Consumer Interest in Automation: Preliminary Observations Exploring a Year's Change

Hillary Abraham, Bryan Reimer, Bobbie Seppelt, Craig Fitzgerald, Bruce Mehler & Joseph F. Coughlin[1]

1. Introduction

In 2016, the MIT AgeLab and New England Motor Press Association (NEMPA) conducted a survey exploring consumers' perceptions and willingness to accept varying levels of automation, as well as how they learned to use technology in their current vehicles (Abraham, et al., 2017). The survey found while approximately one third of the younger adult sample (under 45 years) were somewhat open to full automation, older drivers were more likely to only endorse being comfortable with systems that assist the driver and that do not require them to give up control.

Since the survey was deployed, numerous strides and setbacks have occurred on the path to highly automated vehicles. The first commercial delivery by driverless truck took place (Ohnsman, 2016), Tesla announced all of its vehicles would be produced with fully self-driving hardware (Tesla, 2016), GM announced Super Cruise and "hands-free highway driving" would be available on the 2018 Cadillac (General Motors, 2017), and the National Highway Traffic Safety Administration (NHTSA) announced a first attempt at developing national guidance as we move toward highly automated vehicles (NHTSA, 2016). Simultaneously, media reports of manufacturers overpromising capabilities of semi-automated driving features, driver misuse of their system, and of purported feature failure, were frequent (for examples, see Boudette, 2016; Lambert, 2016; Reilly, 2016). The year saw the first fatality related to a highly automated driving feature (Solomon, 2016), an accident related to self-driving vehicle

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[1] Abraham, Coughlin, Mehler, Reimer, Seppelt are with the MIT AgeLab & New England University Transportation Center. Craig Fitzgerald is an automotive writer, President of the New England Motor Press Association (NEMPA), and originally proposed the survey in conjunction with the May 2016 Annual NEMPA technology conference at MIT.

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testing (Overly, 2017), and the first official investigation of potential defects on an automated driving feature (NHTSA, 2017).

Given the various advances and setbacks in automation over the past year, the 2016 survey was re-deployed to gain deeper insight into the following questions:

1. Are consumers satisfied with technology that is already in their vehicle?
2. How are consumers learning about in-vehicle technologies? How would they prefer to learn?
3. Has the willingness to use automation changed over the past year?
4. Are older adults more or less willing to use autonomous vehicles?

2. Methods

2.1 Participants

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. Recruitment was targeted broadly in order to attract respondents nationwide. After 3 weeks, 3308 individuals had completed the survey. In order to compare results to the previous year's data, criteria for inclusion in this analysis was kept the same as last year; responses were excluded from this analysis if the respondent did not own a vehicle, reported owning a vehicle with a production year earlier than 1980, or if there was evidence the respondent did not read the questions (e.g. free response was unintelligible). Of the 3308 completed surveys, 332 were removed based on these criteria, leaving 2976 responses for analysis. A majority of the removed responses were from individuals who do not currently own vehicles.

The remaining sample had demographics similar to the sample collected in 2016, with some slight differences (Figure 1). The 2017 sample was 53% male and 46% female; the remaining 1% of individuals selected an "other or choose not to answer" option. As in last year's sample, the new sample was weighted toward older adults. Most participants (80%) owned a car with a production year later than 2011.
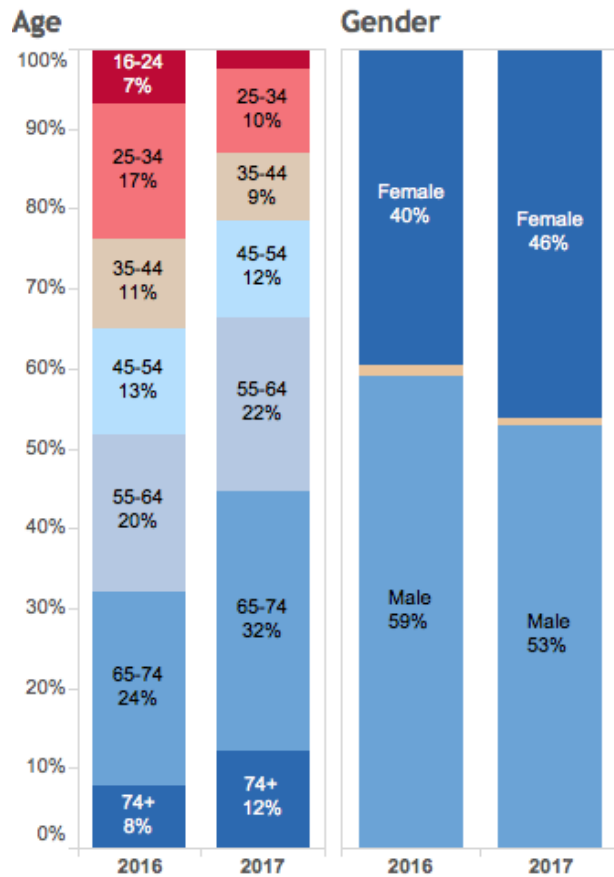
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Figure 1: Age and gender breakdown of 2017 sample compared to 2016

