

UCF Wrong-Way Driving Research Program (2012-Ongoing)

By

Professor Haitham Al-Deek, Ph.D., P.E.

Faculty Adviser of ITE Student Chapter at UCF (24 years)

Department of Civil, Environmental, and Construction Engineering at the University of Central Florida (UCF)

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University of Central Florida
College of Engineering and Computer Science

**Department of Civil, Environmental,
and Construction Engineering**



Leading Factors For WWD

- Drivers under the influence of alcohol/drugs.
- Suicidal drivers (e.g., Florida and Texas).
- Unintentional (confused and elderly) drivers.
- Intentional WW drivers (trying to save time and/or toll money).
- Other (unknown) factors.



Outline

- UCF Wrong-Way Driving (WWD) Research Awards and Recognition, Media Interviews
- UCF Local and National Collaboration on WWD and Funding
- Identifying the Extent of the WWD Problem (Crashes and Non-Crashes Statewide)
- Regional Analysis of WWD and Need for Regional Solutions
- UCF Innovative WWD Hotspots Modeling and Optimization Approach
- Continuing Evaluation of Advanced WWD Countermeasures: Rectangular Flashing Beacon (RFB) and Light Emitting Diode (LED) Wrong Way Signs in Florida



UCF Awards for WWD Research

- 2015 Best Freeway Operations Paper Award, presented by the TRB Freeway Operations Committee- US NRC, Washington D.C. Paper titled “*Wrong Way Driving Multifactor Risk-Based Model for Florida Interstate and Toll Facilities*,” by John Rogers et al. (Dr. Al-Deek is a corresponding co-author and John Rogers is Professor Al-Deek’s PhD student), award first announced in April 2015 then presented to Professor Al-Deek on January 12, 2016 at the TRB 2016 annual meeting.
- 2017 Best Freeway Operations Student Paper Award, TRB meeting. The paper was titled “*Identifying Wrong-Way Driving Hotspots by Modeling Crash Risk and Assessing Durations of Wrong-Way Driving Events*,” by Adrian Sandt, Haitham Al-Deek, and John Rogers. This award was announced by the Freeway Operations Committee Chair, Jon Obenberger, on February 5, 2017. The award will be presented to Adrian Sandt, who is Professor Al-Deek’s PhD student at the TRB annual meeting in January 2018.
- Nominated for the 2017 Cunard Award (entire operations sections of TRB) to recognize lead authors under 35, TRB meeting. The paper was titled “*Identifying Wrong-Way Driving Hotspots by Modeling Crash Risk and Assessing Durations of Wrong-Way Driving Events*,” by Adrian Sandt, Haitham Al-Deek, and John Rogers. The results of the competition will be announced at the TRB 2018 annual meeting in January 2018.
- Adrian Sandt, Professor Al-Deek’s PhD Student, won UTC Student of the Year Competition Award, University Transportation Centers (UTC) representing the Southeastern Transportation Center (STC) led by the University of Tennessee, Knoxville for the year 2017, Award presented by the Consortium for University Transportation Centers (CUTC) sponsored by the US Department of Transportation, Washington D.C., January 2017.



UCF Awards



Student of the Year Award for Dr. Al-Deek's PhD student, Adrian Sandt, by the Consortium of University Transportation Centers (CUTC) on Saturday January 7, 2017 in Washington, D.C.



UCF Awards



TRB 2015 Best Paper Award in Freeway Operations (Presented on 1/12/2016) in Washington, D.C.



UCF Awards



TRB 2016 Best Paper Award by the Regional
Transportation Systems Management and Operations
(Regional TSM&O) Committee on January 11, 2017 in
Washington, D.C.

