An Update on Superstreet Implementation and Research

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Problems in Rural Four-Lane Corridors

• Collisions
  – Angle
  – High-speed
  – Severe

• Treatments?
  – Flashers?
  – Interactive devices?
  – Signalize?

• Accommodating future growth
Problems in Urban Arterial Corridors

- Growing demand
- Conventional solutions exhausted
- Widening?
- Bypasses?
- Structures?
- ITS, transit, demand management, etc.?
Potential Solution: Superstreets

• FHWA: “RCUT” – Reduced Crossing U-turn intersection
• An arterial with only one-way median openings
• Left turn and through movements from side streets redirected
• Part of a menu of unconventional arterial designs
• Published extensively in peer-reviewed literature

US-74 and Elmore Road, Scotland County
Superstreet is One Item on Menu

- 15 designs on current intersection “menu”
  - Most published
  - Most in use in U.S.
- Several promising unconventional interchange designs as well
- Superstreet among most promising new designs
Superstreets Across the US

- Michigan – 1000 miles of median u-turns, one superstreet
- Texas – Extensive one-way frontage roads, one superstreet
- New Orleans – Many median u-turns
- Minnesota – One superstreet
- Maryland – US-301 “J-Turn intersections” since 2001

Median u-turns on Hall Road, Sterling Heights, MI

www.google.com/maps
Superstreets in NC

• Extensive use of leftovers
• At least 10 signalized sites
  ▪ US-15/501 in Orange Co.
  ▪ US-17 in Brunswick Co.
  ▪ Several others
• At least 20 unsignalized sites
  ▪ US-23/74 in Haywood Co. since 2000
  ▪ US-1 in Moore Co.
  ▪ Several others

Courtesy of NCDOT
NC Signalized Superstreets – US-15/501 Orange County
NC Unsignalized Superstreets –
NC-87 at SR-1150/Peanut Plant Road

Courtesy of NCDOT
NC Unsignalized Superstreets – US-74 Jackson County

Courtesy of NCDOT
Conventional Intersection

- Two-way median opening
- 32 conflict points
- “Eight-phase” signal
The Magic of Two-Phase Signals

More arrows = More phases = Less time for Main Through Movement
Basic Superstreet Intersection

- Left turn and side street through movements redirected
- 8 conflict points
- 2 signal phases

![Superstreet Intersection Diagram]

Side street
Main street

60’
600’
Higher-Volume Superstreet Intersection

- Direct left turns from main street to side street
- 14 conflict points

Side street

Main street

Pedestrians
Superstreet Advantages

• Perfect two-way progression with any signal spacing
• Speed control
• Pedestrian crossing
• Safety
• Efficient travel
  ▪ Lower delay, higher capacity, lower emissions…
Perfect Progression
Perfect Progression
Perfect Progression
Perfect Progression
Perfect Progression
Perfect Progression
Perfect Progression
Perfect Progression
Perfect Progression
You Control Speeds

• Set progression speed as high or low as you wish
• Vary the progression speed by location, direction, time, day,…
• Drivers will adjust quickly
• No fancy signal hardware or software needed
• Reassign enforcement resources

Courtesy of NCDOT
Easy and Safe Pedestrian Crossing

US-15/501 in Orange County

• Can install ped signals easily, almost anywhere
• Can create perpendicular rather than diagonal crossing

Courtesy of NCDOT
Recent Research for NCDOT

- Two-year project by NCSU
- Complete December 2010
  - Safety
  - Travel time
  - Perceptions
Safety Analysis Overview

- Unsignalized superstreets
- Three methods
  - Naïve Method
  - Comparison-Group (C-G) Method
    - Accounts for conditions changing with time
  - Empirical Bayes (EB) Naïve Method
    - Accounts for possible bias in site selection
    - Used calibrated crash prediction model from new “Highway Safety Manual”
Unsignalized Superstreet Sites

• 12 individual sites and 1 corridor
• Located in 9 counties across the state
• 4 lane divided major road, 2 lane undivided minor road

US-74 and Elmore Road, Scotland County
Data Collection

• Site data
  ▪ Distances to crossovers
  ▪ Construction periods
  ▪ Road names
  ▪ Road geometry and traffic control measures

• Traffic volume data
  ▪ AADT of major and minor roads

• Crash data
  ▪ Reviewed all crash reports for:
    o Work zones
    o Geometry
    o Traffic control
Naïve Analysis Results