2.2 Survey procedure and instrument

Participants were told 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 six $25 Amazon gift cards if they completed the survey.

To support assessment of possible shifts in attitude, the survey instrument included 12 questions that were asked last year. The remaining instrument was slightly modified from the previous year, with some questions added and others removed in order to explore in more depth topics such as methods of learning to use in-vehicle technology. The resulting survey instrument consisted of a maximum of 28 fixed-response forced-choice questions focusing on automation preferences, technology in the respondent's current vehicle, and alternatives to driving. Questions were filtered if a participant selected a response that would make following questions irrelevant; for example, if a participant did not own a vehicle, they were not asked questions relating to technology in their current vehicle.

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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 how they had purchased their vehicle (e.g. new, used from a dealership, etc.). The survey continued with a maximum of 11 questions on in-vehicle technology, 4 questions on various levels of automation, and 4 questions on perceptions of alternatives to driving. Five additional questions were posed to collect the following demographic information: age, gender identity, household income, type of area they live in, and zip code. The full survey instrument is included in Appendix A. Questions that were asked in both 2016 and 2017 are underlined. The survey was constructed in Qualtrics, allowing participants to take it online via computer or mobile device.

3. Results

3.1 Technology in Current Vehicle

Participants were asked two questions about their feelings regarding the technology in their current vehicles: 1) to the question "how do you feel about the technology in the car you drive today," five response options were provided - very unhappy, like some of the features, no opinion, like most of the features, very happy - and 2), to the question "are you happy with how that technology is integrated with the design of your car today?" an 11-point scale ranging from very unhappy to very happy was provided.
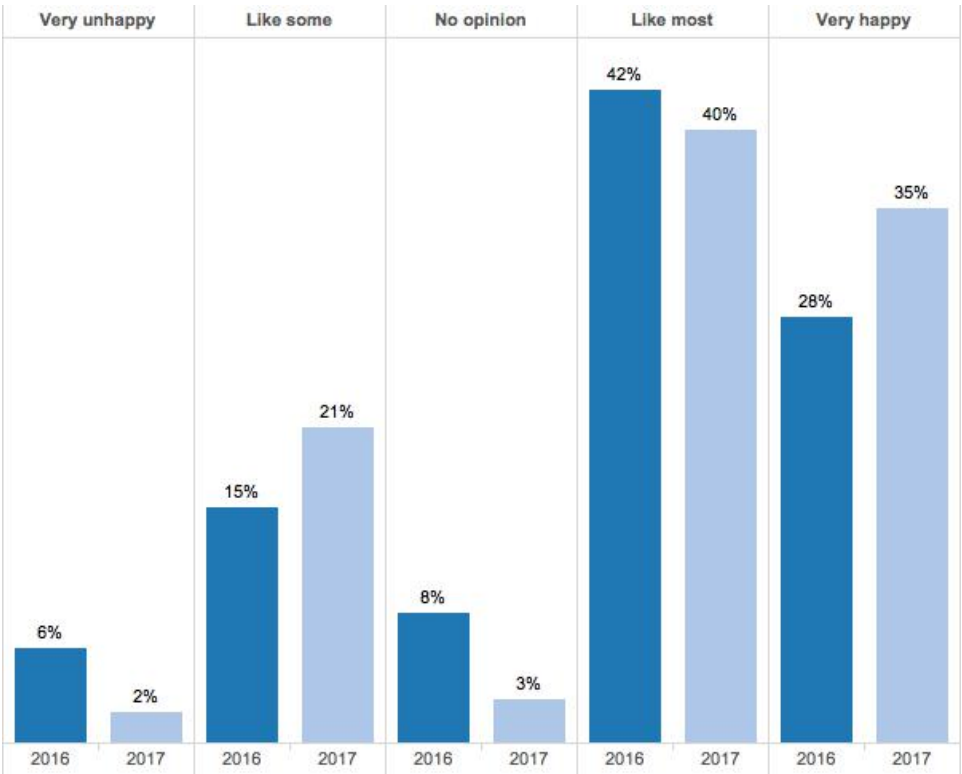