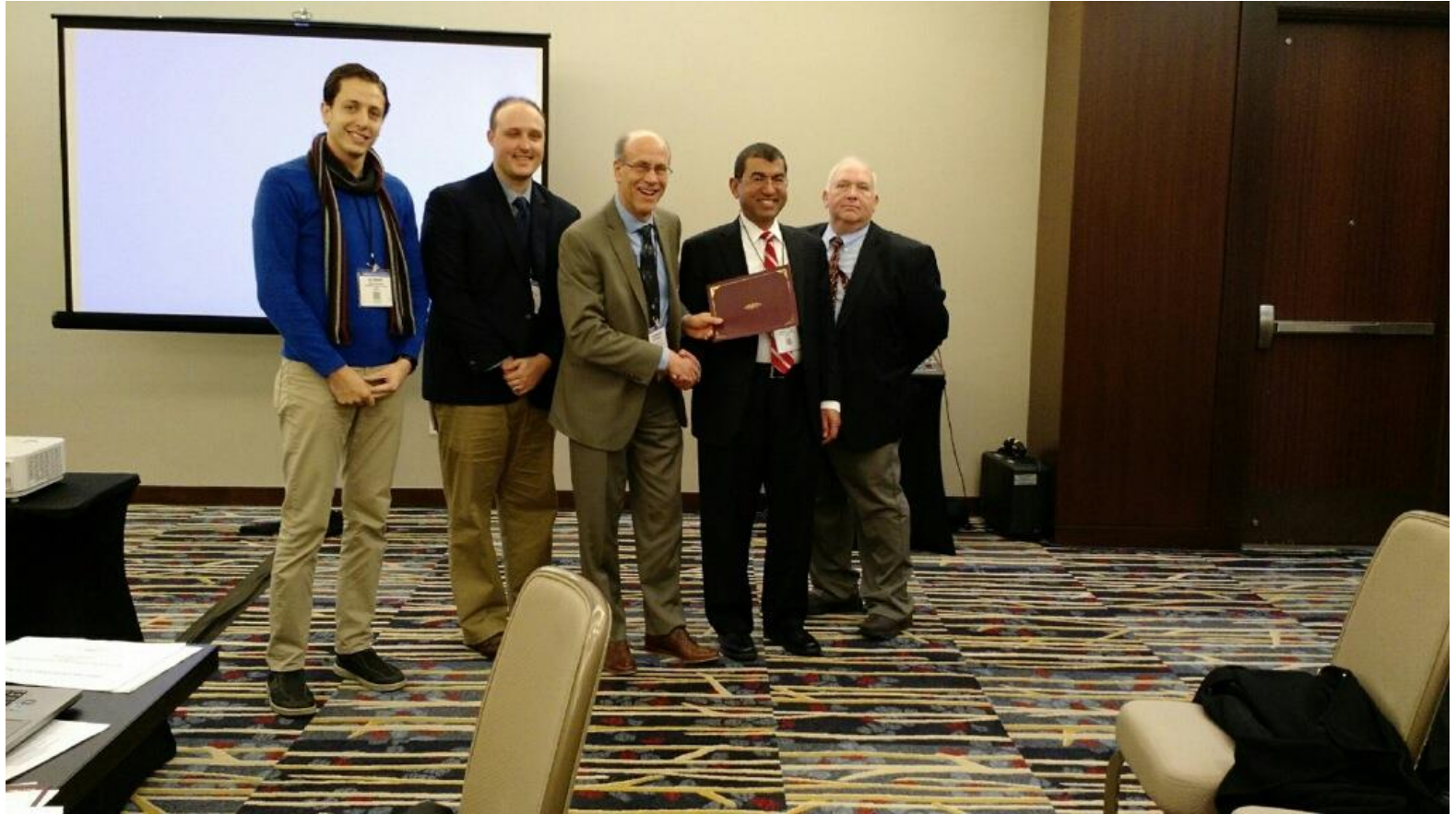
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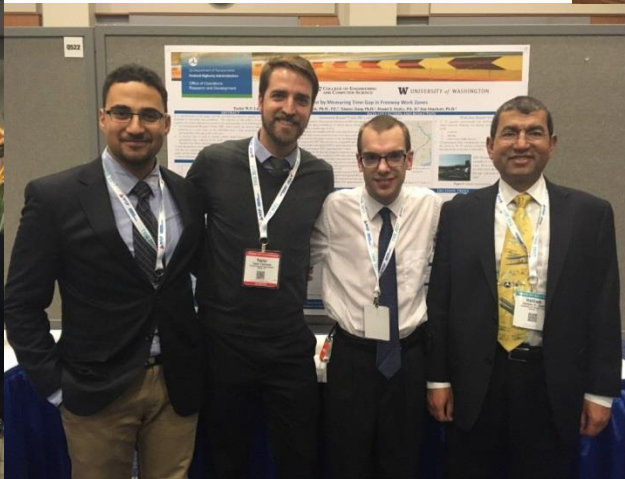
UCF Awards



TRB 2015 Best Paper Award by the Regional
Transportation Systems Management and Operations
(Regional TSM&O) Committee on January 13, 2016 in
Washington, D.C.



UCF WWD Research Team (UCF-ITE Officers)



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Al-Deek Students' Recognition Taylor Lochrane, Ph.D.



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UCF Media Recognition for WWD Research

- **FOX19 NOW** Ohio broadcast on UCF's research findings on **Wrong-Way Driving** on Monday September 19, 2016: <http://www.fox19.com/story/33130527/wrong-way-crashes-on-the-rise-in-the-tri-state>
- **TV Channel 9 (ABC News)** Central Florida broadcast on UCF's research findings on **Wrong-Way Driving** aired at three different times on Thursday July 14, 2016. In addition, the following link was posted on Channel 9 Web Site: http://www.wftv.com/news/program-to-prevent-wrong-way-crashes-appears-to-be-working-expressway-authority-says_20160714212722/401211815
- **TV Channel 13** Central Florida broadcast on UCF's research findings on **Wrong-Way Driving** aired on Thursday July 14, 2016: https://1drv.ms/v/s!Am8opIZU_GEka8C0kUXztdSawG0
- **TV Channel 13 News article** posted on their web site on July 14, 2016: http://www.mynews13.com/content/news/cfnews13/news/article.html/content/news/articles/cfn/2016/7/14/catching_wrong_way_d.html
- Dr. Al-Deek was featured in the UCF College of Engineering and Computer Science (CECS) Marketing Video 2014-2015 Academic Year: https://drive.google.com/file/d/0B_C7H24svH61WIV2SVFBQUZqcjA/view?usp=sharing
- **WMFE NPR radio interview** with Professor Al-Deek to talk about his research findings on **Wrong-Way Driving** on Friday April 17, 2015: <http://www.wmfe.org/expressway-authority-to-add-sensors-along-408-to-prevent-wrong-way-crashes/>



