Human Centered Solutions to Advance Roadway Safety

3rd Annual Summit of UTCs for Safety: Working in partnership to address real-world transportation problems

Max Donath
April 6, 2017

The Roadway Safety Institute is the University Transportation Center for USDOT Region 5, which includes Minnesota, Illinois, Indiana, Michigan, Ohio, and Wisconsin.

CONSORTIUM MEMBERS
Human Centered Solutions to Advance Roadway Safety

Overview

• Driver Assist Systems (snowplow operators, teenage and older drivers)
• Vulnerable Users (pedestrians, bicyclists, the visually impaired)
• Rail Crossing Safety
• Safety on Tribal Lands
• Intersection Safety
• Safety Policies; Better data
• Impaired Drivers (DWI and obstructive sleep apnea)
• Connected Vehicles (V2V, V2I and V2X)
• Work zones: Worker safety/driver distraction
• Safety for design and operations
• Countermeasures for wrong way driving and run-off-road crashes
• See [http://www.roadwaysafety.umn.edu/research/index.html](http://www.roadwaysafety.umn.edu/research/index.html)
Using Bluetooth Low Energy (BLE) Technology to Trigger In-Vehicle Messages at Work Zones

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Objectives

• Investigate Bluetooth Low Energy (BLE) tags that can be deployed in or ahead of work zones to provide in-vehicle warning messages.

• Investigate the effectiveness of using in-vehicle spoken messages to measure drivers’ understanding of the work zone in order to reduce risky behavior, associated with distraction.

• Deploy a BLE based system in or ahead of work zones that can trigger spoken and contextual messages in existing smartphones located in passing vehicles.

• Such messages can be updated remotely in real time and may provide significantly improved situational awareness about dynamic conditions at the work zones.
System Architecture

- Geo-fencing
- Customized Bluetooth firmware
- Automatic Bluetooth scanning
- Auditory feedback through smartphone speaker / car audio system
Experiment Setup

Bluetooth Module

Work Zone Alert App
Work Zone at I-35E and Co. Rd E East in Vadnais Heights, MN

battery powered Bluetooth beacon
Work Zone at I-35E & County Rd. E East

- Geo Fence
- BLE Beacon
- Start BLE Scanning
- Travel Direction

160 m (525 ft)
Summary

• We developed a Bluetooth Low Energy (BLE) system to provide in-vehicle warning messages to a driver.
• Smartphone app performs Bluetooth scan and announces the appropriate message corresponding to specific Bluetooth tag when it is detected.
• A continuous Bluetooth scan is initiated when a vehicle enters a geo-fenced work zone.
• The final message structure and content will be determined from the results of a separate human factors study.
• A smartphone app was developed for tag deployment by contractors and for them to request message updates (e.g. to reflect changes at work zone).
• System is capable of providing in-vehicle messages for motorists approaching a work zone using the BLE technology.
• Experiment results indicated that communication between a smartphone and BLE tags at highway speeds is feasible.
• Future effort to focus on validation of proposed system in a real work zone environment under different traffic conditions.
Computerized Crash Reports Usability and Design Investigation

Nichole L. Morris, Ph.D.

HumanFIRST Laboratory

With acknowledgements to the MN Dept. of Public Safety and:

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Computerized Crash Reports Usability and Design Investigation

• Minnesota’s electronic crash report: Outdated, Too rigid for easy and accurate data entry
  – Initiative to rebuild the entire crash records database
  – Opportunity to completely rebuild the crash report interface with the user in mind
• **Goal:** Design and create a crash report interface that improves accuracy, speed, reliability, and meaningfulness of crash report data
  – Utilize Human Factors analyses and principles
  – Capitalize on the experience and expertise of law enforcement
  – Ensure it accommodates rural officers who very infrequently document crashes, but collectively represent the majority of serious and fatal crash data
I apologize for the stupid being too stupid to print a state report.
Phase 1: Human Factors Analysis

