Countermeasures for Wrong-Way Driving on Freeways

Project Webinar – November 21, 2016
AUDIO MUTED - PLEASE USE CHAT BOX FOR QUESTIONS
Webinar Agenda

- ENTERPRISE Overview
- Project Approach and Key Findings - *Linda Preisen, Athey Creek Consultants*
  
  - Agency Deployments:
    - Iowa DOT: Wrong-Way Driving Testbed – *Willy Sorenson, Iowa DOT*
    - Florida DOT: Statewide Efforts and Countermeasures - *Raj Ponnaluri, Florida DOT*

- Questions/Answers
ENTERPRISE is a FHWA Transportation Pooled Fund Study where members pool funds and resources to:

- Facilitate rapid progress in the development and deployment of ITS technologies; and
- Accelerate the systematic advancement of selected ITS projects.

Members carry out ITS projects and activities including fundamental research, technology development, demonstration, standardization and deployment.

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ENTERPRISE Members

- Transport Canada
- FHWA
**Project Goals**

“Countermeasures for Wrong-Way Driving on Freeways”

- **Document deployments that aim to mitigate wrong-way way driving**
  - Technology/ITS
  - No Technology

- **Increase understanding of countermeasures**
  - Configurations
  - Effectiveness
  - Public Feedback
  - Lessons Learned
The Problem

- U.S. Wrong-Way Fatalities: **Average 350 per year +/-**
- Wrong-Way Crashes & Fatalities – Trend is “flat” compared to fatalities from other crash types which have steadily decreased

(Baratian-Ghorghi et al., 2014)
The Problem

Highway Special Investigation Report: Wrong-Way Driving
(National Transportation Safety Board, 2012)

• **Severity**: Wrong Way (WW) collisions tend to have higher fatality rates than other types of collisions

• **Driver Characteristics**: Alcohol-impaired drivers and older drivers are over-represented in WW crashes

• **Origin**: Primary origin of WW movements is entering an exit ramp

• **When**: Increased frequency of WW collisions at night and on the weekends

*WW drivers tend to drive in what they perceive as their right-hand lane, which is the left-hand lane for drivers in the correct direction.*
Countermeasures – No Technology

Low-mounted Static Signs

Source: Countermeasures for Wrong-Way Movement on Freeways: Overview of Project Activities and Findings (Cooner et al., 2004)
Countermeasures – No Technology

Enhanced Static Signs

- Oversized signs
- Additional signs along exit ramps
- Red reflective tape/sheeting on sign posts
- Multiple signs on same post

Source: National Wrong Way Driving Summit Proceedings, 2014

Source: Arizona DOT

Source: North Texas Toll Authority (Proceedings of the 2013 National Wrong Way Driving Summit, 2014)
Enhanced Pavement Markings

- Wrong way pavement marking arrows
- Raised reflective pavement markings (RPMs)

Source: Illinois DOT (2015 TRB Annual Meeting Session presentation)

Source: North Texas Toll Authority (Proceedings of the 2013 National Wrong Way Driving Summit, 2014)

Source: Arizona DOT
Countermeasures – No technology

Enhanced Pavement Markings

- Pavement marking extensions
- Painted median
- Stop bars at exit ramps

Countermeasures – No Technology

Enhanced Pavement Markings

- Route marking shields at beginning of left turn lanes to entrance ramps

(Source: FDOT SunGuide Disseminator, Sept. 2014)
Countermeasures – No technology

Treatments Applied to Infrastructure at Exit Ramps

- Red delineators along exit ramp (on guardrail or on delineator posts)

Enhanced Regulatory Signs

Blinking LED lights around WW signs
- Vehicle-activated; or
- Blink continually at night/low light

Source: Texas DOT
Enhanced Regulatory Signs

Rectangular Rapid Flashing Beacons (RRFBs) attached to WRONG WAY signs

Source: Ozkul, Lin, Chandler (presentation slides)
Countermeasures – ITS Strategies

Dynamic Alert Systems

- Detection (radar, video, loop detectors)
- Alerts/messages to wrong way drivers
- Alerts/messages to oncoming traffic
- Alerts to traffic management centers / law enforcement

