LIGHT VEHICLE DRIVER ACCEPTANCE CLINICS

PRELIMINARY RESULTS

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NHTSA Research

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Objectives:

- Obtain feedback on connected vehicle technology and safety applications from a representative sample of drivers

- Assess the performance and reliability of 5.9 GHz DSRC communications and GPS in diverse geographic locations and environmental conditions…and

- Promote V2V-based safety technology and potential safety benefits
DAC PROJECT TEAM

CAMP
Vehicle Safety Communications 3

Mercedes-Benz
GM
TOYOTA
HONDA
Ford
NISSAN
Hyundai·Kia Motors
Volkswagen
DENSO
North America

Intelligent Transportation Systems

U.S. Department of Transportation

Federal Highway Administration

Research and Innovative Technology Administration
Volpe National Transportation Systems Center

Virginia Tech Transportation Institute

AUTOMOTIVE EVENTS
Michigan International Speedway
Brooklyn, MI    (Aug 2011)

Brainerd International Raceway
Brainerd, MN   (Sept 2011)

VT TI Smart Road
Blacksburg VA (Nov “11)

Texas Motor Speedway
Fort Worth TX (Dec ’11)

Walt Disney World Speedway
Orlando, FL    Oct 2011)

Alameda Naval Air Station
Alameda CA     (Jan 2012)
DAC VEHICLE RESOURCES

- 16 V2V equipped vehicles
  - 2 from each OEM
  - 8 for use by participants (host vehicles)
  - 8 for use by AE professional drivers during scenario execution (remote vehicles)
- 8 additional V2V equipped “template” vehicles
  - Available as spares for DAC if needed
  - Intended for performance testing (have additional instrumentation)
- DAC vehicles are 16 of the 64 integrated vehicles that will be deployed in Safety Pilot Model Deployment (Ann Arbor, MI)
DAC APPLICATIONS…

- EEBL: Emergency Electronic Brake Lights
- FCW: Forward Collision Warning
- BSW/LCW: Blind Spot Warning/Lane Change Warning
- LTA: Left Turn Assist
- IMA: Intersection Movement Assist
- DNPW*: Do Not Pass Warning
**SAFETY APPLICATIONS & SCENARIOS**

- **V2V Applications & Scenarios**
  - Run the following applications (# of scenarios)
    - EEBL (1); FCW (4); BSW/LCW (2); DNPW (2); IMA (2); LTA (1)

<table>
<thead>
<tr>
<th>Applications</th>
<th>Ford</th>
<th>GM</th>
<th>Honda</th>
<th>Mercedes</th>
<th>Toyota</th>
<th>Hyundai-Kia</th>
<th>Nissan</th>
<th>VW-Audi</th>
</tr>
</thead>
<tbody>
<tr>
<td>EEBL</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FCW</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>BSW / LCW</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X (BSW)</td>
</tr>
<tr>
<td>DNPW</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IMA</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>LTAP / OD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>
**Driver Vehicle Interface (DVI) Examples**

- OEM specific DVIs
  - Audible, visual and / or haptic
PARTICIPANT EXPERIENCE

- Arrival
- Registration
- Pre-drive questionnaire
- Briefing
- Orientation to vehicle and station
- Safety Feature Exposure
- Questionnaire (after each application)
- Post Drive Questionnaire
- Focus Group (if applicable)
SAFETY APPLICATION EXPOSURE

- 112 participants over a 4 day period
- Typically, 4 sessions per day at 8 participants each
- Participants are:
  - Equally split by gender
  - Equally split into three age categories (20-30, 40-50, 60-70)
- Participants experience each V2V safety feature
- After each exposure the experimenter asks a series of questions
  - Captures their immediate impressions
  - Safety Application Effectiveness
  - Relevance of Driver Vehicle Interface (DVI)
- Focus Groups
## Demographic and Application Exposure Breakdowns

### DAC - Overall

<table>
<thead>
<tr>
<th>Age</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>20-30</td>
<td>117</td>
<td>111</td>
<td>228</td>
</tr>
<tr>
<td>40-50</td>
<td>115</td>
<td>117</td>
<td>232</td>
</tr>
<tr>
<td>60-70</td>
<td>115</td>
<td>113</td>
<td>228</td>
</tr>
<tr>
<td>Total</td>
<td>347</td>
<td>341</td>
<td>688</td>
</tr>
</tbody>
</table>