UCF Media Recognition for WWD Research

- **TV Channel 9 (ABC News)** Central Florida broadcast on UCF's research findings on **Wrong-Way Driving** aired at five different times on Wednesday February 11 and Thursday February 12, 2015. The following link is for the first version aired at 6:18 PM on February 11, 2015: <http://www.wftv.com/videos/news/first-wrong-way-driver-alert-system-installed-in/vDFx2M/>
- The Orlando Sentinel mentioned UCF's research findings on **Wrong-Way Driving** in their article on Saturday September 27, 2014: <http://www.orlandosentinel.com/news/breaking-news/os-florida-wrong-way-crashes-20140927-story.html>
- Tampa Bay News mentioned UCF's research findings on **Wrong-Way Driving** in their article on Tuesday September 23, 2014: <http://www.tampabay.com/news/publicsafety/accidents/wrong-way-driving-may-be-more-common-than-thought/2199070>
- **TV Channel 9 (ABC News)** Central Florida broadcast on UCF's research findings on **Wrong-Way Driving** aired at five different times on Monday February 24 and Tuesday February 25, 2014. The following link is for the first version aired at 4:44 PM on February 24, 2014: <http://www.wftv.com/news/news/local/study-shows-few-people-report-wrong-way-driver-cen/ndZ4j/>
- *UCF Public Radio* interviewed Professor Al-Deek to talk about his research on **Wrong-Way Driving** on Wednesday February 26, 2014.
- The *Orlando Sentinel* covered UCF's research story on a significant portion of the first page published on Saturday March 1, 2014 –the two links below show the first page story followed by a 2 minute live video on the Sentinel's web site where Professor Al-Deek talks about his research findings on **Wrong-Way Driving**:
http://articles.orlandosentinel.com/2014-02-28/news/os-wrong-way-accidents-20140228_1_expressway-authority-toll-roads-authority-roads
<http://www.orlandosentinel.com/videogallery/79466468/Video-Wrong-way-driver-study-and-prevention>
- The following blog has been published by the legal team at Largely Law covering UCF's research findings on **Wrong-Way Driving**:
<http://www.largeylaw-blog.com/blog/wrong-way-driving-becoming-increasingly-problematic-in-central-florida/>



UCF WWD Research Program (2012-Ongoing)

A total of 10 sponsored projects in five years...

- 1) **Wrong-Way Driving Phase-1- Study (CFX):** Wrong-Way Driving Incidents on Central Florida Expressway Authority (CFX) Toll Road Network: What is the Extent of this Problem? **Phase 1** (2012-2013) was completed in May 2013.
- 2) **Wrong-Way Driving Phase-2- Study (CFX):** Wrong-Way Driving Incidents on CFX Toll Road Network: Developing Countermeasures. **Phase 2** (2014-2015) was completed in February 2015.
- 3) **Wrong-Way Driving Phase-3- Study (CFX):** Allocating and Evaluating Countermeasures on CFX Roadway Network, Initial **Phase 3** period was 2015-2017.
- 4) **Wrong-Way Driving Phase-3- Study Extension (CFX):** Allocating and Evaluating Countermeasures on CFX Roadway Network, **Phase 3 Extension** , 2017-2019, ongoing...
- 5) **Wrong-Way Driving Phase-1- Study (FTE):** Evaluating the Wrong-Way Driving Incidents Problem on the Florida's Turnpike Enterprise (FTE) Roadway System. **FTE Phase 1** (2014-2015) was completed in December 2015.
- 6) **Wrong-Way Driving Phase-2- Study (FTE):** Deployment and Evaluation of Wrong-Way Driving (WWD) Countermeasures for the Florida's Turnpike Enterprise (FTE) Toll Road System, **FTE Phase 2**, 2016-2019, ongoing...
- 7) **Southeastern Transportation Center (STC) Grant#1:** Evaluating the Wrong-Way Driving Incidents Problem on the FTE's Roadway System. **STC national project** (2014-2015) was completed in March 2016.
- 8) **Southeastern Transportation Center (STC) Grant#2:** Evaluating the Potential of Connected Vehicles in Combating Wrong-Way Driving, 2016-2018, **STC national project** ongoing...
- 9) **National Cooperative Highway Research Program (NCHRP) Project 03-117** "Traffic Control Devices and Measures for Deterring Wrong-Way Movements," in collaboration with Texas A&M Transportation Institute (TTI)—UCF is a subcontractor to TTI, 2015-2017, ongoing...
- 10) **Red Rectangular Rapid Flashing Beacon (RRFBs) Pilot Test on North Texas Toll Authority Road Network, UCF is subcontractor to TTI, 2017-2018, pending contract execution.**



UCF National/International Collaboration and Recognition (2012-Ongoing)

