ROADWAY SAFETY INSTITUTE

Human-centered solutions to advance roadway safety

Human Centered Solutions to Advance Roadway Safety

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

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

REGION 5

Max Donath

April 6, 2017

CONSORTIUM MEMBERS

ILLINOIS
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

WESTERN MICHIGAN UNIVERSITY

The University of Akron

UNIVERSITY OF MINNESOTA
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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

Using Bluetooth Low Energy (BLE) Technology to Trigger In-Vehicle Messages at Work Zones

Chen-Fu Liao, Ph.D.

Department of Civil, Environmental, and Geo-Engineering

University of Minnesota

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

Work Zone DB

Middleware

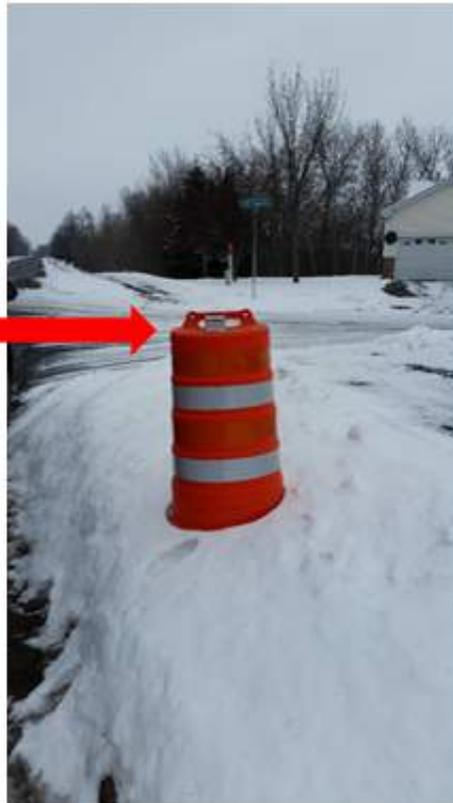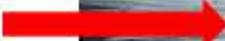**Wireless Network**

