UMTRI Automotive Research Conference
Safety Impact:
Connected / Autonomous Trucks
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February 12, 2014
Presentation Overview

- Heavy Truck Crash Facts
- General Transportation Challenges
- Automation Levels
- Today’s & Next Generation Safety Systems
- DSRC Truck Project
- Technological Challenges
2011 US Large Truck Crash Statistics

- 287,000 large truck DOT reported crashes
- 3,608 trucks involved in fatal crashes
- 3,757 fatalities - 635 truck occupants
  - 2.2% increase in total fatalities over 2010
  - 71% combination vehicles
- 88,000 injuries - 23,000 truck occupants
- Fatalities / 100 million miles traveled 1.41 (+10% from 2010)
  - 45% reduction from 2000
- Alcohol involved in 3.0% of large truck fatal crashes
  - Alcohol involved in 27% of passenger car fatal crashes
- Ref: 32,367 fatalities from all US motor vehicle crashes
  - 1.5% fatality reduction over 2010
  - 1.10 Fatalities / 100 million miles traveled
- Preliminary 2012 results indicate large truck crash fatalities increased 3.7% over 2011 while total vehicle fatalities increased 3.3%
Large Truck Fatal Crashes 2000-2011
General Transportation Challenges

Safety
• 33,561 highway deaths in 2012
• 3,921 fatalities from large truck crashes in 2012
• Leading cause of death for ages 4, 11-27

Mobility
• 5.5 billion hours of travel delay
• $121 billion cost of urban congestion

Environment
• 2.9 billion gallons of wasted fuel
• 56 billion lbs. of additional CO₂
Additional Trucking Challenge

• Motor Carriers are for-hire or private business entities involved in freight transport
• Overarching Goal: Moving freight from location A to B in the safest, most efficient manner possible
• Technologies providing improved safety and efficiency with acceptable paybacks are readily adopted
Elements Driving Safety Improvement

- Safety Culture
- Regulations
- Enforcement
- Training
- Active Safety Systems
  Automation
  Connected Vehicles
- Maintenance

Driving Safety Improvement

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NHTSA Levels of Automation

- Level 0: Driver in complete & sole control of vehicle; braking, steering, throttle
- Level 1 Function Specific: One or more systems that automatically assists driver with a primary vehicle control function
- Level 2 Combined Function: Two or more primary control functions combined to work in unison to relieve driver of control of these functions
- Level 3 Limited Self Driving: Enable driver to cede full control under certain conditions. When necessary, system automatically transitions control back to driver
- Level 4 Full Self Driving
- Today’s well equipped large trucks are at Level 1
Heavy Truck Automation Evolution

**V2V/V2I: supportive technology, not enabling technology**

- **Level 0**
  - V2V
  - V2I

- **Level 1**
  - Active Safety Systems
  - ABS

- **Level 1/2**
  - Integrated Safety
  - ABS, ESC, CMS, LDW, LKA, side sensing

- **Level 3**
  - Partial Autonomous Driving

- **Level 4**
  - Fully Autonomous Driving

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Active Safety Systems vs DRSC V2V

• Active Safety Systems
  • Designed to ASSIST driver maintaining control of vehicle and reducing crash risk
  • Contains on-board sensors, actuators and algorithms to warn and enable the automatic intervention of one or more of the vehicles primary control functions (braking, steering, throttle) when calculated safety thresholds are exceeded
    • ABS, Stability Control, Collision Mitigation

• DSRC V2V
  • Designed to ASSIST driver maintaining control of vehicle and reducing crash risk
  • Contains on-board GPS, vehicle information and communication capability to warn drivers when calculated safety thresholds are exceeded
  • Capable of warning on potential collisions not visible to current active safety systems
  • Relies on other vehicles in traffic stream having similar capabilities
Today’s Integrated Safety System

