Wrong Way Driving:
New Focus on a Persistent Problem

Mark Doctor
Federal Highway Administration
Resource Center
Wrong-way collisions are only about 3% of the crashes on high-speed divided highways.

Wrong-way collisions are much more likely to result in fatal and serious injuries than other types of highway crashes.

On average, about 360 lives are lost each year in about 260 fatal wrong-way collisions.

Sources: NTSB Special Investigation Report 12/01 Dec 2012
Is Alcohol a Factor?

About 69% of fatal wrong-way collisions had indications of alcohol involvement

Source: NTSB Analysis of FARS data

About 31% of all traffic fatalities involve alcohol impairment

Source: NHTSA Traffic Safety Facts 2013 data
When are Wrong Way Collisions Occurring?

22% between 6:00 a.m. to 6:00 p.m.
12% between 6:00 p.m. and 9:00 p.m.
18% between 9:00 p.m. and midnight
31% between midnight and 3:00 a.m.
17% between 3:00 a.m. and 6:00 a.m.

Approximately 57% occurred on the weekends

Source: NTSB Analysis of FARS data
Is Age a Factor?

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Wrong-way Drivers</th>
<th>Right-way Drivers</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;=80</td>
<td>119</td>
<td>4</td>
</tr>
<tr>
<td>70-79</td>
<td>114</td>
<td>47</td>
</tr>
<tr>
<td>60-69</td>
<td>136</td>
<td>82</td>
</tr>
<tr>
<td>50-59</td>
<td>222</td>
<td>153</td>
</tr>
<tr>
<td>40-49</td>
<td>398</td>
<td>284</td>
</tr>
<tr>
<td>30-39</td>
<td>413</td>
<td>314</td>
</tr>
<tr>
<td>20-29</td>
<td>486</td>
<td>413</td>
</tr>
<tr>
<td>&lt;20</td>
<td>514</td>
<td>486</td>
</tr>
</tbody>
</table>

Drivers over the age of 70 constitute about 15% of the at-fault wrong-way drivers.

Within the 70+ age group, wrong-way collisions are over-represented compared to other types of controlled-access highway crashes.

Source: NTSB analysis of FARS data for 2004–2009
How is it happening?

The primary origin of wrong-way movements (when the origin can be determined) is entering the wrong-way at an exit ramp.

Other errors resulting in wrong-way movement include making an improper U-turn on the mainline or improperly using the emergency turnaround through the median.
Does the Interchange Type Matter?

Certain interchange configurations may be more susceptible to WWD.
Lessons Learned: Michigan

• 60% W-W entries associated with partial cloverleaf interchanges

• Applied a systemic approach

Photo courtesy of Michigan DOT
Lessons Learned: Michigan

- SEVERITY DEPENDS ON THE CRASH LOCATION
  - WW crash on mainline: 42% fatal or severe injury
  - WW crash on ramp: 6% fatal or severe injury

If you can stop a wrong-way driver along the ramp (before reaching the mainline), there is a much greater chance of lessening the crash severity
Ramp Terminal Designs

- Raised channelization and islands with angular edges
- Signs and markings to simplify decisions
- Increase/improve roadway lighting
“... countermeasures that reduce the affordance of driving the wrong way (such as geometric alterations) may be more effective than those which require the perceptual abilities of the drivers to function at a certain level (such as signage or pavement markings).”

Source: NCHRP Report 600
Roundabouts may provide excellent channelization against wrong-way entries.

Location: Topeka, KS – I-70 at Rice Road
Connected Vehicle Technologies

• Possible V2I and V2V applications adapted to address WWD
Simple Strategies

Double-posted “Do Not Enter” and “Wrong Way” signs on an exit ramp
(Courtesy of the New York State Department of Transportation)
Need for a Coordinated Effort

- Signing
- Markings
- Design
- Technology

What to do

DUI
Dynamic Response

Wrong way driver reported -- use extreme caution
Reframe the Thinking

• Avoid a “drivers fault” mindset
• There are actions that can be taken to address the problem proactively
• Apply pertinent Human Factors knowledge
Wrong-Way Driving

Traffic safety and highway design literature has historically defined a wrong-way driving (WWD) crash as one in which a vehicle traveling in a direction opposing the legal flow of traffic on a high-speed divided highway or access ramp collides with a vehicle traveling on the same roadway in the proper direction. This definition typically concerns only controlled-access highways (freeways) and associated entrance and exit ramps, and excludes crashes that result from median crossover encroachments.