<table>
<thead>
<tr>
<th>Collision Type</th>
<th>% Change, Conventional to Superstreet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>-34</td>
</tr>
<tr>
<td>Fatal and injury</td>
<td>-60</td>
</tr>
<tr>
<td>Angle and right turns</td>
<td>-86</td>
</tr>
<tr>
<td>Rear-end</td>
<td>22</td>
</tr>
<tr>
<td>Sideswipe</td>
<td>14</td>
</tr>
<tr>
<td>Left turns</td>
<td>-75</td>
</tr>
<tr>
<td>Other</td>
<td>9</td>
</tr>
</tbody>
</table>

8 of 13 sites had statistically significant reduction in total collisions.
10 unsignalized sites showed reduction (9 significant)

<table>
<thead>
<tr>
<th>Collision Type</th>
<th>% Change, Conventional to Superstreet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>-46</td>
</tr>
<tr>
<td>Fatal and injury</td>
<td>-63</td>
</tr>
<tr>
<td>Angle and right turns</td>
<td>-75</td>
</tr>
<tr>
<td>Rear ends</td>
<td>-1</td>
</tr>
<tr>
<td>Sideswipes</td>
<td>-13</td>
</tr>
<tr>
<td>Left turns</td>
<td>-59</td>
</tr>
<tr>
<td>Other</td>
<td>-15</td>
</tr>
</tbody>
</table>
EB Naïve Analysis

- Reduction at all 13 sites (12 statistically significant)

<table>
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</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>-27</td>
</tr>
<tr>
<td>Fatal and injury</td>
<td>-51</td>
</tr>
<tr>
<td>Angle and right turns</td>
<td>-86</td>
</tr>
<tr>
<td>Rear ends</td>
<td>12</td>
</tr>
<tr>
<td>Sideswipes</td>
<td>-12</td>
</tr>
<tr>
<td>Left turns</td>
<td>-76</td>
</tr>
<tr>
<td>Other</td>
<td>8</td>
</tr>
</tbody>
</table>
Safety Study Conclusions

- Superstreet intersections on rural four-lane roads are safer than conventional intersections
  - Reduced collisions at most sites
  - C-G method best
  - 46% reduction recommended for use
- Reduced angle and right turn, left turn, and fatal and injury collisions
Operational Analysis Overview

• Signalized superstreets
• Saturation flow study of median u-turns and directional crossovers
• Comparison of superstreets and conventional intersections
  ▪ Calibrated and validated superstreet models in VISSIM using field data
  ▪ Compared superstreet models to the equivalent conventional intersection
  ▪ Examined travel time
# Superstreet Sites

<table>
<thead>
<tr>
<th>Arterial</th>
<th>No. of Intersections</th>
<th>Cross Street(s)</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>US-15/501</td>
<td>1</td>
<td>Erwin Rd./Europa Dr.</td>
<td>Chapel Hill, NC</td>
</tr>
<tr>
<td>US-17</td>
<td>5</td>
<td>Ploof Rd./Olde Waterford Way</td>
<td>Leland, NC</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gregory Rd./Walmart entrance</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>West Gate Dr./Grandiflora Dr.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Brunswick Forest Pkwy</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lanvale Rd./Brunswick Forest Dr.</td>
<td></td>
</tr>
<tr>
<td>US-421</td>
<td>1</td>
<td>Myrtle Gardens Dr./Carolina Beach Rd.</td>
<td>Wilmington, NC</td>
</tr>
</tbody>
</table>
Superstreet vs. Conventional: Experiment Setup

• Fair comparison:
  ▪ Updated geometries for conventional
  ▪ Optimized signal timing using Synchro

• Travel time comparison for various demand levels:
  ▪ Peak
  ▪ Peak – 10%  Peak + 10%
  ▪ Peak – 20%  Peak + 20%
  ▪ Peak – 40%  Peak + 40%
Superstreet vs. Conventional: Results

• Travel time effects on arterial:
  ▪ Reduced travel time for major through movements
  ▪ Reduced travel time for major left movements at Myrtle Grove and US-17
  ▪ Increased travel time for major lefts at Chapel Hill (no direct left turn)

• Travel time effects on minor road:
  ▪ Minor through and left turn movements negatively impacted
*Note: travel times not weighted by volume
Operational Study Results

