The ITS Heartland TSMO Training Program is comprised of a webinar series, live training, and other educational activities designed to introduce and build upon expertise in performance and operational excellence at all levels: Agency Executives to Design and Operations Staff to Field Level.

Each webinar is broadcast live but ITS Heartland also archives the webinars on their website at www.itsheartland.org. TSMO Expert Teams will be tasked with meeting and presenting to various groups, agencies, organizations and individuals to educate them on TSMO benefits, encourage action, and spur projects forward.

TSMO encompasses a broad set of strategies that aim to optimize the safe, efficient and reliable use of existing and planned transportation infrastructure for all modes. TSMO is undertaken from a systems perspective, which means that these strategies are coordinated with related strategies and across multiple transportation modes.

## Learning Objectives:
- Be able to define TSMO and identify TSMO strategies;
- Recognize TSMO needs and how improving operational efficiency can benefit their agency;
- Identify how construction and maintenance activities affect traffic operations and vice-versa;
- Recognize the impacts that various TSMO strategies will have on their projects and be viewed by the public or political leadership.

## Target Audience Description:
- Maintenance Supervisors, Maintenance Operators, Construction Engineers, Construction Technicians, Inspectors, Traffic Signal Technicians, Contractor Foreman, Contractor Field Engineer, Traffic Control Subcontractors, Law Enforcement, Fire, Towing Companies, etc.
- Planning Personnel, MPO Staff, Traffic Engineers, Public Works Managers, City Planners, Consultants, District Engineers, Bureau Chiefs, etc.
-USDOT to evaluate the impact on targeted audiences. These will include number of attendees, actions taken by agencies and their training professionals worked with the TSMO Steering Committee to develop the curriculum, set training expectations, develop performance measures, and train subject matter experts to provide training. Performance measures will be established through the lens of the USDOT’s vision, core values and mission. The USDOT will also include number of attendees, actions taken by agencies, and subjective feedback obtained through evaluations by participants. Finally, the training sessions will be evaluated for effectiveness in improving the knowledge and skills of the training program staff through valuable feedback from one of the leading programs in the area.

### Results to Date
Since the start of the ITS Heartland TSMO Training Program in June 2017, we have reached over 300 people with our webinars and live-meetings. Of those, 1/3 have been from the private sector and 2/3 from the public sector. The program has received positive feedback from 25% of our participants coming from other parts of the country.
Dat Yacht Race? Oh Yah, You Betcha!—Modeling Bermuda’s Americas’ Cup From Minnesota

Stephen Mombert, P.E., PTO, PTP Transportation Service Leader, Westwood Professional Services, Minnetonka, MN
Vernon Swing, P.E., President/CEO, Swing Traffic Solutions, LLC, Plymouth, MN

Special Thanks to:
Jamie Pekkonen, P.E., P.Eng., Burnel, Ltd.
Jacob Rojer, EIT, Spack Consulting
Setting Priorities for New Interchanges in the Twin Cities

2018 Joint Institute of Transportation Engineers (ITE) International and Midwestern/Great Lakes Districts Annual Meeting and Exhibit

August 21: 2:45 PM to 4:15 PM, Poster Session: Nuts and Bolts

Bryan Nemeth, P.E., PTOE, Bolton & Menk, Inc.

Contact: bryanne@bolton-menk.com, 952-890-0509
Background

- Mobility and safety problems at many at-grade intersections
- Identify regional priorities given high demand for grade separations and limited funding
- Constructed 16 interchanges in past 10 years; avg. construction cost of $20M
Study Objectives

- Identify regional priorities given high demand for grade separations and limited funding
- Provide input to funding decisions

What is the priority for grade separation?
  - High
  - Medium
  - Low

Concept Plan(s)
Has a right-sized project been defined?

Funding Decision(s)

Inadequate funding

Adequate funding

Project Development Process

Setting Priorities for New Interchanges in the Twin Cities
Study Process Overview

- **Phase I. Initial Screening**
  - Which intersections are not candidates for grade separation at this time?

- **Phase II. Detailed Analysis & Screening**
  - Set priorities for future grade separations – High, Medium, Low
  - Best fit, “right-sized” design solutions?
Volume and Capacity Factors

Guidance Based on ADT Thresholds
(MnDOT ICE and HCM guidance for signalized intersections)

Safety, Context & Local Input Factors
Criteria Based on PA Role, Previous Planning, and Local Context

1. Safety (critical crash index)
2. Functional Class & System Context
3. Local Planning Support (previous studies; support at meetings)
4. Right-of-Way and Physical Feasibility (expressway or urban street?)
5. Regional Mobility or Growth Corridor
6. Infrastructure and Funding Cycle

(Items 3, 4, and 6 were sometimes significant in Phase I screening decisions.)
Phase I
 Screening Data Analysis

• **Q.** Could there be a data-driven screening formula?

• **A.** No, but the Study developed innovative guidance on intersection performance.
Phase I Screening Map

91 intersections identified for detailed Phase II analysis

Setting Priorities for New Interchanges in the Twin Cities
Phase II Analysis and Intersection Scoring (Summary of Methods)

- **Weighted Criteria**
  - Mobility = 40%
  - Safety = 30%
  - Context = 30%

- **Intersection Capacity Analysis & Score**
  - High-level study; current peak-hour operations
  - CAP-X: Capacity Analysis for Planning of Junctions (FHWA planning tool)

- **Composite Score** (normalized 1-10)
Phase II Capacity Analysis

- FHWA CAP-X Tool
  - Test intersection data against various solutions
  - Ask: What type of investment to provide a reasonable volume/capacity (V/C) ratio?

