In-Vehicle Monitoring Systems – On and Off Duty: Evaluating Driver Performance and Schedules in a Small Well Servicing Fleet

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Andrew Krum, VTTI
No Pictures or Video Recording

• Videos that we will show are from actual studies, but these participants have agreed to let me show you

• BUT, no cameras, PLEASE!
Video #1, part a

Videos removed for protection of participant identity.
Video #1, part b

Videos removed for protection of participant identity.
Video #1, part c

Videos removed for protection of participant identity.
Did you know?

Motor vehicle crashes are the leading cause of death at work for oil and gas extraction workers.

Within O&G Industry

4 in 10 O&G work-related deaths involve a MV, not including off-duty or commuting deaths

Compared to Other Industries*

O&G MV fatality rate is 8x that of all industries, and is similar to the transportation industry
What is the risk to drivers in the oilfield?

Motor Vehicle Fatality Rate per 100,000 Workers, 2003-2009

<table>
<thead>
<tr>
<th>Industry</th>
<th>Rate per 100,000 Workers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transportation and warehousing</td>
<td>9.3</td>
</tr>
<tr>
<td>Oil and gas extraction</td>
<td>7.6</td>
</tr>
<tr>
<td>Agriculture, forestry, fishing, and...</td>
<td>4.0</td>
</tr>
<tr>
<td>Mining, excl. oil and gas extraction</td>
<td>2.3</td>
</tr>
<tr>
<td>Construction</td>
<td>1.7</td>
</tr>
<tr>
<td>Wholesale trade</td>
<td>1.3</td>
</tr>
<tr>
<td>Utilities</td>
<td>0.9</td>
</tr>
<tr>
<td>All private wage and salary workers</td>
<td>0.9</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>0.4</td>
</tr>
<tr>
<td>Retail trade</td>
<td>0.4</td>
</tr>
<tr>
<td>Services, excl. public administration</td>
<td>0.34</td>
</tr>
</tbody>
</table>

“We are a transportation industry that produces oil and gas.”

Warren Hubler, H&P
Light-duty vehicles most commonly involved in fatal oil and gas crashes

Motor Vehicle Fatalities by Vehicle Type, U.S. Oil and Gas Extraction Industry, 2003-2009
At least half of all fatal oil and gas crashes involve unbelted workers


- Unknown: 38%
- Not used: 38%
- Belt worn: 12%
- Ejected: 12%
Other factors related to fatal motor vehicle crashes

<table>
<thead>
<tr>
<th>Company Type:</th>
<th>Experience:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Well Servicing (62%)</td>
<td>&lt;1 year with employer (32%)</td>
</tr>
<tr>
<td>Drilling Contractors (23%)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Company Size:</th>
<th>Fatigue?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small companies* 4X the risk as large companies</td>
<td>Oncoming collision (21%)</td>
</tr>
<tr>
<td></td>
<td>Roadway departure (17%)</td>
</tr>
</tbody>
</table>

U.S. Oil and Gas Extraction Industry, 2003-2009
Driving differs from other work assignments

- **Less Supervision**
  Changing due to telematics and IVMS

- **Less Controlled Environment**
  Actions of other motorists affect workers

- **Constant Change**
  Operating conditions change constantly
# In-Vehicle Monitoring Systems (IVMS)

<table>
<thead>
<tr>
<th>Records Data</th>
<th>Measures Performance</th>
<th>Changes Behavior</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓ Date and Time</td>
<td>Measures driver performance against a predetermined set of parameters</td>
<td>Has shown to be effective in realizing immediate and</td>
</tr>
<tr>
<td>✓ Speed</td>
<td></td>
<td>positive effect on driver behavior</td>
</tr>
<tr>
<td>✓ Acceleration/Deceleration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>✓ Seat Belt Use</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Motor Vehicle Crash Rates**
- 50–90%

**Speeding**
- 60%

**Miles Driven**
- 8-20%

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Field Practice Research
Virginia Tech Transportation Institute (VTTI)
Field Research

• What is Naturalistic Data collection?
  – Study drivers and vehicle for extended periods
  – Captures driver behavior in full context
  – Video, vehicle network, and other sensors
Research Partnership

• National Surface Transportation Safety Center for Excellence
  – Established in 2005 to share advanced transportation safety techniques and innovations in rural and urban sectors

• Objectives
  – To develop and test transportation devices and techniques that enhance driver performance
  – To evaluate the roadway environment and infrastructure-based safety systems
  – To address mobility for vulnerable road users
  – To examine driver impairment issues

