Consumer Comfort with In-Vehicle Automation: Technology of Today Drives Acceptance of a Self-Driving Future

Chaiwoo Lee, Bobbie Seppelt, Hillary Abraham, Bryan Reimer, Craig Fitzgerald, Bruce Mehler & Joseph F. Coughlin

1. Introduction

Research on consumer interest in automated technologies have reported a recent decline in year-to-year ratings of trust and acceptance (Abraham et al., 2017; Westenberg et al., 2018). Drivers have expressed concerns over the security of on-board data, technology complexity, and outcomes for if and when automated vehicle technology performs contrary to expectation (Westenberg et al., 2018).

This is occurring at the same time that automated vehicle technology is widely forecast to transform how we live and move. Automated vehicle technology is often characterized as the means to alleviate conditions of distracted driving, impaired driving, and other common causes of crashes and adverse interactions with vulnerable road users that are prevalent today. The importance of this issue is highlighted in NHTSA’s (2015) estimate that 94% of crashes are attributable to driver error. However, even with the growing penetration of advanced driver assistance systems (ADAS), fatalities in the United States have shown a reversal of a gradual historical decline and been replaced by an increased number since 2015. While the reality of a highly automated transportation system that removes this source of error offers significant promise of increased safety, it is an open question how fast society will see the benefit from the advances such technology offers.

Several stakeholders have showcased, and are in the process of testing, new automation-based mobility platforms (e.g. robo-taxis, low speed automated shuttles, etc.). Traditional vehicle manufacturers have largely adopted a bottom-up (incremental) approach to automated driving
feature development – designing iteratively forward towards the creation of self-driving features, increasingly based upon the capabilities of ADAS technologies. Tesla recently announced it will augment its Autopilot feature with an ‘On-ramp to Off-ramp’ functionality, which builds on Autopilot’s speed adaptivity and lane centering capabilities to additionally provide decision-making for lane selection amid traffic, exit maneuvers off highway routes, and scheduled transitions back to manual control upon exit (https://electrek.co/2018/03/08/tesla-autopilot-update-on-off-ramp-curve-of-death/, March 2018). Since their introduction, Volvo and GM have released multiple dealer installed software updates to their automated technologies (Pilot Assist and SuperCruise, respectively) which have improved their post-production performance and robustness of these features.

In a 2016 survey of 556 people in the Austin area, the Texas A&M Transportation Institute (TTI) reported that consumers were in a wait-and-see position in terms of acceptance and use of self-driving vehicles. Lack of trust in the technology was reported as the primary reason for drivers being unlikely to use self-driving vehicles. Psycho-social variables such as technology adoption, privacy concerns, and perceptions of safety were more strongly associated with rated acceptance and intent to use than age or income. Previous use of advanced assistance features, such as adaptive cruise control, automated lane keeping, or automated parking systems, were shown to be significantly correlated with intent to use a self-driving vehicle (Zmud et al., 2016). More recently, in a 2018 survey of over 1500 owners of personal-use vehicles (model years 2013-2018) conducted by JD Power and Miller Canfield, ratings showed a year over year decline in trust in fully automated self-driving vehicles. The pattern of consumer responses was interpreted as suggesting an apparent disconnect between trust in “the lower levels of automation technology on the road today vs. the vehicle taking full driving control” (p. 30). ADAS systems represent evolutionary technology that is actively being iterated towards higher capability features. Perceptions and use of currently-deployed technology is anticipated to have a continued significant effect on perceptions of self-driving technology. The current study aims to extend upon these findings through a survey of consumer perceptions and opinions of self-driving technologies, and explores the impact of perspectives and use of lower-level ADAS technology.

In 2016 and 2017, the MIT AgeLab and New England Motor Press Association (NEMPA) conducted surveys exploring consumers’ perceptions and willingness to accept varying levels of automation (Abraham et al., 2017; Abraham et al., 2018). Both surveys found that many drivers are comfortable with the idea of driver assistance features, but far fewer are comfortable with fully self-driving vehicles. Comfort in self-driving vehicles was significantly lower in 2017 than 2016. There appeared to be age differences in comfort with self-driving vehicles that narrowed between the 2016 and 2017 surveys; while younger adults were significantly more likely than older adults to be comfortable with self-driving vehicles in both years, significantly fewer younger adults were comfortable with self-driving vehicles in 2017 than 2016. Survey respondents cited concerns centering around trust, such as disbelief that self-driving vehicles would be safe, reliable, and able to function on today’s complex roadways.
Since the 2017 survey was deployed, the public has been confronted with frequent headlines regarding self-driving vehicle successes, failures, and policy questions. As technology companies, ride share services, and traditional automotive OEMs race toward self-driving technology, policy makers are faced with debates around how to enable the development of (what many believe will become) a lifesaving technology, while simultaneously ensuring reasonable accountability for safety along the way. As a society, there remain open questions as to how safe is safe enough for self-driving cars to replace human drivers and of how the public will deal with the morality and acceptability of the likely inevitable cases of robotic failure that end in the loss of life.

Given the various advances and setbacks in automation over the past year, the survey was re-deployed to gain deeper insight into the following questions:

1. Has consumers’ acceptance of self-driving cars changed over the past year and two years?
2. Have age differences in acceptance of self-driving cars shifted over the past year and two years?
3. What factors are associated with acceptance of self-driving cars?
4. What is the role of current ADAS technologies in their influence on comfort with self-driving technology?

2. Methods

2.1 Participants

As in previous years, participants were recruited using online notices and web posts to the BestRide, MIT AgeLab, and New England University Transportation Center websites, and through an email to a large automotive manufacturer’s consumer panel. The survey was open between March 28th – April 27th, which was roughly the timespan and time of year of previous survey deployments. In total, 4116 individuals completed the survey. Criteria for inclusion in the analysis were kept identical to previous years; responses were excluded from this analysis if the respondent resided outside of the US, did not own a vehicle, reported owning a vehicle with a production year earlier than 1981, or if there was evidence the respondent did not read the questions (e.g. free response was unintelligible). Of the 4116 completed surveys, 611 were removed based on these criteria, leaving 3505 responses for analysis. Of these responses, 1843 (52.6%) came from the manufacturer consumer panel.

The age and gender distribution in the remaining sample is summarized in Figure 1 along with that of the previous two years. The 2018 sample was 54.8% male and 44.1% female; the remaining 1.1% of individuals selected an “other or choose not to answer” option. Similar to previous years, the new sample was weighted toward older adults. Participants aged 65 or older made up 39.4% of the sample, and participants aged 55 to 64 constituted 23.2%. Younger
generations made up smaller percentages: 2.9% aged 16 to 24, 9.9% aged 25 to 34, 11.4% aged 35 to 44, 13.1% aged 45 to 54). The sample was skewed toward individuals with high income and level of education. Participants with graduate or professional degrees made up 41.0% of the sample, while 10.6% had some graduate education and 26.5% had a bachelor’s degree. The remaining 21.9% of the sample were high school educated, in which the majority had additional college or trade school education (17.7%); 1% opted not to answer this question. Participants with total annual household income of $200,000 or more constituted 14.0% of the sample, while 11.4% reported having an annual income between $150,000 to $199,999 and 19.3% between $100,000 and $149,999. The remaining 55.1% of the sample included 36.6% who reported an annual income less than $100,000, and 18.6% who opted not to answer this question.