Source: Texas DOT
Other Countermeasures

Institutional Coordination

- Multi-agency coordination (DOT, law enforcement, etc.)
- Public education
- Legislative modification
- Field checklists

Emerging Approaches

- **Arizona DOT and Texas DOT** - Integrated detection, tracking, & warning systems

Source: *Automatically Detecting Wrong Way Drivers on the Highway* (Simpson, 2014)
<table>
<thead>
<tr>
<th>Deployments</th>
<th>Signing &amp; Pavement Markings</th>
<th>Technology/ITS</th>
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<td><strong>Signing &amp; Pavement Markings</strong></td>
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<td>• Harris County Toll Road Authority (Houston, TX)</td>
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# Deployment Summaries

Information Documented for Each Deployment

- Agency Contact(s)
- Background/Reason for Deployment
- # Sites & Location
- Deployment Dates
- Test/pilot or Long-term Deployment
- Description of Countermeasures
  - Photos, design details (as available)
- Evaluation Efforts/Results
- Coordination
- Guidelines or Standards
- Local/Public Response
- Lessons Learned
- Future Plans
**Deployment Summary**

**Ohio Department of Transportation**

<table>
<thead>
<tr>
<th>Agency</th>
<th>Ohio Department of Transportation (Ohio DOT)</th>
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| Agency Contacts | Derek Troyer  
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Mike McNeill  
Email: Michael.McNeill@dot.state.oh.us  
Phone: (614) 387-1265 |
| Information Source | Interview with Mike McNeill on 6/8/2016  
Interview with Derek Troyer and Mike McNeill on 5/10/2015 |
| Background | Many districts have some sort of signage on exit ramps, but it is currently a mix of DO NOT ENTER (DNE) signs and WRONG WAY (WW) signs. Previous efforts have been primarily reactive, however, Ohio DOT is now attempting to implement signing and pavement marking improvements systematically at a statewide level.  
During a standardization effort, ODOT researched wrong-way crashes in 2015 and discovered that over the past 12 years, 75% of Ohio’s wrong-way crashes occurred within 5 of ODOT’s 12 districts. These five districts are largely urban and will be required to upgrade their signage. District 2 has already implemented the changes to its ramps and signage and improvements to urban areas in District 6 are almost complete.  
ODOT released a new standard construction drawing in 2016 to include revised standardized templates for future upgrades to ramp locations. These new templates and standardized processes will be utilized in rural districts as well as urban areas. This standard construction drawing is shown at the end of this deployment summary. |
| Deployment Locations | District 6 (Central Ohio)  
District 2 (Northwest Ohio)  
Downtown Columbus, OH |
| Number of Sites | Continuing to grow, however the exact number is not known. |
| Deployment Dates | Signing and Pavement Marking Improvements: 2008 and 2013  
Detection with Dynamic Signing and Alerts: September 2015 |
| Test/Pilot or Long-term | Signing and Pavement Marking Improvements: Long-term deployments  
Detection with Dynamic Signing and alerts: One pilot deployment |
| Countermeasure Types | 1) Static Signing and Pavement Marking Improvements  
2) Detection with Dynamic Signing and Alerts |
| Description of Countermeasures | 1) Static Signing and Pavement Marking Improvements  
Two WRONG WAY (WW) signs on the same post, lower sign mounted at 3 ft.  
Pavement marking extension lines to guide drivers onto entrance ramp. |
Deployment Summaries

- Red reflective tape on sign posts: WW and DO NOT ENTER (DNE) signs.
- Dual directional route marker signs at end of ramps.
- Additional signs beyond MUTCD minimums (both sides of ramp).
- Yellow painted island between entrance and exit ramps.
- Wrong-way arrows on exit ramps. (At some locations, this is not standard. Implemented in District 2.)