ROAD WORK AHEAD
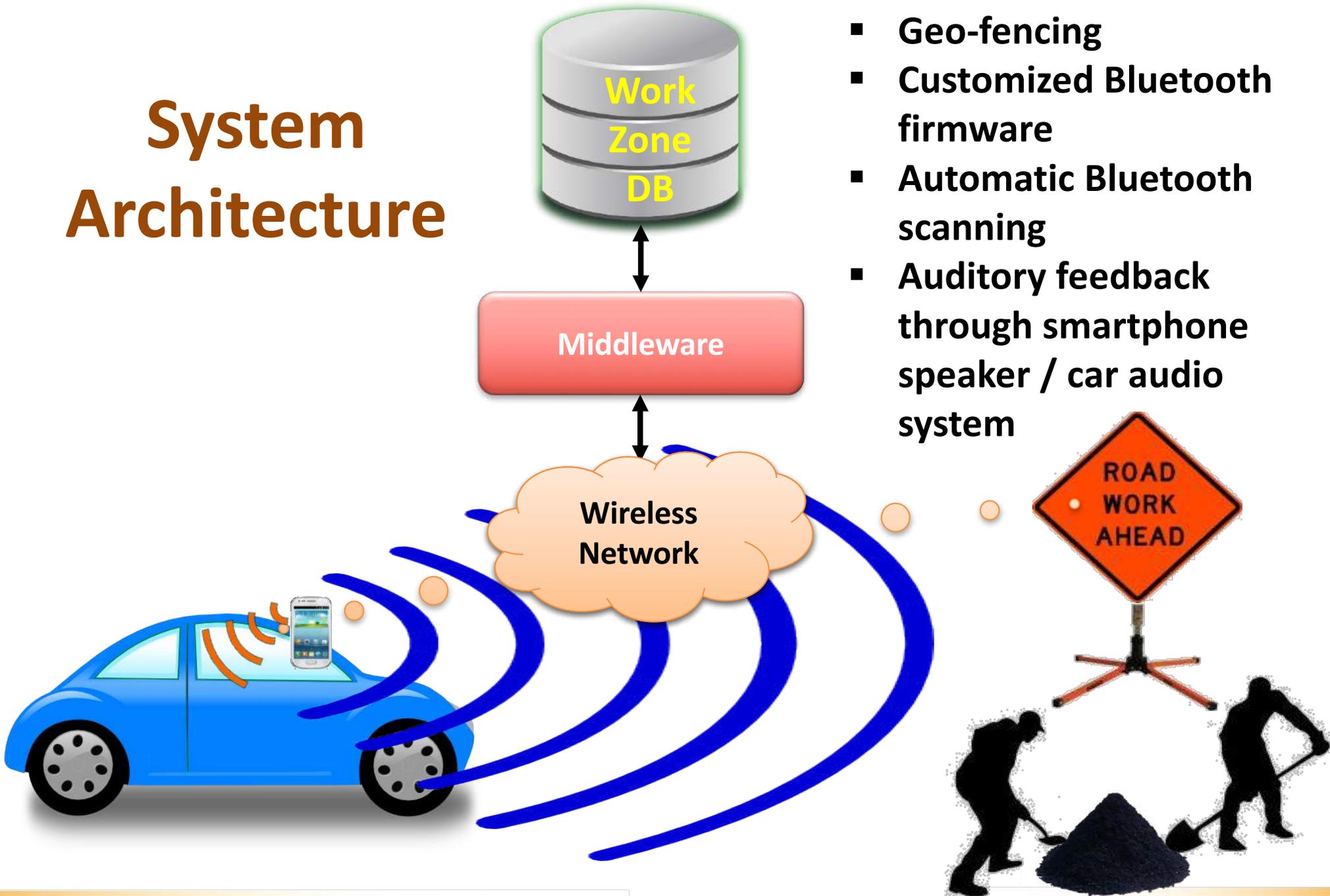
- Geo-fencing
- Customized Bluetooth firmware
- Automatic Bluetooth scanning
- Auditory feedback through smartphone speaker / car audio system

