UCLA INSTITUTE OF TRANSPORTATION STUDIES

Bicycle Level of Service in the Highway Capacity Manual

An Exposition

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INTRODUCTION

How does a street stack up? **The Highway Capacity Manual** contains the only national standard for measuring street performance for bicycling. Its **bicycle level-of-service (BLOS)** model gives a grade, A through F, to segments of streets and intersections.

But many practitioners don't understand how BLOS works. We break open the black box, showing what variables are included and excluded and how sensitive the BLOS calculations are to them.

METHODS

We **summarize the variables included** in the BLOS model and the units of analysis in tables and graphics. We conduct **a sensitivity analysis** using plausible hypothetical cases to show what really drives BLOS. We **inventory important variables that BLOS does not consider,** drawing on the state of bicycle planning practice. Finally, we decipher the origins of BLOS and describe the data sets used to create the model.

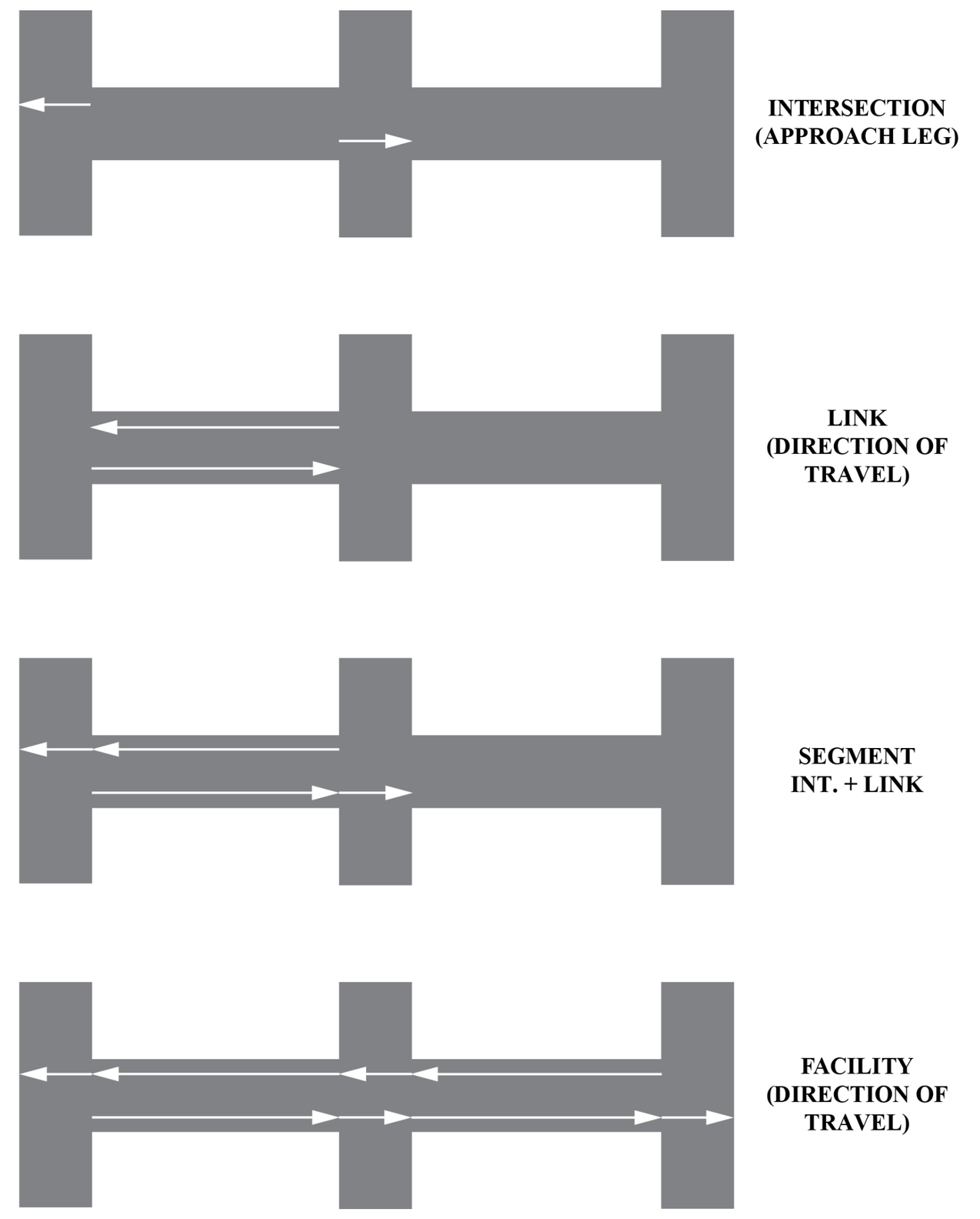
ORIGINS

Some may be surprised at the age and relatively small sample sizes of the data that underlie BLOS. Two studies conducted in 1997 and 2003, both in Florida, with 150 and 60 participants respectively, form the basis for the model. As such, BLOS does not cover post-2005 designs such as cycle tracks, colored bicycle lanes, sharrows, and bicycle boxes.

