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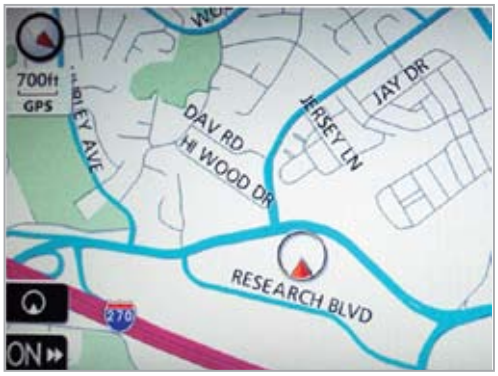
Use of Advanced In-Vehicle Technology By Young and Older Early Adopters

Selected Results From Five Technology Surveys

Photograph Courtesy of AAA Foundation



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16. Abstract This document describes the results of survey research undertaken by the Automobile Club of Southern California. Five technology-specific surveys were conducted with mail-out questionnaires. A total of 40,000 questionnaires were mailed to insurance customers who own vehicles that may have in-vehicle navigation systems, adaptive cruise control, advanced headlamps, electronic backing aids, or rear-view video cameras as standard or optional original equipment. Half of the questionnaires were mailed to vehicle owners who were 25 to 64 years old, and half of the questionnaires were mailed to owners who were 65 or older. The response rate varied for the five technology-specific surveys from 16.6 percent (adaptive cruise control) to 30.7 percent (sensor-based backing aids). Survey items addressed topics such as learning to use the system, behavioral adaptation, system effectiveness, and perceived safety of the system. This report highlights differences in responses between younger and older respondents and compares responses to the five targeted technologies. This report also describes a series of 18 interviews that were conducted with representatives of original equipment manufacturers, regulators, medical practitioners, and professionals in the senior advocacy area. These interviews focused on emerging in-vehicle technologies that may help older drivers.			
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EXECUTIVE SUMMARY

This report describes selected survey data from vehicle owners that was collected by AAA Foundation for Traffic Safety in cooperation with the Automobile Club of Southern California (ACSC). It also includes the results of interviews conducted with representatives of several key groups involved in vehicle technology and older-driver issues The five mail-out surveys described here were designed to assess drivers' experiences with backing aids (proximity sensing systems, rear-view video cameras, adaptive cruise control, advanced HID headlamps (high-intensity discharge), and built-in vehicle navigation systems (they do not address portable navigation units that are sold as aftermarket devices).

All of these technologies are still relatively new to the U.S. passenger vehicle fleet and the purpose of the study was to learn about early adopters' experience using these systems. Some specific areas of interest included drivers' acceptance of the systems, perceived effectiveness and usability of the systems, and behavioral adaptations which may occur with system use. The overarching goal of the study was to learn more about the extent to which in-vehicle technologies enhance or detract from safety, particularly with respect to the capabilities and limitations of older drivers.

One in eight Americans is 65 or older now, and this proportion will continue to grow as the American population ages. It is possible that new technologies can assist older drivers to drive more safely with less stress, thus extending their safe driving years. It's also possible that, for some drivers, new in-vehicle technologies are misunderstood and misused in dangerous ways. This report emphasizes comparisons between drivers' responses to the five technologies and differences between older and younger drivers' responses. The complete results for each of the technology surveys have been published elsewhere (Jenness, Lerner, Mazor, Osberg, & Tefft, 2007, 2008a, 2008b, 2008c).

Technology-specific questionnaires were mailed to 40,000 potential system owners. The samples were selected by ACSC from their database of insurance customers. Only owners of particular vehicle makes and models known to have the technology as a standard feature or as an available option were invited to participate. Half of the questionnaires were mailed to owners who were between 25 and 64 years old and the other half were mailed to vehicle owners who were 65 or older. Vehicle owners were asked to mail back the questionnaire to ACSC in a self-addressed postage-paid envelope even if they did not have the particular technology that the questionnaire was asking about. Overall, approximately 23 percent of the questionnaires from the five surveys were returned, including 5,137 questionnaires from owners of the targeted technologies.

Technology acceptance

A similar question on each of the surveys asked, "If you purchased this same model vehicle again would you want to get [the specific technology]?"

- Among those who currently have the technology the percentage of respondents who said yes varied from 75 percent of ACC owners to 98 percent of backing aid owners.
- Among respondents who currently do not own the technology, the percentage of respondents who said yes varied from 23 percent for HID headlamps to 52 percent for the backing aid technology.

- Older owners of backing aid systems were more likely than younger owners to say that they would want to get the technology again. On the other hand, older owners of HID headlamps and navigation systems were less likely than younger system owners to say that they would want to get those technologies again. Among older owners of HID headlamps, men were more likely than women to say that they would want to get the lamps again.