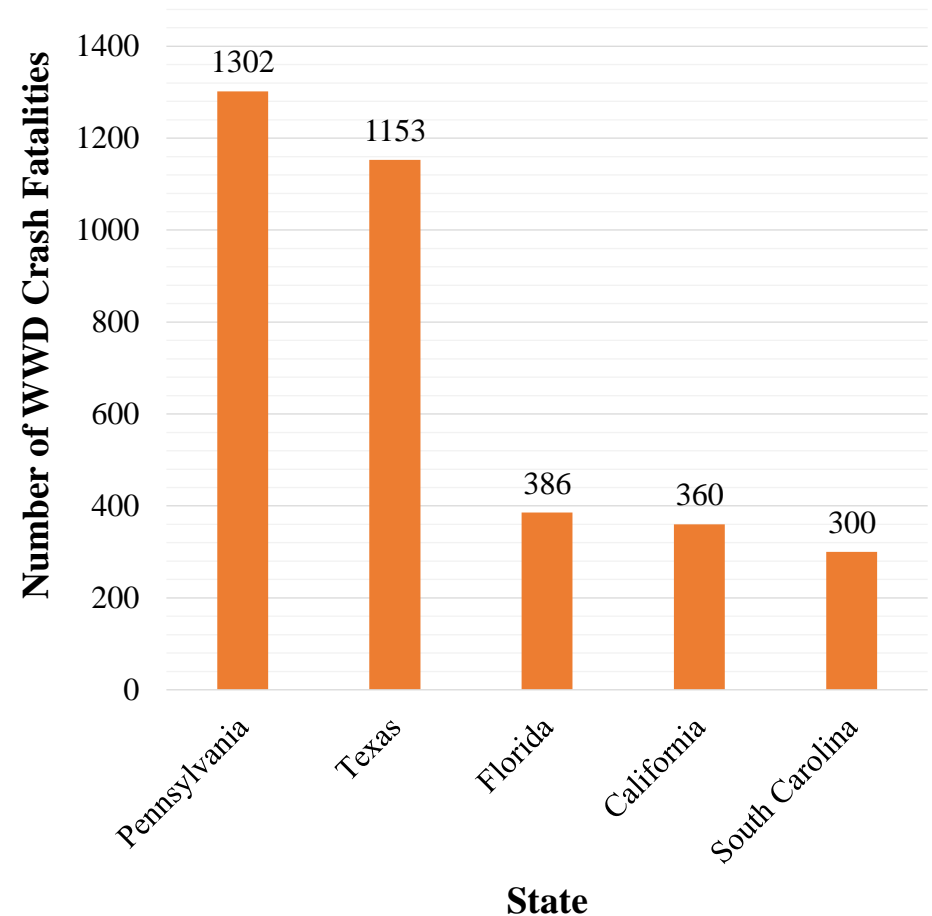
- 1) **WWD Human Factors Workshop at TRB 2018 Annual Meeting on Sunday, January 7, 2018. Collaboration between User Information Systems (AND20), Freeway Operations (AHB20), and Traffic Control Devices (AHB50) committees.**
- 2) In cooperation with TTI, Melisa Finley and Haitham Al-Deek organized and moderated **the 94th TRB Session 686 - Wrong Way Driving: What We Know, What We Are Doing, and Where Are We Going?** A Panel Discussion: Examples of What Agencies Are Currently Doing: **CFX, TxDOT, Illinois DOT, RIDOT, and FHWA**...A TRB Webinar organized by Melisa Finley of TTI followed on April 20, 2016 with several hundred participants.
- 3) Haitham Al-Deek and Melisa Finley organized a call for TRB papers on WWD in 2015 (TRB Freeway Operations and Traffic Control Devices Committees).
- 4) Published and presented numerous papers on the subject at TRB, ASCE, and ITE meetings and elsewhere.
- 5) **Professor Al-Deek is three times keynote speaker (by special invitation) on the subject in various international conferences (2014, 2015, and 2017).**

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WWD Crash Information

- WWD crashes make up about **3% of crashes** on high-speed divided highways, but often result in fatalities or serious injuries (NTSB, 2012).
- Average of **300-400 fatalities per year in United States** due to WWD crashes (Moler, 2002).
- From 2007-2011, there were 386 fatalities due to WWD crashes, **making Florida the third worst state in the nation** (CBS Pittsburgh, 2013).

