Enhanced detection and notification of wrong way driving on today's streets and highways

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The problem of wrong-way driving

- Wrong-way driving accounts for approximately 350 fatalities per year in the United States.
- The number of wrong-way crashes has remained fairly constant over the past decade while the total number of crashes has decreased (Bartian-Ghorghi, Zhou & Shaw, 2014).
The problem of wrong-way driving (in MN)
Factors associated with wrong-way crashes

- Wrong-way crashes tend to have higher fatality rates than other accidents
- Drivers impaired by alcohol and older drivers are the primary constituents
- The primary origin of wrong-way movements is entering an exit ramp
- Occur most frequently at nighttime
- Occur most frequently on the weekends

(NTSB report, 2012)
Primary origin of wrong-way driving

- Partial cloverleaf interchanges
- Diamond interchanges
- Single point directional interchanges
- Freeway feeders

(Zhou & Rouholamin, 2014)
Wrong-way driving countermeasures

<table>
<thead>
<tr>
<th>Preventative Countermeasures</th>
<th>Reactive Countermeasures</th>
</tr>
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<tbody>
<tr>
<td><strong>Low-mounted Signs</strong>: WRONG WAY (WW), DO NOT ENTER (DNE), ONE WAY</td>
<td><strong>Portable Tire Deflation Devices</strong> – Utilized by law enforcement during response efforts</td>
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<tr>
<td><strong>Enhanced Static Signs</strong>: Signs angled at 45 degrees toward drivers, red reflective tape on sign posts (enhanced conspicuity for standard signs), additional signs along exit ramps, signs mounted on the same post, No Left Turn or No Right Turn signs</td>
<td><strong>Dynamic Alert Systems</strong> <em>(ITS/technology)</em></td>
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<tr>
<td><strong>Enhanced Pavement Markings</strong>: Wrong-way arrows on exit ramps, raised reflective pavement markings, stop bars at exit ramps, pavement markings that guide divers onto entrance ramps</td>
<td>- Alerts/messages to wrong-way drivers</td>
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<td><strong>Treatments Applied to Infrastructure</strong>: Painted island between exit/entrance ramps, red delineators along exit ramp</td>
<td>- Alerts/messages to oncoming right-way traffic</td>
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<tr>
<td><strong>Modifications to Traffic Signals</strong>: Straight arrow signal to discourage left turns onto exit ramp</td>
<td>- Alerts to agency-operated traffic management centers</td>
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<td><strong>LED-Enhanced WW Signs</strong>: LEDs around sign border flash continuously <em>(ITS/technology)</em></td>
<td>- Alerts to law enforcement personnel</td>
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<td><strong>In-Pavement Lighting</strong>: Appears as stop bar at end of exit ramp; flash continuously <em>(ITS/technology)</em></td>
<td><strong>Detection with Alert Capability</strong> <em>(ITS/technology)</em></td>
</tr>
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<td><strong>Geometric Design Elements &amp; Modifications</strong>: Removal of obstructions in drivers’ view, raised medians and channelizing islands; corner/control radius improvements</td>
<td>- Loop Detectors</td>
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<td><strong>Institutional Coordination</strong>: Multi-agency coordination, enforcement, public education, legislative modification.</td>
<td>- Radar Detection</td>
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**Emerging Approaches**

- **One-way Directional Rumble Strips**
- **Integrated On-Road Detection and Vehicle Tracking Systems** *(ITS/technology)*
- **In-Vehicle Alert Systems**
  - Audible alerts
  - In-vehicle displays/messages
  - Tactical feedback

(Transportation Pooled Fund Study TPF-5, 2016)
Preventative countermeasures

Red reflective tape on sign post, signs on both sides of the road

LEDs at wrong-way sign borders, flash continuously at night & low light

Wrong-way arrows at exit ramps
Raised pavement marker arrows
Reactive countermeasures

Ramp detection with camera for verification at exit ramp (WisDOT)

Dynamic alert system to wrong-way drivers
Rectangular rapid flashing beacons on WRONG-WAY signs (FDOT)

Vehicle activated DMS
Examples of ITS countermeasure deployment

- Thermal cameras for ramp detection of wrong-way vehicles (ADOT)

(Traffic Technology International, September 13, 2017)
Examples of ITS countermeasure deployment

- **Autoscope® Vision**
Examples of ITS countermeasure deployment

- RTMS SX-300HDCAM video camera for mainline and ramp detection of wrong-way drivers
Examples of ITS countermeasure deployment

- HD video camera for mainline and ramp detection of wrong-way drivers

https://youtu.be/00UilV2cOXU
https://youtu.be/x-o_2rw0eOQ
https://youtu.be/lqz9wxZAU38
SX-300 HDCAM Wrong-way module