There were significant differences between older and younger navigation system owners in how frequently they used their system. As compared to younger respondents, older respondents tended to use their navigation systems less frequently. Forty-four percent of older respondents said that they use the navigation system less than once per month, as compared to 27 percent of younger respondents.

Learning to use the technology

Respondents to the surveys on ACC, backing aids, rear-view cameras, and navigation systems were asked to indicate which methods they used to learn how to use the technology. The vehicle owner's manual was more likely to have been used by respondents to the ACC and navigation system surveys than by respondents to the backing aid and rear-view camera surveys. Respondents to the navigation system survey were more likely than respondents to the other technology surveys to have received help from a friend or relative.

- In general, men were more likely than women to have learned about their vehicle systems by reading the vehicle owner's manual, and from on-road experience and practice.
- Older men were especially likely (nearly 80%) to have used their vehicle owner's manual for learning about their ACC system. Only 52 percent of older women learned how to use ACC from the vehicle owner's manual.
- Both younger and older women were much more likely than men to have learned about their navigation system with the help of a friend or relative.

Respondents were also asked whether there were things about their system that were especially difficult to learn. One-quarter of all navigation system owners said yes to this item. Nine percent of both rear-view camera owners and ACC owners said yes, and less than 4 percent of backing aid owners said yes.

Behavioral adaptation

Several differences were noted between older and younger and between male and female navigation system owners in the ways that they choose to use the system. For example:

- As compared to younger respondents, older respondents said that they manually enter a new street address while driving less often. In fact, 63 percent of older respondents said that they never do this (versus 40% of younger respondents).
- Younger men were more likely than younger women to say that they frequently looked at an area map on the navigation screen while driving (36 versus 22%).
- Older women were more than twice as likely as younger women to say that they never ask their passenger to control or get information from the navigation system while they are driving (23 versus 11%).

A similar item on four of the technology surveys (backing aid, camera, navigation, ACC) asked respondents how their use of (or reliance on) the technology had changed since they first started driving the vehicle. Rear-view camera owners were the most likely to say that their usage of the system had increased (40%). ACC owners were the most likely to say that their reliance on the system had decreased (9.4%). Women who have navigation systems were more likely than men in their age group to say that their usage of the system had increased. Also, younger respondents were more likely than older respondents to say that their usage of the navigation system had increased.

Responses to other items suggest that some drivers may sometimes rely exclusively on their backing aids or rear-view cameras by backing without looking over their shoulder or checking their mirrors. Younger drivers were nearly twice as likely as older drivers to admit doing this.

Perceived effectiveness of the technology for avoiding collisions

On both the ACC survey and the backing aid survey respondents were asked how well they believed that their system would work to help them avoid collisions in several scenarios in which the system will not work well according to typical warnings found in vehicle owner's manuals. Despite these warnings, many respondents indicated that their ACC system would work fairly well or perfectly to assist them to avoid colliding with the vehicle ahead in the following situations:

- 24 percent – Following a vehicle in stop-and-go traffic;
- 43 percent – Encountering a stopped car in your lane ahead;
- 27 percent – Following a vehicle on a curvy road; and
- For all three situations, a large percentage of respondents (35 to 40%) said that they didn't know. Women were more likely than men to say that they didn't know.

None of the results for these three items depended significantly on the respondent's age group.

Among the scenarios presented to backing aid owners where the backing aid system would most likely not be helpful, 53 percent of respondents said that their system would work fairly well or perfectly for helping them avoid a collision as they backed out of a driveway into the street and into the path of an oncoming car. On this item women were more likely than men to say that the system would work perfectly or fairly well for helping them to avoid a collision (63 versus 47%).

User interface and usability

- Older respondents were more likely than younger respondents to have difficulty seeing the video display for the rear-view camera and the navigation system screen due to glare from the sun.
- Despite a higher incidence of hearing problems among older drivers, older navigation system owners were more likely than younger system owners to say that they preferred to listen to turn-by-turn directions rather than viewing directions, although a majority of both older and younger navigation system owners preferred to have both spoken and visual directions presented together.

- Regarding the complexity and number of features available on their navigation systems, younger respondents were twice as likely as older respondents to say that their system was too simple and they wished more things could be done with it (19 versus 9%), while older respondents were more likely than younger respondents to say that their system was too complex (26 versus 15%). The majority of both older and younger respondents thought that their system was about right in terms of its complexity and number of features (65%).

Safety

In each of the five technology surveys, respondents were asked a similar question about whether they thought that they were safer drivers because they had the technology. The exact wording of this item varied slightly by survey:

- Overall, does having the [backing aid/rear-view camera/navigation system] make you a safer driver?
- Overall, does having your HID and/or adaptive headlights make you a safer driver than if you had conventional headlights?
- Overall, are you a safer driver using adaptive cruise control than you would be if you only used conventional cruise control?