Figure 1. Sample characteristics across the three survey years

2.2 Survey procedure and instrument

Participants were told in online instructions that the survey would take less than 15 minutes and would involve answering questions related to their preferences and opinions regarding automated
driving technologies. Participants were offered the opportunity to enter a raffle for one of ten $50 Amazon gift cards if they completed the survey.

The survey instrument included questions asked in the previous surveys that focused on demographics, vehicle ownership, and comfort with automation as well as a number of additional questions that explored the nuanced perceptions of self-driving vehicle. The core questions asked in prior surveys were intended to explore shifts in attitudes toward various levels of automation and were asked in similar orders each of the three years in order to reduce likelihood that new questions influenced responses to these core questions. The final 2018 survey instrument contained 34 questions; however, some questions were not asked if a participant selected a response that would make subsequent questions irrelevant. For example, if a participant did not own a vehicle, they were not asked questions relating to technology in their current vehicle.

Participants were first asked whether or not they owned a vehicle, how long they had owned the vehicle, how many days per week they drove, and what their current commuting methods were. The survey continued with a maximum of 13 questions on perceptions of automation, two questions were intended to gauge the extent to which the respondent would be considered an early adopter, and seven questions were on current vehicle technology. Six additional questions were posed to collect the following demographic information: age (two variants of this question were included to validate response), gender, education, household income, and zip code. The full survey instruments for 2018, 2017, and 2016 are included in Appendices A, B, and C, respectively. The survey was constructed in Qualtrics and administered online.

3. Results

3.1 Automation preferences

Consumer preferences and level of comfort regarding various levels of automation were assessed using the question “What is the maximum level of automation you would be comfortable with?” For this question, participants were asked to choose from five options that differed in the degree of automation: 1) No automation; 2) features that are usually inactive, but activate only in certain events such as a collision (“Emergency Only”); 3) features that actively help the driver while the driver remains in control (“Driver Assist”); 4) features that relieve the driver of all control for periods of time (“Partial Self-Driving”); and 5) features that completely relieve the driver of all control for the entire drive (“Full Self-Driving”). As illustrated in Figure 2, the majority of participants reported they would be comfortable with automation levels in which the driver remains in control (“No Automation”: 5.8% + “Emergency Only”: 14.3% + “Driver Assist”: 51.2% = 71.3%), and a little less than a third of the sample indicated they would be comfortable with features that placed the vehicle in control (“Partial Self-Driving”: 11.8% + “Full Self-Driving”: 16.9% = 27.7%).
Figure 2. Consumer acceptance of vehicle automation over 3 years of surveys

This question was also asked in 2016 and 2017, and was used to identify any changes in consumer acceptance of vehicle automation. Results summarized in Figure 2 show that acceptance of full vehicle automation nominally increased in 2018, following a drop that was observed between 2016 and 2017. There was a continued drop in the percentage of individuals who indicated they would be comfortable with partial self-driving but not full self-driving. When combined, a slightly higher percentage of people said they would be comfortable with partial or full automation in 2018 (28.7%) as compared to 2017 (27.2%). Interestingly, however, there was also an increase in the percentage of people who preferred either “No Automation” or “Emergency Only” forms of automation in 2018 (5.8% + 14.3% = 20.1%) as compared to 2017 (2.2% + 11.2% = 13.2%). These results suggest an overall polarizing effect in reported acceptance of vehicle automation in the past year: consumers have either become accepting of more advanced forms of automation or have shifted in their preference towards less automation. This trend is supported with the concomitant lower percentage of people most comfortable with “Driver Assist” forms of automation (59.4% in 2017 compared to 51.2% in 2018).
It should be noted that the sample characteristics differ somewhat across the 3 years during which the data were collected. As shown earlier in Figure 1, the 2018 study sample included more younger adults than 2017, which was highly weighted toward older adults, but was generally older compared to the 2016 sample. All three study samples included more men than women. In order to account for possible effects of age and gender, comparison between data from 3 years has been repeated with the samples adjusted and balanced to the US Census age and gender distribution. The results from the adjusted samples, with consistent age and gender breakdowns for the 3 years, also revealed the same trend, further confirming a recovery in consumer acceptance of full vehicle automation in 2018 after a drop in 2017, along with a decline in comfort between 2017 and 2018 with “Driver Assist” forms of automation.

Table 1 summarizes how consumers of different ages answered the question on the maximum level of automation they are comfortable with across 3 years of data collection. In this table, darker shaded cells indicate higher frequencies, and lighter shaded cells indicate lower frequencies.

<table>
<thead>
<tr>
<th>What is the maximum level of automation you would be comfortable with?</th>
<th>16-24</th>
<th>25-34</th>
<th>35-44</th>
<th>45-54</th>
<th>55-64</th>
<th>65-74</th>
<th>75+</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Automation</td>
<td>12%</td>
<td>8%</td>
<td>10%</td>
<td>6%</td>
<td>5%</td>
<td>4%</td>
<td>3%</td>
</tr>
<tr>
<td>Emergency Only</td>
<td>18%</td>
<td>11%</td>
<td>16%</td>
<td>16%</td>
<td>15%</td>
<td>12%</td>
<td>17%</td>
</tr>
<tr>
<td>2016 Driver Assist</td>
<td>27%</td>
<td>25%</td>
<td>21%</td>
<td>41%</td>
<td>44%</td>
<td>56%</td>
<td>52%</td>
</tr>
<tr>
<td>Partial Self-Driving</td>
<td>16%</td>
<td>15%</td>
<td>19%</td>
<td>13%</td>
<td>17%</td>
<td>14%</td>
<td>15%</td>
</tr>
<tr>
<td>Full Self-Driving</td>
<td>26%</td>
<td>40%</td>
<td>34%</td>
<td>23%</td>
<td>19%</td>
<td>14%</td>
<td>13%</td>
</tr>
<tr>
<td>No Automation</td>
<td>0%</td>
<td>3%</td>
<td>4%</td>
<td>3%</td>
<td>2%</td>
<td>2%</td>
<td>1%</td>
</tr>
<tr>
<td>Emergency Only</td>
<td>24%</td>
<td>15%</td>
<td>11%</td>
<td>13%</td>
<td>10%</td>
<td>10%</td>
<td>10%</td>
</tr>
<tr>
<td>2017 Driver Assist</td>
<td>46%</td>
<td>43%</td>
<td>49%</td>
<td>55%</td>
<td>63%</td>
<td>65%</td>
<td>69%</td>
</tr>
<tr>
<td>Partial Self-Driving</td>
<td>16%</td>
<td>19%</td>
<td>15%</td>
<td>14%</td>
<td>13%</td>
<td>14%</td>
<td>11%</td>
</tr>
<tr>
<td>Full Self-Driving</td>
<td>14%</td>
<td>20%</td>
<td>21%</td>
<td>15%</td>
<td>12%</td>
<td>10%</td>
<td>10%</td>
</tr>
<tr>
<td>No Automation</td>
<td>8%</td>
<td>7%</td>
<td>5%</td>
<td>8%</td>
<td>6%</td>
<td>5%</td>
<td>5%</td>
</tr>
<tr>
<td>Emergency Only</td>
<td>16%</td>
<td>12%</td>
<td>14%</td>
<td>18%</td>
<td>14%</td>
<td>13%</td>
<td>17%</td>
</tr>
<tr>
<td>2018 Driver Assist</td>
<td>45%</td>
<td>36%</td>
<td>42%</td>
<td>43%</td>
<td>54%</td>
<td>59%</td>
<td>61%</td>
</tr>
<tr>
<td>Partial Self-Driving</td>
<td>12%</td>
<td>12%</td>
<td>10%</td>
<td>13%</td>
<td>11%</td>
<td>12%</td>
<td>11%</td>
</tr>
<tr>
<td>Full Self-Driving</td>
<td>19%</td>
<td>33%</td>
<td>29%</td>
<td>18%</td>
<td>14%</td>
<td>11%</td>
<td>7%</td>
</tr>
</tbody>
</table>