Figure 2: Satisfaction with technology in current vehicle

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As in last year's results, most individuals reported being generally pleased with the technology in the vehicle they drive (Figure 2). Over half reported positive associations with the technology: 35% of participants are very happy with the technology (up from 28% in 2016), and 40% like most of the features. Few participants indicated they are very unhappy with the technology, or have no opinion on it either way (2% and 3% respectively). Mean response for satisfaction with technology integration in their current vehicles was 8.9 (an increase from 8.08 in 2016), indicating most individuals are fairly happy with the integration.
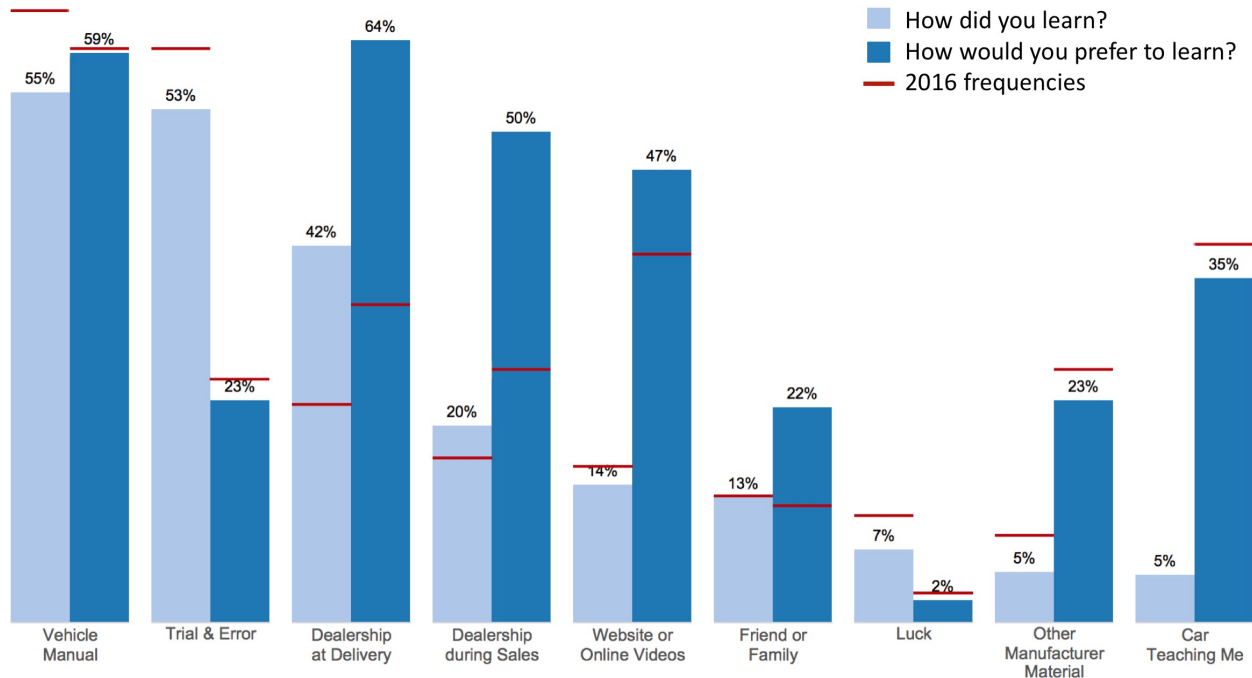