Among the five technologies, the backing aid system had the highest percentage of owners who thought that their system made them safer drivers (83%). Owners of ACC systems were the least likely to say that their system made them safer drivers (38%). Seven percent of ACC owners and 3 percent of navigation system owners said that their system made them less safe. In some cases these percentages varied by age group and gender. For example, younger men were more than twice as likely as younger women to say that the ACC system made them a safer driver (45 versus 20%).

When asked if their system created any new driving problems or safety concerns, nearly 14 percent of ACC owners, 13 percent of navigation system owners, seven percent of rear-view camera owners and three percent of backing aid system owners said yes.

Need for improvements to in-vehicle technologies

Respondents to each of the five surveys were asked if there is anything about their technology that should be improved or changed. The percentage of system owners who said yes varied from 14.5 percent for HID headlamps to 54.3 percent for navigation systems.

Are automobile manufacturers doing enough to design vehicles to accommodate an aging population?

The combined results from four of the surveys indicated that when asked to respond either, "Yes" or "No" to this question a majority of respondents (72%) said, "Yes, " that they believe that automobile manufacturers are doing enough to design vehicles to accommodate an aging population. However, on the fifth technology survey (regarding headlamps) the response choices for this item included, "Don't Know," and 45 percent of respondents chose that response. In this case, only approximately 36 percent of respondents said, "Yes."

Interviews with experts and stakeholders on older-driver issues

In addition to conducting mail-out surveys of vehicle owners, ACSC interviewed representatives of several key groups involved in vehicle technology and older-driver issues. These groups included product planners from original equipment manufacturers (OEMs), regulators, and other government agencies involved with motor vehicles or older drivers, and other professionals and academics concerned with older advocacy, services, and studies.

- In contrast to the survey results from vehicle owners, there appeared to be general consensus among interviewees that not enough was being done to meet the mobility needs of older drivers. Despite the general consensus that not enough was being done to address the needs of older drivers, representatives from the automobile manufacturers reported that their companies do not tailor models, features, or technologies to older drivers or to any specific age group. In general, they reported that their companies offered technologies intended to assist all drivers, and many commented that such technologies were likely to be particularly helpful for older drivers.
- In the safety realm, respondents mentioned physical fragility and concerns about the greater likelihood of older drivers being injured when involved in crashes. They mentioned collision avoidance systems that would enable the vehicle to avoid crashing altogether, and also improved crashworthiness, which was noted to be of particular concern to older occupants due to their increased fragility and increased risk of being injured in the event of a crash.
- A variety of responses were obtained when respondents were asked what obstacles they believed stood in the way of offering more vehicle technologies for older drivers in the United States. Obstacles included: senior's vision limitations; the cost of new technologies; lack of educational options to train older drivers about their deficiencies, inform them about new technologies, and how to use them; and a sense that many older drivers are already feeling overwhelmed and have lost confidence in their abilities to take on new things.
- Respondents were asked what they believed the government could do to improve senior safety and mobility. A couple of respondents took issue with the way NHTSA sets standards and the way they determine compliance, but not with the standards themselves. For instance, one automobile manufacturer suggested that NHTSA standards are not as "performance-based" as they could be and that NHTSA test methods often stand in the way of new developments that could improve safety.

Findings and implications of surveys

Although the systems studied are primarily marketed as convenience systems rather than safety systems, it is clear that many drivers expect that these systems will make them safer drivers, and many respondents overestimated the potential safety benefits. For instance, many people overestimated the effectiveness of ACC and backing aid systems in assisting drivers to avoid collisions, potentially making collisions more likely.

Methods of learning about the technologies varied somewhat between older and younger drivers suggesting that important information about system function and system limitations

may be most effectively communicated by different means to men and women in different age groups. This is an area that would benefit from further research.

Older drivers tended to use their navigation system less than younger drivers and they tended to use several specific navigation system functions less often. Older drivers were also more likely than younger drivers to find their navigation system to be too complex. Simpler, improved design of the navigation system user interface would benefit all drivers, but especially older drivers.

PROJECT OVERVIEW: USE OF ADVANCED IN-VEHICLE TECHNOLOGY BY YOUNGER AND OLDER EARLY ADOPTERS

This report describes survey research conducted with owners of backing aid systems, rear-view video cameras, advanced headlamps, in-vehicle navigation systems, and adaptive cruise control systems. It is the last in a series of five reports that describe the work conducted under the overall project on the use of advanced in-vehicle technology by young and older early adopters (Jenness et al., 2007, 2008a, 2008b, 2008c).

Project Partners

This project was a collaborative effort between the National Highway Traffic Safety Administration and AAA Foundation for Traffic Safety (AAAFTS). AAAFTS joined with the Automobile Club of Southern California (ACSC) to administer mail-out surveys to individuals who were likely to own vehicles equipped with specific advanced in-vehicle technologies. NHTSA engaged Westat, Inc., to work with AAAFTS and ACSC to reduce the data from returned questionnaires, and perform statistical analyses of the results.