- **Assess existing crash report** using HF principles to address human and system performance issues
  - Hierarchical Task Analysis
    - 175 steps for a single unit crash
    - 151: 24 division of responsibilities between the user & system
  - Cognitive Walkthrough Analyses and Interviews
    - 12 officers from 7 agencies
  - Card Sorting Task and Survey
    - 167 officers from 68 agencies

- **Main Findings:**
  - Users preferred a *one-to-many* structure
  - Multiple reliability issues
  - Many components unclear regarding rules
  - Wizard style interface frequently requested
Wizard vs Form-Based Interface

• Wizard
  • e.g. Software Installation
    – Step-by-step queries through a series of dialog boxes in a predetermined order of succession
  – Each dialogue box is devoted to that single question/group of related questions
    • Questions are split up at decision points

• Form
  – Divided into clearly defined sections
  – Content within another section is just an easy click away
  – Interrelationships between all the pieces are made apparent
  – Less restrictive workflow
  – Larger screens with more entry fields
    • Less detailed queries
Phase 2: Interface Design

- Created both Wizard and Form-Based Prototype Interfaces
  - Based on findings from users & new attributes from MMUCC*
  - Largely matched by Functionality, Order, and Content

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<th></th>
<th>1 Unit</th>
<th>2 Units</th>
<th>CMV &amp; Non-Motorist</th>
<th>2 Unit Fatal</th>
<th>3 Units</th>
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<td>57</td>
<td>97</td>
<td>91</td>
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<td>3.4</td>
<td>3.25</td>
<td>2.7</td>
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|                | 10     | 19      | 20                 | 23          | 27      |
| Screens        | 13.6   | 14.3    | 16.95              | 13.3        | 14.6    |

*Model Minimum Uniform Crash Criteria
Phase 2: Design & Usability Testing

Conducted 4 major rounds of usability testing

- **Participants:**
  - 41 law enforcement officers
    - Reached officers in far reaching **rural areas** of the state
    - (varied age, rank, and experience)
    - 23 agencies

- **Measurements:**
  a) Subjective usability & mental workload
  b) Duration
  c) Overall preference

- **Results:** Preference averaged to a 50/50 split
  - Both interfaces were recommended for use
  - No significant differences in user experience
    - Form slightly better under complex scenarios

- **Shift of Responsibilities**
  - Nearly 1:1 ratio
  - System capable of auto-populating up to half of the data entry
    - Huge advancement in terms of user experience and data accuracy capabilities
Final Results and Implementation

- Researchers worked with the state vendor to put both interfaces into practice
  - Assisted with Quality control, Beta Testing, User Acceptance Testing
  - Vendor designed the Form interface to research specifications and attempted a “best of breed” with their existing wizard

- Where are we now?
  - The system went live Jan 1st, 2016
  - ~90,000 crashes have been logged in the new electronic reporting interface
  - Limited required training and positive feedback across agencies!
  - Rural officers no longer submitting paper crash reports: All electronic
  - Research-based Form Interface is most utilized and preferred by officers

- Vendor’s Wizard Interface disliked, underutilized, and being phased out

- What’s next?
  - Current project underway to measure accuracy and completeness of new crash data (2016 vs 2015)
  - Monitor reliability, validity and accuracy of crash reporting by comparing narrative statements to data coded into the report
Education and Workforce Development Activities


– The Works Museum is about hands-on engineering for kids. The Works Museum serves more than 78,000 kids, families, and educators annually, and inspires the next generation of innovators, engineers, and creative problem-solvers.

– Summer camp introducing transportation safety to American Indian students in grades 4-8 is held annually
This past year (Oct 1, 2015 – Sept 30, 2016),
- 26 faculty and research staff
- 23 undergrads, 42 grad students
from our 5 university partners
were involved in the program

For more information, see
http://www.roadwaysafety.umn.edu

Thank You!

Questions?

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