Figure 3: Current and preferred methods for learning to use in-vehicle technologies

Participants were also asked how they learned to use the technology in their vehicles and how they would prefer to learn to use the technology. Figure 3 summarizes the responses for both questions. Similar to last year, the vehicle manual (55%) and trial-and-error (53%) were the two most commonly used techniques. Just as in 2016, far fewer individuals (23%) selected trial-and-error as a preferred method of learning, indicating instead a preference for websites, dealer interactions, other supplied manufacturer material, or having the car teach them. The continued differential between experienced dealer support and preference for more support is particularly noteworthy, as is the substantial endorsement of interest in direct instruction from the vehicle.

3.2 Automation Preferences

Consumers' actual / anticipated comfort with using automation in vehicles was assessed with two questions, each also asked in 2016, corresponding with different

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dimensions of automation: 1) level or degree of automation - "what is the maximum level of automation you would be comfortable with?" - and 2) types or features of automation - "which of the following automotive features would you be comfortable using?". Compared to 2016, in 2017 there was a significant decrease in the proportion of respondents who were comfortable with the idea of a fully self-driving car (Figure 4) and an apparent shift toward more limited automation in the form of "features that actively help the driver while the driver remains in control." Similarly, there was a proportional decrease (Figure 5) in those who were comfortable with features that periodically take control of driving (right most column).
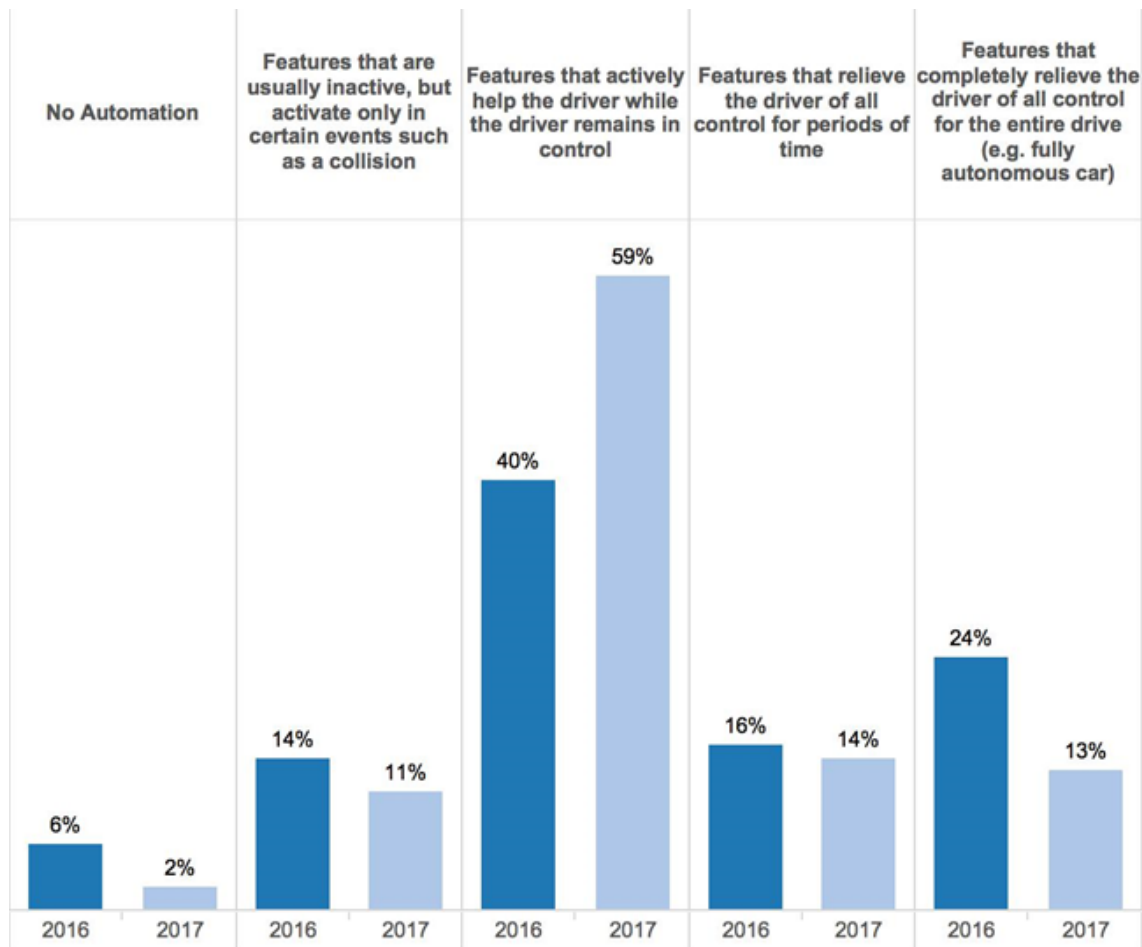

