Evaluation on Impact of Red RRFB Implementation at Freeway Off-Ramps on Driving Behaviors Along Adjacent Arterials

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Outline

• Background on Wrong-Way Driving (WWD)

• Project Motivation

• FDOT Initiatives

• Project Objectives

• Methodology and Data Collection

• Results and Findings

• Conclusions and Future Work
Background on Wrong-Way Driving

- Approximately 350 nationwide fatalities occur per year as a result of WWD (NTSB). A majority of these cases involve:

<table>
<thead>
<tr>
<th>Categories</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic violation</td>
<td>• Driving under the influence (DUI)</td>
</tr>
<tr>
<td></td>
<td>• Intentional reckless driving</td>
</tr>
<tr>
<td></td>
<td>• Suicide</td>
</tr>
<tr>
<td>Inattention</td>
<td>• Falling asleep at the wheel</td>
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<tr>
<td></td>
<td>• Carelessness, absent-mindedness, distraction</td>
</tr>
<tr>
<td></td>
<td>• Inattention to informational signposts</td>
</tr>
<tr>
<td>Impaired judgment</td>
<td>• Physical illness</td>
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<td></td>
<td>• Older driver</td>
</tr>
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<td></td>
<td>• Drivers with psychiatric problems</td>
</tr>
<tr>
<td>Insufficient knowledge</td>
<td>• Lack of understanding of how to use the highway</td>
</tr>
<tr>
<td></td>
<td>• Unfamiliar with the infrastructure</td>
</tr>
<tr>
<td>Infrastructure development</td>
<td>• Insufficient lighting</td>
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<td>• Insufficient field of view</td>
</tr>
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<td>• Heavy vegetation</td>
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</tbody>
</table>
Background on Wrong-Way Driving (cont’d)

Location Map of Wrong-Way Driving Arrests & Crashes In District Seven (April 2014 – May 2015)
Project Motivation

- Significant increase of WWD related fatalities in Florida during the year 2014.
- Yellow Rectangular Rapid Flashing Beacons (RRFBs) are very effective to alert drivers to yield to pedestrians crossing streets.
- However, the impacts of red RRFBs mounted on “WRONG WAY” signs on driving behaviors on adjacent arterial roadways was unknown.

Red RRFBs mounted on “WRONG WAY” sign (Revised from WUSF, 2015)
Project Motivation (cont’d)

Tampa Bay Wrong-Way Driving Crashes from 2014 and 2015
FDOT Initiatives

Installation of Wrong-Way Driving Signing, Pavement Markings and RRFBs
FDOT Initiatives (cont’d)

Wrong-Way Driving Sensor Experimental Deployments at I-275 Main Lanes
FDOT Initiatives (cont’d)

Wrong-Way Driving Sensor Experimental Deployments at I-275 Off-Ramps
Project Objectives

The objectives of this research are:

• To investigate the perception of the motoring public regarding the most informing and effective red RRFBs mounted on “WRONG WAY” signs at selected freeway off-ramps to reduce WWD.

• To measure the impacts of active red RRFBs on driving behaviors on adjacent arterials by observing three specific behaviors:
  • Sudden deceleration
  • Sudden stop
  • Sudden lane changing

• To measure effectiveness of red RRFBs installed at off-ramps and microwave sensors installed along the Interstate 275 mainline on reducing wrong-way driving via crash analysis before and after the implementation.
Methodology and Data Collection

Overview of the methodology used for this project:

<table>
<thead>
<tr>
<th>“Before” red RRFB Implementation</th>
<th>“After” red RRFB Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Conduct public opinion survey to determine the most informing and effective RRFB combination.</td>
<td>• Using the most effective RRFB combination obtained from survey, record their effects on adjacent traffic by:</td>
</tr>
<tr>
<td>• Installation of red RRFBs.</td>
<td>• Manual triggering of red RRFBs.</td>
</tr>
<tr>
<td>• Obtain video recordings of driving behaviors on adjacent arterials as baseline (“before”) data.</td>
<td>• WWD vehicular triggering of RRFBs.</td>
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<tr>
<td></td>
<td>• Perform statistical analysis to compare before and after data.</td>
</tr>
<tr>
<td></td>
<td>• Determine if red RRFBs have adverse effects on driving behaviors on the adjacent arterial.</td>
</tr>
</tbody>
</table>
Methodology and Data Collection (cont’d)

“Before” (baseline) data collection involved obtaining recorded video footage of baseline driving behaviors on adjacent arterials for the selected off-ramps.

Video camera footage of Bearss Avenue and Interstate 275 off-ramp
Methodology and Data Collection (cont’d)

Following red RRFB installation and baseline data collection, a public opinion survey was conducted to evaluate public perception of WWD and to investigate the flashing red RRFB combination that participants found as the “most informing and effective”.

![Image of red RRFB installation and baseline data collection](image-url)
Methodology and Data Collection (cont’d)

Shorter version of the video shown to public opinion survey participants.
Methodology and Data Collection (cont’d)

The public opinion survey targeted three age groups:

- 16-29
- 30-59
- 60+
Methodology and Data Collection (cont’d)

• "After" study started after the installation of red RRFBs at six select I-275 off-ramps (Fowler, Fletcher, and Bearss Avenues northbound and southbound off-ramps).

• Implementation of the “most informing and effective” RRFB combination to be tested in the field.

• Two methods used:
  • Manual triggering of red RRFBs
  • WWD vehicular triggering

• Behaviors were recorded both on camera and manually by the CUTR research team.
**Methodology and Data Collection (cont’d)**

Video camera footage of WWD vehicular triggering of red RRFBs.
The majority of public survey participants favored the RRFB combination with flashing top and bottom RRFBs on both sides of the roadway.

I-275 at Fowler Avenue "Long and Wide Off-Ramp"

- A. Top lights, right side of roadway
- B. Bottom lights, right side of roadway
- C. Top & Bottom lights, right side of roadway
- D. Top lights, left side of roadway
- E. Bottom lights, left side of roadway
- F. Top & Bottom lights, left side of roadway
- G. Top lights, left & right sides of roadway
- H. Bottom lights, left & right sides of roadway
- I. Top & Bottom lights, left & right sides of roadway
Public Opinion Survey Results (cont’d)

- Why was this combination selected as the most effective and informing by the public?

![Pie chart showing public opinion results]

I-275 at Fowler Avenue "Long and Wide Off-Ramp"

- A. The combination got my attention the most
- B. Easy to read the "Wrong-Way" sign
- C. I knew these wrong-way flashing beacons meant imminent danger
- D. Other
Did the public know immediately that these were WWD warning signs?
Public Opinion Survey Results (cont’d)

- Time of day the public expects WWD to occur?
Public Opinion Survey Results (cont’d)

- Why does the public think nighttime has the most likelihood of WWD?

![Pie chart showing public opinion reasons for WWD at I-275 at Fowler Avenue.]

- 47%: The existence of fewer cars on roadway may cause confusion for driver
- 39%: More drivers are at risk of being under the influence of alcohol and/or drugs
- 8%: Both
- 6%: Other
Public Opinion Survey Results (cont’d)

• Does the public talk, text or use their other smartphone functions while driving?

I-275 at Fowler Avenue "Long and Wide Off-Ramp"

- 35%: Only when stopped in traffic or at a traffic light
- 35%: Not at all
- 14%: Yes, minimally
- 16%: Yes, frequently
Public Opinion Survey Results (cont’d)

- Dimmed red RRFB lights vs. non-dimmed?
Public Opinion Survey Results (cont’d)

- Age split of general public who answered the survey.
- Results did not show significant differences between age groups.

