Computerized Crash Reports
Usability and Design Investigation

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Background

- Minnesota began collecting crash reports electronically in 2003
  - By 2014, 97% of crash reports were filed electronically
- Database structure was already 20 years old
- Very brittle and inflexible
- Older technology harder to maintain
  - Skill set harder to find
Call for Vendor

• Minnesota’s Traffic Records Coordinating Committee
  – Crash data highest priority
  – Leverage Federal Data Improvement funding
    • 408 and 405c
• Nichole Morris joined TRCC at just the right time
  – HumanFIRST would end up guiding the vendor in building MNCrash
Human Factors Overview

- Human factors psychologists study human capabilities and limitations
- Apply knowledge to systems and environments
  - Enhance human performance
  - Minimize error
  - Multidisciplinary approach
- Why do we need Human Factors?
  - Increased system complexity
  - Cost of redesign is extremely costly
I apologize for being too stupid to print a state report.
Project Objectives

• 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
Phase 1: Human Factors Analysis

• Assess existing crash report using HF principles to address human and system performance issues
  – Hierarchical Task Analysis
  – Cognitive Walkthrough Analyses
  – Interviews
  – Card Sorting Tasks
  – Survey
Hierarchical Task Analysis (HTA)

• HTA is a systematic process of examining tasks
  – Analysis of plans, goals, and sub-goals

0. Document Motor Vehicle Crash

1. Complete MN Crash Report

1.1 Enter officer information
  1.1.1 Enter the Local Case #
  1.1.2. Enter Officer Name
  1.1.3. Enter Rank
  1.1.4. Select agency Type
  1.1.5. Enter Badge #
  1.1.6. Enter State Patrol STA#

1.2. Locate Crash

Plan 0: 1-then, if death occurs within 30 days of crash--2

Plan 1: 1-2-3. Then 4 and/or 5 as appropriate

Plan 1.1: 1 to 5. Then, if state patrol-6

Plan 1.2: 1—2. Then, if crash occurred on a divided highway—3. Then, if state patrol—4; otherwise 5 or 6 as appropriate—then 7. Then 8—9.
HTA Results

- The HTA describes the tasks shared between the user and the system
  - There were up to 175 steps in total
  - Division of responsibilities between the user and the system was 151:24

- The goal of new crash report was to shift more responsibilities to the system
Phase 1: Human Factors Analysis

• Cognitive Walkthrough Analyses
  – Evaluate current user interface usability
  – Identify goals: are the actions correct?
  – Assess validity and reliability

• Interviews
  – Sampled 12 officers from 7 different agencies with 1-20+ years of experience
Validity & Reliability Issues

• Hit & Run or Parked Vehicles
  – Elements under-used, required for accurate entry of other required elements

• Sequence of Events
  – Unclear inclusion of Collision with “Motor Vehicle in Transport”
  – Non-collision events under utilized
Card Sorting

• Online card sorting software, OptimalSort
  – Feb. 28\textsuperscript{th}-Mar. 20\textsuperscript{th}, 2014
  – 167 officers participated
    • Varied experience level ($M=19.9$, $SD=10.9$)
  – 68 law enforcement agencies participated
    • 57 Police departments, 10 Sheriff’s departments, and Minnesota State Patrol
Best Merge Method

Graphical depiction of percent of agreement for item grouping based on actual agreement and best merge method algorithm.
Possible Report Structure

Graphical depiction of one possible organization of the items within the crash report. Organization is based upon card sorting analyses and cognitive walkthroughs.
HF Design Outcomes

• Users preferred a one-to-many structure and ordering
Phase 2: Design & Usability Testing

• Aim: Build a mock-up crash report based on the findings and recommendations of the HTA, card sorting, and cognitive walkthrough analysis

• Test law enforcement on mock report
  – Assess error rate, subjective usability and acceptance, and mental demand
  – Select best interface style
    • Wizard vs. Form
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
  – Interface is 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 containing more entry fields
  – Less detailed queries