In the United States, WWD crashes result in 300 to 400 people killed each year on average, representing approximately 1 percent of the total number of traffic-related fatalities that occur annually. While this is a small percentage overall, because WWD crashes involve head-on or opposite direction sidewipe crashes at high speeds, they tend to be relatively more severe than other types of crashes. However, there are many strategies and treatments that agencies can consider for implementation that are designed to address wrong-way maneuvers, ranging from geometric design elements, to conventional traffic control devices, to various ITS-based solutions.

Technical Materials

- Guidelines for Reducing Wrong-Way Crashes on Freeways (Illinois, 2014) [PDF]
- Wrong-Way Driving – Road Safety Audit Prompt List (FHWA, 2013) [HTML] [PDF]
Thank You!

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FHWA Office of Safety WWD Contact Information

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WRONG WAY DRIVER PROJECT

TxDOT San Antonio District – TransGuide
John Gianotti, P.E.

April 20, 2016
In Memory of Stephanie Brown

SAPD Officer Stephanie Brown (27 yrs old) killed by a WWD in the line of Duty March 15, 2011
What do we know? WWD on IH 35 at 3 am – 4/1/14
1. US 281 From IH 35 to Stone Oak
Most Events on Any Corridor
2015 GIS Density Map

[Image of a heatmap map showing density distribution along highways such as IH 10, IH 410, US 90, IH 35, IH 37, LP 1604, and US 281.]
Wrong Way Driver Reports by Hour of Day - 2015

Bars Close
San Antonio Wrong Way Driver Task Force

- Challenges
  - Determining points of entry for WWDs
  - More than 400 exit ramps in San Antonio metro area
  - How to get the attention of drivers that are severely impaired
  - Manual of Uniform Traffic Control Devices compliance
  - Spike strips are not MUTCD compliant
Learn from others

- California DOT (Caltrans)
- Utah DOT
- Iowa DOT
- Illinois DOT
- Florida DOT
- Ohio DOT
- North Texas Tollway Authority (NTTA)
- Harris County Toll Road Authority (HCTRA)
What are we doing? Wrong Way Driving Task Force

Organized in the spring of 2011 to examine factors contributing to wrong way driving and to identify methods of addressing wrong way drivers

Task Force Members
- Texas Department of Transportation
- San Antonio Police Department
- San Antonio Transportation and Capital Improvements (TCI)
- Bexar County Sheriff’s Office
- Federal Highway Administration
- Texas A&M Transportation Institute
Enhanced Static Signing & Pavement Markings

- Increased visibility of “WRONG WAY” and “DO NOT ENTER” signs shown to reduce wrong way driving
- TxDOT implemented measures recommended in a prior study:
  - Field Inspection of all ramps using 2004 TTI Study Checklist
  - Ensure all required signs, pavement markings and RPM’s are in place and visible

Wrong Way Arrows
TxDOT Standard Sheet FPM (1)-12
Enhanced Static Signing & Pavement Markings

- Recommend additional (supplemental) measures:
  - Add reflective tape on sign posts
  - Increased size of ONE WAY signs
  - Additional WRONG WAY & DO NOT ENTER signs at critical locations
  - Lowered sign heights*

* Note: TxDOT now allows a 3 ft lowered sign height
2012-14 TTI WWD Study – WRONG WAY Sign Findings

- Takes longer to find sign at BAC 0.12 then at BAC = 0.04 and 0.08
- No difference in the time to identify the sign
  - Among treatments
  - Between sign heights
- Preference data did reveal some differences