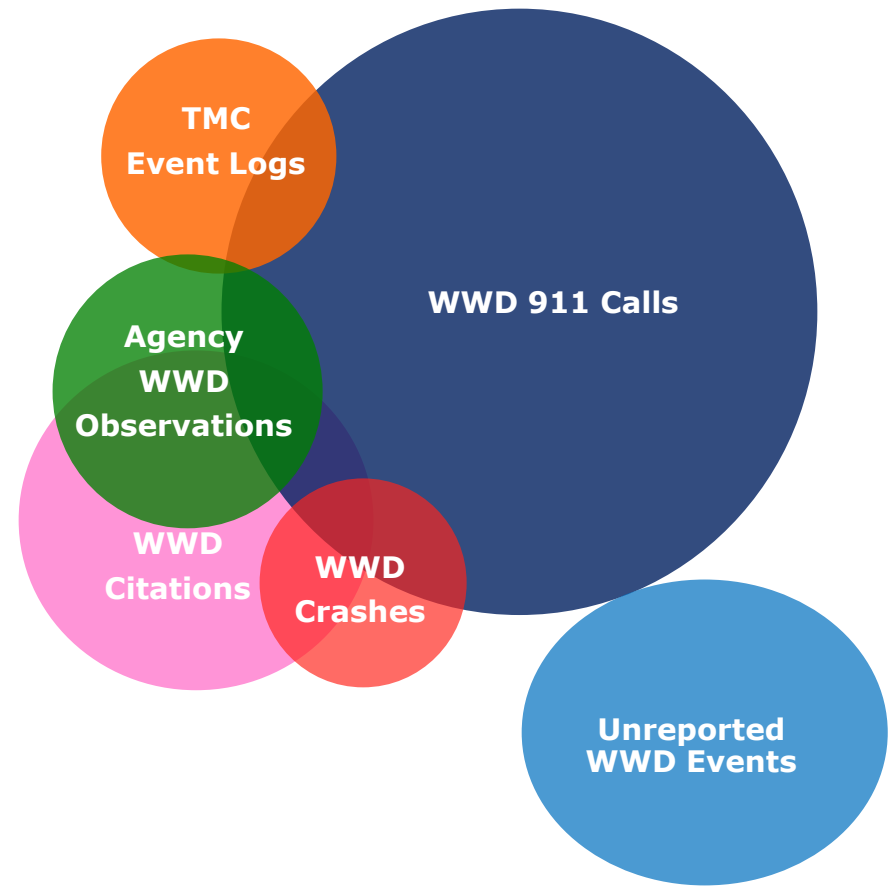


Source: Sandt et al., 2015



UCF Innovative Research Approach: The WWD Data Universe

- Previous research has mainly focused on **WWD crashes** in evaluating countermeasures to stop WWD.
- However, **WWD crashes are only a small portion** of the problem.
- UCF's **innovative and holistic** research approach considers WWD crashes, citations, 911 calls, traffic management center (TMC) logs, agency observations, and unreported WWD events, which all comprise the WWD data universe.

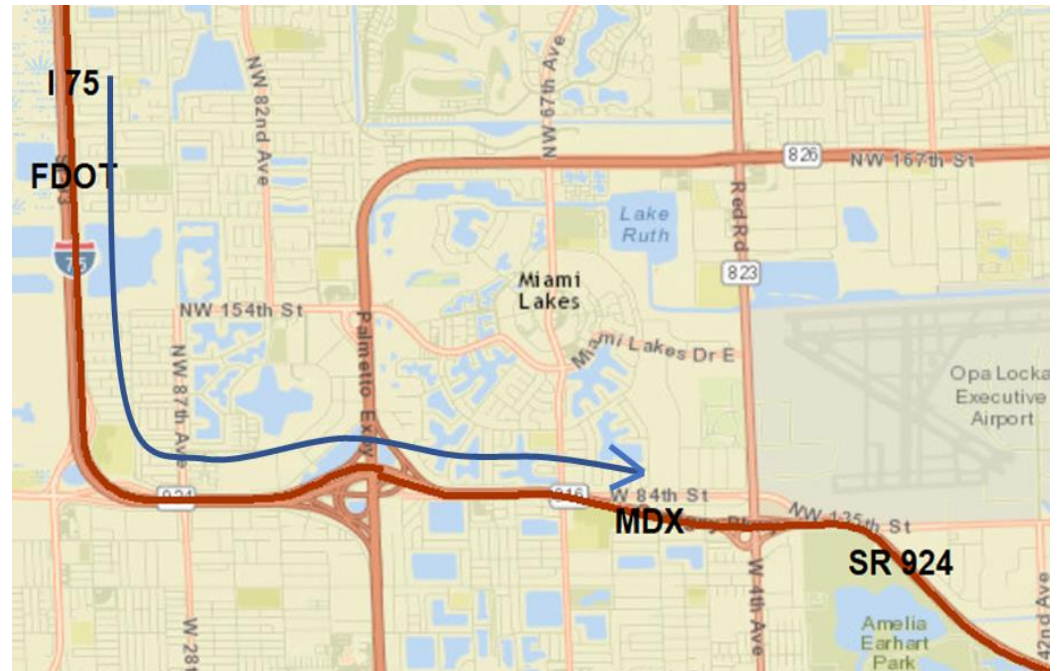
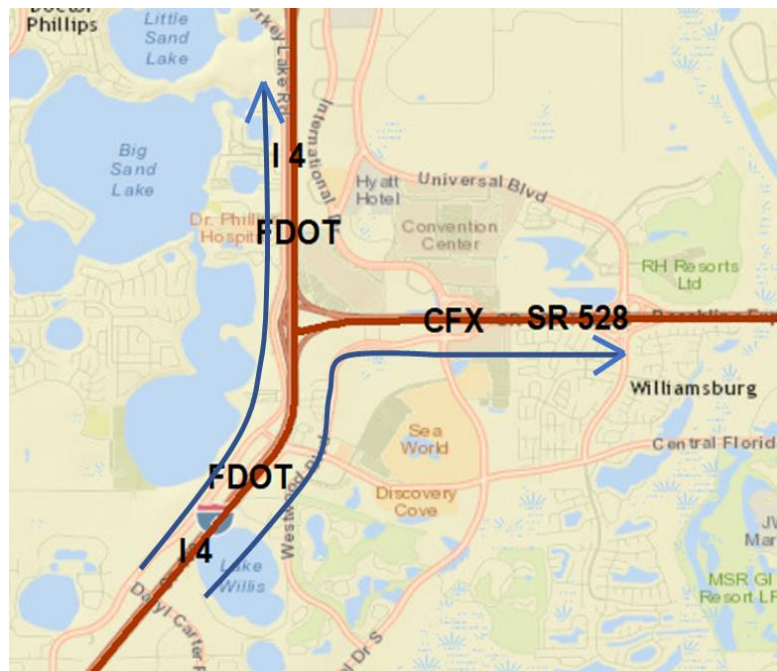


