Motor vehicle safety in the workplace: Research and best practices

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Topics for today’s presentation

- The burden of work-related crashes
- Linking fleet safety management practices with collision and injury rates
- Fatigue risk management
- Distracted driving
- Automated vehicles
Motor vehicle crashes at work

The human and economic burden

- Leading cause of U.S. work-related deaths
- 36% of all deaths in 2017
- 1st or 2nd leading cause in every major industry group
- Over 27,000 deaths from 2003-2017

$25 billion
total cost to U.S. employers for motor vehicle crashes at work

$65,000
per nonfatal injury

$671,000
per death

*Data from 2013
Source: NETS, Cost of Motor Vehicle Crashes to Employers – 2015
Who’s at risk of a fatal work-related crash?

It’s not just truck drivers. Over 60% of workplace crash deaths in 2017 were workers employed in an occupation other than “truck driver.”

- Truck drivers
- Drivers in other high-risk jobs
- Light-vehicle drivers

Source: Bureau of Labor Statistics, Census of Fatal Occupational Injuries
Linking fleet safety management practices with collision and injury rates
Data Source: Network of Employers for Traffic Safety

2016 U.S. fleet safety benchmarking data for 70 companies:
- Number of vehicles and vehicle miles traveled, by vehicle size*
- Number of collisions and injuries
  - Mileage and collisions may include non-work vehicle use by employee and personal use by spouse

Questionnaire on fleet safety practices:
- Fleet safety management system
- Fleet safety interventions

* Light: ≤ 10,000 lb; Medium: 10,001-26,000 lb; Heavy: >26,000 lb
Outcome Measures

Collisions per million miles (CPMM):
Number of collisions / vehicle miles traveled X 1,000,000

% of fleet involved in a collision (%Fleet):
Number of collisions / number of vehicles X 100

Injuries per million miles (IPMM):
Number of injuries / vehicle miles traveled X 1,000,000
## Vehicle Size and Miles Traveled, 2016

<table>
<thead>
<tr>
<th>Vehicle size</th>
<th>Number</th>
<th>Percentage</th>
<th>Total miles</th>
<th>Miles/vehicle</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>All sizes [70 companies]</strong></td>
<td>332,846</td>
<td>100.0</td>
<td>5,474,336,976</td>
<td>16,447</td>
</tr>
<tr>
<td><strong>Light (≤10,000 lb) [66 companies]</strong></td>
<td>262,232</td>
<td>78.8</td>
<td>4,140,101,527</td>
<td>15,788</td>
</tr>
<tr>
<td><strong>Medium (10,001-26,000 lb) [26 companies]</strong></td>
<td>46,959</td>
<td>14.1</td>
<td>545,827,849</td>
<td>11,623</td>
</tr>
<tr>
<td><strong>Heavy (&gt;26,000 lb) [29 companies]</strong></td>
<td>23,655</td>
<td>7.1</td>
<td>788,407,600</td>
<td>33,329</td>
</tr>
</tbody>
</table>
Main Themes Across All 3 Outcomes

- Fatigue mitigation practices
- Mobile phone policies
- In-vehicle monitoring systems (IVMS)
- Collision review and response
- Driver training
Fatigue Mitigation Practices: Light-vehicle Drivers

Lower CPMM

Lower %Fleet

Lower IPMM

**Key elements:**
- Fatigue training for new hires
- Refresher fatigue training for all drivers
- Medical screenings for fatigue
- Restrictions on night driving

Suggests value of extending fatigue risk management to drivers other than those covered by DOT hours-of-service rules
Mobile Phone Policies

Lower CPMM
Lower %Fleet
Lower IPMM

Key elements:
- Prohibiting use of any kind of electronic devices while driving
- Checking mobile phone records after all collisions

Suggests value of: (1) policy that bans all electronic devices while driving; and (2) follow-up after collisions to ensure policy is being followed
In-Vehicle Monitoring Systems (IVMS)

Lower CPMM
Lower/higher %Fleet
Lower IPMM

Key elements:
- Any use of IVMS
- Use of IVMS with video component
- Summarizing IVMS data for upper management

*Some results counterintuitive*

Suggests: (1) value of IVMS implementation with video component and sharing of data summaries; and (2) need for data items that better distinguish companies with/without best practices
Collision Review and Response

- Lower CPMM
- Lower %Fleet
- Lower IPMM

**Key element:**
- Collision review includes determination of severity

Suggests value of in-depth evaluation of collisions
Driver Training

- Lower CPMM
- Lower %Fleet
- Lower IPMM

**Key elements:**
- Driver training for all employees (any form)
- Training for new hires using personal vehicles
- Behind-the-wheel “commentary drives”
- Classroom and behind-the-wheel training for high-risk drivers

*Some results counterintuitive*

Suggests value of: (1) a range of training modes; and (2) training for high-risk and “grey fleet” drivers
Conclusions

- **Fatigue mitigation practices:** Strongly associated with positive fleet safety outcomes, especially for light vehicles

- **Mobile phones:** Positive outcomes for full mobile-phone ban, checking records after all collisions

- **IVMS:** Generally associated with positive outcomes, and more intense implementations were better – but some counterintuitive results