### EEBL, FCW, BSW-LCW*, DNPW, IMA, LTA

<table>
<thead>
<tr>
<th>Make</th>
<th>EEBL</th>
<th>FCW</th>
<th>BSW-LCW*</th>
<th>DNPW</th>
<th>IMA</th>
<th>LTA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acura</td>
<td>91</td>
<td>88</td>
<td>85</td>
<td>85</td>
<td>91</td>
<td>---</td>
</tr>
<tr>
<td>Cadillac</td>
<td>88</td>
<td>87</td>
<td>86</td>
<td>86</td>
<td>88</td>
<td>---</td>
</tr>
<tr>
<td>Ford</td>
<td>85</td>
<td>85</td>
<td>85</td>
<td>84</td>
<td>85</td>
<td>---</td>
</tr>
<tr>
<td>Hyundai</td>
<td>---</td>
<td>172</td>
<td>87</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Infiniti</td>
<td>---</td>
<td>87</td>
<td>173</td>
<td>---</td>
<td>---</td>
<td>173</td>
</tr>
<tr>
<td>Mercedes</td>
<td>87</td>
<td>87</td>
<td>87</td>
<td>---</td>
<td>87</td>
<td>---</td>
</tr>
<tr>
<td>Toyota</td>
<td>172</td>
<td>---</td>
<td>85</td>
<td>---</td>
<td>172</td>
<td>---</td>
</tr>
<tr>
<td>VW-Audi</td>
<td>165</td>
<td>82</td>
<td>---</td>
<td>---</td>
<td>165</td>
<td>---</td>
</tr>
<tr>
<td>Total</td>
<td>688</td>
<td>688</td>
<td>688</td>
<td>255</td>
<td>688</td>
<td>173</td>
</tr>
<tr>
<td>% of Overall</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>37%</td>
<td>100%</td>
<td>25%</td>
</tr>
</tbody>
</table>

*LCW was not available on the Infiniti
A Single Example Showing The “Big-Picture”

DRIVERS TEND TO DESIRE V2V TECHNOLOGY
DESIRABILITY - ACROSS ALL FACTORS

I would like to have this Vehicle-to-Vehicle Communication safety feature on my personal vehicle.

- **Positive**: n = 504
- **Neutral**: n = 116
- **Negative**: n = 3, n = 2, n = 4, n = 7

**Percentage Response (%)**

1: Strongly Disagree  
2  
3: Neither Agree nor Disagree  
4: Strongly Agree
DESIRABILITY ACROSS ALL FACTORS AND PARSED BY AGE

I would like to have this Vehicle-to-Vehicle Communication safety feature on my personal vehicle.

- **60-70**: 91.6% Agree, n = 227
- **40-50**: 90% Agree, n = 230
- **20-30**: 90.3% Agree, n = 227

Percentage response (%)
A Few Examples Demonstrating

DRIVER ACCEPTANCE AS A FUNCTION OF SAFETY FEATURE
OVERALL IMPRESSIONS - USEFULNESS

How useful do you think a safety feature that alerted you to the presence of a (specific threat) would be in terms of improving driving safety in the real world?

<table>
<thead>
<tr>
<th>Safety Feature</th>
<th>Percentage Response (%)</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>LTA</td>
<td>83.8%</td>
<td>173</td>
</tr>
<tr>
<td>IMA</td>
<td>95.5%</td>
<td>685</td>
</tr>
<tr>
<td>FCW</td>
<td>90.5%</td>
<td>686</td>
</tr>
<tr>
<td>EEBL</td>
<td>91.4%</td>
<td>684</td>
</tr>
<tr>
<td>DNPW</td>
<td>88.6%</td>
<td>254</td>
</tr>
<tr>
<td>BSWLCW</td>
<td>90.9%</td>
<td>683</td>
</tr>
</tbody>
</table>

Legend: Positive, Neutral, Negative
I would like to have a safety feature that alerted me to the presence of a (specific threat) on my personal vehicle.

<table>
<thead>
<tr>
<th>Safety Feature</th>
<th>Percentage Response (%)</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>LTA</td>
<td>79.8%</td>
<td>173</td>
</tr>
<tr>
<td>IMA</td>
<td>93.9%</td>
<td>685</td>
</tr>
<tr>
<td>FCW</td>
<td>89.1%</td>
<td>682</td>
</tr>
<tr>
<td>EEBL</td>
<td>89.2%</td>
<td>685</td>
</tr>
<tr>
<td>DNPW</td>
<td>84.5%</td>
<td>252</td>
</tr>
<tr>
<td>BSWLCW</td>
<td>89.4%</td>
<td>682</td>
</tr>
</tbody>
</table>
OVERALL IMPRESSIONS - INTUITIVENESS

How effective was this particular safety feature at alerting you to the presence of a (specific threat)?

