Moving Ahead for Multimodal Performance Measures:

Applying the Charlotte, NC Bicycle and Pedestrian Level of Service Tool in Santa Monica, CA

By Madeline Brozen
The urban street design guidelines in Charlotte, NC, USA are an implementation tool for planning and designing “complete streets” in the region. Following their release and adoption in 2007, these guidelines have received a fair deal of praise, including the 2009 U.S. Environmental Protection Agency (EPA) Award for Smart Growth Achievement. They have additionally been lauded for use of context sensitive design and for including a clear institutional process for applying the guidelines to all stages of project delivery. However, with all of these awards and attention, there was relatively little commentary on the bicycle and pedestrian level of service tools created in part with the guidelines.

Bicycle and pedestrian level of service (LOS) are meant to assist in evaluating intersections from a multimodal perspective and ensure that intersection design reflects the city’s goals of making travel safer and more convenient, particularly for people walking, cycling, and taking transit. These tools were originally envisioned to assess level of service scores for new, different street types, with the different street types including varying modal emphases. In essence, the most auto-oriented streets could have lower acceptable levels of service for biking and walking, while the streets with large numbers of civic, social, and commercial destinations require higher biking and walking levels of service.

Given that the design guidelines are considered a national model for expanding conventional street design with the U.S. EPA’s recognition, our research team wondered whether these tools could be applicable outside of Charlotte. Through a research project funded by the University of California Transportation Center, we applied these tools to several streets in Santa Monica, CA, USA. This article examines how these tools work, describes the street segments we evaluated, and presents the resulting bicycle and pedestrian level of service scores. We conclude by thinking about the applicability of this tool outside of Charlotte and the implications for policy making.

**Charlotte, NC Level of Service Tool Overview**

To complete the level of service calculations, some data must be collected in the field and some information can be collected remotely from observing aerial photographs or online services such as Google Earth. The majority of the inputs are design based; the only operational inputs are about the signal phasing and timing. After all the necessary information is collected, the intersection characteristics are input into a spreadsheet tool. The Charlotte level of service tool is only concerned with scoring conditions at signalized intersections. All intersection approaches are measured individually, then averaged to produce an overall intersection score. The scores correspond to letter grades, “A” through “F.” The higher the score total, the better the letter grade.

According to the Charlotte Department of Transportation, the tool’s focus is “on intersection features that reduce traffic conflicts, minimize crossing distances, slow down traffic speeds, and raise user awareness.” More specifically, conflicts with turning vehicles are identified as the primary issue for pedestrian comfort and safety at intersections. For cyclists, no single issue is identified as primary, but potential conflicts with turning vehicles, desire for physical space removed from vehicle traffic, and adjacent vehicle speeds are identified as key issues. The specific variables that are to be collected in the field and how they affect the overall level of service scores are described in detail below.

**Pedestrian Variables**

1. **Crossing distance:** Wider streets have a larger negative effect on pedestrian level of service than any other factor. The presence of a median refuge can mitigate the effect of large crossing distance, depending on its width.
2. **Signal phasing and timing:** Points are awarded based on how much protection and conflict reduction is provided by the signal phasing and by the amount of time given to cross.
3. **Corner radius:** A smaller radius receives more points and a higher pedestrian level of service.
4. **Right turns on red:** A vehicular right-turn-on-red is a potential conflict point with crossing pedestrians; the absence of this feature increases scoring a small amount.
5. **Crosswalk treatment:** Points are taken off for a lack of a crosswalk. Points are awarded for ladder-type markings and textured or colored pavement.
6. **One-way-street adjustment**: A one-way street results in a point penalty that varies depending upon the number of vehicle-pedestrian conflicts resulting from the left-turn traffic signalization.