In 2018, more people chose full self-driving as the maximum level of automation they are comfortable with compared to 2017. This finding was consistent in all age groups except for the oldest group (75+). However, even after the moderation in the past year, acceptance of full automation fell short compared to 2016 in all age groups. Younger participants between 25 and 44 were most likely to accept full self-driving vehicles, while older adults indicated they would
be comfortable with features that assist the driver, but not with the vehicle taking control of driving. As compared to 2017, across all age groups, there was an overall drop in comfort with driver assist technologies in 2018; yet, as compared to 2016, there was a higher level of comfort. Distributions in this maximum level of preferred automation from 2016 to 2018 seemingly redistributed from an overall increase in comfort in the middle-range forms of automation (Driver Assist) in 2017 back to either end of the automation spectrum in 2018, with an increase across all ages in the preference for “No Automation” and for “Full Self-Driving” (with the one exception of a decreased percentage for Full Self-Driving in the 75+ group).

3.2 Factors contributing to acceptance of vehicle automation

Previous surveys have found evidence that various demographic and socio-economic characteristics – including age, gender, income and education – may be associated with acceptance of vehicle automation (Abraham et al., 2017; Lee et al., 2017). Also, past experiences with technology – both general and those specific to vehicle implementation – have been associated with how people feel about vehicle automation (Abraham et al., 2017; Lee et al., 2017).

The data from this study showed differences in comfort with vehicle automation across age groups, as summarized in Tables 1 and 2. Across all age groups, most people selected features that actively help the driver but for which the driver remains in control as the maximum level in which they are comfortable. Among older groups aged 55+, this option was chosen by the majority. Comparison of the average level further confirmed the age differences. On the scale from 1 (“No Automation”) to 5 (“Full Self-Driving”), the average level of automation participants were comfortable with was highest for younger adults aged 25-34 (3.52) and lowest for older adults 75 or older (2.98). The average scores were 3.18 for ages 16 to 24, 3.15 for ages 45 to 54, 3.14 for ages 55 to 64, and 3.12 for ages 65 to 74.

Differences were observed for other demographic groups as well. As shown in Table 2, men, those with at least a bachelor’s degree, and those in the highest income brackets were more likely to be comfortable with full vehicle automation. On the other hand, people whose highest level of education was high school or less and those in the lowest income bracket of less than $50,000 per year were most likely to indicate that they are not comfortable with any level of vehicle automation. Similar to Table 1, the shadings in Table 2 indicate response frequencies, where darker cells indicate higher frequencies.
Acceptance of vehicle automation was also found to be associated with a tendency to be either early or late adopters of technology. Two questions were asked to get an assessment of participants’ technology adoption behavior. In a behavior-based question that was adapted from Kennedy and Funk (2016), participants were asked to select any of the following that applied to them: 1) I usually try new products before others do; 2) I like being able to tell others about new brands and products I have tried; 3) I like the variety of trying new products; 4) I prefer my tried and trusted brands; 5) I feel more comfortable using familiar brands and products; and 6) I wait until I hear about others’ experiences before I try new products. An “early adopter index” was calculated based on the responses according to the scoring guideline in Kennedy and Funk (2016). In another question, participants were asked to rate themselves on a scale from 1 (avoid as long as possible) to 10 (try as soon as possible) in response to the question “in general, how would you rate yourself as being an avoider or an early adopter of new technology?” Positive correlations were found between these adoption behavior measures and the maximum level of automation participants were comfortable with, indicating that people who show behaviors descriptive of being an early adopter or who rate themselves as early adopters are more likely to be accepting of higher levels of vehicle automation. Kendall’s tau coefficients were calculated as .161 for the behavioral index and .241 for the self-assessment. Both correlations were significant at p=0.01.
Associations were also observed with current experiences with in-vehicle technologies. Overall, participants who had driver assistance technologies in their own car or another car they drive were, on average, more comfortable with higher levels of vehicle automation than those who did not have these technologies in their cars. The average scores, on the scale from 1 (“No Automation”) to 5 (“Full Self-Driving”), ranged from 3.31 to 3.43 for participants who currently had these technologies, which were significantly higher than average scores ranging from 3.13 to 3.18 for those that don’t have these technologies. Results are illustrated in Figure 3. These findings highlight the overall preference of consumers towards “Driver Assist” technology – current state of the art – regardless of their personal technology experience.

Figure 3. Comfort level with automation: associations with technologies in current vehicle

Regression analysis was carried out to examine the causal effects of associated demographic factors – age, gender, education and income – and behavioral factors – early adopter index, early adopter self-assessment and past/current experiences with in-vehicle technology – on acceptance of vehicle automation. Separate models were fitted for participants who have the five ADAS technologies covered in the survey – forward collision warning, lane departure warning, lane keeping assist, adaptive cruise control and active park assist. The results of the regression analysis are summarized in Table 3.
### TABLE 3  Regression results

<table>
<thead>
<tr>
<th>Dependent variable: What is the maximum level of automation you would be comfortable with?</th>
<th>Forward collision warning</th>
<th>Lane departure warning</th>
<th>Lane keeping assist</th>
<th>Adaptive cruise control</th>
<th>Active park assist</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>-0.129**</td>
<td>-0.103**</td>
<td>-0.077</td>
<td>-0.100**</td>
<td>-0.022</td>
</tr>
<tr>
<td>Gender¹</td>
<td>0.170*</td>
<td>0.155**</td>
<td>0.161**</td>
<td>0.094*</td>
<td>0.139</td>
</tr>
<tr>
<td>Education</td>
<td>0.120*</td>
<td>0.098</td>
<td>0.075</td>
<td>0.078*</td>
<td>0.071</td>
</tr>
<tr>
<td>Income</td>
<td>-0.003</td>
<td>-0.008</td>
<td>-0.011</td>
<td>0.058</td>
<td>-0.129</td>
</tr>
<tr>
<td>Early adopter index</td>
<td>0.045</td>
<td>0.076</td>
<td>0.055</td>
<td>-0.032</td>
<td>0.184</td>
</tr>
<tr>
<td>Early adopter self-assessment</td>
<td>0.265**</td>
<td>0.244**</td>
<td>0.221**</td>
<td>0.276**</td>
<td>0.289*</td>
</tr>
<tr>
<td>Frequency of using given technology²</td>
<td>-0.021</td>
<td>0.059</td>
<td>0.030</td>
<td>0.076</td>
<td>0.093</td>
</tr>
<tr>
<td>Feeling toward the given technology³</td>
<td>0.185**</td>
<td>0.112**</td>
<td>0.185**</td>
<td>0.185**</td>
<td>0.074</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Model summary</th>
<th>R²</th>
<th>F(df1, df2)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.190</td>
<td>19.608** (8, 667)</td>
</tr>
<tr>
<td></td>
<td>0.175</td>
<td>16.465** (8, 622)</td>
</tr>
<tr>
<td></td>
<td>0.176</td>
<td>11.349** (8, 424)</td>
</tr>
<tr>
<td></td>
<td>0.198</td>
<td>20.134** (8, 651)</td>
</tr>
<tr>
<td></td>
<td>0.300</td>
<td>4.277** (8, 80)</td>
</tr>
</tbody>
</table>