- Example Results, Summarized (Trunk Highway 7):

<table>
<thead>
<tr>
<th>Capacity Analysis Summary</th>
<th>Existing Intersection</th>
<th>Expanded Intersection</th>
<th>Alternative At-Grade Intersection</th>
<th>Add PA Capacity</th>
<th>Hybrid Interchange</th>
<th>Full Interchange</th>
</tr>
</thead>
<tbody>
<tr>
<td>TH 7-A</td>
<td></td>
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</tr>
<tr>
<td>1 CH 101</td>
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<tr>
<td>2 Woodland Rd.</td>
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<td></td>
<td>![Symbol]</td>
<td>![Symbol]</td>
</tr>
</tbody>
</table>

Key:
- ![Symbol] V/C ≥ 1.0
- ![Symbol] V/C > 0.85 & < 1.0
- ![Symbol] V/C ≤ 0.85

Setting Priorities for New Interchanges in the Twin Cities
Phase II Weighted Criteria

- Phase II Criteria & Weights – *Which intersections:*
  - Serve higher volumes of traffic, reduce mobility, and cause variable travel times? *(Mobility = 40%)*
  - Have a higher rate/cost of severe crashes? *(Safety = 30%)*
  - Can accommodate grade separation, serve regional routes, and leverage other modes? *(Corridor Context = 30%)*

- Technical Steering Committee (TSC) members helped to establish these weights
Composite Scores & Priorities

- **Composite Score**
  - Representative Capacity Score (half of composite score)
  - Score for Weighted Criteria (the other half)
  - Resulting scores guided grade-separation priorities

- **Example (Trunk Highway 7):**

  ![Intersection Scores and Grade-Separation Priorities](chart.png)

  - **Intersection measures:**
    - **Capacity:** Do peak-hour volumes exceed design?
    - **Mobility:** Are daily volumes and congestion high?
    - **Safety:** Are there many or severe crashes?
    - **Context:** Are plans and multi-modal factors supportive?
Phase II Priority Map (91 Intersections)

**Grade-Separation Priorities:**
- 34 High
- 27 Medium
- 30 Low

**26 Focus Areas**
- Intersection locations & corridors
- Likely basis for future corridor studies

**Grade-Separation Priority**
- High
- Medium
- Low
Detailed Focus Area Example (TH 65-A)

### Capacity Analysis Summary

<table>
<thead>
<tr>
<th>Existing Intersection</th>
<th>Expanded Intersection</th>
<th>Alternative Al-Grade Intersection</th>
<th>Add PA Capacity</th>
<th>Hybrid Interchange</th>
<th>Full Interchange</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Medtronic Pkwy.</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Moore Lake Dr.</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Mississippi St.</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. 73rd Ave.</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>5. Osborne Rd.</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. 81st Ave.</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. 89th Ave.</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. 89th Ave.</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Key**
- V/C ≥ 1.0
- V/C > 0.85 & < 1.0
- V/C ≤ 0.85

### Intersection Scores and Grade-Separation Priorities

#### 1. Medtronic Pkwy (6.3/High)

- **Capacity**
  - High: 6.3
- **Mobility**
  - High: 6.3
- **Safety**
  - Medium: 6.3
- **Context**
  - High: 6.3

#### 2. Moore Lake Dr (6.7/Low)

- **Capacity**
  - Low: 6.7
- **Mobility**
  - Low: 6.7
- **Safety**
  - Medium: 6.7
- **Context**
  - Low: 6.7

#### 3. Mississippi St (6.4/Low)

- **Capacity**
  - Low: 6.4
- **Mobility**
  - Low: 6.4
- **Safety**
  - Medium: 6.4
- **Context**
  - Low: 6.4

#### 4. 73rd Ave (5.5/Medium)

- **Capacity**
  - Medium: 5.5
- **Mobility**
  - Medium: 5.5
- **Safety**
  - Medium: 5.5
- **Context**
  - Medium: 5.5

#### 5. Osborne Rd (6.6/High)

- **Capacity**
  - High: 6.6
- **Mobility**
  - High: 6.6
- **Safety**
  - High: 6.6
- **Context**
  - High: 6.6

#### 6. 81st Ave (6.6/High)

- **Capacity**
  - High: 6.6
- **Mobility**
  - High: 6.6
- **Safety**
  - High: 6.6
- **Context**
  - High: 6.6

#### 7. 89th Ave (6.6/High)

- **Capacity**
  - High: 6.6
- **Mobility**
  - High: 6.6
- **Safety**
  - High: 6.6
- **Context**
  - High: 6.6

#### 8. 89th Ave (6.0/Medium)

- **Capacity**
  - Medium: 6.0
- **Mobility**
  - Medium: 6.0
- **Safety**
  - Medium: 6.0
- **Context**
  - Medium: 6.0

### Legend

- **Grade-Separation Priority**
  - High: Red
  - Medium: Yellow
  - Low: Green

- **Interchange**
  - Medium: Yellow
  - Low: Green
  - High: Red

---

**Figure 10**

Anoka County - TH 65-A Focus Area

Source: Mn/DOT, MDOT

**January 2017**

**Setting Priorities for New Interchanges in the Twin Cities**
## Capacity Analysis Example (TH 65-A)

### Capacity Analysis Summary

<table>
<thead>
<tr>
<th></th>
<th>Existing Intersection</th>
<th>Expanded Intersection</th>
<th>Alternative At-Grade Intersection</th>
<th>Add PA Capacity</th>
<th>Hybrid Interchange</th>
<th>Full Interchange</th>
</tr>
</thead>
<tbody>
<tr>
<td>TH 65-A</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>1 Medtronic Pkwy.</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>2 Moore Lake Dr.</td>
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<td></td>
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</tr>
<tr>
<td>3 Mississippi St.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 73rd Ave.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 Osborne Rd.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 81st Ave.</td>
<td></td>
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<td></td>
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<tr>
<td>7 85th Ave.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 89th Ave.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Key**
- \( V/C \geq 1.0 \)
- \( V/C > 0.85 \) & \( < 1.0 \)
- \( V/C \leq 0.85 \)

- **Existing Intersection** – The existing traffic demands and conditions at the intersection
- **Expanded Intersection** – Assumes the addition of turn lanes to the intersection
- **Alternative At-Grade Intersection** – Assumes a reduced-conflict or unconventional intersection
- **Add PA Capacity** – Assumes the addition of continuous capacity to principal arterial mainline
- **Hybrid Interchange** – Assumes use of limited grade separation elements with other at-grade features
- **Full Interchange** – Assumes a fully grade-separated intersection (various configurations)
**Composite Score Summary (TH 65-A)**

**Intersection Scores and Grade-Separation Priorities**

<table>
<thead>
<tr>
<th>Intersection</th>
<th>Score</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medtronic Pkwy</td>
<td>6.8</td>
<td>High</td>
</tr>
<tr>
<td>Moose Lake Dr</td>
<td>4.7</td>
<td>Low</td>
</tr>
<tr>
<td>Mississippi St</td>
<td>4.4</td>
<td>Low</td>
</tr>
<tr>
<td>73rd Ave</td>
<td>5.4</td>
<td>Medium</td>
</tr>
<tr>
<td>Osborne Rd</td>
<td>6.6</td>
<td>High</td>
</tr>
<tr>
<td>81st Ave</td>
<td>6.6</td>
<td>High</td>
</tr>
<tr>
<td>85th Ave</td>
<td>6.6</td>
<td>High</td>
</tr>
<tr>
<td>89th Ave</td>
<td>6.0</td>
<td>Medium</td>
</tr>
</tbody>
</table>