<table>
<thead>
<tr>
<th>Safety Feature</th>
<th>Percentage Response (%)</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>LTA</td>
<td>84.8%</td>
<td>171</td>
</tr>
<tr>
<td>IMA</td>
<td>92.8%</td>
<td>685</td>
</tr>
<tr>
<td>FCW</td>
<td>87.4%</td>
<td>683</td>
</tr>
<tr>
<td>EEBL</td>
<td>91.1%</td>
<td>684</td>
</tr>
<tr>
<td>DNPW</td>
<td>91.7%</td>
<td>253</td>
</tr>
<tr>
<td>BSWLCW</td>
<td>86.2%</td>
<td>679</td>
</tr>
</tbody>
</table>

U.S. Department of Transportation
An Example of

DRIVER’S ASSESSMENT OF SYSTEM LIMITATIONS
What percentage of vehicles would need to be similarly equipped before you believe the benefits would be noticeable? (select one)

Percentage of Respondents (%)

Cumulative Percentage of Participant Perception on Necessary Market Penetration

- 1%
- 2%
- 4%
- 9%
- 26%
- 35%
- 54%
- 80%
- 91%
- 100%

Percentage of Vehicles Similarly Equipped

10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
An Example Demonstrating Demographic Relationship to
SELF-REPORTED UNDERSTANDING OF V2V
OVERALL IMPRESSIONS

After experiencing these vehicle-to-vehicle safety features first hand, please tell us how well you think you understand this technology and how it works. (select only one)

Percentage Response (%)

- I don't understand it: n = 0
- I understand it, but still have some questions: n = 153
- I fully comprehend how this technology works: n = 530
OVERALL IMPRESSIONS

After experiencing these vehicle-to-vehicle safety features first hand, please tell us how well you think you understand this technology and how it works. (select only one)

- I fully comprehend how this technology works
- I understand it, but still have some questions
- I don’t understand it

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Percentage Response (%)</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>60-70</td>
<td>71.4%</td>
<td>227</td>
</tr>
<tr>
<td>40-50</td>
<td>78.3%</td>
<td>230</td>
</tr>
<tr>
<td>20-30</td>
<td>83.2%</td>
<td>226</td>
</tr>
</tbody>
</table>

U.S. Department of Transportation
A Willingness to Pay Example Indicating

DRIVER’S VALUE V2V
At what price level might you begin to feel this collective group of safety applications (Vehicle-to-Vehicle communications safety feature) is too expensive to consider purchasing? (select one)

- 1: More than $50
- 2: More than $100
- 3: More than $150
- 4: More than $200
- 5: More than $250

Percentage of Respondents (%)

- 4% (Raw Response)
- 5% (Cumulative Percentage)
- 11%
- 22%
- 58%
A Couple Examples Asking Drivers About

UNINTENDED CONSEQUENCES
Monitoring or interpreting information provided by these safety features is no more distracting than using my car's radio.

<table>
<thead>
<tr>
<th>Location</th>
<th>Percentage Response (%)</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alameda, CA</td>
<td>71.8%</td>
<td>117</td>
</tr>
<tr>
<td>Fort Worth, TX</td>
<td>76.5%</td>
<td>119</td>
</tr>
<tr>
<td>Blacksburg, VA</td>
<td>74.8%</td>
<td>119</td>
</tr>
<tr>
<td>Orlando, FL</td>
<td>76.5%</td>
<td>119</td>
</tr>
<tr>
<td>Brainerd, MN</td>
<td>76%</td>
<td>96</td>
</tr>
<tr>
<td>Brooklyn, MI</td>
<td>71.9%</td>
<td>114</td>
</tr>
</tbody>
</table>
IMPACT ON SAFETY – COMPLACENCY

Availability of these safety features would cause drivers to pay less attention to the driving environment.

60-70

47.6% n = 227

40-50

47% n = 230

20-30

32.3% n = 226

Percentage response (%)

Agree Neutral Disagree
Executive Summary

FOCUS GROUP
FOCUS GROUP OVERVIEW

- 12 focus groups were conducted

- Each group was comprised of eight participants (for a total of 96) who had just completed the driving portion of the study.

- Mix of gender and ages in each group, randomly assigned to participate in each focus group.

- Each participant per focus group had driven one of the eight OEM vehicles, and had experienced the majority of scenarios.

- The focus group moderator was Helen I. Thomas of Automotive Events.
INITIAL SUMMARY OF OVERALL REACTIONS

The illustration below demonstrates respondents’ most common reactions to this technology … that saving a life or many lives, far outweighs the potential drawbacks:

- **Drawbacks**
  - Dependency
  - Complacency
  - Over-Reliance

- **Benefits**
  - Saves Lives
  - Prevents or Mitigates Accidents
**Next Steps**

- Final data analysis underway at VTTI
  - Includes Thematic Content Analysis of Focus Group discussion and responses to open ended questions

- Comprehensive presentation of results during RITA ITS-JPO Safety Program Industry Workshop
  - Chicago - Sept 25-27

- Draft Final Report due from CAMP VSC3 in Sept 2012
  - Must be subjected to NHTSA review process prior to publication
  - Published report will be available on NHTSA and RITA ITS websites:
    - RITA ITS: [http://www.its.dot.gov/connected_vehicle/connected_vehicle.htm](http://www.its.dot.gov/connected_vehicle/connected_vehicle.htm)