Purpose

The purpose of the project was to assess drivers' experiences with recently introduced in-vehicle technologies. Safety issues (either positive or negative) may be discovered or better understood from the experiences of early adopters before the technologies become widely deployed in the U.S. vehicle fleet. Some specific areas of interest included drivers' acceptance of the systems, perceived effectiveness and usability of the systems, and behavioral adaptations which may occur with system use.

Specific objectives were to:

- Determine driver acceptance and behavioral adaptation to advanced technology currently available in production automobiles.
- Determine how the use of the technology has affected the driving task from a safety point of view.
- Determine how acceptance and use of technology is influenced by system interface characteristics, operation, and performance.
- Assess drivers' ability to learn how to use the technology and integrate it into the driving task.
- Compare drivers' reactions to and understanding of different interface designs.
- Identify future research needs.

The overarching goal was to learn more about the extent to which advanced in-vehicle technologies enhance or detract from safety, particularly with respect to the capabilities and limitations of older drivers. For the purposes of this study, drivers 65 or older are referred to as "older drivers," and drivers 25 to 64 years old are referred to as "younger drivers." It is possible that new technologies can assist older drivers to drive more safely with less stress, thus extending their safe driving years. It is also possible that, for some drivers, new in-vehicle technologies are misunderstood and misused in dangerous ways.

Project Scope

The project partners selected five in-vehicle technologies for investigation. Some of the factors considered in the choice of technologies were the research priorities of NHTSA and AAAFTS, the relative numbers of vehicle owners in the ACSC insurance database who could be expected to have each technology, and the potential to explore human factors and safety issues associated with each technology through survey methods. Five separate surveys were developed to cover:

- Backing aid systems (sensor-based systems)
- Rear-view video camera systems
- High-intensity discharge (HID) headlamps, and directionally adaptive headlamps
- Navigation systems
- Adaptive cruise control

A total of 40,000 questionnaires were mailed to ACSC-insured members who were invited to participate based on the known manufacturer, model, and model year of their vehicles and the likelihood that the vehicles would have one of the five specific in-vehicle technologies. The number of questionnaires mailed for each technology type is shown below:

Backing Aid Systems	5,000
Rear-View Camera	5,000
Advanced Headlamp Systems	10,000
Navigation Systems	10,000
Adaptive Cruise Control	10,000
Total questionnaires mailed	40,000

The results of these five surveys have been released in a series of reports covering the different in-vehicle technologies investigated. This report compares selected results from all five surveys and includes some additional analyses to examine age and gender-related differences in responses.

In addition to conducting mail-out surveys of vehicle owners, ACSC interviewed representatives of several key groups involved in vehicle technology and older-driver issues. These groups will including product planners from OEMs, regulators and other government agencies involved with motor vehicles or older drivers, and other professionals and academics concerned with older advocacy, services, and studies. The interview procedures and results are summarized at the end of this report.

IN-VEHICLE TECHNOLOGIES STUDIED

Backing Aid Systems

For the purposes of the backing aid survey, the generic terms, "backing aid system" and "backing aid" have been used to refer to the class of sensor-based parking assistance systems that are intended to assist drivers in performing low-speed backing and parking maneuvers by providing some form of signal (typically an auditory tone) to communicate the presence of and distance to obstacles. The vast majority of systems limit coverage to the rear of the vehicle, however, some systems are offered with both front and rear coverage zones. Typically, these systems use ultrasonic sensors to detect the proximity of obstacles to the vehicle's bumper. These systems are being sold under a variety of names, including Park Distance Control, Rear Parking Assist, Reverse Park Aid, Parktronic, and Reverse Sensing Warnings, among others. Although these systems are primarily marketed as driver convenience features rather than as safety features (collision warning system), some consumers may mistakenly believe that the systems will help them to avoid collisions with all potential obstacles including small moving children and animals.

Rear-View Video Camera Systems

The rear-view camera survey focused on video camera systems that are intended to aid in parking and avoiding obstacles, but unlike sensor-based backing aid systems, these systems do not provide an active warning to indicate the presence of rear obstacles. Rear-view cameras may allow drivers to detect unexpected and unseen obstacles while backing, such as children and pets. However, they require direct glances to an in-vehicle display which is often located outside of a driver's typical line of site when backing; rear images are usually displayed on existing multifunctional displays (located on the center console) used to provide navigation and other vehicle system information.

Advanced Headlamp Systems

The headlamp survey was designed to address both high-intensity discharge headlamps (HID) and directionally adaptive headlamp systems. HID headlamps differ from conventional headlamps in the way they produce light. HID headlamps use a high-voltage electrical arc rather than a tungsten filament as in conventional halogen headlamps. This results in the HID lamp having a brighter, more bluish-white appearance. Directionally adaptive headlamp systems automatically adjust the direction of the projected beam when the vehicle is turning. Because very few respondents reported that they have adaptive headlamps, data analyses focused on respondents with HID headlamps.