• Stakeholders

November 29-30, 2016
Study Overview

• Industry and research partnership to collect IVMS and Naturalistic Data.
  – Baseline: No manager feedback or driver reports, 1 month
  – Transition: Driver and manager training period, 2-3 weeks
  – Intervention: Manager and driver reports active, 2 months

• Goals:
  – Determine if IVMS impacted driver performance
  – Discover site workers typical schedule over 3 months
  – Discover IVMS and environmental challenges from video/vehicles.
Fleet and Technology

• Fleet
  – Oil and gas well servicing site crew pickup trucks

• IVMS Technology: Cartasite® ROVR™ (21 vehicles anonymously)
  – Connects to vehicle OBDII; Measures braking, acceleration, speeding, idling and night driving time; Provides drivers and manager scorecards, urgent or emergency events

• Research Technology: VTTI MiniDAS & ROVR (4 vehicles)
  – Connected to vehicle OBDII; Windshield-mount, forward-road/driver-face video, and GPS data; Pre- and post-questionnaires for drivers
**Methods**

- **Fleet-Wide Data**
  - Matched vehicle performance (speeding, aggressive) over time from baseline to intervention (driver anonymous)

- **Driver Focused Sample Data**
  - Developed typical commute and schedule from traceable driver (participants) trip purpose and start/destination

<table>
<thead>
<tr>
<th>Blocked Trip</th>
<th>IVMS Trip</th>
<th>Departure Location</th>
<th>Arrival Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - Commute</td>
<td>1</td>
<td>Home</td>
<td>Address</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Address</td>
<td>GPS Only</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>GPS Only</td>
<td>Well</td>
</tr>
<tr>
<td>2 - Commute</td>
<td>1</td>
<td>Yard</td>
<td>Highway</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Highway</td>
<td>Address</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Address</td>
<td>Home</td>
</tr>
<tr>
<td>3 - Site to Site</td>
<td>1</td>
<td>Well</td>
<td>Address</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Address</td>
<td>US Route</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>US Route</td>
<td>Interstate</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Interstate</td>
<td>St. Route</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>St. Route</td>
<td>Well</td>
</tr>
</tbody>
</table>
IVMS Fleet-Wide Driver Performance

• 21 vehicles, 15 weeks, over 140,000 miles applied to analysis

• Speeding Events
  – Baseline Avg: 6.74 events/hr.; Intervention Avg: 2.66 events/hr.
    * Overall Average: 4.61 events per hour

November 29-30, 2016
IVMS Fleet-Wide Driver Performance

- 21 vehicles, 15 weeks, over 140,000 miles applied to analysis
- **Aggressive Driving Events** (braking, acceleration)
  - Baseline Avg: 1.04 events/hr.; Intervention Avg: 0.52 events/hr.
  - *Overall Average: 0.72 events per hour*

![Graph showing aggressive driving events per hour over data collection weeks]
Driver Focused Sample Schedule

Averages across 3 well-site workers during 99-day period:

- On-Duty: 72 days
- Commute, daily distance: 147.6 miles (including home to yard)
- Commute, daily time: 2.9 hours
- On-Duty, daily time: 12.5 hours

Combined daily working time: 15.4 hours
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Video #2

Videos removed for protection of participant identity.
Video #3

Videos removed for protection of participant identity.
Conclusions on Fleet-Wide Data

Based on weekly reports across 21 vehicles...

- Speeding was reduced by 60%
- Aggressive driving behaviors were reduced by 50%
- During four weeks of baseline collection, one vehicle had:
  - Worst rate of speeding events (AVG: 40/hour), and
  - Worst or second-worst rate of aggressive events (AVG: 3.1 hard brakes/hour)
  - During intervention unsafe behaviors reduced by up to 80%
- Efficiency: Average idle time ~22 hours per vehicle/week
Conclusions on Focused Sample Data

• Driver questionnaires
  – Opinions on IVMS remained neutral to positive at study end
  – Drivers rated the future usefulness of receiving real-time speeding alerts very positively (statistically significant)

• Trip Activity and Schedules (well-site worker sample)
  – Nearly 3 hour daily commute on/off highway
  – Daily scheduled work activity 15.4 hours

• Naturalistic Video Sensor Analysis
  – Multiple factors lead to safety-critical events
  – Some factors are under management and driver control
  – Management needs more information to make actionable decisions
Technologies: Near and Future

• Manager Coaching Versus System Training
• Sustainable Performance by Rewards
• Driver-Vehicle Behavior
  – Vehicle kinematics; Highway lane-keeping; Eye glance; Blink rate
• Driver-Crew-Site Schedule
  – On-Duty Hours; Last month-last week-next week
• Driver-Crew Physiology
  – Sleep; Heart rate; Electrical body signals (e.g. EEG)