Figure 4: Maximum level of automation respondents would be comfortable with

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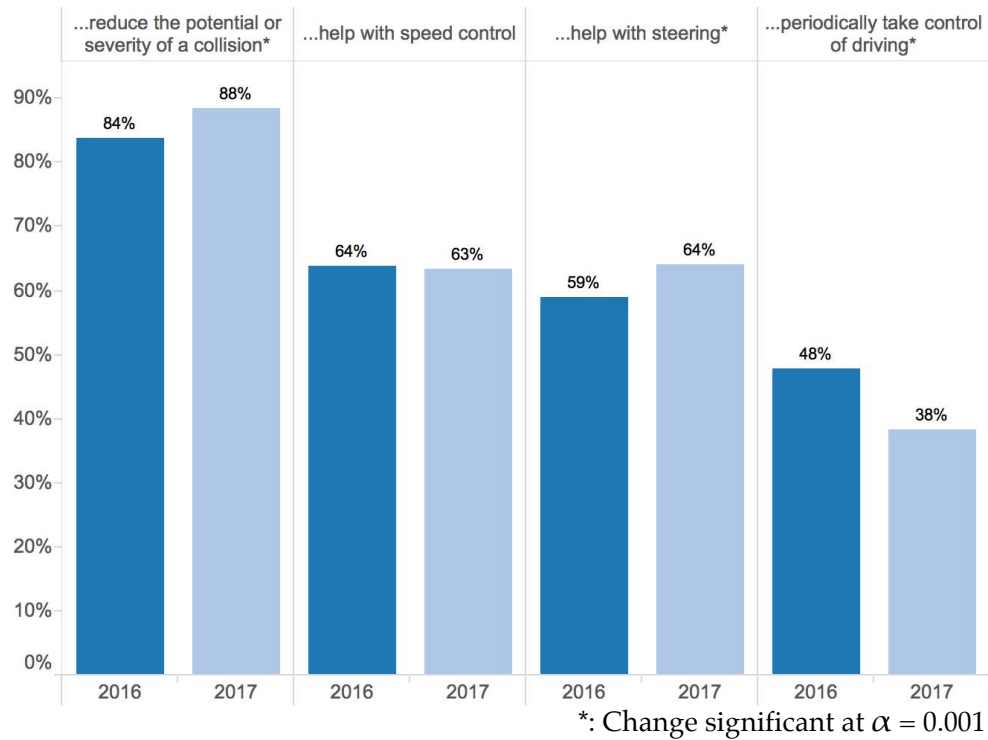*: Change significant at $\alpha = 0.001$

Figure 5: Types of automotive features respondents would be comfortable using

Table 3 summarizes how consumers of different ages answered the question on the maximum level of automation they are comfortable with, comparing 2016 and 2017. Darker cells indicate higher frequencies, and lighter cells indicate lower frequencies.

Table 3. Age differences in willingness to use automation in vehicles: maximum level of automation

		16-24	25-34	35-44	45-54	55-64	65-74	75+
2016	No Automation*	12%	8%	10%	6%	5%	4%	3%
	Emergency Only	18%	11%	16%	16%	15%	12%	17%
	Help Driver*	27%	25%	21%	41%	44%	56%	52%
	Partial Autonomy	16%	15%	19%	13%	17%	14%	15%
	Full Automation*	26%	40%	34%	23%	19%	14%	13%
2017	No Automation	0%	3%	4%	3%	2%	2%	1%
	Emergency Only*	24%	15%	11%	13%	10%	10%	10%
	Help Driver*	46%	43%	49%	55%	63%	64%	69%
	Partial Autonomy	16%	19%	15%	14%	13%	14%	10%
	Full Automation*	14%	20%	21%	15%	12%	10%	10%