Source: Al-Deek et al., 2013



Regional Analysis of WWD

- 10.5% of multi-data WWD events ended in a different county than where they started.
- Potential for WW vehicles to cross agency boundaries on same or different roadways.



UCF WWD Hotspots Modeling Approach

- UCF has developed an **innovative and holistic modeling approach** that considers **multiple types of WWD events** (not just WWD crashes) and **design and volume data to determine WWD hotspots on limited access facilities**.
- Identifying these WWD hotspots can help agencies determine where **advanced WWD countermeasures** (e.g., RFB and LED Wrong Way signs) or enhancements to existing conventional countermeasures should be implemented to best reduce WWD.
- **No other research has combined all of this data into one approach.**



Outline of WWD Hotspots Modeling Approach

- The UCF WWD hotspots modeling approach can determine the roadways and roadway segments that have the highest WWD crash potential risk:
 - A model is developed to **predict the number of WWD crashes** based on the innovative and holistic UCF approach.
 - **The predicted crashes are added to the actual WWD crash frequencies to obtain WWD crash potential risk.**



Why Use Roadway Segments?

- One of the **primary difficulties** in modeling WWD crashes on limited access facilities is determining the WWD point of entry.
- Some WWD crashes occur right near the point of entry, whereas others can be **10 or more miles away**.
- It is **often unknown** where the wrong-way driver entered the facility, especially if there are **no 911 calls** before a crash occurs.
- To account for this **uncertainty** in the WWD point of entry, the WWD hotspots modeling approach **examines roadway segments** rather than individual interchanges.

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The Main Results of WWD Segment Model

- The main results of this WWD segment model show which segments have high potential for WWD crashes.



WWD Hotspots Modeling in South and Central Florida

- UCF first developed a **WWD hotspots model** for South Florida (the main WWD hotspot in Florida).
- Modeled WWD crashes on 7-interchange roadway segments of limited access facilities in Miami-Dade and Broward Counties from 2011-2014.
- A WWD hotspots model was also developed for Central Florida (the other main WWD hotspot in Florida).
- Modeled WWD crashes on **5-interchange** roadway segments for eight limited access facilities in seven Central Florida counties.
- Considered design and volume characteristics in addition to WWD crashes, citations, and 911 calls.



Central Florida WWD Hotspots Modeling Roadway Segments Ranking

Roadway	Starting Interchange	Ending Interchange	WWD Crash Potential Risk	Ranking
SR 91	SR 417	Turkey Lake Plaza	8.840	1
SR 91	Osceola Parkway	I-4	8.670	2
SR 91	SR 528	SR 50	7.691	3
SR 91	US 441	SR 408	7.367	4
I-4	SR 482	CR 423	7.181	5
I-4	SR 435	US 17/92/441	7.035	6
I-4	SR 528	Conroy Rd.	6.943	7
I-4	Central Fl. Parkway	SR 91	6.886	8
I-95	CR 5-A	I-4	5.642	9
I-4	SR 91	Michigan St.	5.338	10