**Intersection measures:**
- **Capacity**: Do peak-hour volumes exceed design?
- **Mobility**: Are daily volumes and congestion high?
- **Safety**: Are there many or severe crashes?
- **Context**: Are plans and multi-modal factors supportive?
Role of the Study in Future Planning

• Results:
  – Modify TPP and MnSHIP investment scenarios
  – Provide input to funding decisions for competitive state and federal awards
  – Serve as a reference for local planning and policy reviews
  – Make the case for additional funding

• Advises the right-sizing of proposed projects based on intersection priorities

Regional Investment Philosophy
Before and After Operational Evaluations of Two Diverging Diamond Interchanges

Wei Zhang1, Gregory Jordan2, Alan Sharp3
1 Program Manager, USDOT/FHWA Office of Safety R&D
2 President, Skycomp, Inc, 3Director of Survey Operations, Skycomp, Inc

Abstract

Helicopter Based TLAP Configurations – 1 mile above ground

- One prosumer camera covers an area of 1.75 ml by 1.25 ml.
- Up to 4 cameras with different zooms can be used on each flight.
- Multiple intersections are monitored simultaneously.
- Traffic data was continuously collected for 90 minutes at 1 Hz rate, each camera captured 5400 high resolution images per flight.
- Images are rotated and shifted slightly and then zoomed into each intersection. After processing, when flipping through the images, they look like taken from a fixed camera.
- The following types of traffic data can be derived from the TLAP images:
  - Intersection turning movement counts of vehicle, pedestrian, and cyclist
  - Travel time between any two defined locations
  - Average travel speed on any segment
  - Queue length by lane on each approach
  - Trip delay by movement and by approach
  - Vehicle classification
  - Origin-destination matrix of the defined network

Visual gates defined for after period analyses

Visual gates defined for before period analyses

Introduction

- The diamond interchange at I-75 & University Pkwy, Sarasota, FL was one of the worst bottlenecks in southwest Florida, clogging both the interstate and arterial roads.
- In August 2015, FDOT started a $74.5M design-build project to turn it into a 10-lane DDI. By then, over 50 DDIs had been opened in the U.S., and this design had been accepted as a cost effective solution to congestion and related safety and pollution problems. Rather than just been a later comer, FDOT made a bold move to make Florida’s 1st DDI the largest DDI in the world.
- FDOT hired an experienced consultant to do the project management and design work. The project development involved broad public participation including over 50 public meetings.
- Comprehensive analysis was done to ensure the DDI will be able to handle the heavy traffic at the interchange.
- The DDI was opened traffic in September, 2017.

Operational Evaluation

- FHWA collaborated with FDOT to conduct before/after operational evaluation using time lapsed aerial photography (TLAP) technology.
- Both helicopter and drone were used to collect field traffic data. The survey area included the DDI crossovers and the two signal intersections outside the DDI on University Pkwy.
- Before period aerial survey was conducted in July 2015, and after period survey was done in April 2018.
- Corresponding traffic MOEs such as turning movement count by intersection, travel time by movement, travel speed by segment, and queue by approach by lane, etc. were used to assess the before and after operational characteristics.

Helicopter and the survey area it covers from 1 mile above

Conclusions

- The DDI reduced travel time for through movement by 33%, and for left-turn on ramp traffic by 40%; the corresponding average speeds were increased by 53% and 68% respectively.
- For right-turn on ramp traffic (starting from upstream signal intersection), marginal reduction in travel time was also achieved.
- Similar improvements were observed for other movements, such as off-ramp left-turn.
- Field videos indicate there are still congestions from DDI exit to the downstream signal intersections on both side of the DDI, but little to no congestion from the adjacent signals leading to the DDI.
- Further improvement should be explored to reduce or eliminate congestions between DDI and downstream signal intersections.

Before period MOE measures (selected)

<table>
<thead>
<tr>
<th>Segment</th>
<th>Avg Trip Time (sec)</th>
<th>Avg Speed (MPH)</th>
<th>Avg Trip Time (sec)</th>
<th>Avg Speed (MPH)</th>
<th>Segment Length (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EB-Thru</td>
<td>159</td>
<td>19</td>
<td>201</td>
<td>15</td>
<td>4465</td>
</tr>
<tr>
<td>EB-NB</td>
<td>114</td>
<td>23</td>
<td>123</td>
<td>22</td>
<td>3925</td>
</tr>
<tr>
<td>EB-SB</td>
<td>58</td>
<td>32</td>
<td>48</td>
<td>38</td>
<td>2707</td>
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<tr>
<td>WB-Thru</td>
<td>161</td>
<td>19</td>
<td>195</td>
<td>16</td>
<td>4433</td>
</tr>
<tr>
<td>WB-NB</td>
<td>47</td>
<td>42</td>
<td>62</td>
<td>32</td>
<td>2900</td>
</tr>
<tr>
<td>WB-SB</td>
<td>133</td>
<td>19</td>
<td>165</td>
<td>15</td>
<td>3660</td>
</tr>
</tbody>
</table>

After period MOE measures (selected)

<table>
<thead>
<tr>
<th>Segment</th>
<th>Avg Trip Time (sec)</th>
<th>Avg Speed (MPH)</th>
<th>Avg Trip Time (sec)</th>
<th>Avg Speed (MPH)</th>
<th>Segment Length (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EB-Thru</td>
<td>106 (-33%)</td>
<td>29 (53%)</td>
<td>143 (-29%)</td>
<td>21 (40%)</td>
<td>4493</td>
</tr>
<tr>
<td>EB-NB</td>
<td>67 (-41%)</td>
<td>39 (70%)</td>
<td>80 (-35%)</td>
<td>32 (45%)</td>
<td>3790</td>
</tr>
<tr>
<td>EB-SB</td>
<td>52 (-10%)</td>
<td>41 (28%)</td>
<td>50 (4%)</td>
<td>43 (13%)</td>
<td>3131</td>
</tr>
<tr>
<td>WB-Thru</td>
<td>106 (-34%)</td>
<td>29 (53%)</td>
<td>161 (-17%)</td>
<td>19 (19%)</td>
<td>4482</td>
</tr>
<tr>
<td>WB-NB</td>
<td>45 (-4%)</td>
<td>45 (7%)</td>
<td>49 (-21%)</td>
<td>41 (28%)</td>
<td>2937</td>
</tr>
<tr>
<td>WB-SB</td>
<td>80 (-40%)</td>
<td>32 (68%)</td>
<td>97 (-41%)</td>
<td>27 (80%)</td>
<td>3778</td>
</tr>
</tbody>
</table>

Notes:

- (% numbers) indicate changes relative to before condition.
- Segment lengths for the same directional travels differ slightly between before and after periods’ surveys.
- The # of vehicles traced for each O-D pair vary from 5 to over 150.
- Numbers shown in **Bold Blue** font indicate major movements (through and left turn on ramp) targeted by DDI.
- Savings in road user cost can be computed by multiplying the per vehicle reduction in travel time by the number of vehicles on the corresponding movement.