*: Age differences significant at $\alpha=0.05$

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In the 2016 data, a higher proportion the younger adult sample (less than 45 years) were comfortable with the idea of cars driving themselves compared to older adults. In particular, among 2016 participants aged 25 to 34, 40% said the maximum level of automation they would be comfortable with is full autonomy. The proportion of participants who indicated that they would be comfortable with full autonomy and automation features that take control of driving were significantly lower for older segments. As shown in Table 3, adults 45 and older were more comfortable with active assistance technologies that help the driver while the driver remains in control, but less comfortable with partial or full autonomy.

The 2017 data suggest a proportional shift away from comfort with full automation. Across all age ranges, a lower proportion of respondents were interested in full automation when compared to 2016. This trend was particularly notable for younger adults aged 16-44. A higher proportion of respondents indicated comfort with systems that actively help the driver, without requiring the driver to relinquish control.

3.3 Inclination to Purchase a Self-Driving Car

Respondents were asked up to two questions relating to their interest in purchasing a self-driving car. The first question asked "How much would you consider paying for a car that completely drives itself?" Participants were able to select one of 5 price ranges, or a sixth option indicating "I would never purchase a car that completely drives itself." Nearly half of respondents indicated they would never purchase a car that completely drives itself (Figure 6).
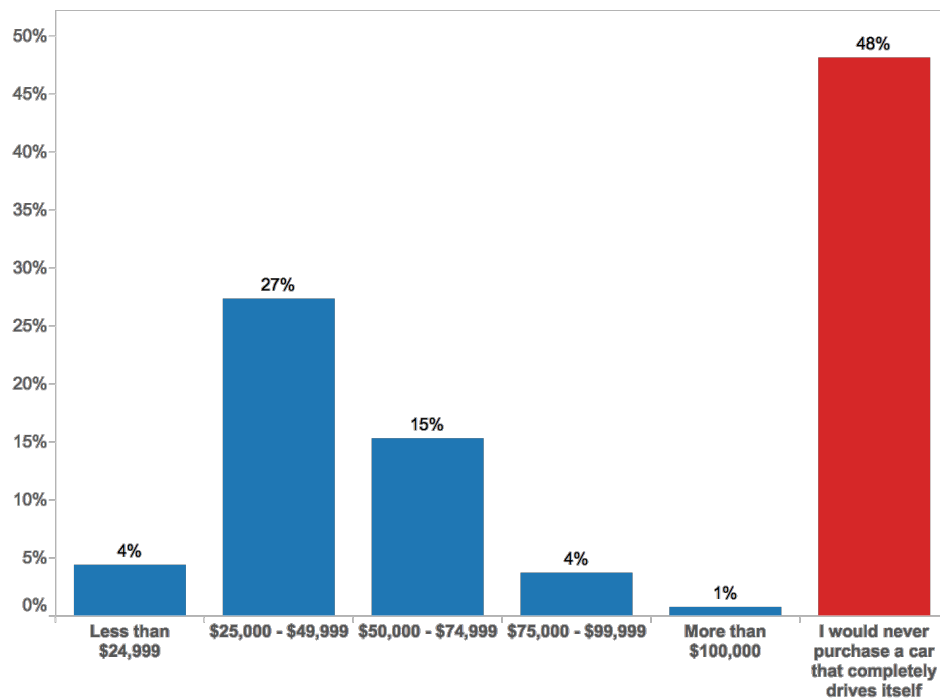

Figure 6: Amount participants would consider paying for a self-driving car

Participants who indicated they would never purchase a self-driving car were then asked to elaborate on the factors most relevant to their decision never to purchase a car that drives itself. An initial summary of these factors is provided in Figure 7. The most cited hesitation was discomfort with the loss of control; other commonly mentioned factors included not trusting the technology, a disbelief that it would be robust enough to rely on exclusively, and a feeling that self-driving cars are unsafe.

Figure 7. Stated hesitations related to purchasing a self-driving car.