Navigation Systems

The survey on navigations systems considered only systems built in by the vehicle manufacturer as original equipment and excluded portable navigation devices. Navigation systems incorporate a relatively large number of features and options for configuring displayed information and executing tasks. A variety of methods exist for programming a destination into a navigation system, and most systems tend to support at least five different methods, with street address, point of interest, and address book entry methods among the

most prevalent. Some systems allow destinations to be programmed using a phone number, and even speech commands using voice recognition software.

Many, but not all navigation systems restrict or lockout complex tasks (i.e., destination entry) when the vehicle is moving. All systems warn the driver against attempting to interact with the device while driving. Nevertheless, many systems do incorporate features that may minimize glance times to displays (and eyes-off-road time) and manage information flow such as limiting the number of available menu options or rows of items on a display, and use of auditory outputs for routing information and system feedback.

Adaptive Cruise Control Systems

A separate survey was conducted on adaptive cruise control (ACC) systems. Adaptive cruise control is an in-vehicle convenience feature designed to maintain a set speed and, when applicable, adjust the set speed to maintain a specified distance from a lead vehicle. When following another vehicle, the ACC system will automatically slow down or speed up in responses to changes in the lead vehicle's speed. Two critical characteristics of most ACC systems are that they do not react to stationary or slow moving vehicles and they may react to vehicles in other travel lanes, especially on curves. Vehicle owner's manuals typically include this information, but it may be included among several other warnings, making it less likely to be noticed.

SURVEYS

Content Areas

Mail-out questionnaires were developed to address several key content areas, including:

- Background information about the vehicle owner – age, gender, experience with the vehicle, etc.;
- Acceptance of the technology – use and desire to obtain the technology;
- Learning how to use the technology – sources of information, difficulty with learning;
- Behavioral adaptation to the technology – changes in driving behavior with the technology, how drivers rely on the technology;
- Perceived effectiveness of the technology – how well owners believe that the technology works under several specific scenarios and weather conditions;
- User interface and usability – sounds and visual displays;
- Safety – overall opinion of the safety of the system, driving incidents related to the technology; and
- Need for improvements – owners' suggestions for needed improvements regarding the technology and regarding the design of vehicles for older people.

The questionnaire items for all five surveys are listed by topic area in Appendix A. Some of these items are based on items previously developed by Llaneras (2006). All vehicle owners who received questionnaires in the mail were asked to return the questionnaire even if they did not have the indicated technology on their vehicle.

Sampling

ACSC queried its database to identify a subset of customers who owned particular vehicle models (and model years) that had one of the technologies of interest as standard equipment or might have it as optional equipment. Questionnaires were mailed to a random sample of these candidate system owners. To the extent possible, one-half of the questionnaires for each technology survey were mailed to vehicle owners 65 or older, and the other half were mailed to vehicle owners who were 25 to 64 years old. Respondents were not offered any incentives for their participation.

RESULTS FROM SURVEYS OF VEHICLE OWNERS

This report focuses on selected items from the five technology surveys conducted for this project. Age-related and gender-related differences in drivers' responses are highlighted here as are comparisons between drivers' reactions to the different technologies. The complete set of results is presented in the final reports for each specific technology survey (Jenness et al., 2007, 2008a, 2008b, 2008c).

All comparisons between age groups involved respondents who were younger than 65 (younger group) being compared to respondents who were 65 or older (older group). All tests of statistical significance were performed with $\alpha = .05$.

1. General Characteristics of Survey Respondents

Response rates

Vehicle owners selected for the various technology surveys were instructed to return the questionnaires even if they did not have the technology of interest on their vehicles. The number and percentage of questionnaires mailed out and returned are shown in Table 1.

Table 1. Response rates for the five technology surveys

Frequency (Percent)	Backing Aid System	Rear-View Camera	HID Headlamps	Navigation System	Adaptive Cruise Control	Total
Questionnaires mailed	5,000	5,000	10,000	10,000	10,000	40,000
Valid responses	1,537	1,481	2,126	2,236	1,659	9,040
Percentage of valid responses	(30.74)	(29.62)	(21.26)	(22.36)	(16.59)	(22.60)
Respondents who confirmed that they have the technology	1,087	1,069	1,117	1,494	370	5,137
Percentage of respondents who confirmed that they have the technology	(70.72)	(72.18)	(52.54)	(66.82)	(22.30)	(56.83)
Respondents who confirmed that they have the technology as a percentage of questionnaires mailed	(21.74)	(21.38)	(11.17)	(14.94)	(3.70)	(12.84)

Age and gender of respondents

Although the basic sampling plan was the same for all five technology surveys, the response rates and the age and gender distributions of respondents who confirmed that they actually had the specific in-vehicle technology differed by survey. Figures 1 to 5 show the number of respondents to the five surveys in each of six age categories who confirmed they have the technology targeted by the questionnaire they received. The dark bars represent the number of men and the lighter bars represent the number of women. When comparing responses to similar items on the five technology surveys, it is important to keep in mind that the age and gender distributions for respondents differed between the surveys. For example, the respondents with a backing aid system tended to be older (median age = 69 years) than the respondents with a rear-view camera (median age = 51 years). Approximately 38 percent of the respondents who reported owning a backing aid system are women, while 47 percent of the respondents who own a rear-view camera are women.