Source	Focus of study	Location	Number of participants
(Landis, et al., 1997)	Bicycle link	Tampa, FL	145
(Landis, et al., 2001)	Pedestrian link	Pensacola, FL	75 (exact no. not stated)
(Landis, et al., 2003)	Bicycle intersection	Orlando, FL	59 (66% male)
(Petritsch, et al., 2005)	Pedestrian intersection	Sarasota, FL	46 (67% female)

Table 1: Sources of data underlying the Highway Capacity Manual 2010 Bicycle Level of Service and Pedestrian Level of Service

UNITS



Grade	Numerical Range
A	$x \leq 2.00$
B	$2.00 < x \leq 2.75$
C	$2.75 < x \leq 3.50$
D	$3.50 < x \leq 4.25$
E	$4.25 < x \leq 5.00$
F	$x > 5.00$

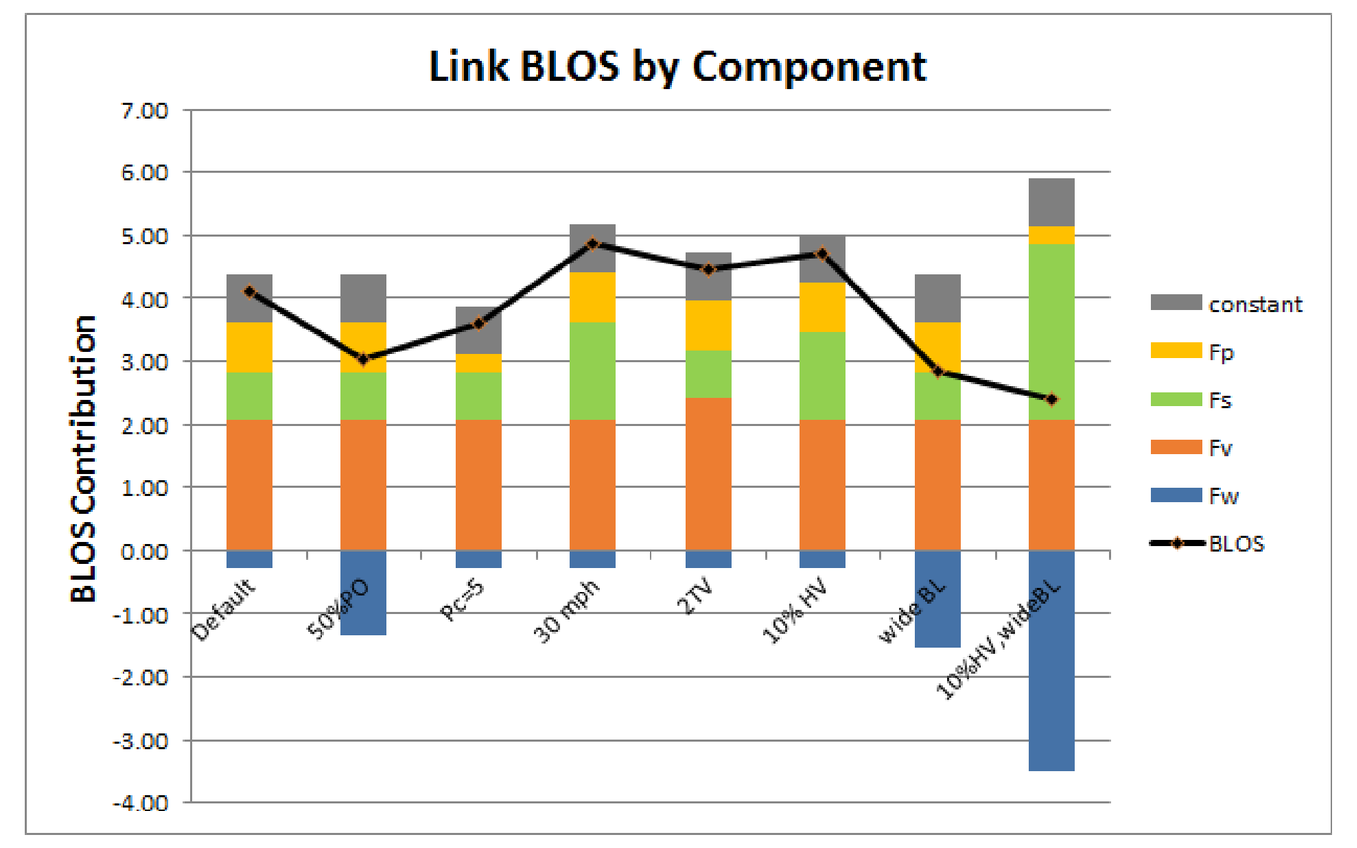
Units of analysis used to assign a grade to a section of street; numerical ranges to convert scores to grades. Lower numbers are better scores.