¹ Gender was coded 0 = female, 1 = male
² Response scale for frequency of use: 1 (never), 2 (rarely), 3 (sometimes), 4 (frequently), 5 (every time I drive)
³ Response scale for feeling toward technology: 1 (strongly dislike), 2 (dislike), 3 (neutral), 4 (like), 5 (strongly like)

*p < .05, **p < .01

Across all five regression models, for each analyzed with responses from participants who said that they have the given technology in their vehicle or another vehicle they drive, the early adopter self-assessment was a significant predictor. In other words, across users of the five given technologies in the sample, their self-ratings of being an early adopter positively contributed to comfort with higher levels of vehicle automation. The following factors were also significant for all models, except for active park assist: participant’s gender and feeling (i.e., like or dislike) toward the given technology. Among drivers of vehicles with forward collision warning, lane departure warning and adaptive cruise control, age and education were also significant predictors of comfort with vehicle automation.

The coefficients for different predictors suggest that people’s self-assessment of their adoption behavior is, among the factors included in the regression models, the most influential one. As this assessment concerns technologies in general, rather than those specific to the vehicle, it suggests that people’s attitudes and behaviors regarding technologies in different domains may easily transfer to another. It should also be noted that how one feels about an in-vehicle technology is a stronger and more significant predictor compared to how often one uses that technology. Across all five regression models, except for active park assist, having a more positive feeling toward an in-vehicle technology was associated with the driver being more accepting of higher levels of automation. This is in line with results from an earlier survey (Abraham et al., 2017), which found that higher satisfaction with technology integration in the current vehicle is associated with higher trust toward automakers and technology companies to produce a self-driving car.
3.3 Willingness to use a self-driving vehicle

In order to gain deeper insight into the factors associated with automation preference, in this most recent survey, participants were asked a series of three questions regarding their willingness to use a self-driving vehicle based on given circumstances. The first question simply asked “Would you be willing to use a self-driving vehicle?” Two following questions asked participants about their willingness to use a self-driving vehicle under conditions in which they were no longer able to drive, or if the self-driving vehicle was as safe a driver as them. Results are summarized in Figure 4.

![Figure 4. Willingness to use self-driving vehicle](image)

Only about 4 in 10 participants initially indicated that they would be willing to use a self-driving car, while the rest were divided between not willing (33.6%) and unsure (26.3%). On the other hand, when they were asked to consider a condition in which they were unable to drive, those willing to use a self-driving car made up the majority (58.4%), and the percentage of those not willing to use decreased (16.9%). Under the condition that a self-driving car would be as safe as they are, the percentage of participants willing to use increased even more (64.9%), and those still unwilling made up a small portion of the sample (13.5%). While consumers are seemingly uneasy about using a self-driving car, these results indicate that their willingness to use one may be dependent on their ability and/or access to drive manually, and that perceptions of relative safety may be a key factor in acceptance.

Participants who responded “no” or “not sure” to the question on willingness to use a self-driving car if it were as safe as themselves were asked to describe a level of safety at which point they would be willing to use one. This open-ended question was asked to understand consumer definitions of safety in the context of automated driving. Coding of the open responses showed that 11.1% of those asked this follow-up question said that such a level does not exist, indicating that they would not be willing to use a self-driving vehicle under any condition. Others gave descriptions of how safe a self-driving car would have to be for them: 1.6% said that
it would have to be perfect, 2.5% indicated that it would have to be safer than a human, 64.6% indicated that it would have to be as safe as them, 7.6% indicated that it would have to be proven reliable, and 8.21% were not sure, while the remaining 4.3% described other conditions.

3.4 Consumers’ knowledge of and exposure to automated driving

When asked if, to their awareness, self-driving cars are available for purchase today, less than half (48.5%) answered “no”, which correctly reflects the current state of the art, while over half of the sample (51.5%) either responded “yes” (22.7%) or were unsure (28.8%). This indicates that the broader public may have a limited knowledge of the current state of the technology, and also points to the possibility of consumers having inconsistent definitions of self-driving.

Participants were also asked if they or someone they know had ever driven or taken a ride in a vehicle they would describe as self-driving. The majority responded “no” (86.7%) or were not sure (5.1%). A small percentage of people who responded “yes” to this question (8.2%) were asked to provide more detail in an open-ended format. Coding of these open responses showed that, as depicted in Figure 5, for those who responded “yes”, the self-driving vehicle was most often a consumer-level vehicle. Tesla was referenced in 35% of these responses, while 49% mentioned some other consumer vehicle. Only 14% of these responses talked about an experimental or test vehicle, which represents the current state of the art for self-driving vehicles.

![Figure 5. Breakdown of the 8.2% of participants who responded "Yes" to having ridden in a self-driving vehicle.](image)

In order to examine how knowledge of related events may have affected consumer attitudes toward automated driving, participants were asked if anything happened in the past year that contributed to their feelings or attitudes toward automation and/or self-driving vehicles. Those that responded “yes”, which made up 55.7% of the sample, were asked to describe the event in an open-ended format. As shown in Figure 6, many participants referred to the fatal crash in March 2018 that involved Uber’s automated vehicle or another incident involving
automated vehicles. With a large portion of the responses citing the crash or another incident, most responses point towards negative effects on attitudes toward automation and/or self-driving. On the other hand, a smaller number of responses cited recent technology improvements, indicating some positive affect.

Figure 6. Recent events that contributed to participants’ attitudes toward automation

The vast majority of people who indicated something had happened to influence their feelings or attitudes toward automation and/or self-driving referenced something they had seen in the media, as shown in Figure 7. As the survey was conducted shortly after the Uber crash in Arizona, these responses were further analyzed to see how media reports were mentioned in the responses over the course of data collection. As illustrated in Figure 7, most of these responses explained that something they had seen in the media negatively contributed to their attitudes toward automation and/or self-driving vehicles, while only a small fraction described positive effects. Figure 7 also shows that, while the number of responses fluctuated over the course of data collection, the general trend was a decrease in the number of such responses as time passed after the crash. It is interesting to note that participants’ acceptance of full automation had increased in the past year, as shown earlier in Figure 2, despite many of the participants describing negative influences from recent events.
A further analysis of open responses across the survey period on the question of what events occurred in the past year that contributed to a person’s feelings on automation or self-driving vehicles shows, as seen in Figure 8, the extent to which media is influential in shaping people’s perceptions. Figure 8 plots the percentage of responses that specifically referenced the Uber crash moving across the survey period by day from its occurrence. Despite similar patterns, references to the Uber crash declined over time, while references to media reports in general remained relatively constant. In short, people report being highly influenced by media in their general attitudes towards automation. Single high-profile events like the Uber crash dominate people’s perceptions in the short-term, but are overridden by newer or more salient events over time.
Figure 8. In response to the question "Please explain what has happened in the past year that has or may have contributed to your feelings on automation or self-driving vehicles", the percentage of responses that mentioned Media or the Uber Crash over time, starting from when the crash occurred.