Conclusions

- The DDI reduced travel time for through movement by 33%, and for left-turn on ramp traffic by 40%; the corresponding average speeds were increased by 53% and 68% respectively.
- For right-turn on ramp traffic (starting from upstream signal intersection), marginal reduction in travel time was also achieved.
- Similar improvements were observed for other movements, such as off-ramp left-turn.
- Field videos indicate there are still congestions from DDI exit to the downstream signal intersections on both side of the DDI, but little to no congestion from the adjacent signals leading to the DDI.
- Further improvement should be explored to reduce or eliminate congestions between DDI and downstream signal intersections.
What are Charter Schools?

- “Charter schools are public schools that operate under a performance contract, or a ‘charter’ which frees them from many regulations created for traditional public schools while holding them accountable for academic and financial results.”

- Charter schools do not just serve “local” residents within a specific geographic area, but provide parents with expanded education options.

- They are perceived to offer equal or better education than public schools, which in many instances does not cost additional money beyond that for public school attendance.

Study Purpose:

- To assess the transportation impacts associated with charter schools in the Tampa Bay region of Florida.

- To compare with standard ITE trip rates associated with private schools (K-8), public elementary and middle/junior high schools.

- To establish local trip generation rates for charter school land uses.
Study Objective:

- Evaluate ten (10) kindergarten to eighth grade (K-8) site locations in the Tampa Bay region to help develop trip generation guidelines for charter school uses.

- The locations selected for study have been coordinated with agency staff from FDOT, Hillsborough County, Pinellas County, Pasco County and the affiliated school districts.

Site Selection Criteria:

- Select a variety of locations in the Tampa Bay Region for evaluating trip generation characteristics

- Identify a minimum of one school in each county (Hillsborough, Pinellas and Pasco) to be studied.
Conclusion and Recommendations:

The theory that charter schools typically generate significantly greater traffic than traditional public schools is shown to be true in this trip generation study. Additionally, although charter schools and private schools share similar travel characteristics, this study shows that charter schools generate more traffic than their comparable counterpart. Although previous studies have also supported these outcomes, it is important to note that the average charter school trip generation of 10% more trips assumed by related traffic impact studies, are almost doubled in the results of the charter school study in the Tampa Bay region.

On average, charter school generated approximately 19% more trips than private school (K-8) estimates based on ITE Trip Generation Manual in the AM peak hour. This notable difference substantiates that not only does trip generation information need to be supplemented with additional information about the site’s characteristics to avoid gross underestimation or overestimation, but also that, with the increase of the number of sites studied, the reliability of the data and observations drawn from continued trip generation studies regarding charter schools will increase as well. Hence, it is therefore recommended, that as charter schools continue to be a land use of interest, a weighted average of documented trip generation rates be used for trip generation estimation.
Factors Impacting Selection

- Single-Purpose Facility
- Suburban Location
- Primarily Grades K-8
- Approximately ≥ 300 Students

Factors Not Impacting Selection

- Transportation Alternative: Busing
- Restrictive Access

Outside the Scope of Study

- Statewide Geographic Diversity
Selected Tampa Bay Charter School Sites

Charter Schools

1. Henderson Hammock School
2. Hillsborough Academy of Math and Science
3. Horizon Charter School of Tampa
4. Independence Academy
5. Lutz Preparatory School
6. Southshore Carter Academy
7. Athenian Academy
8. Plato Academy of Clearwater
9. Plato Academy of Palm Harbor
10. Imagine School at Land O’ Lakes
## School Operational Characteristics

<table>
<thead>
<tr>
<th>School Name</th>
<th>Jurisdiction</th>
<th>Number of Students</th>
<th>Number of Access Points</th>
<th>Busing Offered?</th>
<th>Hours of Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Henderson Hammock School</td>
<td>Hillsborough</td>
<td>1,101</td>
<td>2</td>
<td>No</td>
<td>8:00 AM - 3:00 PM</td>
</tr>
<tr>
<td>Hillsborough Academy of Math and Science</td>
<td>Hillsborough</td>
<td>738</td>
<td>2</td>
<td>No</td>
<td>8:30 AM - 3:00 PM (K-3) 8:30 AM - 3:30 PM (4-8)</td>
</tr>
<tr>
<td>Horizon Charter School of Tampa</td>
<td>Hillsborough</td>
<td>259</td>
<td>2</td>
<td>No</td>
<td>8:15 AM - 3:00 PM</td>
</tr>
<tr>
<td>Independence Academy</td>
<td>Hillsborough</td>
<td>765</td>
<td>2</td>
<td>No</td>
<td>8:15 AM - 3:15 PM (K-5) 8:45 AM - 3:45 PM (6-8)</td>
</tr>
<tr>
<td>Lutz Preparatory School</td>
<td>Hillsborough</td>
<td>760</td>
<td>2</td>
<td>No</td>
<td>8:00 AM - 3:00 PM</td>
</tr>
<tr>
<td>Southshore Charter Academy</td>
<td>Hillsborough</td>
<td>805</td>
<td>2</td>
<td>No</td>
<td>8:30 AM - 3:30 PM (K-5) 9:00 AM - 4:00 PM (6-8)</td>
</tr>
<tr>
<td>Athenian Academy</td>
<td>Pinellas</td>
<td>398</td>
<td>2</td>
<td>Yes</td>
<td>8:15 AM - 3:15 PM</td>
</tr>
<tr>
<td>Plato Academy of Clearwater</td>
<td>Pinellas</td>
<td>423</td>
<td>1</td>
<td>No</td>
<td>8:40 AM - 3:10 PM</td>
</tr>
<tr>
<td>Plato Academy of Palm Harbor</td>
<td>Pinellas</td>
<td>365</td>
<td>1</td>
<td>No</td>
<td>8:40 AM - 3:10 PM</td>
</tr>
<tr>
<td>Imagine School at Land O’ Lakes</td>
<td>Pasco</td>
<td>781</td>
<td>2</td>
<td>Yes</td>
<td>8:50 AM - 3:30 PM</td>
</tr>
</tbody>
</table>
Data Collection:

- Data collected between January 24 and March 1, 2017.