District 6 (Central Ohio):
- Implemented in approximately 2008
- Implemented signing/pavement markings similar to drawings dated August 2013
- Systematic implementation, at all ramps in the district

District 2 (Northwest Ohio):
- Implemented in August 2013
- At all ramps: Increased the number of DNE and WW signs, now one sign on each side of ramp
- At side-by-side partial cloverleaf ramps: Implemented the entire improved design configuration

Two WW Signs on Same Post, Both Sides of Ramp, Red Reflective Tape on Posts
(Source: Ohio DOT)

Red Reflective Tape on Posts
(Source: Ohio DOT)

- Wrong-Way Traffic Control for Partial Cloverleaf Interchanges (Single Lane Exit)
- Wrong-Way Traffic Control for Diamond Interchanges (Single Lane Exit)

2) Flashing LEDs Around WW Sign and Alerts
- Single pilot site at one ramp in downtown Columbus (District 6, Neil Avenue)
- Installed in September 2015
- Vehicle-activated flashing LEDs around border of WW sign
- Alert to Transportation Management Center (TMC) and law enforcement
- Two sets of detection plus a camera for verification: One at the bottom of the ramp and another at the top of the ramp. If a vehicle is detected at the first detection site, the LED signs will flash. If the vehicle is detected at the second detection site, the Ohio DOT Traffic Management Center and Columbus Police Department dispatchers are notified.

Evaluation Efforts/Results
An evaluation is not planned due to the random nature of wrong-way crashes.
- Video captured by traffic cameras have been used to verify that the system has been effective in instances where violators have self-corrected and turned around after reaching the flashing signs.

Coordination
ODOT plans to engage law enforcement in future efforts to help identify locations where wrong-way reports are occurring in order to target potential corridors for future improvements. See “Lessons Learned” section for additional information.

Guidelines or Standards
- Ohio DOT created drawings for partial cloverleaf interchanges (single lane exit) and diamond interchanges (single lane exit). See the following pages for drawings.
- Ramp improvements per these drawings are anticipated to be standard statewide in summer 2016 following inclusion in the Traffic Engineering Manual. 2 of 12 Districts have already implemented improvements.

Local/Public Response
A local news story pointed out that Ohio DOT has implemented signing and pavement marking improvements:

Lessons Learned
Ohio continues to experience wrong-way fatalities and is working with law enforcement and looking at video from traffic cameras to determine entry points and trends of wrong-way drivers. Through this process ODOT hopes to identify potential corridors and implement additional detection with dynamic sign systems.

Future Plans
- ODOT has standardized the process of upgrading ramps by developing a standard construction drawing for wrong-way traffic control at ramps. See the following page for this drawing.
- ODOT is considering additional detection with dynamic sign systems and possibly selecting potential corridors for additional implementation, especially in urban areas.
Deployment Summaries

Wrong Way Traffic Control for Partial Cloverleafs

NOT TO SCALE

04/12/2012

NOTES:
1) INSTALL WRONG WAY SIGNS A MINIMUM OF 4 FEET ABOVE THE EDGE OF TRAVELED WAY (WHEN CONDITIONS ALLOW).  
2) INSTALL DURABLE DOTTED EXTENSION LINE  
3) DO NOT ENTER SIGNS MAY BE INSTALLED AT 4 FEET ABOVE THE EDGE OF TRAVELED WAY, IF THE LOWER HEIGHT DOES A CREATE SIGHT TRIANGLE ISSUE FOR RAMP TRAFFIC, AND/OR DOES NOT INTERFERE WITH PEDESTRIAN MOVEMENTS  
4) INSTALL KEEP RIGHT (R4-7B), IF MEDIAN FOR TWO-WAY RAMPS IS STRIPED ONLY.

<table>
<thead>
<tr>
<th>SIGN TYPE</th>
<th>SIZE</th>
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<tbody>
<tr>
<td>DO NOT ENTER (R5-1)</td>
<td>48&quot;X48&quot;</td>
</tr>
<tr>
<td>WRONG WAY (R5-1A)</td>
<td>42&quot;X30&quot;</td>
</tr>
<tr>
<td>ONE WAY (R6-1L/R)</td>
<td>54&quot;X18&quot;</td>
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Key Findings

- Design Considerations
- Effectiveness
- ITS/Technology Countermeasures
- Posting Messages to DMS – oncoming traffic
- Feedback from Local Motorists
- Coordination and Education
Non-Technology Improvements:

• Most common countermeasures:
  – Red reflective tape on sign posts
  – Oversized signs
  – Additional signs beyond MUTCD standards
  – Low-mounted signs
  – Pavement marking arrows
  – Skip lines to guide drivers onto entrance ramp

• Low-mounted signs range from 2 ft. to 5 ft.
  – Snow maintenance considerations

• Statewide standards vs. saturated deployments
Key Findings: ITS/Technology

Technology Deployments:

• Nearly all have detection with alert to TMC
• Detection: Dual radar with camera, high definition radar, loops, video analytics
  – Success with redundancy
  – Many agencies reported decrease of false positives over project period
  – Single, side-fire HD radar: High number of false positives
• Passive vs. Reactive Alerts to WW Drivers
  – Vehicle-activated (active)
  – Flash continuously at night (passive)
  – Flash continuously day and night (passive)

* Passive systems do not require detection; less costly.
Key Findings: ITS/Technology

Technology Deployments:

• In-pavement Lighting (appearance of stop bar)
  – FDOT - 4 pilot sites in rural areas
  – HCTRA phasing out in-pavement lighting due to maintenance issues

• RRFBs on WRONG WAY Signs
  – FDOT (Tampa) and Central Florida Expressway Authority
  – Technology evaluations underway

• Automated Functions in AMTS
  – HCTRA: Cameras automatically pan toward detection site upon detection, GIS-based map shows vehicle’s direction of travel; one button to active nearby DMS
Findings: Effectiveness

Effectiveness:

• Many deployments are quite recent
  – Will take time to have enough “after” data

• Difficult to evaluate
  – Low number of crashes; random patterns
  – Deployments not concentrated
  – Not tracking # of WW occurrences, just crash data

• Advancements in overall state of knowledge
  – Lessons learned, new research/evaluations, peer exchange
Key Findings: Effectiveness

Effectiveness:

- **TxDOT San Antonio District**: WRONG WAY signs continuously blink at night/low light
  - 34% reduction in avg monthly WW events
  - 45 months of data (July 2012-March 2016)

- **Harris County Toll Road Authority (Texas)**: WRONG WAY signs continuously blink at night/low light
  - 2015: Verified that 28 of 40 wrong-way drivers self-corrected

- **Anecdotal Reports**: Several agencies reported observing drivers self-correcting when encountering flashing signs (LEDs around sign border and RRFBs on signs)
Key Findings: Messages on DMS

Message Content:

- Varies Widely Among Agencies

Rhode Island DOT: 

Florida DOT (Tampa):

Florida DOT (Florida Turnpike – Miami):
Key Findings: Messages on DMS

Message Content:

HCTRA (Texas):

![Image of DMS sign with messages: WARNING WRONG WAY DRIVER AHEAD and WARNING ALL TRAFFIC MOVE TO SHOULDER AND STOP]
Message Content:

Texas DOT (San Antonio District):

Wrong Way Driver Reported --- Use Extreme Caution
Key Findings: Messages on DMS

Message Content:

Texas DOT (San Antonio District): Plans to Change

Recommended

Alternative 15-character message

(Source: Finley, et al., 2016)
Key Findings: Feedback from Local Motorists

• **Limited Public Response:**
  – Most reported very limited or no feedback from motorists after implementing countermeasures

• **Potential Influences from Media Coverage:**
  – Media coverage following wrong-way crashes - draws attention to the issue
  – Rhode Island DOT: Anecdotal observation that wrong-way driving events tend to decrease after media stories, suggesting that public education campaigns may have a positive effect
Key Findings: Coordination and Education

• Many agencies: Targeted efforts to address wrong-way driving have improved coordination with law enforcement
  – San Antonio Wrong Way Task Force (formed in 2011)
    • Outreach to bar owners, e-tone on police radio
  – Missouri DOT: Multi-agency coalition selected I-44 in St. Louis for pilot corridor
  – Florida DOT: DUI education efforts underway
Lessons Learned

Additional Lessons Learned:

*See Deployment Summaries in the Final Report*
“Countermeasures for Wrong-Way Driving on Freeways”

Final Report: posted at www.enterprise.prog.org

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