4. Conclusions

Automation preferences

Across age groups, from samples collected in 2017 and 2018, there has been an increase in the percentage of survey respondents who were comfortable with Full Self-Driving automation, but a decrease in comfort with lower-level forms of automation. More people preferred no automation or features that activate only in certain events such as a collision ("Emergency Only") in this most recent survey as compared to respondents from 2017.

Overall, for 2018, of the five possible levels ranging from no automation to full self-driving, survey respondents indicated they were most comfortable with forms of automation in which they remained in control over those that placed the vehicle in control.

Factors contributing to acceptance of vehicle automation

In exploring factors that contribute to overall acceptance of vehicle automation, those of a younger age, with a high level of education and income, a high frequency of advanced driver assistance system (ADAS) use, positive affect for ADAS technology, and high self-rated technology adoption tendency were the primary indices of increased comfort. Of these factors, the most significant predictor of a person’s level of comfort with self-driving technologies was
how they rated themselves as being more of an early or late adopter of technology on a scale of 1 (“Avoid as long as possible”) to 10 (“Try as soon as possible”) (e.g., “Some people prefer to avoid new technologies for as long as possible while others like to try them out as soon as they become available. In general, how would you rate yourself as being an avoider or an early adopter of new technology?”). The second strongest predictor of comfort with vehicle automation was how comfortable drivers were with current on-road driver assistance features. These results underscore the importance of how manufacturers and suppliers are designing and deploying technologies in the impact consumers’ current-day assessments have on their future willingness to try new technology. Consumer acceptance must to some extent come first to provide the opportunity to reap its benefits.

**Willingness to use and perceptions of safety**

In how consumers are currently assessing self-driving features, results on their willingness to use these features and perceptions of safety indicate there is for many respondents an overall reluctance and distrust of higher-level technologies. Consumers are seeking assurance that self-driving features will be at least as safe as they are. Having this confidence of technology reliability increased willingness to use vehicle automation from less than half to almost a 2/3 majority (from 40.1% to 64.9%). These results suggest that consumers are hesitant about the performance of self-driving features. There are multiple factors contributing to this hesitancy: negative media reports, experience with current ADAS systems, and confusion over what and how current technologies differ from self-driving features.

**Consumers’ knowledge of and exposure to automated driving**

The media hype over self-driving technologies is clearly affecting our consumer psyche. Negative media reports linger in consumers’ minds for weeks, impacting both perceptions of their safety and understanding of what self-driving technology is. Over half of sampled consumers believe self-driving vehicles are currently available for purchase – this is not the case. This figure reflects a troubling consequence of over-hyped technology and the many promises that were made for a near self-driving future are as yet unrealized.

Overall, the survey findings indicate that present-day technologies are formative in how they are shaping consumer perceptions of more advanced technologies to come. Current ADAS systems represent evolutionary technology that is actively being iterated towards higher capability features. Frequently over-hyped and sometimes under-performing, current-day features are actively shaping consumer sentiments of self-driving ones. Education campaigns and responsible media reporting are needed to help calibrate (and temper) consumer expectations of a self-driving future.
5. Acknowledgments

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About the AgeLab

The Massachusetts Institute of Technology AgeLab conducts research in human behavior and technology to develop new ideas to improve the quality of life of older people. Based within MIT’s Center for Transportation & Logistics, the AgeLab has assembled a multidisciplinary team of researchers, as well as government and industry partners, to develop innovations that will invent how we will live, work and play tomorrow. For more information about AgeLab, visit agelab.mit.edu.
References


Kennedy, B. and Funk, C. 2016. 28% of Americans are 'strong' early adopters of technology. Available at http://www.pewresearch.org/fact-tank/2016/07/12/28-of-americans-are-strong-early-adopters-of-technology/


Appendix A: 2018 Survey Battery

The survey was constructed in Qualtrics, allowing it to be taken online via computer or mobile device.

Survey on Automated Driving Technologies

The following survey from the Massachusetts Institute of Technology AgeLab contains questions about your current vehicle, technology in your vehicle, automation preferences, driving alternatives, and demographics. The survey should take less than 15 minutes to complete. There are no anticipated risks to you for completing the survey. Filling out this survey is entirely voluntary. You are free to end the survey at any point if you would prefer not answering any of the questions.

If you complete the survey before Friday, April 27th you will have the option to enter a raffle to win one of ten $50 Amazon gift cards.

If you have any questions or concerns, please contact us at mit.agelab2@gmail.com.

Your current vehicle

1. Do you currently own a vehicle?
   - Yes
   - No
   *(if yes, answer 2-4. If no, skip to 5.)*

   For the following questions, please consider the vehicle you drive most frequently when answering.

2. What are the Make, Model, and Year of your vehicle?
   Make: __________________
   Model: __________________
   Year: __ __ __ __

3. How long have you owned the vehicle (in years)? Please round to the nearest whole number; for example, if you have owned your car for two and one-half years, enter “3.” ______

4. *(if yes)* About how many days per week do you drive your vehicle? Please round to the nearest whole number; for example, if you drive slightly more frequently than 5 days per week, you may enter “6.” ______

5. If you currently have a regular commute, for example, travelling from your home to work or school on a regular basis, how is most of your time spent during your commute?
   a. I do not have a regular commute
   b. Driving
c. Being driven by another individual I know (e.g. carpool)
d. A taxi, Uber, Lyft, or other ride-sharing service
e. Biking
f. Walking
g. Public transportation
h. Other (please explain) _______________

6. *(If have a commute)* Do you currently use any additional commuting methods aside from the one selected in the previous question? Please select all that apply.
   - [ ] I do not use any other commuting methods
   - [ ] Driving
   - [ ] Being driven by another individual I know (e.g. carpool)
   - [ ] A taxi, Uber, Lyft, or other ride-sharing service
   - [ ] Biking
   - [ ] Walking
   - [ ] Public transportation
   - [ ] Other (please explain) _______________

**Automation Preferences**

7. What is the maximum level of automation you would be comfortable with?
   - [ ] No automation
   - [ ] Features that are usually inactive, but activate only in certain events such as a collision
   - [ ] Features that actively help the driver while the driver remains in control
   - [ ] Features that relieve the driver of all control for periods of time
   - [ ] Features that completely relieve the driver of all control for the entire drive (e.g. fully autonomous or “self-driving” car)

8. Would you be willing to use a self-driving vehicle? Please feel free to elaborate if you wish.
   - [ ] Yes __________
   - [ ] No __________
   - [ ] I’m not sure __________

9. Would you be willing to use a self-driving vehicle if you were no longer able to drive; for example, due to age or injury? Please feel free to elaborate if you wish.
   - [ ] Yes __________
   - [ ] No __________
   - [ ] I’m not sure __________

10. Would you be willing to use a self-driving vehicle if it were as safe a driver as you?
    - [ ] Yes
    - [ ] No
    - [ ] I’m not sure
    - [ ] I don’t know how to drive

*(If No or I’m not sure, answer 11)*
11. Is there a level of safety at which point you would be willing to use a self-driving vehicle?