- **Collision review:** Determining collision severity associated with positive outcomes

- **Driver training:** Several modalities associated with positive outcomes, and more intensive approaches were better – but some counterintuitive results
Fatigue risk management
Defining fatigue

A physiological state of reduced mental or physical performance capability

• Results from sleep loss, extended wakefulness, circadian phase, and/or workload (mental and/or physical activity)

• Can impair a person’s alertness and ability to adequately perform safety-related operational duties

Source: International Civil Aviation Organization
Fatigue and motor vehicle crashes

- Police reports for fatal crashes involving a drowsy driver in 2016:¹
  - 2.5% of drivers (n=1,310)

- An estimated 15%-20% of all crashes involve fatigue²

Barriers to identification and enforcement

No standard protocol for law enforcement

No objective measure

Limited legislation by states
Effects of fatigue and sleep deprivation

- Overlooking or skipping tasks
- Slower reaction times
- Impaired decision making
- “Tunnel vision”
- Inability to adapt to changing information
- “Microsleeps”

People who are fatigued often don’t recognize their own poor performance.
The need for sleep

**Fact:** The average adult needs 7 or more hours of sleep per night.¹

**How much sleep do workers get?**

37% get less than 7 hours per night.²

Circadian rhythms: The sleep-wake cycle

- Peak alertness
- Slightly impaired
- Reduced alertness
- Dangerously drowsy
Acute vs chronic fatigue

**Acute**: Short-term sleep deprivation

- 17 hours awake = **.05 BAC**
- 24 hours awake = **.10 BAC**

**Chronic**: Long-term “sleep debt”

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Dawson & Reid, 1997; Williamson & Feyer, 2000; Falleti et al. 2003; Arendt et al. 2005; Howard et al., 2007; Yegneswaran & Shapiro, 2007; Elmenhorst et al., 2009
Sleep and fatigue: Culture and beliefs

**Workplace**
- Meeting operational and contractual expectations
- Pride in getting the job done
- Perception that admitting fatigue is a sign of weakness

**Our society**
- Sleep is the first thing we give up
- Functioning without sleep is a badge of honor
- Fatigue is not seen as impairment
What is fatigue risk management (FRM)?

**Goal:** Ensure that safety-critical personnel perform at adequate levels of alertness

- Manages worker fatigue as a specific hazard
- Fits within a comprehensive safety management system
  - More flexible and adaptable than regulations
- Data-driven
- Responsibility is shared
The case for FRM

• Regulations don’t cover everyone at risk
• Regulations don’t consider:
  – Differences in how individuals experience fatigue
  – Circadian rhythms
  – Effects of sleep loss over extended periods
  – Off-duty choices about time use
  – Commuting times
• FRM can be tailored to the industry and local environment
Components of FRM

- Balance between workload and staffing
- Shift scheduling:
  - Maximize sleep opportunities and quality
  - Schedule safety-critical tasks for peak alertness times
- Fatigue training
- Monitoring of fatigue and fitness for duty
- Sleep disorder management
- Environment and workplace design
- Journey management
Personal fatigue countermeasures

- Sleep
- Caffeine
- Napping

Sleep and fatigue: The bottom line

- The only truly effective remedy for fatigue is sleep.
- No amount of experience, motivation, or professionalism can overcome the body’s biological need to sleep.
NIOSH fatigue fact sheets for oil & gas

For workers

For employers


https://www.cdc.gov/niosh/docs/2018-125/default.html
Other fatigue resources

- International Association of Oil & Gas Producers [2019]. Managing fatigue in the workplace (OGP 626).

  https://www.nsc.org/work-safety/safety-topics/fatigue


- Gander P, et al. [2011]. Fatigue risk management: Organizational factors at the regulatory and industry/company level.
  Accident Analysis & Prevention 43 : 573-590.

  Sleep Medicine Reviews 9 : 365-380.
Distracted driving
Key road safety issue: Distracted driving

Distracted driving occurs any time you take your eyes off the road, your hands off the wheel, or your mind off the task of driving.
Distracted driving: The facts¹

- Claimed 3,450 lives in the U.S. in 2016 (9% of fatal crashes).
- 486 deaths (14% of distracted driving fatalities) involved a phone.
- 391,000 people were injured in MV crashes involving distracted drivers in 2015.

On average, a nonfatal injury crash at work involving distraction costs the employer $72,442.²

Sources: ¹NHTSA, ²NETS
What are the main types of distractions?

- Visual: Eyes off the road
- Manual: Hands off the wheel
- Cognitive: Thinking about something other than driving
Sending or reading a text message takes the driver’s eyes off the road an average of:

4.6 seconds

A vehicle traveling at 55 mph will go:

368 feet, more than a football field

Source: NHTSA.
Why does cognitive distraction put us at risk?

• Your brain has limited ability to perform more than one task at the same time.

• Your brain has a finite capacity for attention.

• Task switching is neither instant nor seamless.

• The cost is reduced situational awareness.
Are hands-free phones safer?