VARIABLES TABLE EXAMPLE

Name	Variable	Units	Algebraic Terms	Direction of effect on BLOS	Notes on data definitions
curb-to-curb width of the cross street	W_{cd}	feet	$0.0153W_{cd} - 0.2144W_t$	Increasing this degrades BLOS.	
left-turn demand flow rate	v_{lt}	vehicles per hour	$0.0066\frac{v_{lt}+v_{th}+v_{rt}}{4N_{th}}$	Increasing this degrades BLOS.	The HCM's language makes it unclear if this should be a *measured* quantity or a *modeled* quantity
through demand flow rate	v_{th}	vehicles per hour	$0.0066\frac{v_{lt}+v_{th}+v_{rt}}{4N_{th}}$	Increasing this degrades BLOS.	As above.
right-turn demand flow rate	v_{rt}	vehicles per hour	$0.0066\frac{v_{lt}+v_{th}+v_{rt}}{4N_{th}}$	Increasing this degrades BLOS.	As above.
number of through lanes (shared or exclusive)	N_{th}	number	$0.0066\frac{v_{lt}+v_{th}+v_{rt}}{4N_{th}}$	This variable affects both the F_w and the F_v term in conflicting ways. With more lanes, W_{cd} is likely to be larger, but if traffic is held constant F_v would decrease.	
width of the outside through lane	W_{ol}	feet	$W_{ol} + W_{bl} + I_{pk}W^*_{os}$	Increasing this improves BLOS, unless W_{cd} is increased in which case this variable has a conflicted effect.	
width of the bicycle lane	W_{bl}	feet	$W_{ol} + W_{bl} + I_{pk}W^*_{os}$	Increasing this improves BLOS, unless W_{cd} is increased in which case this variable has a conflicted effect.	This is 0 if there is no bicycle lane.
on-street parking occupancy	p_{pk}	percentage	Used to define $I_{pk} = 0$ if $p_{pk} > 0$. Otherwise $I_{pk} = 1$.	Where curbs are present, BLOS is degraded.	
width of paved outside shoulder	W_{os}	feet	W_{os}	Increasing this improves BLOS, unless W_{cd} is increased in which case this variable has a conflicted effect.	
presence of curbs	N/A	binary	If curb is present, and $W_{os} \geq 1.5$, $W^*_{os} = W_{os} - 1.5$. Otherwise, $W^*_{os} = W_{os}$.	If this is non-zero, BLOS is degraded.	

Table 2: Data required to calculate BLOS for a signalized intersection.

SENSITIVITY EXAMPLES



Components of Link BLOS can be positive or negative, with wide lanes and bike lanes counteracting poor pavement and high speeds and traffic volumes.

Traffic speed degrades Link BLOS, but the relationship is logarithmic; the effect decreases as speeds increase.

WHAT DETERMINES BICYCLE LOS?

At an **intersection**: the width of the street being crossed and the bicyclists' operating space (wide outside lane, shoulder, or bike lane). High traffic volumes also influence the score.

On a **link**: depending on their values, all three can heavily influence the score: 1) vehicle volumes (esp. heavy vehicles) 2) vehicle speeds, and 3) bicyclists' operating space.

On a **segment**: a function of intersection BLOS and link BLOS, with a large constant that makes it very difficult to achieve a grade above C.

On a **facility**: a length-weighted sum of segment BLOS scores.

POLICY IMPLICATIONS

By enabling broader scrutiny of the BLOS model, we hope to target resources towards the most crucial improvements. We suggest three major changes:

1. Help agencies model changes to vehicle volumes and speeds; scores greatly depend on predicting these accurately
2. Make the model sensitive to the variety of street treatments that now exist in the U.S. and the range of variables that are currently known to affect bicyclist safety and comfort
3. Simplify the functional form of the model for improved usability and transparency

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