__________________________________________________________________
__________________________________________________________________

Randomize presentation of 12 & 13 questions

12. In which of the following contexts would you personally consider riding in a self-driving vehicle if the vehicle did allow you or someone else to take control of driving at any point? Please select all that apply.

- Privately owned
- Subscription car sharing (e.g. Zipcar)
- Private ride service (e.g. Taxi, Uber, or Lyft)
- Ride-sharing service (e.g. in place of Uber Pool or Lyft Line)
- Other (Please explain) _______________
- None of the above

13. In which of the following contexts would you personally consider riding in a self-driving vehicle if the vehicle did not allow you or someone else to take control of driving at any point? Please select all that apply.

- Privately owned
- Subscription car sharing (e.g. Zipcar)
- Private ride service (e.g. Taxi, Uber, or Lyft)
- Ride-sharing service (e.g. in place of Uber Pool or Lyft Line)
- Other (Please explain) _______________
- None of the above

14. Would you be comfortable sharing the road with, but not personally riding in, a self-driving vehicle (e.g. others are riding in a self-driving vehicle, while you are driving or riding in a vehicle operated by a human driver)? Please select all that apply.

- Yes, if a passenger could take control
- Yes, if a remote operator could take control
- Yes, if a passenger could not take control
- No

15. To your awareness, are self-driving vehicles available for purchase today?

a. Yes
b. No
c. I’m not sure

16. Have you, or has someone you know, ever driven or taken a ride in a vehicle you would describe as self-driving? If so, please explain.

- Yes
- No
- I’m not sure

(If Yes or I’m not sure, answer 17)
17. Please provide more details about the vehicle you would describe as self-driving; for example, the ride you or someone you know took, the car itself, or why you consider the vehicle self-driving.
___________________________________________________________________________
___________________________________________________________________________

18. Has anything happened in the past year that has contributed to your feelings or attitudes toward automation and/or self-driving vehicles? This may be a personal experience, an experience from somebody you know personally, an event you heard about in the news or online, or some other factor.
   ○ Yes
   ○ No
   ○ I’m not sure
(If Yes or I’m not sure, answer 19)

19. Please explain what has happened in the past year that has or may have contributed to your feelings on automation or self-driving vehicles:
___________________________________________________________________________
___________________________________________________________________________

Technology Preferences (randomize presentation of next 20 and 21)

20. Which of the following statements describes you well when it comes to technology? Please select all that apply. (randomize order of response options)
   ○ I usually try new products before others do
   ○ I prefer my tried and trusted brands
   ○ I like being able to tell others about new brands and products I have tried
   ○ I like the variety of trying new products
   ○ I feel more comfortable using familiar brands and products
   ○ I wait until I hear about others’ experiences before I try new products

21. Some people prefer to avoid new technologies for as long as possible while others like to try them out as soon as they become available. In general, how would you rate yourself as being an avoider or an early adopter of new technology?

   1  2  3  4  5  6  7  8  9  10
   Avoid as long as possible                              Try as soon as possible

Technology in your current vehicle (if respondent owns vehicle)

22. Which of the following technologies are in your current vehicle or another vehicle you drive? If you are unsure of any of the technologies, you may click on it for an explanation. Please note, clicking will open a new tab and take you to third-party websites. (Links not included in this copy)

   In my vehicle     In another vehicle in my household      I do not have or use a vehicle          I’m not sure
23. How frequently do you use the technology in your car? *(Technologies only listed if selected in 22)*

<table>
<thead>
<tr>
<th>Technology</th>
<th>Never</th>
<th>Rarely</th>
<th>Sometimes</th>
<th>Frequently</th>
<th>Every time I drive</th>
<th>I’m not sure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Push button start</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>A built-in GPS or navigation system</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Apple CarPlay or Android Auto</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Cruise Control</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Adaptive Cruise Control</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Automatic Parallel Parking</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
</tbody>
</table>

*(If participant has GPS or CarPlay)*
24. In general, what do you use more frequently for navigation?  
   a. *(if GPS is selected)* In-vehicle GPS  
   b. *(if CarPlay is selected)* Apple CarPlay or Android Auto  
   c. A smartphone  
   d. Other (please explain) ________  
   e. I do not use navigation systems  

25. How frequently does the technology in your car provide assistance or a notification?  
   *(Technologies only listed if selected in 22)*  

<table>
<thead>
<tr>
<th>Technology</th>
<th>Never</th>
<th>Rarely</th>
<th>Sometimes</th>
<th>Frequently</th>
<th>Every time I drive</th>
<th>I’m not sure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forward Collision Warning</td>
<td>O</td>
<td>0</td>
<td>0</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Lane Departure Warning</td>
<td>O</td>
<td>0</td>
<td>0</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Lane Keeping Assist</td>
<td>O</td>
<td>0</td>
<td>0</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
</tbody>
</table>

26. How do you feel about the technology in your car?  
   *(Technologies only listed if selected in 22)*  

<table>
<thead>
<tr>
<th>Technology</th>
<th>Strongly Dislike</th>
<th>Dislike</th>
<th>Neutral</th>
<th>Like</th>
<th>Strongly Like</th>
<th>I’m not sure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forward Collision Warning</td>
<td>O</td>
<td>0</td>
<td>0</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Lane Departure Warning</td>
<td>O</td>
<td>0</td>
<td>0</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Lane Keeping Assist</td>
<td>O</td>
<td>0</td>
<td>0</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Push button start</td>
<td>O</td>
<td>0</td>
<td>0</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>A built-in GPS or navigation system</td>
<td>O</td>
<td>0</td>
<td>0</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
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<td>O</td>
<td>0</td>
<td>0</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Cruise Control</td>
<td>O</td>
<td>0</td>
<td>0</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Adaptive Cruise Control</td>
<td>O</td>
<td>0</td>
<td>0</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Automatic Parallel Parking</td>
<td>O</td>
<td>0</td>
<td>0</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
</tbody>
</table>

27. Why do you “Strongly Like” these features:  
   *(List features for which “strongly like” was selected)*
28. Why do you “Strongly Dislike” these features: (List features for which “strongly dislike” was selected)


Demographics
The following questions are for general demographics purposes.
29. What is your current age? ______

30. What is your year of birth? ______

31. What gender do you identify with?
   - Male
   - Female
   - Other or prefer not to answer

32. Please describe the highest level of formal education you have completed:
   - Some high school
   - High school graduate
   - Some college
   - Associates degree or trade school certificate
   - Bachelor’s degree
   - Some graduate education
   - Completed graduate or professional degree (e.g. Masters, LCSW, JD, Ph.D., MD, etc.)
   - Other or prefer not to answer

33. What best describes your total annual household income?
   - Less than $25,000
   - $25,000 – $49,999
   - $50,000 – $74,999
   - $75,000 – $99,999
   - $100,000 – $149,999
   - $150,000 – $199,999
   - $200,000 to $299,999
   - $300,000 or more
   - I prefer not to answer

34. What is your zip code? If you would prefer not to answer, please enter "Prefer not to answer"
   ______
Appendix B: 2017 Survey Battery

The survey was constructed in Qualtrics, allowing it to be taken online via computer or mobile device.