Any Passengers?
  If yes, Input details
  If no, End

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Interface Design

- Created both Wizard and Form-Based Interfaces
  - Justinmind Prototyper Pro Software
  - Based on findings from users & New attributes from MMUCC
  - Largely matched by Functionality, Order, and Content

<table>
<thead>
<tr>
<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>Screens</td>
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<td>97</td>
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<td>14.3</td>
<td>16.95</td>
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Decision Aids

- Embedded hyperlinks and information bubbles
Decision Aids

State of Minnesota Traffic Crash Report

Unit 1:

1st Event  2nd Event  3rd Event  4th Event

What was the 1st event that happened to unit 1?

Lane Departure or Non-Collision
- Collision w/ Non-Fixed Object
- Collision w/ Fixed Object

Ran Off Roadway Right
- Ran Off Roadway Left
- Cross Median
- Cross Centerline
- Reentering Roadway
- Separation of Units
- Downhill Runaway
- Overturn/Rollover
- Fire/Explosion
- Immersion (Full or Partial)
- Jackknife
- Cargo/Equipment Loss or Shift
- Fell/Jumped From Motor Vehicle
- Thrown or Falling Object
- Other Non-Collision
Usability Testing

Conducted 4 major rounds of usability testing

• **Within-subject design**: order of interface presentation was counterbalanced across participants
  – Participants documented a pre-determined crash scenario
  – “Think aloud” method
  – Sessions (~1.5 hours) were recorded through screen video imaging and audio recording using Morae software

• **Participants**:
  – 41 law enforcement officers (varied age, rank, and experience)
    • 23 agencies

• **Measurements**:
  a) Subjective usability
  b) Subjective mental workload
  c) Duration
  d) Preference & overall impression

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Outcomes

• Preference
  – Users were largely split in preference between Wizard and Form-based interface
  – Both interfaces are recommended for use

• Usability, Mental Effort, and Duration
  – No significant differences between interfaces
  – Form slightly better under complex scenarios

• Iterative Design

• Shift of Responsibilities
  – Nearly 1:1 ratio!

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<td>Avg. Fields/Screen</td>
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<td>Required User Entry</td>
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<td>151</td>
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<td>Total Entry Fields</td>
<td>339</td>
<td>315</td>
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Kicking off Report Build

- The RFP for the system required the vendor to include results of the Human Factor analysis
  - By coupling with an experienced vendor, Minnesota was able to get a “best of breed”
  - Unaware of any other State with so many options for officers
  - Goal of high quality data by easing the burden of collection
Implementation

Minnesota DPS hired Appriss to build interfaces based on HumanFIRST designs – 3 data entry methods created:
• Quick Capture
• Wizard
• Form

2 platforms:
• Website
• Standalone platform

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Mapping Tool
Final Stretch!

• Collaborated with Appriss to ensure interface designs were fully implemented
  – Quality control, Beta Testing, User Acceptance Testing

• Continued usability testing to guide final modifications
  – 2 final rounds of testing of final report platforms
    • Quick Capture, Wizard, and Form
  – 18 law enforcement officers (9 agencies)
    • Recommended final design modifications to resolve any observed errors, confusion, or frustration
Go Live! – Where are we now?

• Just under 30,000 crashes have been logged in the new system
  – Positive feedback!
  – Some agencies are using the reporting tools
  – Fine-tuning and enhancements continue
What’s Next

• Continue to incorporate feedback
• Data back to agencies and training to use
• Public Portal for aggregated crash data inquiries
Acknowledgments

- Research Staff from HumanFIRST Laboratory
  - Jacob Achtemeier, B.S., Jennifer Cooper, B.A., Alice Ton, M.S.
- Minnesota Traffic Records Coordinating Committee
  - Kathleen Haney (MnDPS)
  - Brad Estochen & Katie Fleming (MnDOT)
- Minnesota Crash Data Users Group

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