4. Initial Conclusions

Consistent with findings from a larger, nationally representative J.D. Power survey (J.D. Power, 2017), comfort or trust in full automation appears to be declining. While the shift away from trust in automation was observed across all age groups, it was particularly noteworthy in the younger half of the age ranges: this was the demographic that was most open to automation a year ago. Younger respondents' confidence appears to have shifted, becoming more cautious. Although younger respondents are still somewhat more accepting of full automation than older respondents, the gap between older and younger adults' perceptions of automation is closing in the direction away from acceptance of automation.

The decline in confidence in full automation appears to be a multifaceted issue. The perception that self-driving cars need to work perfectly to be acceptable, combined with present and past experiences of low-risk technology failure both in and out of vehicles, may lead many consumers to believe the technology will never be good enough such that they can trust it with their lives. The difficulty here is that it remains an open question as to how safe a self-driving vehicle needs to be in order to become socially acceptable as a mobility option. For instance: Do self-driving cars need to be safer than human drivers in all conditions? Safer than human drivers in the specific area of operation? Meet the requirements of vision-zero by being involved in no traffic related fatalities? Or fully avoid all conflicts such that even the most minor of crashes, such as a curb strike, are eradicated? Furthermore, do performance goals need to differ across the product development lifecycle from engineering design, testing, to consumer trials and eventual deployment? Perhaps, these are the types of questions consumers need to see being discussed on a broader social level by technologists and manufacturers leading the developments as perceptions and opinions related to automated technologies continue to evolve. Armed with such perspectives and relevant information, consumers may be better equipped to more adequately gauge the performance and potential benefits of systems through the evolution of the technology.

If automation technology is to be widely accepted and successfully commercialized, new investments are needed in the 'soft side' of high tech to address consumer concerns. The continued divergence between how consumers report learning (or not learning) how to use advanced technologies and their stated interest in learning options provides an excellent starting point for manufacturers, dealers and other stakeholders to begin addressing some of these concerns. Encouraging the appropriate use of driver assistance and other human-centric automated vehicle systems by investing in educational resources that consumers prefer may be an important stepping stone to improving consumer interest, confidence, and trust in self-driving technology.

5. Acknowledgment

6. Other Activities

Beyond the present surveys, other work in our group being conducted as part of the Advanced Vehicle Technologies (AVT) Consortium (http://agelab.mit.edu/avt) (Abraham, McAnulty, Mehler, & Reimer, 2017)

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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.

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Appendix A:

The survey was constructed in Qualtrics, allowing it to be taken online via computer or mobile device. Underlined items were common to both the 2016 and 2017 surveys.

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. <u>How do you feel about the technology in the car you drive today?</u>
    ( )   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. <u>Are you happy with how the technology is integrated with the design of your car today?</u>

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

    Very   Very
    Unhappy   Neutral   Happy
    (Note: Responses rescaled from 1 to 11 for reporting purposes.)

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(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. <u>How did you learn to use the technology in the car you drive today? (Select all that apply.)</u>
   [ ] 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. <u>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)</u>
   [ ] 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. <u>What is the maximum level of automation you would be comfortable with?</u>
   ( ) 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. <u>Which of the following automotive features would you be comfortable using? Select all that apply.</u>
[ ] 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?
( ) More than $100,000
( ) $75,000 to $99,999
( ) $50,000 to $74,999
( ) $25,000 to $49,999
( ) Less than $24,999
( ) I would never purchase a car that completely drives itself

(if "I would never purchase")

20. What factors are most relevant to your decision never to purchase a car that drives itself?

_____

_____

_____

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Alternatives to Driving

Which of the following driving alternatives **do you have access to** or can you use in your current environment**?** (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

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
    ( ) 45 to 54
    ( ) 55 to 64
    ( ) 65 to 74
    ( ) 74 plus

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

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( ) $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. <u>What is your zip code? (For general demographic purposes; skip if preferred.)</u>
    _____

29. Thank you for participating in our survey! If you have any comments for the researchers, please list them below:

    _____

    _____

    _____

30. If you would like to be entered into the raffle for one of six $25 Amazon gift cards, please provide us your email address in the space below. Your email address with neither be stored with nor linked to your responses.

    E-mail: _____