- Superstreet reduced average travel time per vehicle by about 20%

<table>
<thead>
<tr>
<th>Intersection</th>
<th>Pk-40%</th>
<th>Pk-20%</th>
<th>Pk-10%</th>
<th>Peak</th>
<th>Pk+10%</th>
<th>Pk+20%</th>
</tr>
</thead>
<tbody>
<tr>
<td>US-15/501 @ Erwin/Europa</td>
<td>-1.6%</td>
<td>-16.2%</td>
<td>-4.8%</td>
<td>-1.6%</td>
<td>-13.8%</td>
<td>-16.8%</td>
</tr>
<tr>
<td>US-421 @ Myrtle Gardens Dr.</td>
<td>-2.2%</td>
<td>-6.7%</td>
<td>-12.7%</td>
<td>-1.5%</td>
<td>-11.9%</td>
<td>-12.7%</td>
</tr>
<tr>
<td>US-17 corridor (avg. for all intersections)</td>
<td>-3.7%</td>
<td>-7.7%</td>
<td>-15.4%</td>
<td>-26.5%</td>
<td>-79.6%</td>
<td>-100.2%</td>
</tr>
<tr>
<td>US-17 @ Ploof/Poole</td>
<td>-2.8%</td>
<td>-15.1%</td>
<td>-18.6%</td>
<td>-27.8%</td>
<td>-71.8%</td>
<td>-106.3%</td>
</tr>
<tr>
<td>US-17 @ Walmart/Gregory</td>
<td>-3.9%</td>
<td>-10.9%</td>
<td>-27.8%</td>
<td>-54.0%</td>
<td>-89.6%</td>
<td>-99.2%</td>
</tr>
<tr>
<td>US-17 @ Grandiflora/West Gate</td>
<td>-7.2%</td>
<td>-8.3%</td>
<td>-5.6%</td>
<td>-19.2%</td>
<td>-122.8%</td>
<td>-146.6%</td>
</tr>
<tr>
<td>US-17 @ Brunswick Forest Pkwy</td>
<td>-2.6%</td>
<td>-0.6%</td>
<td>-20.2%</td>
<td>-23.4%</td>
<td>-80.8%</td>
<td>-104.3%</td>
</tr>
<tr>
<td>US-17 @ Lanvale/Brunswick Forest</td>
<td>-1.7%</td>
<td>-5.4%</td>
<td>-8.2%</td>
<td>-10.0%</td>
<td>-32.9%</td>
<td>-49.4%</td>
</tr>
</tbody>
</table>
Operational Conclusions

- Superstreet outperformed conventional for overall travel time per vehicle
- Largest travel time savings during high demand periods
- Major road positively impacted
- Minor road negatively impacted, but volumes lower
  - Use another design if minor street volume too high
- More capacity – adds to intersection’s useful life
- Superstreet successful at three very different locations
Perception Surveys

- To determine the perceived effects of superstreets on:
  - Nearby motorists
  - Commuting motorists
  - Business owners

Courtesy of NCDOT
Resident Survey

- Four waves of mailings
- Sent to 500 randomly-selected residents
  - Half near signalized sites, half near unsignalized sites
  - Residents within two-mile radius of the superstreet
- Response rate 29%
Resident Survey Results

- Navigation through the superstreet

<table>
<thead>
<tr>
<th></th>
<th>Signalized</th>
<th>Unsignalized</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easier/less confusing</td>
<td>33%</td>
<td>41%</td>
<td>36%</td>
</tr>
<tr>
<td>The same</td>
<td>17%</td>
<td>20%</td>
<td>19%</td>
</tr>
<tr>
<td>More difficult/more confusing</td>
<td>41%</td>
<td>31%</td>
<td>37%</td>
</tr>
</tbody>
</table>
## Resident Survey - Results

- Ability to safely navigate the superstreet

<table>
<thead>
<tr>
<th></th>
<th>Signalized</th>
<th>Unsignalized</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive</td>
<td>49%</td>
<td>61%</td>
<td>54%</td>
</tr>
<tr>
<td>Negative</td>
<td>22%</td>
<td>20%</td>
<td>22%</td>
</tr>
<tr>
<td>Same</td>
<td>28%</td>
<td>15%</td>
<td>23%</td>
</tr>
</tbody>
</table>
Resident Survey - Results

- Difference in travel time

<table>
<thead>
<tr>
<th></th>
<th>Signalized</th>
<th>Unsignalized</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less travel time</td>
<td>18%</td>
<td>13%</td>
<td>16%</td>
</tr>
<tr>
<td>No change</td>
<td>32%</td>
<td>50%</td>
<td>39%</td>
</tr>
<tr>
<td>More travel time</td>
<td>51%</td>
<td>33%</td>
<td>44%</td>
</tr>
</tbody>
</table>
Resident Survey - Results