- Five-hour video counts were conducted at all the site access driveways on any given Tuesday, Wednesday or Thursday.

- The school calendar for each selected school was checked to note any extenuating circumstances.

- Vehicles were counted during the AM peak period (6:30 AM to 9:00 AM) and the school’s PM peak period (1:30 PM to 4:00 PM).
## Charter School Peak Hour Trip Data Summary Table

<table>
<thead>
<tr>
<th>Location</th>
<th>AM Peak Hour</th>
<th></th>
<th>PM Peak Hour</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Entering</td>
<td>Exiting</td>
<td>Total</td>
<td>Entering</td>
<td>Exiting</td>
<td>Total</td>
<td></td>
</tr>
<tr>
<td>Henderson Hammock School</td>
<td>594</td>
<td>520</td>
<td>1,114</td>
<td>228</td>
<td>372</td>
<td>600</td>
<td></td>
</tr>
<tr>
<td>Hillsborough Academy of Math and Science</td>
<td>330</td>
<td>322</td>
<td>652</td>
<td>203</td>
<td>236</td>
<td>439</td>
<td></td>
</tr>
<tr>
<td>Horizon Charter School of Tampa</td>
<td>201</td>
<td>185</td>
<td>386</td>
<td>136</td>
<td>156</td>
<td>292</td>
<td></td>
</tr>
<tr>
<td>Independence Academy</td>
<td>425</td>
<td>395</td>
<td>820</td>
<td>250</td>
<td>251</td>
<td>501</td>
<td></td>
</tr>
<tr>
<td>Lutz Preparatory School</td>
<td>460</td>
<td>398</td>
<td>858</td>
<td>270</td>
<td>335</td>
<td>605</td>
<td></td>
</tr>
<tr>
<td>Southshore Charter Academy</td>
<td>454</td>
<td>443</td>
<td>897</td>
<td>210</td>
<td>215</td>
<td>425</td>
<td></td>
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<tr>
<td>Athenian Academy</td>
<td>287</td>
<td>252</td>
<td>539</td>
<td>143</td>
<td>194</td>
<td>337</td>
<td></td>
</tr>
<tr>
<td>Plato Academy of Clearwater</td>
<td>313</td>
<td>266</td>
<td>579</td>
<td>168</td>
<td>183</td>
<td>351</td>
<td></td>
</tr>
<tr>
<td>Plato Academy of Palm Harbor</td>
<td>197</td>
<td>191</td>
<td>388</td>
<td>97</td>
<td>135</td>
<td>232</td>
<td></td>
</tr>
<tr>
<td>Imagine School at Land O’ Lakes</td>
<td>307</td>
<td>289</td>
<td>596</td>
<td>206</td>
<td>236</td>
<td>442</td>
<td></td>
</tr>
<tr>
<td><strong>Peak Hour Trip Totals</strong></td>
<td>3,568</td>
<td>3,261</td>
<td><strong>6,829</strong></td>
<td>1,911</td>
<td>2,313</td>
<td><strong>4,224</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>52%</td>
<td>48%</td>
<td></td>
<td>45%</td>
<td>55%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Establishing a Trip Generation Rate:

Due to the absence of data in the ITE *Trip Generation Manual, 9th Edition* covering the charter school land use, the establishment of a local trip generation rate/equation was justified. Section 4.5 of the ITE *Trip Generation Handbook, 3rd Edition* goes on to give further criteria in determining justification, all of which were satisfied in this study:

- At least three local sites are counted (preferably five).
- The weighted average rate for the counted sites is at least 15% higher or lower than the comparative Trip Generation rate, or if the Trip Generation provides only two or fewer data points.
- The local counts provide consistent results.

Per the *Trip Generation Handbook*, the computed trip generation rate, as opposed to the equation, was selected as the local trip generation estimator.
## Charter School Trip Rates

<table>
<thead>
<tr>
<th>Location</th>
<th>Number of Students</th>
<th>Weekday AM Peak Hour of the Generator</th>
<th>Weekday PM Peak Hour of the Generator</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Total Trips</td>
<td>Trip Generator Rate</td>
</tr>
<tr>
<td>Henderson Hammock School</td>
<td>1,101</td>
<td>1,114</td>
<td>1.012</td>
</tr>
<tr>
<td>Hillsborough Academy of Math and Science</td>
<td>738</td>
<td>652</td>
<td>0.883</td>
</tr>
<tr>
<td>Horizon Charter School of Tampa</td>
<td>259</td>
<td>386</td>
<td>1.490</td>
</tr>
<tr>
<td>Independence Academy</td>
<td>765</td>
<td>820</td>
<td>1.072</td>
</tr>
<tr>
<td>Lutz Preparatory School</td>
<td>760</td>
<td>858</td>
<td>1.129</td>
</tr>
<tr>
<td>Southshore Charter Academy</td>
<td>805</td>
<td>897</td>
<td>1.114</td>
</tr>
<tr>
<td>Athenian Academy</td>
<td>398</td>
<td>539</td>
<td>1.354</td>
</tr>
<tr>
<td>Plato Academy of Clearwater</td>
<td>423</td>
<td>579</td>
<td>1.369</td>
</tr>
<tr>
<td>Plato Academy of Palm Harbor</td>
<td>365</td>
<td>388</td>
<td>1.063</td>
</tr>
<tr>
<td>Imagine School at Land O’ Lakes</td>
<td>781</td>
<td>596</td>
<td>0.763</td>
</tr>
<tr>
<td><strong>Average Rate</strong></td>
<td></td>
<td><strong>1.07</strong></td>
<td><strong>0.66</strong></td>
</tr>
</tbody>
</table>
Average Vehicle Trips versus Number of Students

 Weekday AM Peak Hour of the Generator

\[ y = 0.812x + 163.16 \]
\[ R^2 = 0.8328 \]