Age: I-275 at Fowler Avenue
"Long and Wide Off-Ramp"
## "Before and "After" Analysis Results

### Sample results from “Before” Study – I-275 & Bearss Avenue Northbound Off-Ramp

<table>
<thead>
<tr>
<th>Date/Time Period</th>
<th>Total Number of Vehicles</th>
<th>Sudden Deceleration</th>
<th>Sudden Stops</th>
<th>Sudden Lane Changing</th>
</tr>
</thead>
<tbody>
<tr>
<td>January 9-10, 2015</td>
<td>1,392</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>11pm-1am</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>January 10, 2015</td>
<td>461</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>1am-4am</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>January 10-11, 2015</td>
<td>1,390</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>11pm-1am</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>January 11, 2015</td>
<td>465</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1am-4am</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

### Sample results from “After” Study – I-275 & Bearss Avenue Northbound Off-Ramp

<table>
<thead>
<tr>
<th>Date/Time Period</th>
<th>Manual vs. WWD Vehicle Triggering</th>
<th>Total Number of Vehicles</th>
<th>Sudden Deceleration</th>
<th>Sudden Stops</th>
<th>Sudden Lane Changing</th>
</tr>
</thead>
<tbody>
<tr>
<td>April 24-25, 2015</td>
<td>WWD vehicle-triggered RRFBs</td>
<td>902</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>11pm-1am</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>April 25, 2015</td>
<td>WWD vehicle-triggered RRFBs</td>
<td>470</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1am-4am</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>May 15-16, 2015</td>
<td>Manually-triggered RRFBs</td>
<td>858</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>11pm-1am</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>May 16, 2015</td>
<td>Manually-triggered RRFBs</td>
<td>477</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1am-4am</td>
<td></td>
<td></td>
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</table>
Statistical Testing

- Statistical testing of both “before” and “after” data two-tailed t-tests were performed to check for statistical significance of red RRFB implementation effects.
  - $H_0$: The implementation of red RRFBs does not have a negative impact on the adjacent arterial driving behaviors when compared to the before-implementation driving behaviors data on the same adjacent arterial.

- These t-tests were performed to a 95% CI.
The absolute value of all t-calculated values were found to be less than the t-critical value obtained from the t-distribution critical values table at 95% CI.

Failed to reject the null hypothesis.

The implementation of the red RRFBs has no impact on the driving behaviors on the adjacent arterial to the off-ramp.
Conclusions and Future Work

• 69.5% of public survey participants selected the combination of placing “WRONG WAY” signs on both the left and right sides of an interstate off-ramp with red RRFBs activated at the top and bottom.

• 58% of the participants selected non-dimmed flashing red RRFBs over the dimmed option.

• The implementation of red RRFBs can effectively alert wrong-way drivers while not adversely impacting driver behaviors on adjacent arterials.

• The effectiveness of red RRFBs on the reduction of wrong-way crashes will be investigated via a before-and-after crash data analysis.
Conclusions and Future Work (cont’d)

• CUTR to evaluate red RRFB locations’ vehicle detection data within a three year period, beginning February 2015

• CUTR to evaluate the use of 18 microwave sensors for wrong-way detection on I-275 between Bearss Ave. and I-4 interchange within a three year period on I-275, beginning October 2015

• FDOT to install 7 additional wrong-way driving sensors and 900 MHz wireless transmitters for exit ramps along I-4, I-175, I-275, and I-375

• FDOT to restore the 3 legacy wrong-way driving sensors to operational status

• FDOT to create a District Seven wrong-way driving sensors deployment map
Conclusions and Future Work (cont’d)

• FDOT to prepare systems engineering-related documentation for wrong-way driving sensors deployments

• FDOT to develop CPR practices for wrong-way driving education and enforcement

• FDOT to develop proposed District Seven regional wrong-way driving countermeasures strategic plan for arterials

• FDOT to retrofit wrong-way driving sensors on remaining District Seven interchanges and main lanes on case-by-case basis
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