Driver experience program

- Driver assistance and driving automation systems change the driving task and the driver’s role
- Level 2 driving automation requires the driver to remain engaged in the driving task
- How do drivers interact with technologies that assist with or automate parts of the driving task?

Vehicles

- 2016 Toyota Prius
- 2016 Infiniti QX60
- 2016 Honda Civic
- 2017 Audi Q7
- 2017 Audi A4
- 2016 Infiniti QX80
- 2016 Honda Civic
- 2016 Toyota Prius
Recorded information from over 60,000 miles and 2 years of daily driving

<table>
<thead>
<tr>
<th></th>
<th>phase 1</th>
<th>phase 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>March - July 2016</td>
<td>54</td>
<td>47</td>
</tr>
<tr>
<td>August 2016 - January 2017</td>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td>employee drivers</td>
<td>33,584</td>
<td>31,331</td>
</tr>
<tr>
<td>reported days of driving</td>
<td>354</td>
<td>423</td>
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</table>

First phase focused on driver interactions with various technologies

Post-use survey topics

- Participants indicated their level of agreement with various statements about:
  - Trust
    - e.g., system is dependable, suspicious of system, system is reliable
  - Ease of use
    - e.g., easy to use, functions well-integrated, learned to use quickly, confident in using
  - Comprehension of system displays and status
    - e.g., information located where expected, easy to understand setting or status
  - Reported likes, dislikes and unexpected system behavior

Side-view assist ranked first in trust

Average rating and 95% confidence interval by system

- [Diagram]
  - side-view assist (Honda, Audi, Infiniti)
  - forward collision warning
  - adaptive cruise control
  - lane departure warning
  - active lane keeping (Honda, Audi)

- [Graph]
  - strongly disagree
  - disagree
  - neutral
  - agree
  - strongly agree
Honda’s ACC system scored lowest in trust
Average rating and 95% confidence interval by vehicle

- Honda Civic
- Audi Q7
- Toyota Prius
- Infiniti QX60

Infiniti’s side-view assist was trusted the least
Average rating and 95% confidence interval by vehicle

- Audi Q7
- Honda Civic
- Infiniti QX60

Technologies had different problem areas
Percentage of drivers by complaint type

- Adaptive cruise control
- Active lane keeping
- Lane departure warning
- Forward collision warning
- Rear view camera

- Functionality and performance
- User interface
- Circumstance
- Noise
Technologies had different problem areas

Percentage of drivers by complaint type

- Active lane keeping lane departure warning
- Forward collision warning
- Side view assist

Drivers complained about Honda's ACC system performance

Percentage of driver comments about ACC by complaint type

- Honda Civic
- Infiniti QX60
- Toyota Prius
- Audi Q7

Technologies had different problem areas

Percentage of drivers by complaint type

- Functionality and performance
- User interface
- Circumstance
- None

Participants:

- Participant 302CV: “[ACC] approaches too close for comfort when cars in front slow down quickly.”
- Participant 121SA: “[ACC] didn’t decelerate fast enough for stopped traffic at the bottom of hills.”
- Participant 329SV: “You have to get in a wrestling match for control of the wheel on curves.”
- Participant 301SV: “I did not feel well notified by the system of when it was on and had been working, but no longer could identify the lines.”
- Participant 305SV: “On highways this worked well, but the constant pressure in one direction was fatiguing.”
Drivers complained about Honda’s ACC system performance

<table>
<thead>
<tr>
<th>Functionality and performance</th>
<th>User interface</th>
<th>Circumstance</th>
<th>None</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participant 101CA</td>
<td>“Lags and sudden acceleration/deceleration in more congested situations.”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Participant 116SA</td>
<td>“It also seemed to brake very abruptly and hard.”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Participant 326SV</td>
<td>“I did not gradually slow down, it would brake too hard when not necessary and then accelerate.”</td>
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</table>

Percentage of driver comments about ACC by complaint type

Drivers also complained about Audi’s ACC system performance

<table>
<thead>
<tr>
<th>Functionality and performance</th>
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<th>Circumstance</th>
<th>None</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participant 301CV</td>
<td>“The acceleration response when changing lanes to around a slower vehicle.”</td>
<td></td>
<td></td>
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<tr>
<td>Participant 327SV</td>
<td>“Integration with Nav system where vehicle would slow automatically for turns.”</td>
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<td></td>
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<tr>
<td>Participant 314SV</td>
<td>“The predictive function that adjusted for school zones, etc.”</td>
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<td></td>
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<tr>
<td>Participant 320SV</td>
<td>“Would lower speed for school zones that were not active.”</td>
<td></td>
<td></td>
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<tr>
<td>Participant 321SV</td>
<td>“It would reduce speed very quickly which made me very nervous of someone hitting me.”</td>
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</tbody>
</table>

Second phase focused on collecting information about using automation in specific situations
Overall, I felt this technology improved my driving experience
Percentage of drivers who agreed or strongly agreed, by technology

I feel comfortable using adaptive cruise control when traveling on…
Percentage of drivers who agreed or strongly agreed

I feel comfortable using active lane keeping when traveling on…
Percentage of drivers who agreed or strongly agreed
Manufacturer guidance for using adaptive cruise control in owner’s manual varies

- Free-flowing interstates
- arterials with intersections
- roads with hills
- stop-and-go traffic
- Local roads

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Recommended Use</th>
<th>Use Not Recommended</th>
<th>Stated Limitations Apply</th>
<th>No Guidance Provided</th>
</tr>
</thead>
<tbody>
<tr>
<td>Honda</td>
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<tr>
<td>Infiniti</td>
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<tr>
<td>Toyota</td>
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<tr>
<td>Audi</td>
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Manufacturer guidance for using active lane keeping in owner’s manual varies

- Free-flowing interstates
- arterials with gentle to moderate curves
- roads with moderate hills
- winding, curvy roads

<table>
<thead>
<tr>
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</tr>
<tr>
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</tbody>
</table>

Driving automation struggles in some situations
Drivers had mixed experiences with driver assistance technologies and automation.
- Expressed favorable opinions about some technologies more than others and for different reasons.
- Drivers may not be comfortable using current driving automation technologies in every situation, even when they are able.
  - Most comfortable using automation in low demand situations suggesting limited use and safety benefits.
  - Manufacturers often do not recommend use in demanding situations.
- Driving automation systems should limit use to the intended operational design domains and not rely on driver discretion.