Experiment Setup

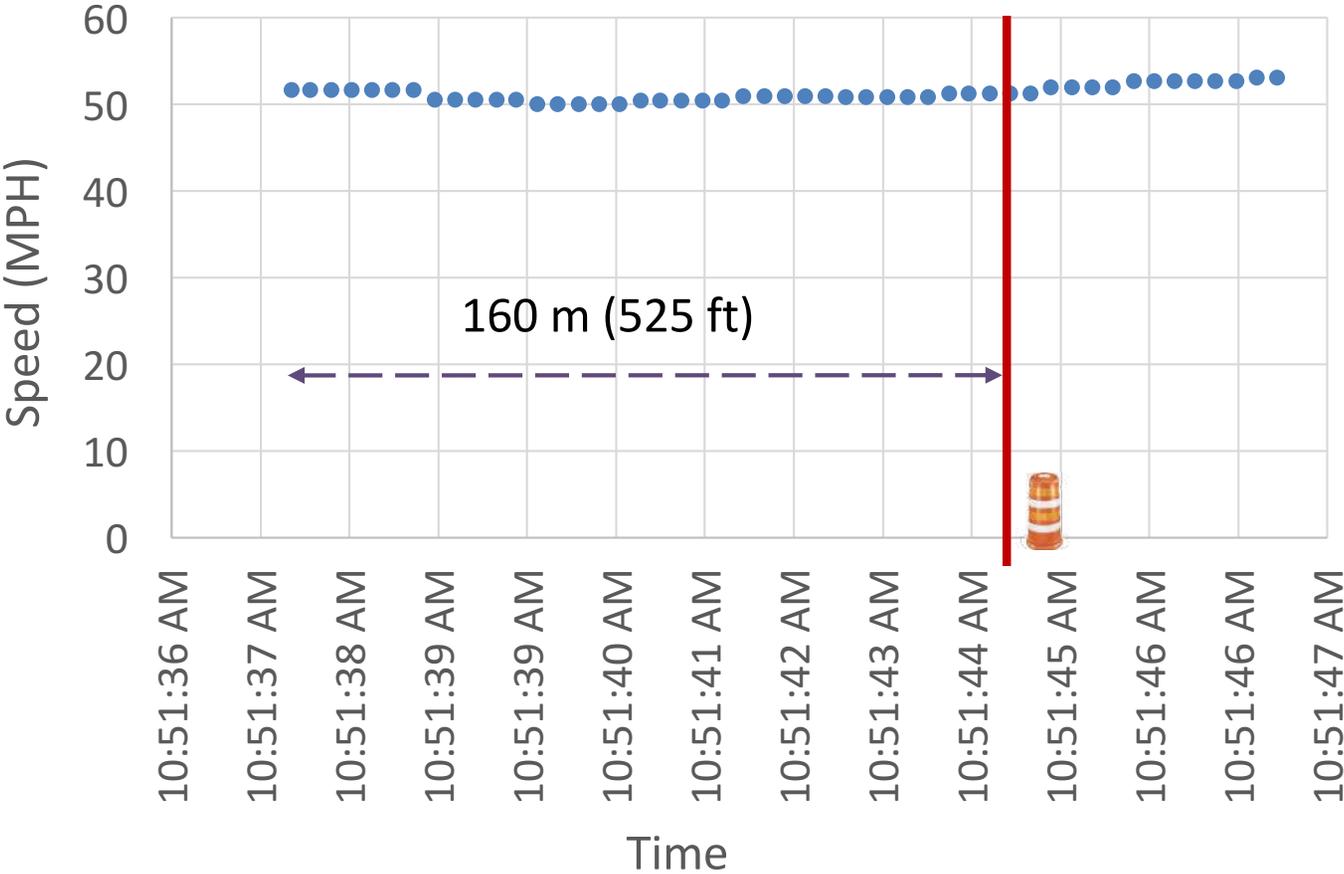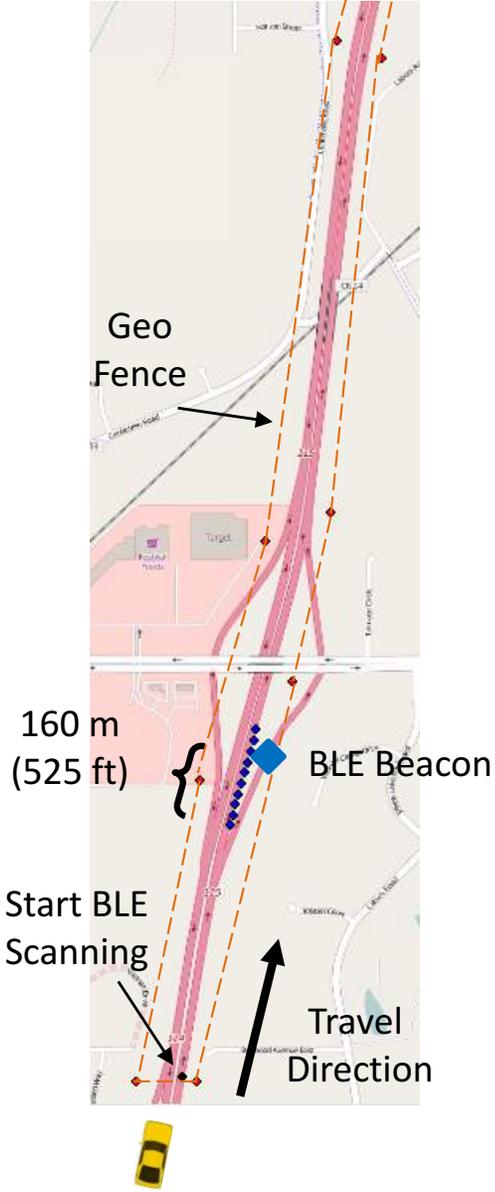## Work Zone Alert App