- Number of stopped vehicles

<table>
<thead>
<tr>
<th></th>
<th>Signalized</th>
<th>Unsignalized</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>More stopped vehicles</td>
<td>45%</td>
<td>25%</td>
<td>37%</td>
</tr>
<tr>
<td>No change</td>
<td>16%</td>
<td>27%</td>
<td>21%</td>
</tr>
<tr>
<td>Fewer stopped vehicles</td>
<td>36%</td>
<td>41%</td>
<td>38%</td>
</tr>
</tbody>
</table>
Resident Perception Summary

• Travel more safely
  – Both signalized and unsignalized sites
• More travel time
  – Both signalized and unsignalized sites
• Stopped vehicles
  – More at signalized sites, fewer at unsignalized sites
• Would like to make a legal left turn on red
Commuter Survey

• Process:
  - 4-waves of emails
  - Sent to 2520 UNC-CH faculty and staff
    - US-15/501 major arterial into campus
    - Immense campus directory
    - Randomly selected from list
  - 513 responses
Commuter Survey - Results

- Navigation through the superstreet

<table>
<thead>
<tr>
<th>Response</th>
<th>Commuters</th>
<th>Non-Commuters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easier</td>
<td>19%</td>
<td>18%</td>
</tr>
<tr>
<td>Same</td>
<td>36%</td>
<td>28%</td>
</tr>
<tr>
<td>More difficult</td>
<td>45%</td>
<td>54%</td>
</tr>
</tbody>
</table>
Commuter Survey - Results

- Effect on ability to safely navigate the superstreet

<table>
<thead>
<tr>
<th>Response</th>
<th>Commuters</th>
<th>Non-Commuters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positively</td>
<td>33%</td>
<td>36%</td>
</tr>
<tr>
<td>Same</td>
<td>44%</td>
<td>32%</td>
</tr>
<tr>
<td>Negatively</td>
<td>22%</td>
<td>32%</td>
</tr>
</tbody>
</table>
Commuter Survey - Results

- Difference in travel time (TT)

<table>
<thead>
<tr>
<th>Response</th>
<th>Commuters</th>
<th>Non-Commuters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less TT</td>
<td>36%</td>
<td>27%</td>
</tr>
<tr>
<td>No change</td>
<td>52%</td>
<td>39%</td>
</tr>
<tr>
<td>More TT</td>
<td>12%</td>
<td>35%</td>
</tr>
</tbody>
</table>
Commuter Survey - Results

- Number of stopped vehicles

<table>
<thead>
<tr>
<th>Response</th>
<th>Commuters</th>
<th>Non-Commuters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fewer stopped</td>
<td>45%</td>
<td>53%</td>
</tr>
<tr>
<td>No change</td>
<td>36%</td>
<td>22%</td>
</tr>
<tr>
<td>More stopped</td>
<td>20%</td>
<td>24%</td>
</tr>
</tbody>
</table>
Commuter Perception Summary

- Safer
- More difficult to navigate
- Fewer stopped vehicles
- Travel time
  - Greater for residents
  - Less for commuters
Business Owner Survey

- Personal interviews
- Responses from 29 business owners or managers
  - Varied in type and size
  - No statistical analyses
Business Perception Summary

- Chapel Hill respondents recognized traffic flow and safety improvements
- Some negative impact on business growth and operations
- Some customer access and confusion problems
Superstreets Should Help Businesses Grow

• Safer, more efficient, and…

• Less need to reconstruct in future
• Flexible crossover location
  – May be able to line up to business driveway
• More aggressive to signalize
• Slower speeds
Other Superstreet Disadvantages?

• Wider median and right-of-way?
  – No, use loon

• Higher construction cost?
  – Marginal, costs coming down

• Difficult for crossing bicycles?
  – Research needed
Recommendations

• Consider superstreets for upgrading arterials similar to those studied
  ▪ High volume, divided arterial
  ▪ Low volume minor road

• Rural or urban
  – It is safe when unsignalized
  – It is efficient when signalized

• Better as a corridor than isolated intersection

• Evaluate the possibility for left turn on red
Recommendations

• Cite collision savings of 46%
• Cite travel time savings of 20%
• Take advantage of all superstreet features and potential
• Be proactive in education and public awareness of superstreet benefits
Questions?

US-74 in Jackson County

Courtesy of NCDOT