Survey on Automated Driving Technologies

The following survey contains questions about your current vehicle, technology in your vehicle, automation preferences, driving alternatives, and demographics. The survey should take less than 15 minutes to complete. If you complete the survey before (date) you will have the option to enter a raffle to win one of six $25 Amazon gift cards.

Filling out this survey is entirely voluntary. You are free to end the survey at any point if you would prefer not answering any of the questions.

Your current vehicle

1. Do you currently own a vehicle?
   a. Yes
   b. No

For the following questions, please consider the vehicle you drive most frequently when answering.

2. How long have you owned the vehicle (in years)? ____

3. (if yes) About how many days per week do you drive your vehicle? ____

(If participant does not own a car, skip Q4-14 & 16)

4. How did you purchase or acquire your car?
   ( ) New
   ( ) Used, from a friend or family member
   ( ) Used, from a private seller
   ( ) Used, from a dealership
   ( ) Used from another source (please specify) __________
   ( ) Other ____________________

(If Q4 is Used from a dealership)

5. Is the brand of the vehicle you purchased the same as the brand of the dealership you visited? (e.g. purchased a used Ford vehicle from a Ford dealership)
   ( ) Yes
   ( ) No

Technology in your current vehicle
For the following questions, **technology** refers to in-vehicle systems including, but not limited to, GPS / navigation, Bluetooth, WiFi, Rear-View Cameras, Adaptive Cruise Control, Lane Centering or Lane Keeping Assist systems, auto-park features, and other similar systems.

6. Do you have any technology in your car?
   - [ ] Yes
   - [ ] No

*(If participant does not have technology in their car, skip Q7-14 & 16)*

7. Do you use the technology in the car you drive today?
   - [ ] I do not have any technology in my car
   - [ ] I do not use most of the features
   - [ ] I use about half of the features
   - [ ] I use most of the features
   - [ ] I use all of the features

8. How do you feel about the technology in the car you drive today?
   - [ ] I do not have any technology in my car
   - [ ] I'm very unhappy with the technology
   - [ ] I like some features
   - [ ] I have no opinion
   - [ ] I like most of the features
   - [ ] I'm very happy with the technology

9. Are you happy with how the technology is integrated with the design of your car today?
   - [ ] Very Unhappy
   - [ ] Neutral
   - [ ] Very Happy

   (Note: Responses rescaled from 1 to 11 for reporting purposes.)

*(If purchased new or used from a dealership)*

10. How much time did the salesperson or dealership staff spend with you explaining the technology in your car?
   - a. No time
   - b. Less than 30 minutes
   - c. 31-60 minutes
   - d. 61-90 minutes
   - e. Over 90 minutes

*(If new or used from a dealership)*

11. How much time would you have preferred the salesperson or dealership staff spend with you explaining the technology in your car?
a. No time  
b. Less than 30 minutes  
c. 31-60 minutes  
d. 61-90 minutes  
e. Over 90 minutes

(IF new or used from a dealership)

12. How would you rate your level of understanding in the technology in your car after the salesperson or dealership staff explained it to you?  
   a. I didn’t know most of the technology present in the vehicle  
   b. I was familiarized with most of the technology, but needed some help to use it  
   c. I was familiarized enough with most of the technology that I could try to figure it out without assistance  
   d. I understood most of the technology and could show others how to use it  
   e. I understood the concepts of most of the technology and how it works, and felt confident I would be able to use similar systems in another vehicle

(IF Q4 is not new or used from a dealership)

13. How would you rate your level of understanding in the technology in your car when you picked up the car for the first time?  
   a. I didn’t know most of the technology present in the vehicle  
   b. I was familiar with most of the technology, but needed some help to use it  
   c. I was familiar enough with most of the technology that I could try to figure it out without assistance  
   d. I understood most of the technology and could show others how to use it  
   e. I understood most of the concepts of the technology and how it works, and felt confident I would be able to use similar systems in another vehicle

(IF participant owns a car & has technology)

14. How did you learn to use the technology in the car you drive today? (Select all that apply.)  
   [  ] A friend or family member  
   [  ] Websites or on-line videos  
   [  ] Dealer while interacting with sales staff before purchase  
   [  ] Dealer during delivery  
   [  ] Vehicle manual  
   [  ] Other material provided by the manufacture  
   [  ] Trial and error  
   [  ] By luck  
   [  ] The car teaches me  
   [  ] Other (please specify)  
   [  ] I don’t know how to use the technology in my car
15. How would you prefer to learn about the technology in the car you drive today or the next vehicle you purchase? (Select all that apply)
   [ ] A friend or family member
   [ ] Websites or on-line videos
   [ ] Dealer while interacting with sales staff before purchase
   [ ] Dealer during delivery
   [ ] Vehicle manual
   [ ] Other material provided by the manufacture
   [ ] Trial and error
   [ ] By luck
   [ ] The car teaches me
   [ ] Other (please specify)
   [ ] I am not interested in purchasing a car with any technology

*(If participant owns a car & has technology)*

16. Where would you rate your level of understanding of the technology in your vehicle today?
   a. I don’t know most of the technology present in my vehicle
   b. I am familiar with most of the technology, but might need some help to use it
   c. I am familiar enough with most of the technology that I could try to figure it out without assistance
   d. I understand most of the technology and can show others how to use it
   e. I understand most of the concepts of the technology and how it works, and feel confident I would be able to use similar systems in another vehicle

**Automation Preferences**

17. What is the maximum level of automation you would be comfortable with?
   ( ) No automation
   ( ) Features that are usually inactive, but activate only in certain events such as a collision
   ( ) Features that actively help the driver while the driver remains in control
   ( ) Features that that relieve the driver of all control for periods of time
   ( ) Features that completely relieve the driver of all control for the entire drive (e.g. fully autonomous car)

18. Which of the following automotive features would you be comfortable using? Select all that apply.
   [ ] Features that reduce the potential or severity of a collision (e.g. automatic emergency braking, reverse collision mitigation)
   [ ] Features that help with speed control (e.g. adaptive cruise control)
   [ ] Features that help with steering (e.g. lane keeping assistance)
   [ ] Features that periodically take control of driving (e.g. highway automation, traffic-jam assist)

19. How much would you consider paying for a car that completely drives itself?
20. What factors are most relevant to your decision never to purchase a car that drives itself?

___________________________________________________________________________
___________________________________________________________________________
___________________________________________________

(if “I would never purchase”)

21. Which of the following would you consider to be mobility solutions as an occasional alternative to driving? (Select all that apply.)

