Introduction

Bicycle-specific traffic signals are an emerging transportation solution in the United States that can improve safety for cyclists and mitigate difficult connections in the bike network. Although their increased use has been demonstrated in a recent survey, operational discrepancies exist from signal to signal, particularly with regard to timing. In accord is a lack of consistency in the literature with respect to methodology and reporting of cyclist performance characteristics and the exploration of variables that affect them. This study addresses research gaps related to cyclist performance.

A detailed methodology for estimating cyclist performance values was applied to video data collected at multiple intersections in several Oregon jurisdictions. Empirical values for characteristics most critical for signal timing – speeds and accelerations from stop, and reaction times to green indications – were determined along with differences in performance between recreational and commuter cyclists.

This poster summarizes research of cyclist behavior at signalized intersections in Portland, Eugene, Corvallis, Beaverton and Clackamas County, Oregon. A total of 753 cyclists were observed. For each cyclist observed arriving on red, a set of descriptive variables were collected (e.g., age, sex, helmet use, type of bike, clothing, presence of cargo, arrival in group). Time-based event data were collected to establish reaction times, speeds, and accelerations.

Objective

To develop operational guidelines for timing and phasing of bicycle-specific traffic signals or modifications that can be made to existing signals to better accommodate bicycles.

Data Assembly

A portable video data collection system that was used was equipped with two camera inputs (wide-angle cameras) and contained a battery and digital video recorder (DVR). The cameras were pole mounted, out of the view of most road users. Video data was collected at the following six locations:

- Pearl St and E 18th Ave, Eugene, OR
- NW Buchanan and NW 5th Ave, Corvallis, OR
- SE Johnson and Bell, Clackamas, OR
- SE Madison and SE Grand, Portland, OR
- NE Vancouver and NE Weidler, Portland, OR
- SW Lombard and SW 5th Street, Beaverton OR

Data Reduction Methodology

For analyzing performance characteristics, only cyclists who: 1) came to a complete stop at the intersection; 2) stopped at one of the designated reference lines; 3) was the forward-most cyclist at the signal; 4) had at least one foot on the ground; and 5) used the bike lane before and after the intersection were eligible to become part of the dataset. These constraints allowed researchers to determine the perception reaction time, acceleration, and velocity of a cyclist in a consistent manner.

Reference Line

This datum refers to the reference line closest to the cyclist's front wheel just before departure. The far and near sides of the 1-foot-wide stop bar were used, and since cyclists do not consistently stop directly over the stop bar, additional reference lines (in orange) were marked to calculate the distance traveled by cyclists stopping near, but not at, the stop bar.

Reaction Time

The value for reaction time was defined as the difference between time of green and departure time.

Acceleration and Speed

Utilizing two time/distance measurements and the formulas presented in a paper by Figliozzi, Wheeler and Monsere (2012), it is possible to classify a cyclist’s performance case, acceleration and cruising speed value. Each bicycle crossing time is allocated to an acceleration case, then average acceleration and cruising speed values are calculated for each bicycle rider. By aggregating individual rider performance values, it is possible to put together distribution functions of average acceleration and cruising speeds. These distributions can be used to calculate average and 15th percentile values. Finally, it should be noted that the speed and acceleration distributions are a function of the intersection width and the chosen values for $d_1$ and $d_2$. However, $d_1$ and $d_2$ are not equal across observations from the same intersection due to the utilization of reference lines.

Analysis and Results (continued)

observed crossing times by intersection width excluding reaction times

Analysis and Results

Conclusions

- The AASHTO defaults are clearly conservative for acceleration. Nearly every cyclist observed in this research attained much higher average accelerations. For all cyclists, the 1.5 feet/sec² AASHTO default is approximately the 0.4th percentile in the observed data.
- The AASHTO default cruising speed of 14.7 ft/sec is higher than the median value observed in the field. The default speed is approximately the 58th percentile of the observed data (meaning that approximately 58% of cyclists we observed were slower than or were able to attain this cruising speed).
- The AASHTO default perception-reaction time of 1.0 seconds is between the 32nd and 39th percentile of the observations. Approximately 61% of observed cyclists had reaction times longer than 1.0 second.
- The combination of AASHTO defaults in the clearance formula, however, produces conservative timing values (due to the low assumed acceleration). An analysis of the actual crossing times of cyclists indicates that nearly all riders are accommodated by the AASHTO default timing with the exception of some recreational riders at a wide intersection.
- Statistically significant differences were found between alone and group, recreational and commuter, and grade or no grade in each of the performance categories. The analysis suggests there is a performance difference between commuters and recreational riders (classified by weekday and weekend) that merits adjustments to the default values. Alternatively, field-based measurement of cyclist performance at a particular location could be easily made with the methodology developed in this research.