- Integrates with Supervisor software used for Vision®
SX-300 HDCAM Wrong-way module

- Easily configure zones for wrong-way incidents
SX-300 HDCAM Wrong-way module

- Configure email alerts for incident alarms. Emails are sent with attached snapshot of incident.
SX-300 HDCAM Wrong-way module

- Easily to review and save snapshots and video clip of incidents
SX-300 HDCAM Wrong-way module

- Easily to review and save snapshots and video clip of incidents
SX-300 HDCAM Wrong-way module

- Testing at DCTC test track

10-70 mph
100% detection to 175’
80% @ 212’
62% @ 250’

Targeting 99% daytime
95% nighttime

https://youtu.be/kflQvgjm0Bg

https://youtu.be/3tBrphW7b8k
Examples of ITS countermeasure deployment

- There are a number of countermeasure deployments that are ongoing or concluded

<table>
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<td>Connecticut DOT</td>
<td>Missouri DOT</td>
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<tr>
<td>Florida: Central Florida Expressway</td>
<td>Ohio DOT</td>
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<tr>
<td>Florida DOT: Florida Turnpike Enterprise</td>
<td>Rhode Island DOT</td>
</tr>
<tr>
<td>Florida DOT: Statewide</td>
<td>Texas: Harris County Toll Road Authority</td>
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<td>Florida DOT: Tallahassee</td>
<td>Texas DOT: San Antonio</td>
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<tr>
<td>Florida DOT: Tampa</td>
<td>Washington State DOT</td>
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<tr>
<td>Iowa DOT</td>
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(Transportation Pooled Fund Study TPF-5, 2016)
Examples of ITS countermeasure deployment

- A number of agencies have implemented statewide deployments to address wrong-way driving:
  
  Arizona DOT, Connecticut DOT, Florida DOT, Michigan DOT, Rhode Island DOT and Washington DOT

- The following have adopted standards or policies for signage and pavement markings:
  
  Connecticut DOT, Florida DOT, Michigan DOT, Washington DOT, Wisconsin DOT, Ohio DOT
Examples of ITS countermeasure deployment

- Iowa Department of Transportation (Iowa DOT)
- High definition radar detection (24 mainline locations (July 2014 – present)
- Video analytics detection: Traffic cameras at 3 exit ramps (conducted in November 2013)
- Improvements to Static Signing and Pavement Markings
Examples of ITS countermeasure deployment

- Iowa Department of Transportation (Iowa DOT)

1) High-Definition Radar Detection at Various Mainline Locations, with Alerts to DOT personnel for Post-Processing
   - Upon detection, an alert is sent to DOT personnel for post-processing.
   - Each detection event is reviewed, including camera footage at the site and along the U.S Highway 30 corridor, in attempt to determine:
     - Confirmed event or false call
     - Point of entry
     - Resulting vehicle action (e.g. self-correct within the ramp, any 911 calls reporting the wrong-way event, any response from law enforcement)
   - All wrong-way reports (911 calls, law enforcement responses) are tracked to determine whether a detection was made for actual wrong-way events.
Examples of ITS countermeasure deployment

- Iowa Department of Transportation (Iowa DOT)

2) Video Analytics Software Detection with Alerts to DOT personnel
   - A controlled field test was conducted at 3 exit ramps, each with a camera equipped with a separate proprietary video analytics software system.
   - The highest level of performance for 12 test drives was 100% detection of wrong-way vehicles during the day and an 83% detection rate at night.
   - Slow vehicle speeds and nighttime lighting were factors that adversely impacted detection rates.
   (Preisen and Deeter, 2014)
Examples of ITS countermeasure deployment

- Iowa Department of Transportation (Iowa DOT)

(Transportation Pooled Fund Study TPF-5, 2016)
Examples of ITS countermeasure deployment

- Iowa Department of Transportation (Iowa DOT)
- Radar detection:
  - 98% of the detections were false calls
  - Nearly 60% of the confirmed wrong-way events were detected by radar, 40% were not

- Iowa DOT observed over 200 confirmed “pass-bys” on video where right-way traffic passed by a wrong-way vehicle without a crash
- No crashes occurred through May 2016 during the test period

- Lessons learned include side-fire radar produces too many false calls and that it is best to locate cameras near points of entry
Key resources with practical guidance

- FHWA Wrong Way Driving Web Page (Federal Highway Administration, 2016)
- Wrong Way Driving Road Safety Audit Prompt List (Federal Highway Administration, 2013)
- Guidelines for Reducing Wrong Way Crashes on Freeways (Zhou & Rouholamin, 2014)

Thank you!