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Thought Difficult to Find Sign</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard</td>
<td>31%</td>
</tr>
<tr>
<td>Oversize</td>
<td>17%</td>
</tr>
<tr>
<td>Tape</td>
<td>13%</td>
</tr>
<tr>
<td>LED</td>
<td>13%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Thought Caught Attention More</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oversize</td>
<td>92%</td>
</tr>
<tr>
<td>Tape</td>
<td>88%</td>
</tr>
<tr>
<td>LED</td>
<td>85%</td>
</tr>
<tr>
<td>2 FT</td>
<td>54%</td>
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</table>
DMS Wrong Way Driver Warning Message – May 2011

- No lane instructions given
- Message displayed first, then operator searches for vehicle using cameras
- Displayed Until:
  1) WWD stopped,  2) Accident found,  or  3) SAPD cancels Alert
Recommended warning messages

- Activate beacons when warning message displayed
  - Catch attention of motorists
  - Distinguish from other messages

What if the sign does not have beacons?
- Can flash entire message
- Do not flash one line

Post when wrong way driver reported
Displayed in both directions of travel
Detection Technologies (Radar Sensors)

Radar on Exit Ramps

Radar on Mainlanes
Exit Ramp Counter measures

Existing Signs

New LED WW signs
Mainlane Counter measures

LED & BLANK-OUT WRONG WAY SIGNS
ACTIVATED BY CONTACT CLOSURE
RADIO LINK

RADAR ON OSB USED
FOR WWD DETECTION
Mainlane Counter measures
# US 281 Pilot Project - 44 Month Results

<table>
<thead>
<tr>
<th></th>
<th>July 2012 to March 2016</th>
</tr>
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<tbody>
<tr>
<td>Reduction in Avg. Rate of WWD Events (TransGuide Logs)</td>
<td>34.62%</td>
</tr>
<tr>
<td>Reduction in Avg. Rate of WWD Events (SAPD 911 Logs)</td>
<td>31.19% (thru May 2014)</td>
</tr>
<tr>
<td>Project Cost</td>
<td>$377,605</td>
</tr>
<tr>
<td>Annual Cost Savings – Avg. of SAPD &amp; TxDOT data</td>
<td>$280,282</td>
</tr>
<tr>
<td>Benefit - Cost ratio</td>
<td>14.8 : 1</td>
</tr>
<tr>
<td>Cost Recovery Time (yrs)</td>
<td>1.3</td>
</tr>
</tbody>
</table>
Where are we going?

Construction Projects

- US 281
- Completed Projects
- Under Construction
Detection methods

- Single point radars have proven to be unreliable for detecting WWD – too many false positives.
- Dual radars or detection at two points seem to more effective – TxDOT is just beginning to test the dual radar configuration.

New detection ideas or methods

- Dual radars
- Dual radars with a camera
- Radar/camera combination device
- Pods in the pavement for detection
- Loops in the pavement
SAVING LIVES

53 Serious crashes have been prevented since 2011 by TRANSGUIDE OPERATORS, SAPD DISPATCHERS AND OFFICERS.

TRANSGUIDE OPERATORS

David Rodrigues, Ben Lopez, Mando Rodriguez, Louis Ugarte, Crystal King, Mike Barker, Ishmael Trevino, Jason Wells, Christine Jauregui, Don Deaton

SAPD DISPATCHERS

Michael Summers, Stephanie Hovis, Ashley Hard, Dawn Campbell, Scott Arnold
Thank you

John Gianotti, P.E.
john.gianotti@txdot.gov

2015 National Roadway Safety Award Winner
TxDOT San Antonio District
TransGuide Office
Wrong Way Driver Program
Wrong-Way Driving Detection and Prevention System: A Pilot Deployment

Bryan Homayouni, PE
Manager of Traffic Operations
Central Florida Expressway Authority

Transportation Research Board Webinar - April 2016
About Us

- Created as OOCEA in 1963
- Became Central Florida Expressway Authority on June 20, 2014
- Orlando metropolitan area
- CFX operates:
  - 109-centerline miles of expressway
  - 13 mainline toll plazas
  - Over 1,300,000 weekly transactions
WRONG-WAY DRIVING STATISTICS

• Wrong-way collisions:
  – 3% of crashes on high-speed divided highways
  – 12-27 times higher fatality rate than other types of accidents