Bluetooth Module

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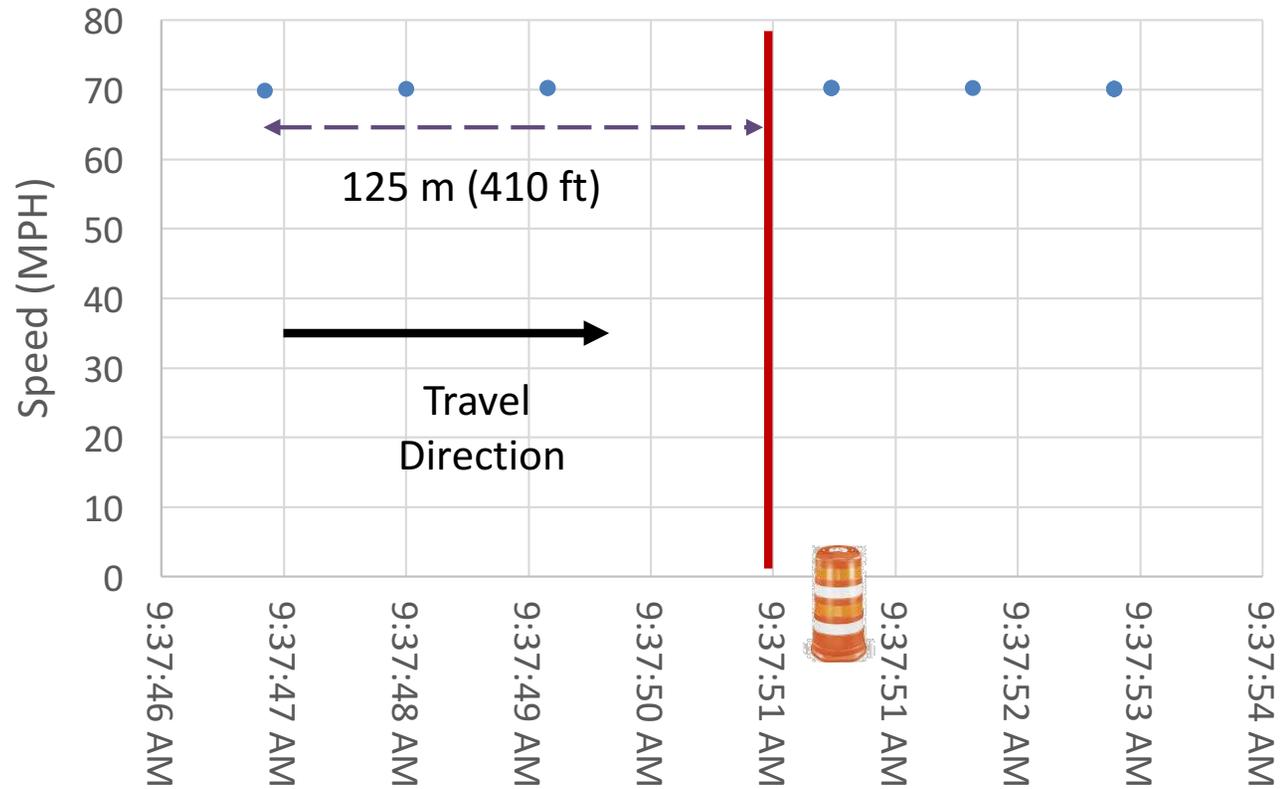