A synthesis of 342 scientific articles\(^1\) showed measurable declines in driving performance for:

- Hand-held phones: 82% of studies
- Hands-free phones: 81% of studies

The best mobile phone policies cover...

- All employees
- Hand-held and hands-free use
- All vehicle types
- All mobile devices
- All work-related communications

Resources

✓ eDriving seminar: The seven stages of distraction denial  https://www.edriving.com/distracted-driving/

✓ National Safety Council, Safe Driving Toolkit  
https://www.nsc.org/road-safety/tools-resources/safe-driving-kit

✓ International Assn. of Oil and Gas Producers (IOGP)  
Automated vehicles: Coming soon to a road near you?
SAE Levels of Automation\(^1\)
- Range from Level 0 (no automation) to Level 5 (full automation)

Advanced Driver Assistance Systems (ADAS)
- Now on the market: Can control braking or steering (or both) in certain situations
- Human driver is responsible for driving

Automated Driving System (ADS)
- Can control all driving tasks some or all of the time
- Human driver does not have to monitor driving

\(^1\) https://www.sae.org/standards/content/j3016_201806/
SAE Levels of Automation 0-2: Driver Support

<table>
<thead>
<tr>
<th>0</th>
<th>No Automation</th>
<th>1</th>
<th>Driver Assistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Automation</td>
<td>The human driver does all the driving.</td>
<td>Driver Assistance</td>
<td>An advanced driver assistance system (ADAS) can sometimes assist the human driver with either steering or braking/accelerating, but not both at the same time.</td>
</tr>
<tr>
<td>2</td>
<td>Partial Automation</td>
<td>2</td>
<td>Partial Automation</td>
</tr>
<tr>
<td>Partial Automation</td>
<td>In some situations, an ADAS can control both steering and braking/accelerating at the same time. But, the human driver must continue to pay full attention at all times and perform the rest of the driving task.</td>
<td>Partial Automation</td>
<td></td>
</tr>
</tbody>
</table>

The human driver is still responsible for monitoring the driving environment.

Adapted from NHTSA [2018]. The road to full automation. https://www.nhtsa.gov/technology-innovation/automated-vehicles#topic-road-self-driving
Where We Are Now: Levels 0-2

**Level 0:** Warnings and momentary assistance:
- Automatic emergency braking
- Blind spot warning
- Lane departure warning

**Level 1:** Help the driver with steering **OR** acceleration/braking
- Lane centering
- Adaptive cruise control

**Level 2:** Help the driver with steering **AND** acceleration/braking
- Lane centering and adaptive cruise control **AT THE SAME TIME**
Truck Platooning

Level 1 or 2 automation:
• Might combine adaptive cruise control and lanekeeping

Source: U.S. Department of Transportation.
Driver Assistance for Transit Buses

Level 0-2 automation:

- May include ADAS such as collision avoidance, lane centering, automatic docking
- Human driver is always present and responsible for driving

Source: U.S. Department of Transportation.
SAE Levels of Automation 3-5: Automated Driving

3

Conditional Automation

An Automated Driving System (ADS) can perform all driving tasks in some situations. At these times, the human driver must be ready to take back control whenever the ADS requests it. In all other cases, the human driver performs the driving task.

4

High Automation

An ADS can perform all driving tasks and monitor the driving environment in some situations. At these times, the human driver does not need to pay attention.

5

Full Automation

An ADS can do all the driving in all situations. Humans in the vehicle are just passengers and never need to be involved in driving.

The automated driving system monitors the driving environment.

Adapted from NHTSA [2018]. The road to full automation. https://www.nhtsa.gov/technology-innovation/automated-vehicles#topic-road-self-driving
Passenger-vehicle Automation: Limited-access Highway

Level 3 automation:

• On limited-access highway and under appropriate conditions, the human driver is expected to re-assume vehicle control when instructed to do so.

• The human driver is responsible for all driving tasks for the rest of the trip (Level 0-2).

Source: U.S. Department of Transportation.
Highway Co-Pilot

Level 4 automation:
- Operates only on limited-access highways
- Human driver doesn’t have to be in the driver’s seat while on the highway, but must take over vehicle operation on surface streets (Level 0)

Source: U.S. Department of Transportation.
Automated Bus Service on a Fixed Route

Level 4 automation:
• Remote supervisor oversees operation
• No human driver is needed

Source: U.S. Department of Transportation.
Fully Autonomous Haul Truck on a Mine Site

Level 5 automation:

- Remote supervisor monitors operation
- No human driver is needed
Management Practices for the Safe Operation of Partially and Fully Automated Vehicles:

- Companion to the Z15.1 fleet safety standard
- Not a standard, but lays the foundation for a future standard
- Covers management of current fleet vehicles with ADAS (Levels 0-2)
- Also covers how to prepare for deployment of more highly-automated vehicles (Levels 3-5)

Key Educational Resource: mycardoeswhat.org

Explains advanced vehicle safety features using videos, graphics, and games
Automated vehicles: The bottom line

• Automation is not the silver bullet that will make crashes a thing of the past.

• Vehicles with and without automated features will be sharing the road for another 30 years.

• Fleet managers need to manage vehicles with ADAS now and prepare for what’s coming.
Questions?

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