• Nationally:
  – 1,566 fatal wrong-way crashes on limited-access highways (2004-2009)
  – 2,139 fatalities (2004-2009)
  – Averages 261 fatal collisions nationally (2004-2011)
  – Averages 360 fatalities per year (2004-2011)
WRONG-WAY DRIVING STATISTICS

Related Factors for Drivers and Motorcycle Riders Involved in Fatal Crashes, 2013
FARS/GES 2013 Data Summary (USDOT)

<table>
<thead>
<tr>
<th>Factors</th>
<th>Percent</th>
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<tbody>
<tr>
<td>Unknown</td>
<td>12.2</td>
</tr>
<tr>
<td>None reported</td>
<td>30.7</td>
</tr>
<tr>
<td>Other factors</td>
<td>11.6</td>
</tr>
<tr>
<td>Making improper turn</td>
<td>1.5</td>
</tr>
<tr>
<td>Wrong-way driving</td>
<td>1.9</td>
</tr>
<tr>
<td>Drowsy, asleep, fatigued, ill, or blackout</td>
<td>2.8</td>
</tr>
<tr>
<td>Vision obscured (rain, snow, etc.)</td>
<td>3.3</td>
</tr>
<tr>
<td>Operating vehicle in erratic, reckless, or negligent manner</td>
<td>3.4</td>
</tr>
<tr>
<td>Swerving or avoiding</td>
<td>3.7</td>
</tr>
<tr>
<td>Failure to obey traffic signs, signals, or officer</td>
<td>4</td>
</tr>
<tr>
<td>Overcorrecting/oversteering</td>
<td>4.5</td>
</tr>
<tr>
<td>Operating vehicle in a careless manner</td>
<td>4.7</td>
</tr>
<tr>
<td>Distracted driving</td>
<td>6.6</td>
</tr>
<tr>
<td>Failure to yield right-of-way</td>
<td>7.1</td>
</tr>
<tr>
<td>Failure to keep in proper lane</td>
<td>8.3</td>
</tr>
<tr>
<td>DUI</td>
<td>13.5</td>
</tr>
<tr>
<td>Driving too fast</td>
<td>19.9</td>
</tr>
</tbody>
</table>
WRONG-WAY DRIVING STATISTICS

NTSB\textsuperscript{1} analysis of FARS\textsuperscript{2} data (2004-2009) showing reported blood alcohol concentration (BAC) levels of wrong-way drivers

\textsuperscript{1}NTSB: National Transportation Safety Board
\textsuperscript{2}FARS: Fatality Analysis Reporting System
STUDYING WRONG-WAY DRIVING ON CENTRAL FLORIDA EXPRESSWAYS

- Research study conducted by the University of Central Florida (UCF)
- Examination of:
  - Crash statistics
  - Citations
  - Reported WWD driving activity
  - Telephone survey of CFX customers
- Based on results of telephone survey:
  - Estimated that only 10% of drivers who see WWD activity call 911
  - WWD driving activity may be under-reported
  - Data collection required to determine the full extent of the problem
STUDYING WRONG-WAY DRIVING ON CENTRAL FLORIDA EXPRESSWAYS

• Study recommended a pilot deployment of WWD countermeasures equipment
• Pilot deployment will:
  – Test RRFB countermeasures
  – Collect data to help CFX determine the extent of WWD activity at the pilot locations
• Study led to a model for predicting number of crashes associated with WWD on CFX network

Picture courtesy of UCF (Concept Slide Produced by UCF and Presented to CFX in Spring 2013)
PARTNERS

• U.S. Department of Transportation Federal Highway Administration
• University of Central Florida (UCF)
• Florida Highway Patrol (FHP)
• Florida Department of Transportation (FDOT)
• Central Florida Expressway Authority (CFX)
CURRENT DEPLOYMENT SITES (PHASE 1)
CURRENT DEPLOYMENT SITES (PHASE 1)

CENTRAL FLORIDA EXPRESSWAY AUTHORITY
CURRENT DEPLOYMENT SITES (PHASE 1)
PARKING LOT TESTING

- Temporary parking lot test conducted to verify technology
- Tested visibility of beacons during day and night conditions
- Experimented with radar detection zones in a controlled environment
PARKING LOT TESTING
Preliminary Lessons-Learned