battery powered Bluetooth beacon
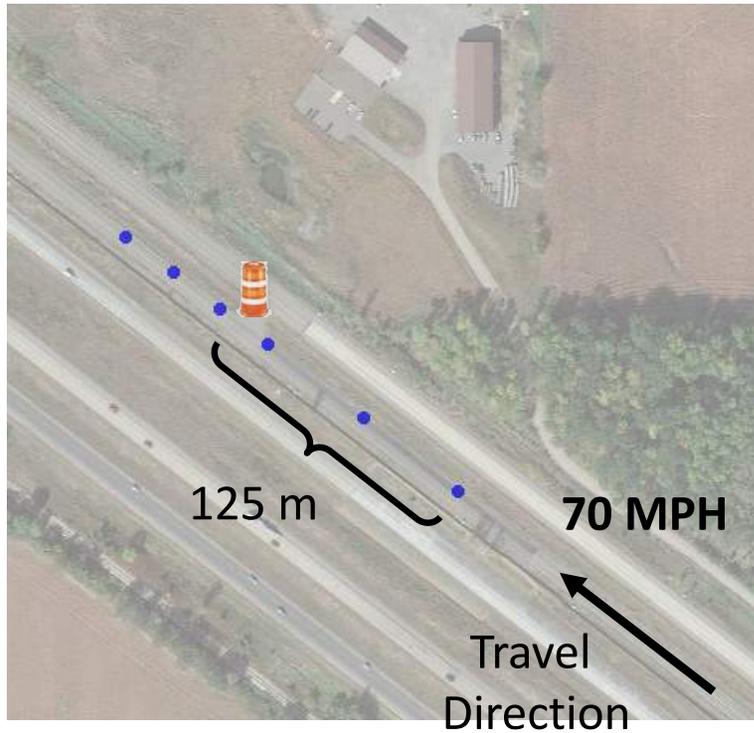
Work Zone at I-35E & County Rd. E East

MnROAD

WZ-002 @ 70 MPH

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.

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Computerized Crash Reports Usability and Design Investigation

Nichole L. Morris, Ph.D.

HumanFIRST Laboratory

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

Albany PD	Bloomington PD	Dakota Co. SD	Hopkins PD	Melrose PD	Owatonna PD	Rochester PD	St. Peter PD
Apple Valley PD	Blue Earth PD	Deephaven PD	La Crescent PD	Minneapolis PD	Park Rapids PD	Roseville PD	Stearns Co. SD
Austin PD	Brainerd PD	Douglas Co. SD	Lake Benton PD	MN State Patrol	Paynesville PD	Saint Peter PD	Truman PD
Avon PD	Burnsville PD	Duluth PD	Lake City PD	Montevideo PD	Polk Co. SD	Sartell PD	Wadena Co. SD
Baudette PD	Cannon Falls PD	Eagan PD	Lake Crystal PD	Moorhead PD	Princeton PD	Sauk Center PD	Waseca PD
Belle Plaine PD	Carlton Co. SD	East Grand Forks PD	Land of Lakes Co SD	Mower Co. SD.	Prior Lake PD	Sauk Rapids PD	Wayzata PD
Beltrami Co. SD	Chippewa Co SD	Eden Prairie PD	Le Center PD	New Prague PD	Red Lake Nation PD	So. Lake Minnetonka PD	West Hennepin PD
Bemidji PD	Clay Co. SD	Edina PD	Mahnomen Co. SD	Norman Co. SD	Rice PD	St. Cloud PD	West St. Paul
Benson PD	Coon Rapids PD	Farmington PD	Mankato PD	North Mankato PD	Richfield PD	St. Joseph PD	Willmar PD
Benton Co. SD	Cottage Grove PD	Fergus Falls PD	Marshall PD	Olmstead Co. SD	Robbinsdale PD	St. Paul PD	Zumbrota PD
	Crystal PD						

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

 

STATE OF MINNESOTA - DE

ACCIDE

(LAW ENFO

I apologize for being too stupid to print a state report.

LOCAL CASE NO.		DED ?				
HIT-AND-RUN ?	PUB PROP ?	VEHICLES #	LED #	INJURED #	$ MIN ?	IF RO.
ROUTE SYSTEM ON	ROUTE NUMBER OR STREET NAME					
COUNTY NO	☐ CITY ☐ TWP		INT ELEM	REFERENCE POINT + .		

