner-Fairbank Highway Research Center
6300 Georgetown Pike
McLean, VA
22101-2296

Visit us at www.tfhrc.gov

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FHWA Contact:
Ann Do, 202–493–3319

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