Emergency Vehicle Operator On-Board Device Distractions

Christine Yager

Human Factors Program
Texas A&M Transportation Institute
Texas A&M University
Project Objectives

- Literature review
- Catalogue devices unique to emergency response vehicles
- Human factors elements of emergency vehicle operations
- Distraction prevention measures
- Identify possible future research areas
Prevalence of In-Vehicle Technology

- 30,100 fire departments and 17,985 law enforcement agencies in the U.S.
- Most frequently performed (13%) in-vehicle task: MDT
- 90% of officers serving a population >25,000 use some form of in-field computer system
Distracted Driving Stats

- In 2012: 10% of total fatal and 18% of total injury crashes were caused by driver distraction
- Cellphone usage while driving: 12% of fatal and 7% of injury crashes
- At any given time, 660,000 drivers are using a cell phone or electronic device
Crash Stats for Emergency Vehicles

- Fatalities involving emergency vehicles from 2002-2012 (NHTSA FARS and GES report)

<table>
<thead>
<tr>
<th>Year</th>
<th>Police Vehicles</th>
<th>Fire Vehicles</th>
<th>Ambulances</th>
<th>Total Fatalities</th>
<th>In emergency use</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fatalities</td>
<td>In emergency use</td>
<td>Fatalities</td>
<td>In emergency use</td>
<td>%</td>
</tr>
<tr>
<td>2002</td>
<td>119</td>
<td>59</td>
<td>50</td>
<td>12</td>
<td>8</td>
</tr>
<tr>
<td>2003</td>
<td>141</td>
<td>69</td>
<td>49</td>
<td>24</td>
<td>19</td>
</tr>
<tr>
<td>2004</td>
<td>112</td>
<td>46</td>
<td>41</td>
<td>21</td>
<td>14</td>
</tr>
<tr>
<td>2005</td>
<td>108</td>
<td>44</td>
<td>41</td>
<td>29</td>
<td>19</td>
</tr>
<tr>
<td>2006</td>
<td>117</td>
<td>39</td>
<td>33</td>
<td>19</td>
<td>16</td>
</tr>
<tr>
<td>2007</td>
<td>132</td>
<td>62</td>
<td>47</td>
<td>22</td>
<td>21</td>
</tr>
<tr>
<td>2008</td>
<td>106</td>
<td>54</td>
<td>51</td>
<td>26</td>
<td>15</td>
</tr>
<tr>
<td>2009</td>
<td>90</td>
<td>33</td>
<td>37</td>
<td>17</td>
<td>9</td>
</tr>
<tr>
<td>2010</td>
<td>84</td>
<td>43</td>
<td>51</td>
<td>14</td>
<td>9</td>
</tr>
<tr>
<td>2011</td>
<td>81</td>
<td>38</td>
<td>47</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>2012</td>
<td>83</td>
<td>35</td>
<td>42</td>
<td>14</td>
<td>9</td>
</tr>
</tbody>
</table>
Crash Stats for Emergency Vehicles

• Fatal emergency vehicle crashes that occurred in non-emergency mode: 50% in 2002 → 54% in 2012
• In 2012, there were 131 emergency vehicle crash related fatalities
• Of these fatalities, about 93 (71%) were occupants of other vehicles or people outside the vehicle
• Ambulance crashes: inattention is a major cause of crashes
  o In emergency mode: 45.9%
  o In non-emergency mode: 22.6%
Crash Stats for Emergency Vehicles

- Minnesota, 2006-2010:
  - 14% of crashes involved driver distraction
  - 12% of crashes involved distraction from in-vehicle technologies
  - MDT was most frequent technology (7%)
- MDTs used two to five times more often when the patrol vehicle is double crewed
- When more resources are available → increased attention and situational awareness
Theory of Driver Distraction

• Definition: “Driver distraction is a diversion of attention away from activities critical for safe driving toward a competing activity.” (Regan, Lee, & Young, 2009)

• Decrements in driving performance with secondary concurrent task:
  o Attention allocation issues
  o High levels of mental workload

• Emergency vehicle driver challenges:
  o Multiple secondary tasks required as part of normal job duties
  o High mental workload and stress levels
Human Information Processing