**Bicycle Variables**

Two categories overlap from the pedestrian calculations: crossing distance and right turns on red. However, the crossing distance for bicyclists does not have as great a contribution to the overall score as it does for pedestrians. The additional variable categories are as follows:

1. **Bicycle travel way and speed of adjacent traffic**: Bicycle lanes get the most points. Where there are no bicycle lanes, wide curb lanes get more points than standard width curb lanes. Each type is awarded more points when the adjacent automobile speed limit is lower.

2. **Signal features – left turn phasing and stop bar location**: The more permissive left turns are, the lower the scoring, with protected only left hand turns receiving the most points because they present the fewest opportunities for conflict. The checklist also favors intersections that have a bicycle stop line further into the intersection than the vehicle line.

3. **Right turn traffic conflict**: The checklist lists several possible ways an intersection’s lane configuration and design can mitigate a conflict between a right turning vehicle and a bicycle passing through. A bicycle lane to the right of the vehicle lane at the point of intersection results in a large penalty of twenty points.

4. **Right turns on red**: A prohibition on vehicular right turns at a red light adds points to increase bicycle level of service.

5. **Crossing distance**: An intersection with intersection crossing distance greater than three lanes decreases the points awarded to the bicycle level of service score.

**Methodology**

To test the use of the Charlotte tool, we selected fifteen intersections on five streets near the University of California Los Angeles (UCLA) campus in the City of Santa Monica, CA. These intersections contain a range of different street typologies and design characteristics, particularly number of lanes and traffic volume intensity.

**Arizona Avenue**

Arizona Avenue (Figure 1) is a minor avenue, with the highest level of pedestrian activity among the test segments. It includes one travel lane in each direction, curbside parking, and bicycle lanes in both directions and is intersected by a pedestrian-only street.

**Main Street**

Main Street (Figure 2) is a commercial, moderate density, collector street with one travel lane in each direction, a dedicated center-turn lane, bicycle lanes on both sides of the street, curbside parking, and tree-lined sidewalks. This street is fairly similar to Arizona Avenue, with the addition of the center-turn lane and moderately higher traffic volumes.

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**Figure 1. Arizona Avenue in Santa Monica, CA, USA had the highest pedestrian activity among test segments.**

**Figure 2. Main Street in Santa Monica, CA, USA.**

**Figure 3. 17th Street in Santa Monica, CA, USA.**
17th Street
17th Street (Figure 3) is a minor avenue, serving local auto trips and bicycle trips. The right of way between Broadway and Colorado includes one travel lane in each direction, bicycle lanes on both sides of the street, and some curbside parking. From Colorado to Olympic, 17th Street narrows and excludes curbside parking.

20th Street
This segment is parallel to 17th Street, a few blocks away, with two travel lanes in each direction and a center turn lane (Figure 4). The street has no curbside parking or bicycle facility. It provides access to the Santa Monica Freeway and is designed to serve regional auto trips.

Cloverfield Boulevard
Cloverfield Boulevard (Figure 5) is a major avenue designed to serve regional automotive trips, connecting nearby streets to the Santa Monica Freeway with a high volume of traffic, including many heavy-duty vehicles, with no curbside parking or bicycle lanes. From Broadway to Colorado, the right of way includes two travel lanes in each direction and a center turn lane. From Colorado to Olympic, Cloverfield Boulevard widens considerably to include three travel lanes in each direction and a two-lane median for dedicated left turns.

Based solely on our impressions of walking and biking along the segments, we predicted Arizona Avenue would receive the highest level of service scores and Cloverfield Boulevard would receive the lowest scores. Beyond the two extremes, our intuition was that the intersections along Main Street would receive moderate scores, slightly worse than Arizona, with 17th Street intersections below that and 20th Street would appear second to last in the rankings. Our hypothesis did not differentiate between cyclist and pedestrian scores.

Results from Applying the Level of Service Tool in Santa Monica, CA, USA.