- Telematics
- ABS
- Inward Looking Camera
- Pedestrian Detection
- Blind Spot Monitoring
- Blind Spot Warning
- Collision Mitigation
- Lane Departure Warning
- Stability Control
Hardware & Performance Integration

• ABS foundation for advanced safety systems
  • Regulated technology
  • Helps prevent high levels of wheel slip (wheel lock) during braking

• Stability Control provides architecture to allow control system to automatically apply service brakes
  • Reduces risk of untripped rollovers and loss of control events

• Lane Departure Warning (Vision)
  • Potentially a second object recognition input for CMS
  • Warns on unintended lane drifts
Tractor ABS + Electronic Stability Control (ESC)
Collision Mitigation Systems

- Active braking system designed to reduce / mitigate forward collisions
- Based on single radar sensor
- Warnings: Collision, stationary object and haptic
- Active Braking: Adaptive cruise control and collision mitigation
Integrated Safety System Roadmap

- Increased performance levels
  - Partial braking on stationary objects
  - Increased deceleration on moving/stopped objects
- Able to react to additional crash scenarios
  - Integration of V2V
- Relieve driver of control functions for discrete time periods
  - ACC, CACC
  - Self steering in certain controlled environments
- Full autonomy (self driving) in certain vocations
  - Mining vehicles, military
Connected CV – Integrated Truck Project

• DOT project awarded in April 2011
• Develop and demonstrate DSRC safety applications as well as several V2I applications
• Integrate data acquisition systems to allow for thorough testing
  • Support NHTSA test program
• Conduct two driver clinics
• Support model deployment of the technology
• Project team
DRSC Hardware

Wireless Safety Unit 1.5 (WSU)

DSRC Antenna

DVI

CAN Gateway

Truck J1939

WSU 1.5 Primary

RS232

DGPS

WSU 1.5 Secondary

DVI

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V2V Safety Applications

Forward Collision Warning (FCW)

Intersection Movement Assist (IMA)
V2V Safety Applications

Blind Spot Warning (BSW)

Hard Braking Leading Vehicle >.4G (HBLV)

Blind Spot/ Lane Change Caution
Blind Spot/ Lane Change Warning

Caution
Hard Braking Ahead
WARNING

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V2I Applications

Curve Speed Warning (CSW)

Bridge Height Inform (BHI)

Caution Curve Ahead

Warning

Bridge Ahead

Clearance 14' 6"
Safety Pilot: Heavy Truck Driver Clinics

- Transportation Research Center, East Liberty, Ohio – July 10 – 26, 2012
- Former Alameda Naval Air Station, California – August 22-23, 2012
- Evaluate Driver Acceptance of V2V applications on Heavy Trucks
  - Surveys and direct observation of driver reaction to safety warnings
  - Recruited drivers with valid CDLs
  - Participants paid
Driver Demographics

- 112 participants total
  - 64 in Ohio
  - 48 in California
- 61 one-on-one in-depth interviews
- 109 male, 3 female participants
- Experience level: recent trainee through corporate training directors

"I would like to have this Vehicle-to-Vehicle Communication safety feature on my truck"

- All Apps: 0% - 6% - 106%

Disagree
Neither
Agree
Safety Pilot: Model Deployment

• Model for national deployment of technology

• Determine real world technology effectiveness at reducing crashes & how drivers respond to safety applications

• One year deployment began August 2012. Scheduled to conclude February 2014

• Terabytes worth of data being collected and analyzed by the Volpe Center
  • Initial report expected in next few weeks
Safety Pilot: Model Deployment

- Conducted in Ann Arbor, Michigan
- Cars, transit buses, heavy and medium trucks equipped with DSRC devices participating

<table>
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<th>Integrated Vehicles</th>
<th>Retrofit/Aftermarket Devices</th>
<th>Vehicle Awareness Devices</th>
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<tr>
<td>Heavy Trucks</td>
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<td><strong>Total</strong></td>
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<td>319</td>
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Model Deployment – Heavy Truck