- Two light bars per sign (top and bottom) will be used to improve visibility of beacons
  - Initial test only had one light bar
- Two pairs of signs will be deployed at each ramp (beacons at the remote pair slaved to the first pair)
  - Provides enhanced visibility of warning in the event the driver passes the first sign before beacon activation
RAMP DETECTION EQUIPMENT

Add top and bottom red RRFB to wrong-way signs at existing locations

Add supplemental wrong-way signs and RRFB between existing wrong-way signs and the expressway mainline

Legend
- Direction of Travel
- Wrong-Way Arrows
- Lane-Use Arrows
- Optional

Use stop line if STOP sign is installed

Notes: Modify as appropriate for multi-lane crossroads
Red rectangular rapid flash beacons (RRFB) (two bars per sign)

Radar (one forward-facing, one rear-facing)

Camera (one forward-facing, one side-facing)

Retroreflective red tape on pole

Cellular modem antenna
Wrong-way driver enters ramp
Detected by first radar
Confirmation photo
Wrong-way driver enters ramp

Detected by first radar

Confirmation photo

Beacons activate
Wrong-way driver continues
Detected by second radar
Confirmation photo
System alert
STATUS OF PROJECT

• Ramp 1 (Phase 1):
  – Installed January 2015

• Ramps 2-5 (Phase 1):
  – Installed June 2015

• 19 Additional Ramps (Phase 2a):
  – Construction Notice to Proceed in April 2016
  – Anticipated completion by end of summer 2016

• 10 Additional Ramps (Phase 2b):
  – Design complete; advertised for construction in April 2016
  – Construction Notice to Proceed targeted for summer 2016
FUTURE DEPLOYMENT SITES (PHASE 2)
ONGOING ACTIVITY

- Coordinating with partners
- Posting messages to CFX dynamic message signs for right-way drivers
  - SR 528 at 520
  - SR 408 at Kirkman and Hiawassee
- Phase 2 deployment underway
SR 408 TESTING
Wrong-Way Turnarounds

Eighteen documented since January 2015:
- Sixteen on SR 408
- Two on SR 528
ACTUAL TURN-AROUND

Correct Traffic Flow:
THANK YOU!

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Chief of Technology / Operations
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Central Florida Expressway Authority
(407) 690-5000
Mitigating Wrong-Way Driving (WWD) Using Connected Vehicles (CV)

Melisa D. Finley
Research Engineer
Texas A&M Transportation Institute

TRB Webinar
April 20, 2016
Texas WWD Crashes on Freeways*

- 1187 crashes
  - 2551 vehicles
  - 3726 people
- Severity
  - 10% fatal crashes
  - 46% injury crashes
- 86% in urban areas
- Primary cause = alcohol

* 2010 to 2014
Blood Alcohol Concentration*

* 2007 to 2011 on freeways
CV WWD System

Detection
Verification
Notification
Alert
Clear
Phase 1

• February 2015 – December 2015

• Research tasks
  – Summarized state-of-the-practice
  – Conducted needs assessment
    • Traffic management entity
    • Law enforcement
    • Drivers (CV and non-CV)
  – Developed concept of operations, functional requirements, and high-level system design
  – Assessed fixed signing and in-vehicle warning messages
Purpose of ConOps

- High-level goals and objectives of the system
- Identifies user needs for the system
- Details design criteria for the system
- Describes the needs for a WWD system from the stakeholder perspectives

**Who, what, why, where, when, and how!**
Warning Messages for DMS

• Some evidence VEH initially misunderstood
• “Ahead” implied
• Non-specific driving actions inferred
In-Vehicle Warning

• Roadside Alert (RSA) messages
  – Provide warning information to drivers of nearby hazards
  – Not just any information can be sent
  – Rigid structure and integer codes must be used

• Does **not** represent final form of message
Phase 2

- April 2016 – October 2017
- Research tasks
  - Finalize design
  - Develop validation test plan
  - Procure equipment
  - Deploy prototype system on closed-course
  - Conduct validation testing
  - Identify information needs of right-way drivers
  - Consider Phase 3 model field deployment
Contact Information

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