FLASHING RED ARROW: LEFT-TURN INDICATION AND INTERSECTION SAFETY

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PRESENTATION OUTLINE

1. Background
2. Locations
3. Before-After Study
4. Conclusion
BACKGROUND

• Only Maryland and Delaware use flashing red arrow (FRA) display; most states utilize flashing yellow arrow

• Deployed by SHA since 1989

• Typical reasoning for FRA installations on SHA roads:
  • Crash pattern on an EP controlled LT movement (existing signals)
  • Original equipment for newly designed signals

• Temporary or permanent solution

• Can work part-, or full time, depending on the need and conditions. Uses standard LT signal heads and controller
LOCATIONS

To date, TDSD/TOD identified 60 Intersections with FRA

Known FRA Locations by District

Distribution by # of legs

Distribution by # of opposing thru lanes
RESEARCH OBJECTIVES

What is the effect of Flashing Red Arrow on crashes?

Can FRA improve one crash pattern but have a negative impact elsewhere?

How can we control for the effect of just the LT display?
BEFORE-AFTER STUDY SELECTION CRITERIA

• SATISFY THE MAIN RESEARCH OBJECTIVE
  • Accept locations where FRA was the sole improvement at the time of deployment (replacement for 5-head EP display)
  • Accept all intersection layouts (half-signal, T or 4-leg; 1-, 2-, or 3 opposing lanes)
  • Accept temporary or permanent installations
  • Reject previously unsignalized intersections
  • Generally, reject part-time FRA’s (However, possible inclusion after careful time-of-day filtering of the crash data)

• CRASH DATA RELIABILITY
  • 3 calendar years of crash data for both ‘before’, and ‘after’ condition
  • Reject ‘too old’ installations (before 2000) due to potentially unreliable ‘before’ crash data.
  • Reject ‘too new’ installations (after 2013) due to insufficient ‘after’ data.
<table>
<thead>
<tr>
<th>Location</th>
<th>District</th>
<th>Leg</th>
<th>Opposing thru lane</th>
<th>Date of approval</th>
<th>Date of installation</th>
</tr>
</thead>
<tbody>
<tr>
<td>MD 8 @ MD 18</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>3/1/2009</td>
<td>3/25/2009</td>
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<tr>
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<td>4</td>
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<td>10/1/2012</td>
<td>9/30/2013</td>
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<td>2</td>
<td>4</td>
<td>3</td>
<td>10/1/2012</td>
<td>12/11/2012</td>
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<tr>
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<td>4</td>
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<td>3</td>
<td>2/1/2003</td>
<td>7/19/2003</td>
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<tr>
<td>MD 26 @ Johnsville</td>
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<td>2</td>
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<td>6/14/2012</td>
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<tr>
<td>MD 85 @ Guilford Dr</td>
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<td>4</td>
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<td>5/14/2008</td>
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<td>4</td>
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<td>MD 108 @ Lark Brown Rd</td>
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<td>4</td>
<td>2</td>
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<td>10/23/2012</td>
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<td>1/3/2012</td>
<td>7/13/2012</td>
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<tr>
<td>US 40 @ Marriottsville Rd</td>
<td>7</td>
<td>4</td>
<td>2</td>
<td>12/1/2008</td>
<td>2/26/2009</td>
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</tbody>
</table>
RESULTS

Before After

Mean 12.55 5.82

Diff 6.73

$t$ 4.006

P-value 0.0025

95% conf int [2.99, 10.47]
### RESULTS

<table>
<thead>
<tr>
<th>Location</th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>MD 8 @ MD 18</td>
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<td>3</td>
</tr>
<tr>
<td>US 60 @ Edgewood</td>
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<td>1</td>
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<tr>
<td>US 29 @ MD 328</td>
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<td>9</td>
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<tr>
<td>US 50 @ MD 331</td>
<td>16</td>
<td>17</td>
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<tr>
<td>MD 40 @ I-495</td>
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<tr>
<td>MD 29 @ Jacksonville</td>
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<td>MD 13 @ Shrigley Rd</td>
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<tr>
<td>MD 159 @ Lake Penn Rd</td>
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<tr>
<td>MD 150 @ Kings Rd</td>
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</tr>
<tr>
<td>US 40 @ Marriottsville Rd</td>
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<td>0</td>
</tr>
</tbody>
</table>

#### Mean

Before: 5.91  
After: 5.91

#### Diff

0.00

#### t

0.00

#### P-value

1.00

#### 95% confidence interval

[-2.64, 2.64]

NOT significantly different
RESULTS

Before    After
Mean      25.18   18.55
Diff      6.64
\( t \)    3.73
P-value   0.0039
95% conf inv [2.67, 10.60]
CONCLUSIONS

• Left-turn related and total number of crashes decreased after the FRA treatment

• No change in the number of rear-end crashes

• Gathering a larger sample expected to yield a more statistically convincing argument and allow for CMF development
FUTURE DIRECTIONS

- The Crash Modification Factors for FRA will be developed to systematically model the effect on safety.
- As the sample increases, consider expanding the study onto more strictly defined sub-groups of intersections (e.g. previously unsignalized, T-only, effect of number of opposing lanes, etc.)

What to look forward to in 2017:

- OOTS Application Guideline on FRA Signal Display (TDSD)
- Research paper documenting this study in detail (TDSD/UMD)
QUESTIONS?