- Con-way Freight and Sysco Detroit LLC participating fleets
- 19 tractors fitted with DSRC devises
  - 12 tractors equipped with dataloggers
- Test applications include Forward Collision Warning, Intersection Movement Assist, Blind Spot Warning, Emergency Electronic Brake Lights & Curve Speed Warning
- Collision Mitigation System deactivated for the test
Vehicle 2 Vehicle
CV Communication Challenges

- Trailer presence and length needs to be considered
  - How to automatically supply this data to tractor installed devise
- Articulated vehicles present additional challenges
  - Intersection clearance, lane changes
- Warnings must be integrated with current active safety systems
  - Cannot have two devises providing similar warnings
    - On-board CMS, Blindspot Detection
- Security of messages must be assured
- Can payback be ensured during the initial years of deployment?
- Will regulation be required to achieve adequate penetration rate for payback (light and heavy vehicles)?
  - Information transmitted from other vehicles in the traffic stream required to make decisions
  - What percentage of vehicles on the public roads need to be equipped prior to achieving a safety benefit?
Cooperative Adaptive Cruise Control Project

• Federal Highway (FHWA) awarded project in early October to team led by Auburn University
  • Peloton, ATRI, Peterbilt, Meritor WABCO
• Second award granted to a team led by UC Berkley
• Team will research Partial Automation for two Truck Platooning
  • Cooperative Adaptive Cruise Control builds off current Adaptive Cruise Control
  • Key technologies include radar, V2V communications, positioning, actuation and Human-Machine Interfaces (transmitting critical information to leading and following drivers)
Key CACC Research Tasks

- Document traffic flow and fuel economy improvement potentials
- System robustness
- System reaction to passenger car cut-ins and other highway anomalies
- How to find similarly equipped vehicles
- Responsibilities of lead driver
- Return on investment
Powering Connected Trucks for Safety and Efficiency
NHTSA Regulatory Decisions

• NHTSA has regulatory authority to mandate installation of V2V equipment & software and regulate its performance
  • Content of safety message
  • How & where vehicles convey their warnings to drivers

• Able to regulate aftermarket V2V equipment

• Can not require or directly regulate security system. Has authority to enter into contracts for security services

• On February 3rd, NHTSA announced plans to initiate a regulatory proposal to require V2V devices be installed in new light vehicles

• NHTSA scheduled to make a heavy truck V2V decision in later part of 2014
  • Data from Ann Arbor Safety Pilot to be used to determine cost benefit of technology
Challenges Moving Toward Advanced Automation Levels

• Achieving sufficient technology payback
  • Especially Level 3
• Validation requirements
• Potential reduction in driver skills
• Transition from complete system control back to driver – Level 3
  • Will driver be prepared?
• Liability concerns
• Infrastructure improvements
• Mixed vehicle population
Next Steps Toward Autonomous Functionality

• Continued development of higher performance sensors and actuators, cost optimized for volume production

• Adaptive vehicle based active safety systems
  • Integrating traffic stream, environment & infrastructure information – “Big Data”

• Higher software reliability levels and tools to validate

• Cyber security

• V2I private sector payback initiatives
  • Wireless inspection, e-parking, e-tolling, weigh in motion
Summary

• Use of heavy truck active safety systems increasing
  • ABS (mandated)
  • Stability control – approx 50% of class 8 tractor build
    • Notice of Proposed Rulemaking Issued May 2012
    • Final rule expected August 2014
  • Collision Mitigation – approx 10% of class 8 tractor build
    • Rulemaking being seriously considered
• Changes in automation level will be evolutionary, not revolutionary
• Integrated active safety system development will continue to progress
  • Significant safety improvements possible and expected
  • For near term, systems will assist drivers, not replace them
Save Lives, Increase Value, Reduce Costs

Cutting edge

“There’s a way to do it better – find it.”

Thomas Edison

Trendsetting

Novel

Groundbreaking

Thanks!

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