UNIT 1

FACTOR 1	POSITION	DRIVER LICENSE NUMBER -1			STATE	CLASS	DL STATU	
FACTOR 2	NAME (FIRST, MIDDLE, LAST)					DATE OF BIRTH		
MNUVER	ADDRESS					DR VIOLTNS ?	RESTRIC	
PHYSCL	CITY, STATE, ZIP							
RCOMND	ADDRESS CORRECT ?	SEX	SAFE EQPT TYPE	SAFE EQPT USE	AIRBAG	EJECT	INJ SEV	
ALCHL TEST ?	TYPE	DRUG TEST ?	TYPE	TO HOSP ?	TRANSPORT ☐ AMB ☐ OTHER	AMBULANCE SERVICE	RUN NUMBER	

OCCUP #	OWNER NAME							FIRE ?
VEH TYP	ADDRESS							TOWED ?
VEH USE	CITY, STATE, ZIP						PULLING UNIT ?	DIRECT
DMG LOC	MAKE	MODEL		YEAR	COLOR			
DMG SEV	PLATE #	ST REG	YEAR REG	SEQUENCE OF EVENTS FIRST	SECOND	THIRD	FOURTH	MOST HARM EVEN
	INSURANCE			POLICY NUMBER				

CARGO BDY TYPE	HAZ MAT PLAC ?	WAIVED ?	INSPECTION #	INSP BADGE #	IF ACCIDENT INVOLVED / REMEMBER TO NOTIFY T

COMMERCIAL VEHICLE NUMBER 1 - MOTOR CARRIER NAME

DOT NUMBER

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
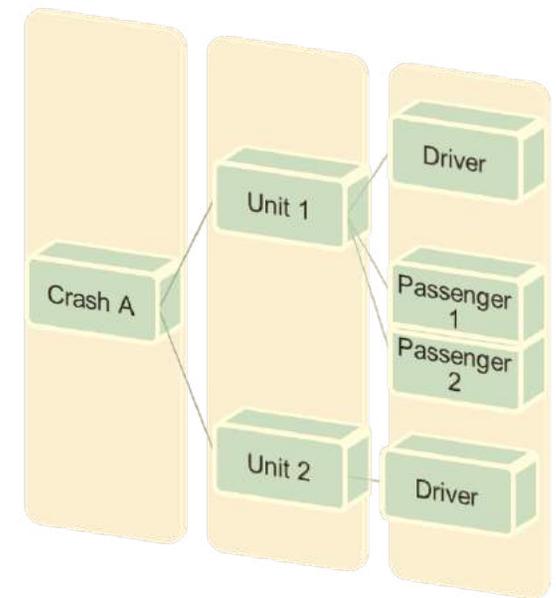
Wizard vs Form-Based Interface

- ## 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

  Any Passengers?

  If yes,   If no,

  Input details   End
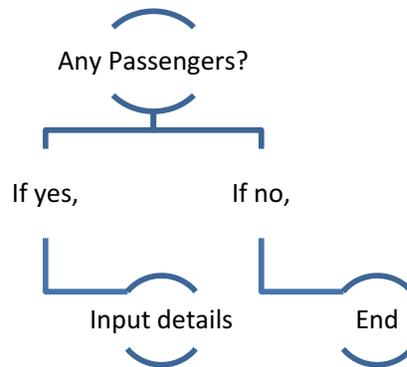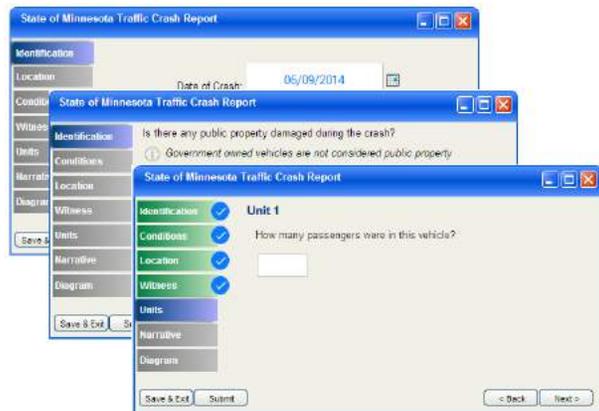
- ## Form