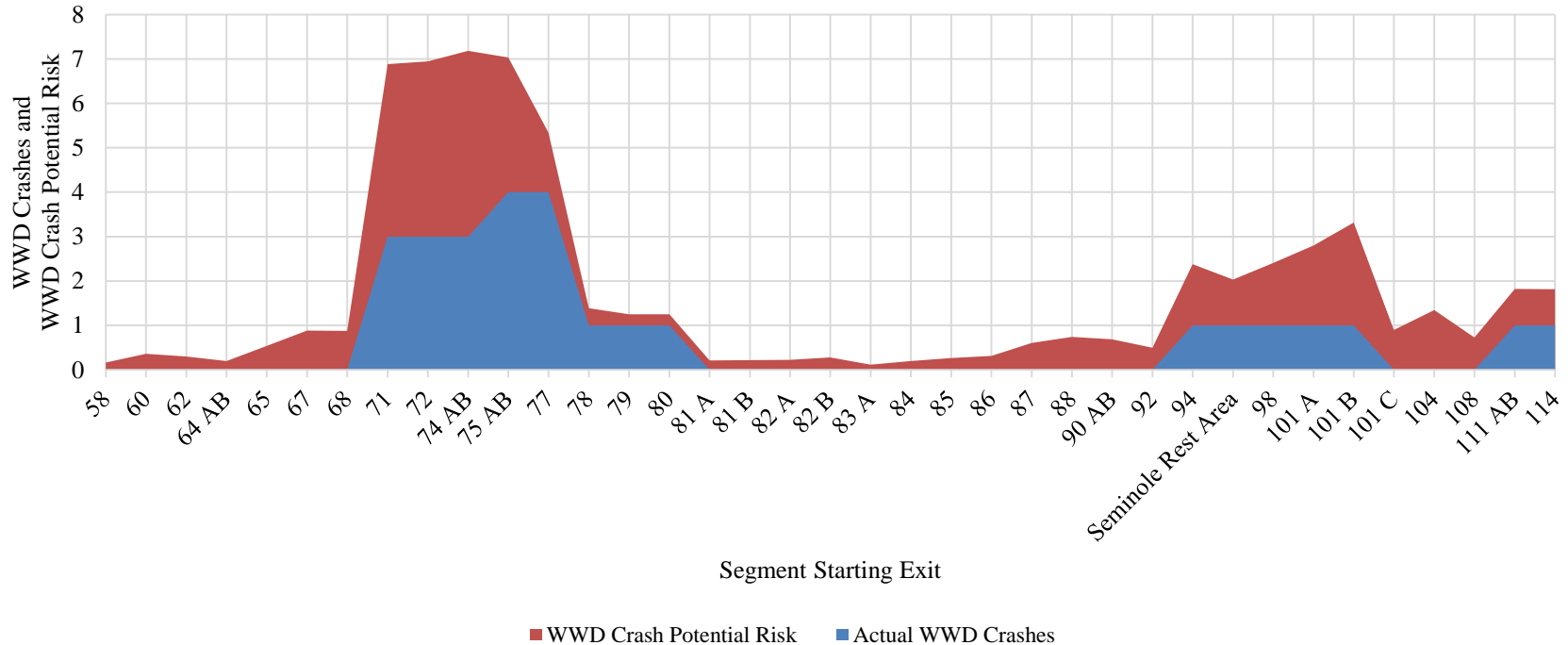
- SR 91 and I-4 in Orange County have multiple WWD hotspots in top ten Central Florida roadway segments.
- Regional rankings for all Central Florida interstates and toll roads.



Central Florida WWD Hotspots Modeling

Example Graph for I-4

I-4 Segment WWD Crashes and WWD Crash Potential Risk in Central Florida



- This graph shows the actual WWD crashes and WWD crash potential risk for I-4 in Central Florida.
- Highest risk segment from exit 74AB (Sand Lake Road) to exit 79 (John Young Parkway) (length of 5.4 miles).

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UCF Optimization Approach

- Allows agencies to determine cost-effective locations for WWD countermeasure implementation within WWD hotspots.
- Based on WWD hotspots modeling results.
- Provides cost savings compared to equipping entire segments or corridors.



Continuing Evaluation of Advanced WWD Countermeasures

- In addition to developing the WWD hotspots modeling approach, UCF has also been evaluating the use of advanced WWD countermeasures in Florida.
- Focus on two Florida regions where advanced WWD countermeasures have been implemented:
 - Central Florida: Wrong Way signs equipped with Rectangular Flashing Beacons (RFBs), cameras, and detectors.
 - South Florida: Wrong Way signs with light emitting diodes (LEDs), cameras, and detectors.



Advanced WWD Countermeasures in Florida



Video showing LED Wrong Way signs used in South Florida from viewpoint of wrong-way driver.

Source: Florida's Turnpike Enterprise



Video showing RFB Wrong Way signs used in Central Florida from viewpoint of wrong-way driver.

Source: Central Florida Expressway Authority



Advanced WWD Countermeasures: LED Wrong Way Signs

- LED Wrong Way signs have been installed at **17 ramps on SR 821 and SR 869** in South Florida as part of a pilot test by the Florida's Turnpike Enterprise (FTE).
- Implementation of LED signs as part of FTE pilot test in South Florida was completed in **October 2014**.
- **Total of 61 WWD detections through September 2017**.
- Eight of these WWD detections resulted in the wrong-way vehicle turning around (**turnaround rate of 13.1%**). This percentage does not necessarily represent the entire turn arounds because LEDs have only one camera which makes it difficult to confirm turn arounds.

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Before-After Study of Seventeen LED Signs

- WWD event modification factors were calculated for the LED equipped sites and equivalent control sites.
- The results indicated that there was a **49% reduction** in WWD 911 calls at a 99% confidence level and a 38% reduction in combined WWD events (911 calls and citations) at a 95% confidence level for the treatment sites due to the implementation of the LED signs.
- The importance of the reduction in WWD events is that they could lead to a **lower risk of potential WWD crashes** at the treated sites.



Advanced WWD Countermeasures: RFB Wrong Way Signs

- RFB Wrong Way signs have been installed at **35 ramps** on SR 408, SR 414, SR 417, SR 429, SR 451, and SR 528 in Central Florida.
- Two sets of signs; each set has one sign on each side of the ramp.
- All four signs have two RFB light bars (on the top and bottom of the signs) that flash with red lights when a wrong-way vehicle is detected.
- **First implementation in February 2015.**
- **Total of 224 WWD detections through September 2017.**
- 175 of these WWD detections resulted in the wrong-way vehicle turning around (**turnaround rate of 78.1%**).