Average Vehicle Trips versus Number of Students

 Weekday PM Peak Hour of the Generator

\[ y = 0.4102x + 160.1 \]
\[ R^2 = 0.7632 \]
Table presents the trip generation comparison with the corresponding rates found in the ITE database. The trip rates are particularly higher than those presented by ITE; thus, these rates will provide a more accurate trip estimate for charter school analysis. The results revealed that on an average, ITE rates for private schools (K-8) provide an underestimation of the peak hour trips for charter schools by 16% during the AM peak hour and by 9% during the PM peak hour. The percent difference in rate estimation begins to grow more substantially when charter school trip rates are compared to that of public schools. These results support the theory, substantiated by related studies, that charter schools generate more trips than estimates, based on ITE Trip Generation Manual, for private schools. At least three local sites are counted (preferably five).
Strategies for Enhancing Safety and Mobility with Flashing Yellow Arrows

BACKGROUND

Bellevue, WA
- Population of 140,000
- 1,100 lane miles
- Urban Downtown
- 200 Traffic Signals
- 100% Adaptive Signals (SCATS)
- Over 150,000 jobs

Flashing Yellow Arrows (FYA) Program in Bellevue
- Implemented since 2010
- Evaluated left turn phasing as part of adaptive signal conversion
- Performance review every 6 months
  - Collision Review
  - Delay Calculations
  - Operation Modifications

FYA PROTECTED-PEMISSIVE LEFT TURN (PPLT) DISPLAY

DIFFERENCE BETWEEN TRADITIONAL PPLT and FYA PPLT
- Flashing yellow arrow (FYA) instead of green ball for permissive phase
- Dedicated signal head for left turn phase means permissive phase is not tied to adjacent thru phase
- Can select between protected only and protected-permissive
- Can run lead-lag with PPLT by eliminating the yellow trap

*There is also a 3 section option that the City of Bellevue does not use (therefore not shown)

Collision analysis only include collisions involving a car turning left on a FYA

Based on 2010-2017 City of Bellevue Collision Database

 Flashing yellow arrow (FYA) installation

Approaches with FYA Compared to Collisions Involving FYA

Converted 110 approaches from Protected Only to FYA
Converted 121 approaches from Traditional PPLT to FYA
Strategies for Enhancing Safety and Mobility with Flashing Yellow Arrows

TIME OF DAY VS ADAPTIVE PROTECTED ONLY

Based on data collected for:
- Historical Volumes
- Gap Availability
- Collision History

Number of FYA-related Collisions by Time of Day

ADAPTIVE PROTECTED ONLY
Based on real-time traffic conditions:
- Opposing lane queues through intersection
- Unexpected congestion special events or collisions
- Measured congestion or volume threshold

12% of FYA approaches operate on a time of day or adaptive basis
- Time of day most typically for evening commute
- First step before converting back to protected only 24/7

60% reduction in collisions (going from 24/7 to time of day)

BELLEVUE’S EXPERIENCE

12% of FYA approaches operate on a time of day or adaptive basis
- Time of day most typically for evening commute
- First step before converting back to protected only 24/7

60% reduction in collisions (going from 24/7 to time of day)

TIME OF DAY PROTECTED ONLY

Based on data collected for:
- Historical Volumes
- Gap Availability
- Collision History

Number of FYA-related Collisions by Time of Day

BELLEVUE’S EXPERIENCE

60% reduction in collisions (going from 24/7 to time of day)

LEAD-LAG WITH PROTECTED-PERMISSIVE

Yellow Trap (with Green Ball Display)

WHO: Driver that received the leading protected phase
WHEN: After permissive phase, when the protected lagging left is served
WHAT: Permissive left turn phase changes to yellow and then red when opposing indication is still green because it shares indication with adjacent through phase
WHY: If a driver turning left has entered the intersection, they need to clear but the opposing movement is still green

Corridor running lead-lag with FYA

Lead-Lag Phase Change

Permissive
Change Interval to Lagging
Leading Left Turn Phase
Lagging

“Perceived Yellow Trap” or “Virtual Left Turn Trap” (with FYA display)

WHO: SAME
WHEN: SAME
WHAT: Signal heads adjacent to left turn head turn yellow and then red while left turn stays FYA
WHY: Driver’s may wrongly assume their left turn is going to red or that the opposing phase also changed to red

Lead-Lag Phase Change

Permissive
Change Interval to Lagging
Leading Left Turn Phase
Lagging

BELLEVUE’S EXPERIENCE

FYA Approaches vs FYA Collisions by Lead-Lag Phasing

Number of collisions split almost evenly between leading and lagging approach

Lead-lag used with FYA if there is an operational benefit

Created By: Darcy Akers, EIT | City of Bellevue, WA
Strategies for Enhancing Safety and Mobility with Flashing Yellow Arrows

**PROTECTED PEDESTRIAN PHASING**

*Balancing safety and efficiency by:*
- Omitting permissive phase when pedestrian is activated (left turn remains red)
- Reducing conflict between people crossing and people turning
- Adding less delay for driver than 100% protected only

**CONSIDERATIONS**

- Cannot re-serve pedestrian phase or serve late after FYA has started
- Could increase pedestrian delay
- FYA phase only runs if there is time remaining after pedestrian clearance

50% of FYA approaches have Protected Pedestrian Phasing
- Installed at locations that had previously been protected only
- Considering more widespread use

2 Pedestrian Collisions involving left turn on FYA at locations with protected pedestrian phasing in 6+ years

**RIGHT TURN FLASHING YELLOW ARROW**

- Can be used if there is a dedicated right turn pocket
- Draws attention to yield condition
- Can be used with leading pedestrian interval without delaying through movement
- Incorporates overlap phase

**BELLEVUE’S EXPERIENCE**

Currently used on 4 approaches (more planned)

New but well understood

No history of pedestrian collisions in 4 years
Introduction

Background:
- Merge dynamics present unique safety challenges due to the forced interactions between multiple drivers within a constraining roadway environment.
- Alternating merge behavior has shown to increase safety and reduce crashes; however, this behavior is not typically observed for a myriad of reasons.
- Part of the issue is related to driver comprehension of merging expectations and/or roadway design.

Objective:
- Investigate the effect of experimental signage on promoting alternating merge behavior downstream of intersections.

Methodology

Computer Static Evaluation:
- Online survey conducted over a two month period
- Five symbol signs and three word signs evaluated in thirteen different merge scenarios
- Respondents chose lane approach preference for each sign
- Most/least preferred sign to promote even merging was chosen

Driving Simulator Experiment:
- Signs 1, 2, and 8 chosen to further study based on survey results
- 24 participants in full-immersion driving simulator study
- 12 scenarios based on independent variables: vehicle starting in left/right lane, two different traffic conditions, and the three merge signs.
- Data collected in real-time through notetaking and virtual location tracking
- Simulator utilized was a 1995 Sudan cab with 135 degrees of view

Results and Discussion

Static Evaluation
- The traditional merge sign, Sign 1, (W4-2) yielded the strongest result in terms of driver recognition and comprehension.
- The most effective picture and word signs to promote even merging are Sign 2 and Sign 8, respectively.