- Humans have limited attentional and information processing “resources”
- Multitasking = allocating these limited resources among multiple tasks:
  - Good multitasking: spread processing demand among available resources
  - Bad multitasking: demand for some types of resources exceeds their capacity
Multiple Resources Model

Greatest increase in driver crash risk with concurrent visual-spatial-manual tasks (Fitch et al., 2013)
Examples: Problematic Tasks While Driving

- MDT interaction
  - Visual, spatial, manual interaction
  - Reading data/verifying control actions may require eyes-off-road time greater than critical 2-second duration
  - High workload
- Radio
  - Induces workload similar to cell phone conversation
  - Manual interaction (though some hands-free)
  - Conversation may load spatial processing resources (e.g., when discussing locations)
## Other Tasks Identified

<table>
<thead>
<tr>
<th>VISUAL TASKS</th>
<th>AUDITORY TASKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Driving: visually monitoring the roadway/surroundings and driving-related displays</td>
<td>- Driving: listening for sounds related to the driving/navigation task</td>
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<td>- Monitoring MDT for notifications and activity changes</td>
<td>- Monitoring radio communications from dispatchers or other responders</td>
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<td>- Reading call notes</td>
<td>- Communicating directly or over an intercom with other responders in the vehicle</td>
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<tr>
<td>- Searching for and identifying locations of interest on maps</td>
<td>- Receiving and interpreting audible cues or vocalizations from MDT</td>
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<tr>
<td>- Viewing live video feeds</td>
<td>- Listening to read-aloud call notes from MDT</td>
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<tr>
<td>- Reading environmental data, such as vehicle license plates</td>
<td>- Listening to speed detection system auditory output</td>
</tr>
<tr>
<td>- Observing speed detection system visual displays</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>PHYSICAL TASKS</th>
<th>COGNITIVE TASKS</th>
</tr>
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<tbody>
<tr>
<td>- Driving: manually controlling the speed and heading of the vehicle</td>
<td>- Driving: cognitive tasks such as route planning, hazard avoidance</td>
</tr>
<tr>
<td>- Interacting with MDT through touchscreen, touchpad, and keyboard controllers</td>
<td>- Strategic and tactical decision making and planning for response activities</td>
</tr>
<tr>
<td>- Interacting with radio controls (handset and console)</td>
<td>- Interpreting call notes and other MDT data</td>
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<td>- Interacting with light and siren controls</td>
<td>- Processing related to in-vehicle control tasks during response activities</td>
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<td>- Adjusting onboard video system cameras</td>
<td>- Navigating between various MDT function screens</td>
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Wireless connectivity can be intermittent, requires login procedure to reconnect, temptation to do this while driving
Touchscreens are problematic – require “anchoring” the hand on the frame to stabilize finger touches.
More often the touchpad is preferred because in a consistent location, easier for precision controls. But this requires more visual attention.
Cramped spaces can force awkward postures for key controls (gearshift, climate controls, siren controls). Requires longer time with eyes-off-road to visually confirm.
Need to be caught up on a call can lead to interactions with detailed visual displays.
Sometimes outdated maps or lack of navigation assistance
Visibility issues: with MDT and normal video camera mounting in a Crown Victoria
Ambulance drivers en route to hospital are alone in cab. May have to enter changes in MDT while driving (in emergency mode)
Fire engine drivers may be tempted to use side/backup cameras for general awareness of surroundings but lose full awareness of front of vehicle
Fire engine drivers may at times need to turn MDT around and interact with it if lieutenant is too busy communicating with other firefighters/battalion chief/dispatch while en route.
Fire battalion chief has to monitor several radios (3 in this case), interact with MDT, GPS, and coordinate response en route.
Usually single-crewed!
Potential Solutions & Research Needs

• Agency orders to prohibit personal cellphone use and/or limit driver interactions with MDT and other in-vehicle technologies (e.g., double-crewed)

• Technology redesign

• Research needs:
  o True extent of the problems
  o Human factors research
  o Test new interface designs
Contact Information:

Christine Yager  
Human Factors Program  
Texas A&M Transportation Institute  
c-yager@ttimail.tamu.edu