  - 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
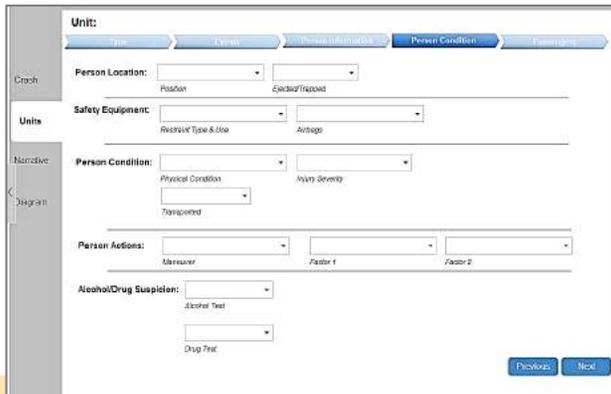   - Less detailed queries

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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

Wizard

Form

	1 Unit	2 Units	CMV & Non-Motorist	2 Unit Fatal	3 Units
Screens	37	57	97	91	120
Questions/ Screen	1.6	3.4	3.25	2.7	2.8
Screens	10	19	20	23	27
Questions/ Screen	13.6	14.3	16.95	13.3	14.6

*Model Minimum Uniform Crash Criteria

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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

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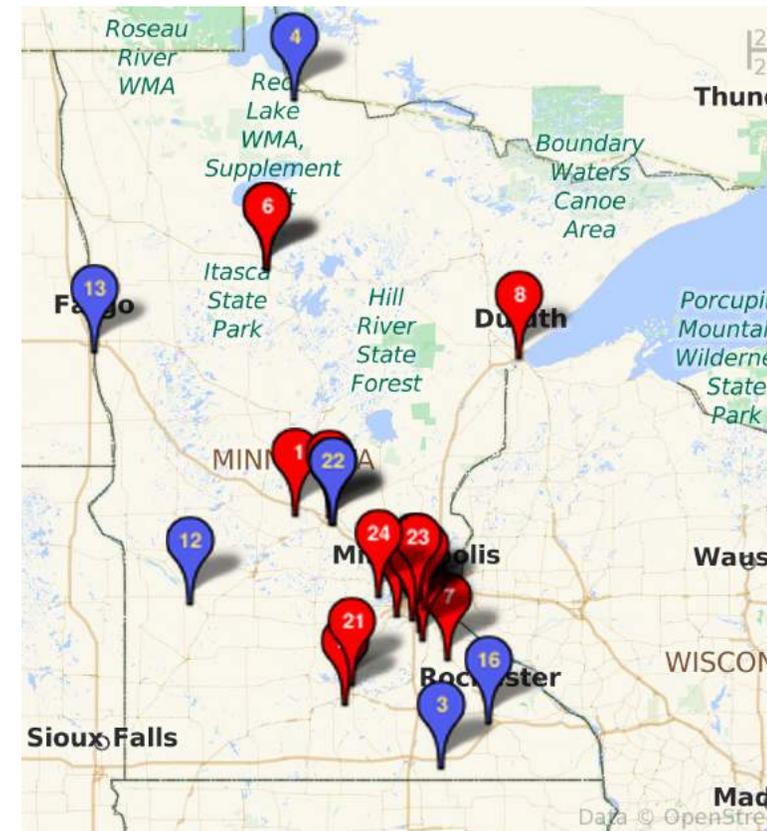
Final Results and Implementation

- Researchers worked with the state vendor to put both interfaces into practice
  - Assisted with Quality control, Beta Testing, User Acceptance Testing
  - Vendor designed the <u>Form interface to research specifications</u> 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

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Education and Workforce Development Activities

- Pedestrian safety exhibit for K-12 audience opened at The Works Museum on December 9, 2016. https://theworks.org

- 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

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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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