Driving Simulator Experiment
- User-vehicle positioning, or which lane the user is in prior to entering the merge scenario, significantly impacts which lane they occupy downstream.
- Traffic configuration significantly effects lane choice upstream of a merge scenario.
- Experimental alternative merge signage did not contribute to unsafe driver behavior in the simulator environment.

Conclusions

Future Research
- Safety impacts of alternative merge; downstream merge conflicts
- Field implementation of alternative merge signage through pilot study
- Effects of geometric design on merging by establishing a joint-merge concept

Acknowledgements
This research was funded in part through research fellowships awarded by the Safety Research Using Simulation (Safer Sim) University Transportation Center (UTC). Funding for the UTC Program is provided by the Office of Assistant Secretary for Research and Innovation (OST-R) of the United States Department of Transportation (USDOT).

For more information contact
Alyssa Ryan • alyssaryan@umass.edu
Worldwide Parking Best Practices

Presented by: W. Hollis Loveday, P.E.

Melbourne, Australia; Sydney, Australia; Toronto, Canada; Tokyo, Japan; Kuala Lumpur, Malaysia; Amsterdam, Netherlands; Birmingham, UK; Glasgow, UK; London, UK; Seoul, South Korea; San Francisco, US; and Washington, US.

Technology

Top Annual Public Transport Ridership

1. Beijing 3.606 billion
2. Tokyo 3.411 billion
3. Shanghai 3.401 billion
4. Seoul 2.620 billion
5. Guangzhou 2.568 billion
6. Moscow 2.356 billion
7. New York City 2.175 billion
8. Hong Kong 1.711 billion
9. Mexico City 1.624 billion
10. Paris 1.536 billion

Daily number of train passengers in the Greater Tokyo Area: 20 million more than the individual populations of over 100 countries in the world.
INTRODUCTION AND PURPOSE

- **LEVEL OF SERVICE (LOS)**
  - INCEPTION IN 1965
  - INDICATOR OF QUALITY OF SERVICE
  - MEASURE USED BY MAJOR JURISDICTIONS/STATE DEPARTMENTS
  - TYPICALLY, LOS D IS CONSIDERED ‘ACCEPTABLE’
  - FASTER CONNECTIVITY AND MOBILITY IN ALL MAJOR AREAS EXCEPT VEHICULAR TRAFFIC SINCE 1965
  - NEED TO UPDATE STANDARDS?

<table>
<thead>
<tr>
<th>LOS</th>
<th>Unsignalized Delay (sec/veh)</th>
<th>Signalized Delay (sec/veh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>&lt;10 seconds</td>
<td>&lt;10 seconds</td>
</tr>
<tr>
<td>B</td>
<td>10 to 15 seconds</td>
<td>10 to 20 seconds</td>
</tr>
<tr>
<td>C</td>
<td>15 to 25 seconds</td>
<td>20 to 35 seconds</td>
</tr>
<tr>
<td>D</td>
<td>25 to 35 seconds</td>
<td>35 to 55 seconds</td>
</tr>
<tr>
<td>E</td>
<td>35 to 50 seconds</td>
<td>55 to 80 seconds</td>
</tr>
<tr>
<td>F</td>
<td>&gt; 50 seconds</td>
<td>&gt; 80 seconds</td>
</tr>
</tbody>
</table>


Similar to waiting at traffic light or stop sign
BACKGROUND AND HISTORY ON LEVEL OF SERVICE

National LOS Standard Overview

- No national mandates on LOS
  - FHWA states that it “…does not have regulations or policies that require specific minimum LOS values for projects on the NHS (National Highway System).” LOS provided in AASHTO’s green book is to be used as guidance and not mandated.
- LOS increased popularity during the interstate-building era (1950s to 1990s)
  - Appropriate metric for this type of large scale project planning
- However, LOS is the most common metric used to make design decisions at the state and local level.
- Most jurisdictions require LOS C or D for planning level studies, such as for Traffic Impact Studies.
  - LOS standards are applied to the peak hour of the entire week, resulting in overdesigning of roadways and intersections.
  - Overdesigning → wider roadways and intersections → higher vehicular speeds → unsafe conditions for all users

National Traffic Trends vs LOS Thresholds

- The HCM LOS thresholds introduced in the year 2000 were defined to “represent reasonable ranges in control delay”.
- Since the year 2000, apart from the recession period, the transportation system has spurred.
- Urban US city trends since 2000:
  - Lane miles: 40% increase
  - Vehicle miles traveled: 30% increase
  - Annual Person-Hours Delay: 13.5% increase
  - Smaller urban areas (those of less than 500,000 residents): 30.43% increase

Fallbacks of LOS

- When used in measuring “impact” of developments, it is biased against the last-in development
- LOS thresholds imply false sense of precision
- Often used as only metric for evaluation. Other metrics need to be evaluated in combination with LOS

**What is Level of Service (LOS)?**

<table>
<thead>
<tr>
<th>LOS</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOS A</td>
<td>Free flowing, uninterrupted travel. Delay: 0-1 second/vehicle</td>
</tr>
<tr>
<td>LOS B</td>
<td>Free flow. Other vehicles are not affected. Delay: 1-3 seconds/vehicle</td>
</tr>
<tr>
<td>LOS C</td>
<td>Freeway operation is feasible. Delay: 3-9 seconds/vehicle</td>
</tr>
<tr>
<td>LOS D</td>
<td>Approachable but unstable condition. Delay: 9-18 seconds/vehicle</td>
</tr>
<tr>
<td>LOS E</td>
<td>Unstable, questionable condition. Delay: 18-38 seconds/vehicle</td>
</tr>
<tr>
<td>LOS F</td>
<td>Does not operate. Delay: &gt;38 seconds/vehicle</td>
</tr>
</tbody>
</table>

Source: Maryland DOT Policy Manual

**Traffic Trend in Urban US Cities**

- Urban Lane-Miles
- Urban VMT
- Annual Person-Hours of Urban Traffic Delay

Source: Prepared for the US DOT Bureau of Transportation Statistics by the MIT Department of Urban Studies and Planning
LAND USE SPECIFIC IMPACTS