SR 408 EB Exit 2 at Good Homes Rd 7-3-2017 – 2:58:19 AM



Correct Traffic Flow: 

BlinkLink

System: SR 408 EB Exit 2 at Good Homes Rd Alert Time: 7/3/2017 2:58:19 AM Powered by TAPCO



SR 408 EB Exit 2 at Good Homes Rd 7-3-2017 – 2:58:26 AM



Correct Traffic Flow:  BlinkLink

System: SR 408 EB Exit 2 at Good Homes Rd Alert Time: 7/3/2017 2:58:26 AM Powered by TAPCO



SR 528 EB Exit 31 at SR 520 6-19-2017 – 12:55:25 AM



Correct Traffic Flow: 

BlinkLink

System: SR 528 EB Exit 31 at 520 Alert Time: 6/19/2017 12:55:25 AM Powered by TAPCO



SR 528 EB Exit 31 at SR 520 6-19-2017 – 12:55:28 AM



SR 528 EB Exit 31 at SR 520 6-19-2017 – 12:56:18 AM



Correct Traffic Flow:



BlinkLink

System: SR 528 EB Exit 31 at 520 Alert Time: 6/19/2017 12:56:18 AM Powered by TAPCO



Advanced WWD Countermeasure Preferences

- UCF has surveyed Florida drivers, law enforcement officers, and FDOT officials about their preferences regarding LED and RFB Wrong Way signs.
- **72%** of surveyed Florida drivers preferred the use of RFB signs over LED signs (sample size = 900).
- **71%** of surveyed Florida Highway Patrol (FHP) officers and FDOT officials preferred the use of RFB signs over LED signs (sample size = **247 FHP officers and 4 FDOT officials—4 FDOT districts**).
- **76%** of Central Florida toll road users preferred the use of RFB signs over LED signs (sample size = 900).
 - The RFB signs were mainly preferred by FHP officers and Central Florida toll road users **due to the additional set of signs and better flashing**, while FDOT officials mainly preferred the additional set of signs.

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Preliminary Conclusions about Florida Advanced WWD Countermeasures

- Both the LED and RFB Wrong Way signs have successfully alerted wrong-way vehicles and caused them to turn around before entering the mainline. It was possible to confirm more turn arounds with RFBs than with LEDs because RFBs have two or three cameras instead of one.
- Both LED and RFB Wrong Way signs have potential of reducing WWD crashes and saving lives.
- Regular drivers and FHP officers prefer the RFB signs over the LED signs, mainly due to the better flashing and additional set of RFB signs that are being used in Central Florida.



Sample of UCF Journal Publications on WWD Research

- 1) Sandt, A. , Al-Deek, H., and Rogers, J., “Identifying Wrong-Way Driving Hotspots by Modeling Crash Risk and Assessing Durations of Wrong-Way Driving Events,” Journal of the Transportation Research Board, No. 2616, pp. 58-68, DOI: 10.3141/2616-07, August 2017. This paper was nominated for the Transportation Research Board’s Cunard award (operations section) in February 2017 (this award is to recognize lead authors under 35). It was selected as the best student paper by the Freeway Operations committee for the year 2017. The student paper award was announced in February 2017 and will be presented to the lead author and coauthors at the TRB meeting in January 2018.
- 2) Rogers, J., Al-Deek, H., Alomari, A., and Carrick, G. “Modeling the Risk of Wrong-Way Driving on Freeways and Toll Roads,” Journal of the Transportation Research Board, No. 2554, pp. 166-176, DOI: 10.3141/2554-18, November 2016.
- 3) Rogers, J., Al-Deek, H., Alomari, A., Consoli, F., and Sandt, A. “Wrong-Way Driving on Florida Toll Roads: An Investigation into Multiple Incident Parameters and Targeted Countermeasures for Reductions,” International Journal of Engineering Management and Economics (IJEME) (Special Issue on Transport), Volume 5, Nos. 3/4, pp. 144-168, March 2015.
- 4) Rogers, J., Sandt, A. , Al-Deek, H., Alomari, A., Uddin, N., Gordin, E., Dos Santos, C., Renfrow, J., and Carrick, G. “Wrong-Way Driving Multifactor Risk-Based Model for Florida Interstates and Toll Facilities,” Journal of the Transportation Research Board, No. 2484, pp. 119-128, DOI: 10.3141/2484-13, December 2015. This paper was nominated for the Transportation Research Board’s D. Grant Mickle award in April 2015. It was selected as the best paper by the Freeway Operations committee for the year 2015. The paper award was announced in April 2015 and a plaque was presented to Professor Al-Deek (corresponding author) along with the award copies presented to all co-authors on January 12, 2016 at the TRB meeting.
- 5) Sandt, A. , Al-Deek, H., Rogers, J., and Alomari, A., “Wrong-Way Driving Prevention: Incident Survey Results and Planned Countermeasure Implementation in Florida,” Journal of the Transportation Research Board, No. 2484, pp. 99-109, DOI: 10.3141/2484-11, December 2015.