[ ] Car Sharing (Zipcar, etc.)
[ ] Ridesharing App (Uber, Lyft, etc.)
[ ] Traditional ridesharing service (Taxi)
[ ] Rides from family or friends
[ ] Manual bike from a parking hub close to the city
[ ] Electric bike from a parking hub close to the city
[ ] Manual biking as the entire trip
[ ] Electric biking as the entire trip
[ ] Public Bus
[ ] Subway or train
[ ] Walking
[ ] Other _________________________
[ ] None of the above
22. Which of the following would you consider to be mobility solutions as a **permanent alternative to car ownership**, either on their own or combined? (Select all that apply.)
- [ ] Car Sharing (Zipcar, etc.)
- [ ] Ridesharing App (Uber, Lyft, etc.)
- [ ] Traditional ridesharing service (Taxi)
- [ ] Rides from family or friends
- [ ] Manual bike from a parking hub close to the city
- [ ] Electric bike from a parking hub close to the city
- [ ] Manual biking as the entire trip
- [ ] Electric biking as the entire trip
- [ ] Public Bus
- [ ] Subway or train
- [ ] Walking
- [ ] Other _________________________
- [ ] None of the above

23. Which of the following **have you used** in the past year as an alternative to driving? (Select all that apply.)
- [ ] Car Sharing (Zipcar, etc.)
- [ ] Ridesharing App (Uber, Lyft, etc.)
- [ ] Traditional ridesharing service (Taxi)
- [ ] Rides from family or friends
- [ ] Manual bike from a parking hub close to the city
- [ ] Electric bike from a parking hub close to the city
- [ ] Manual biking as the entire trip
- [ ] Electric biking as the entire trip
- [ ] Public Bus
- [ ] Subway or train
- [ ] Walking
- [ ] Other _________________________
- [ ] None of the above

**Demographics**

24. Which of the following most closely describes the community where you currently live?
   a. Downtown in a large city
   b. Neighborhood outside of a large city
   c. Mid-sized city
   d. Small city
   e. Rural area

25. What age range do you fit in?
   ( ) 16 to 24
   ( ) 25 to 34
   ( ) 35 to 44
26. What gender do you identify with?
   ( ) Male
   ( ) Female
   ( ) Other or prefer not to answer

27. What best describes your total household income?
   ( ) Less than $25,000
   ( ) $25,000 – $49,999
   ( ) $50,000 – $74,999
   ( ) $75,000 – $99,999
   ( ) $100,000 – $149,999
   ( ) $150,000 – $199,999
   ( ) $200,000 to $299,999
   ( ) $300,000 or more
   ( ) I don’t know or I prefer not to answer

28. What is your zip code? (For general demographic purposes; skip if preferred.)
   ________
Appendix C: 2016 Survey Battery

The survey was constructed in Qualtrics, allowing it to be taken online via computer or mobile device.

Survey on Automated Driving Technologies

Filling out this survey is entirely voluntary. You are free to end the survey at any point if you would prefer not answering any of the questions.

1. What is the Year, Make and Model of your current car? (manually enter Year, pull-down selection for Make and Model – included option for “Do not own a car”)

2. What is the maximum level of automation you would be comfortable with?
   ( ) No automation
   ( ) Features that are usually inactive, but active only in certain events such as a collision
   ( ) Features that actively help the driver while the driver remains in control
   ( ) Features that relieve the driver of all control for periods of time
   ( ) Features that completely relieve the driver of all control for the entire drive (e.g. fully autonomous car)

3. Which of the following automotive features would you be comfortable using? Select all that apply.
   [ ] Features that reduce the potential or severity of a collision (e.g. automatic emergency braking, reverse collision mitigation)
   [ ] Features that help with speed control (e.g. adaptive cruise control)
   [ ] Features that help with steering (e.g. lane keeping assistance)
   [ ] Features that periodically take control of driving (e.g. highway automation, traffic-jam assist)

4. In the future, should fully automated vehicles become available, which of the following options for primary control of the vehicle in the case of automation failure would be acceptable?
   ( ) An operator in the vehicle takes control (e.g., like today’s driver)
   ( ) A remote operator takes control of the vehicle (e.g., like a drone operator)
   ( ) The vehicle automatically pulls to the side of the road and awaits service

5. How would you rate your overall level of trust in a traditional automaker (e.g., Ford, Toyota, GM, etc.) to produce an autonomous car?
   -5 -4 -3 -2 -1 0 1 2 3 4 5
   Very Distrustful Neutral Very Trustful

6. How would you rate your overall level of trust in a Silicon Valley tech company (e.g., Apple, Google, etc.) to produce an autonomous car?
   -5 -4 -3 -2 -1 0 1 2 3 4 5
7. How much would you consider paying for a car that completely drives itself?
   ( ) $100,000 to $150,000 plus
   ( ) $75,000 to $99,999
   ( ) $50,000 to $74,999
   ( ) $25,000 to $49,999
   ( ) $24,999 and under

8. Which of the following would you consider to be mobility solutions as an occasional alternative to driving? (Select all that apply.)
   [ ] Car Sharing (Zipcar, etc.)
   [ ] Ridesharing (Uber, Lyft, etc.)
   [ ] Manual bike from a parking hub close to the city
   [ ] Electric bike from a parking hub close to the city
   [ ] Public Bus
   [ ] Subway or train
   [ ] Other _________________________
   [ ] None of the above

9. Which of the following would you consider to be mobility solutions as a permanent alternative to car ownership? (Select all that apply.)
   [ ] Car Sharing (Zipcar, etc.)
   [ ] Ridesharing (Uber, Lyft, etc.)
   [ ] Manual bike from a parking hub close to the city
   [ ] Electric bike from a parking hub close to the city
   [ ] Public Bus
   [ ] Subway or train
   [ ] Other _________________________
   [ ] None of the above

10. Which of the following have you used in the past year as an alternative to driving? (Select all that apply.)
    [ ] Car Sharing (Zipcar, etc.)
    [ ] Ridesharing (Uber, Lyft, etc.)
    [ ] Manual bike from a parking hub close to the city
    [ ] Electric bike from a parking hub close to the city
    [ ] Public Bus
    [ ] Subway or train
    [ ] Other _________________________
    [ ] None of the above

11. How do you feel about the technology in the car you drive today? (Select the closest answer.)
    ( ) I'm very unhappy with the technology
12. For your most recent car purchase, do you feel that the sales staff encouraged you to buy technology that was not needed?

( ) Yes
( ) No
( ) Don’t know or Unsure

13. How did you learn to use the technology in the car you drive today? (Select all that apply.)

[ ] A friend or family member
[ ] Websites or on-line videos
[ ] Dealer while interacting with sales staff
[ ] Dealer during delivery
[ ] Vehicle manual
[ ] Other material provided by the manufacture
[ ] Trial and error
[ ] By luck
[ ] Other (please specify)
[ ] I don’t know how to use the technology in my car

14. How would you prefer to learn about the technology in the car you drive today?

[ ] A friend or family member
[ ] Websites or on-line videos
[ ] Dealer while interacting with sales staff
[ ] Dealer during delivery
[ ] Vehicle manual
[ ] Other material provided by the manufacture
[ ] Trial and error
[ ] By luck
[ ] The car teaches me
[ ] Other (please specify)

15. Are you happy with how that technology is integrated with the design of your car today?

-5 -4 -3 -2 -1 0 1 2 3 4 5

Very unhappy
Neutral
Very happy

16. What age range do you fit in?

( ) 16 to 24
( ) 25 to 34
( ) 35 to 44
( ) 45 to 54
17. What gender do you identify with?
   ( ) Male
   ( ) Female
   ( ) Other or prefer not to answer

18. What is your zip code? (For general demographic purposes; skip if preferred.)
    ________