<table>
<thead>
<tr>
<th>Street Intersection</th>
<th>Bicycle</th>
<th>Pedestrian</th>
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</thead>
<tbody>
<tr>
<td>Arizona &amp; 3rd</td>
<td>115 / A</td>
<td>95 / A</td>
</tr>
<tr>
<td>Arizona &amp; 4th</td>
<td>63 / C</td>
<td>73 / C</td>
</tr>
<tr>
<td>Arizona &amp; 5th</td>
<td>60 / C</td>
<td>72 / C</td>
</tr>
<tr>
<td>Main &amp; Ocean Park</td>
<td>83 / B</td>
<td>80 / B</td>
</tr>
<tr>
<td>Main &amp; Hill</td>
<td>68 / C</td>
<td>88 / B</td>
</tr>
<tr>
<td>Main &amp; Ashland</td>
<td>68 / C</td>
<td>88 / B</td>
</tr>
<tr>
<td>17th &amp; Broadway</td>
<td>75 / B</td>
<td>78 / B</td>
</tr>
<tr>
<td>17th &amp; Colorado</td>
<td>53 / D</td>
<td>81 / B</td>
</tr>
<tr>
<td>17th &amp; Olympic</td>
<td>44 / D</td>
<td>71 / B</td>
</tr>
<tr>
<td>20th &amp; Broadway</td>
<td>50 / D</td>
<td>67 / C</td>
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<td>Cloverfield &amp; Olympic</td>
<td>21 / E</td>
<td>33 / E</td>
</tr>
</tbody>
</table>

Table 1. Level of Service Scores and Grades at City of Santa Monica, CA Intersections.

Discussion
What improvements does the Charlotte level of service tool suggest for these intersections? To answer this question, we created graphs showing how the different variables contribute to the overall grade. The graphs that follow show a score of a single intersection for each segment we analyzed. These graphs present a quick, visual approach to understanding where improvements should be focused to achieve level of service grade objectives.

For pedestrians, as seen in Figure 6, the main contributor to the overall grade/score is the total crossing distance. The streets with the larger crossing distance, notably 20th Street and Cloverfield
Boulevard, received fewer points and were penalized more. For bicyclists, bicycle travel through the intersection, including bike facility presence or absence, contributes most of the overall score. Arizona, Main, and 17th Streets all have bicycle lanes, while 20th Street and Cloverfield Boulevard do not have any bicycle infrastructure. Where bicycle lanes are present, intersections with the bicycle lane to the inside of the right turn lane received additional points. All of the streets were penalized for both cycling and walking because right-turn-on-red vehicle movements were allowed. Overall, we could easily understand where improvements were needed by having the graphic score representations in Figures 6 and 7.

Figure 6. Pedestrian Variable Contribution

Figure 7. Bicyclist Variable Contribution

Conclusion
This exercise of applying the Charlotte tools outside of the original jurisdiction appeared fairly fruitful. The scores were in line with our hypothesis and the results are intuitive. The scoring output demonstrates where strategic improvements at intersections could improve walking and bicycling conditions. Additionally, the scoring was consistent; there were no unexpected spikes or sudden deviations. Lastly, the spreadsheet tool is user-friendly and producing the scores requires little technical assistance. Overall, any tool should strive to provide intuitive, consistent results and be easy to use. Our experience demonstrated that the Charlotte Level of Service tool has all of these qualities.

Beyond the potential use of the Charlotte Level of Service tool itself, this analysis highlighted the value in the process of putting a tool in place. This tool was a direct result of the vision in the transportation action plan, an outline for 25-years of land use and transportation decisions, being translated into urban street design guidelines. This is to say the tool is likely to be less effective in cases where a city’s or region’s overarching mobility goals are less defined. In conclusion, cities should ensure they have clearly defined goals and visions for the future before trying to find a new tool for evaluating streets for walking and cycling. After that non-insignificant task, tweaking the Charlotte tool to reflect the region’s goals and guidelines could be a plausible way forward.

Acknowledgments
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References
6. Ibid.

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