- Traffic Impact Studies evaluate impacts based on trips generated by the proposed development.
- Certain developments are driven by community/office needs—e.g.: Neighborhood Retail Centers, Schools, etc.
- The trips associated with these land uses will be generated regardless, as there is a demand. The proximity of the developments to communities or office parks changes travel pattern.
- Hence, traffic impacts from these land uses should not have the same benchmark as other land uses which result in addition of new trips to the network.
**Vehicle LOS/Delay vs Multi-modal LOS/Delay**

- Focus on vehicle LOS/delay for planning
- Multi-modal LOS may be different than the vehicle LOS for the same facility
- A more holistic approach to determine LOS for urban facilities

**A Sliding Scale for LOS**

- LOS is a step function based on the delay whereas user experience is linear
- The LOS letter can change by a small increase in traffic

<table>
<thead>
<tr>
<th>Scenario 1</th>
<th>No Build Conditions</th>
<th>Build Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delay (s/veh)</td>
<td>25</td>
<td>50</td>
</tr>
<tr>
<td>% Increase in Delay</td>
<td>-</td>
<td>100%</td>
</tr>
<tr>
<td>LOS</td>
<td>LOS C</td>
<td>LOS D</td>
</tr>
<tr>
<td>Acceptable LOS?</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Scenario 2</th>
<th>No Build Conditions</th>
<th>Build Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delay (s/veh)</td>
<td>50</td>
<td>60</td>
</tr>
<tr>
<td>% Increase in Delay</td>
<td>-</td>
<td>20%</td>
</tr>
<tr>
<td>LOS</td>
<td>LOS D</td>
<td>LOS E</td>
</tr>
<tr>
<td>Acceptable LOS?</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

**Other Measures of Effectiveness (MOEs)**

- Using alternative MOEs or a combination to get a better picture of the traffic operations

<table>
<thead>
<tr>
<th>Measures of Effectiveness (MOEs)</th>
<th>Traffic Operations</th>
<th>Safety</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume to Capacity Ratio (v/c)</td>
<td>Predicted Crashes</td>
<td></td>
</tr>
<tr>
<td>Queue length</td>
<td>Predicted Crash Frequency</td>
<td></td>
</tr>
<tr>
<td>Density</td>
<td>Conflicts</td>
<td></td>
</tr>
<tr>
<td>Speed</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Other Factors to Consider**

- Vulnerable users – pedestrians, bicyclists, motorcyclists, children, elderly, etc.
- Traffic calming measures, infrastructure improvements – road diets, bike lanes, crosswalks
- Standards based on the character of the surrounding area – rural vs suburban vs urban
- A more regional analysis and reduction of VMT as opposed to intersection level LOS analysis

**Road Diet on Edgewater Dr., Orlando, FL**

[Image of Road Before and After]


http://www.flickr.com/photos/greenlaneproject/22108020763
A New Interchange Design: The Double Offset-T Interchange
By: Peter Yu (peteryu0822@gmail.com), Pullman High School

Introduction
Conventional intersection designs can be inadequate due to the inability to serve increasing traffic volumes and to properly handle safety problems. One way of addressing these problems is by implementing innovative geometric designs. A new interchange configuration called the Double Offset-T Interchange (DOTI) offers better performance, improves safety, and may decrease construction costs.

Design & Operations

Benefits of the DOTI
- Provides for two phase traffic signals with short cycle lengths, significantly reducing delay.
- Increases the capacity of through traffic movements on the cross road.
- Slower design speed reduces both the risk and severity of collisions.
- Significantly reduces the number of conflict points, thus theoretically improving safety.
- Improves mobility & safety for pedestrians and bicyclists.
- Reduces the amount of driver confusion and decreases the likelihood of wrong-way maneuvers.
- Potentially reduces the number of lanes on or under the overpass, hence decreasing structure costs.

Limitations of the DOTI
- More right-of-way is needed at the on-ramp intersection quadrants, on the cross road, and on the bridge approaches.
- Capacity for vehicles turning left to and from the ramps is relatively low, especially where land availability is limited.

Methodology
The microsimulation software PTV VISSIM is used to gain insight into the operational performance of the DOTI in comparison to a conventional diamond interchange.

The interchanges in the analysis each have two through lanes, two left turn lanes, and one right turn lane on the cross road in either direction. Each off-ramp has two left turn lanes and two right turn lanes. Traffic is composed of 98% passenger cars and 2% heavy vehicles, which all travel at a desired speed of 40 km/h (~25 mph).

Performance is evaluated under three volume scenarios: high, medium, and low. For each simulation, a full hour (3,600 seconds) of traffic data is collected.

Table 1: Traffic Scenarios & Performance Results

<table>
<thead>
<tr>
<th>Traffic Scenario</th>
<th>Off Ramp Input Per Direction (vph)</th>
<th>Cross Road Input Per Direction (vph)</th>
<th>Total Input (vph)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Left</td>
<td>Through</td>
<td>Right</td>
</tr>
<tr>
<td>High</td>
<td>700</td>
<td>0</td>
<td>600</td>
</tr>
<tr>
<td>Medium</td>
<td>600</td>
<td>0</td>
<td>400</td>
</tr>
<tr>
<td>Low</td>
<td>450</td>
<td>0</td>
<td>300</td>
</tr>
</tbody>
</table>

Results

Table 2: Traffic Scenarios & Performance Results

<table>
<thead>
<tr>
<th>Traffic Scenario</th>
<th>MT (vph)</th>
<th>Average Delay (s)</th>
<th>Average Delay (s)</th>
<th>Average Delay (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional</td>
<td>7,590</td>
<td>76.94</td>
<td>6,132</td>
<td>4,314</td>
</tr>
<tr>
<td>DOTI</td>
<td>7,877</td>
<td>39.81</td>
<td>6,163</td>
<td>4,334</td>
</tr>
<tr>
<td>Improvement</td>
<td>3.78%</td>
<td>48.26%</td>
<td>0.51%</td>
<td>0.46%</td>
</tr>
</tbody>
</table>

Table 2: Traffic Scenarios & Performance Results

*MT = Model Throughput

Conclusion
- Especially for higher traffic volumes, the DOTI has better performance and offers lower delays as compared to the performance of the conventional diamond interchange.
- Capacity for through movements is higher for the DOTI in comparison to the conventional diamond interchange.
- The Double Offset-T Interchange is useful in locations with moderate to high through movements on the cross road, moderate to low left turning movements, and where a sufficient amount of right-of-way is available.