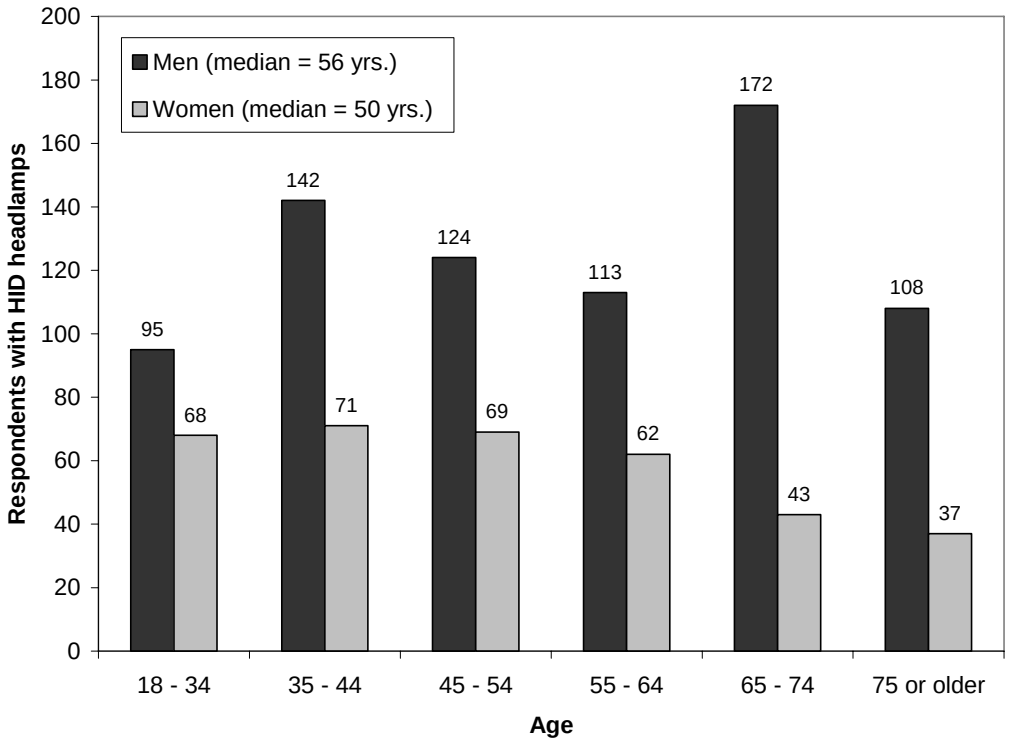

Figure 1. Age and gender of respondents who have HID headlamps

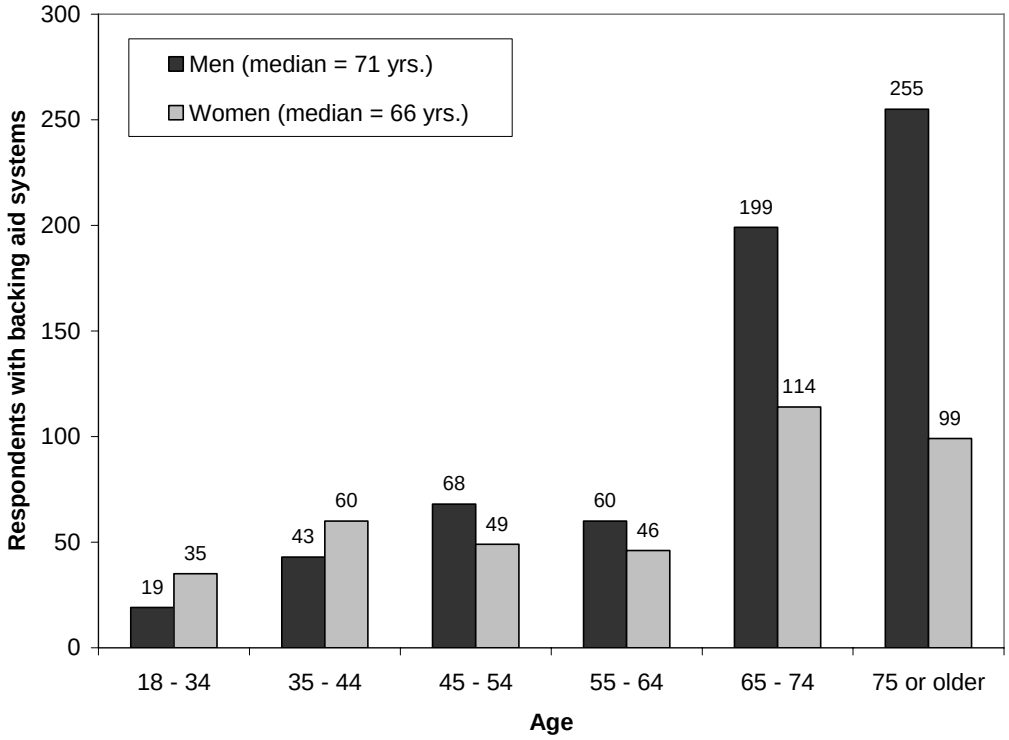

Figure 2. Age and gender of respondents who have a backing aid system

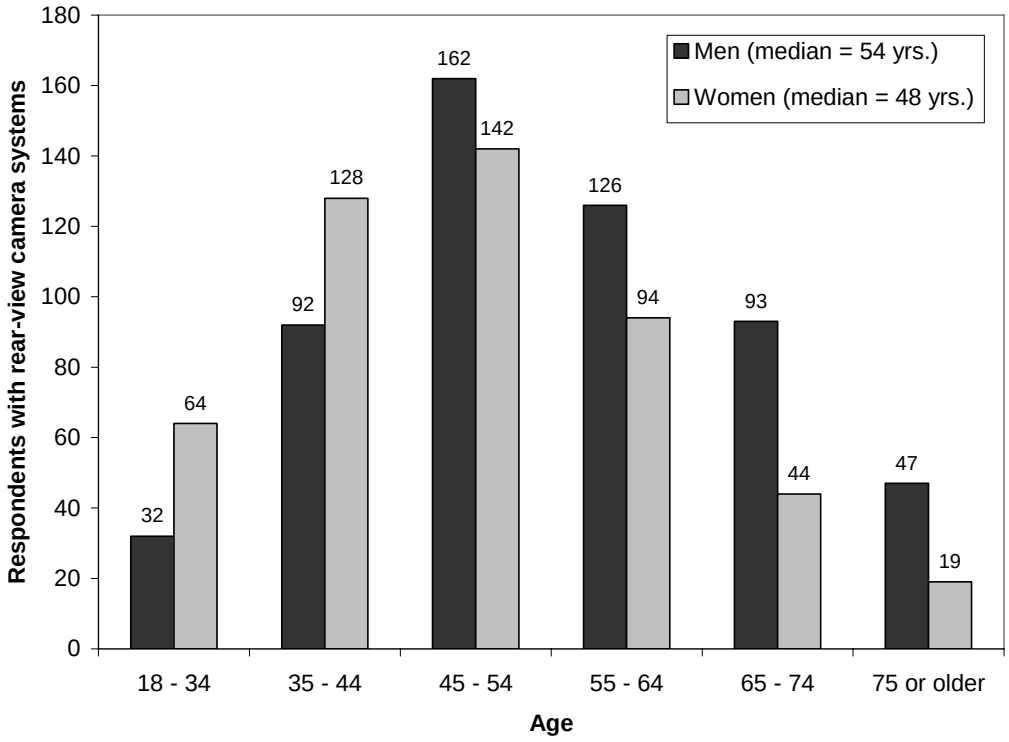

Figure 3. Age and gender of respondents who have a rear-view camera system

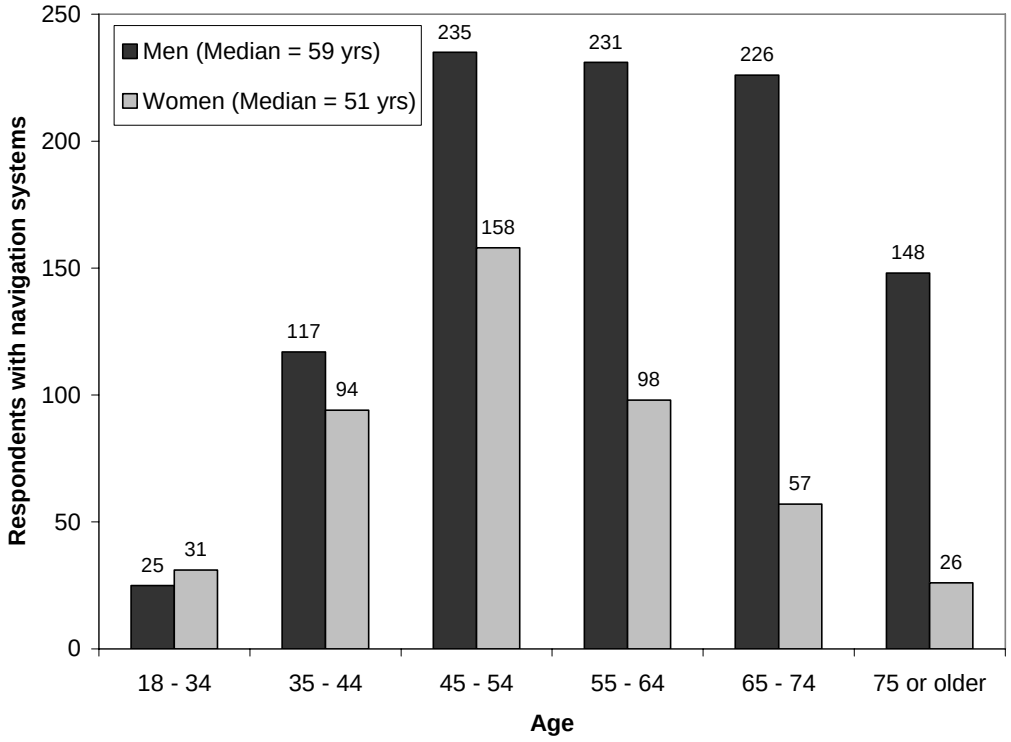

Figure 4. Age and gender of respondents who have a navigation system

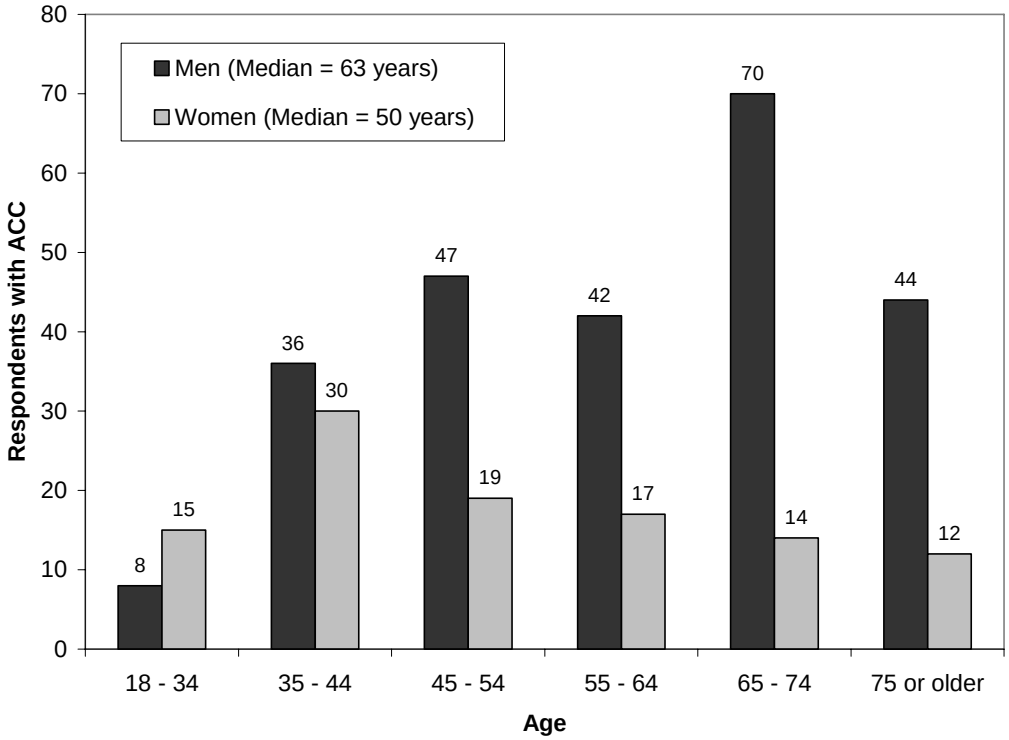

Figure 5. Age and gender of respondents who have an adaptive cruise control system

2. Technology Acceptance

Desire to have the technology

A similar question on each of the five technology surveys asked vehicle owners, "If you purchased this same vehicle again would you want [the specific technology]?" The percentage of respondents who answered "yes" to this question on each survey is shown in Figure 6. The responses from those who already have the technology are shown by the dark bars while the responses from those who do not currently have the technology are shown by the lighter bars. For each technology, those who currently have the system were much more likely to say that they would want it if they purchased their same vehicles again. Nearly all (98%) owners of backing aid systems said that they would want to get the technology if they purchased their same vehicles again, but only 75 percent of ACC owners would want to get an ACC system again. Among those who responded to one of the surveys but did not have the targeted technology, 52 percent of respondents who do not have a backing aid system indicated that they would want one, while only 23 percent of respondents who do not have HID headlamps indicated that they would want them. More detailed comparisons of age-related and gender-related differences in responses to this item are given below.

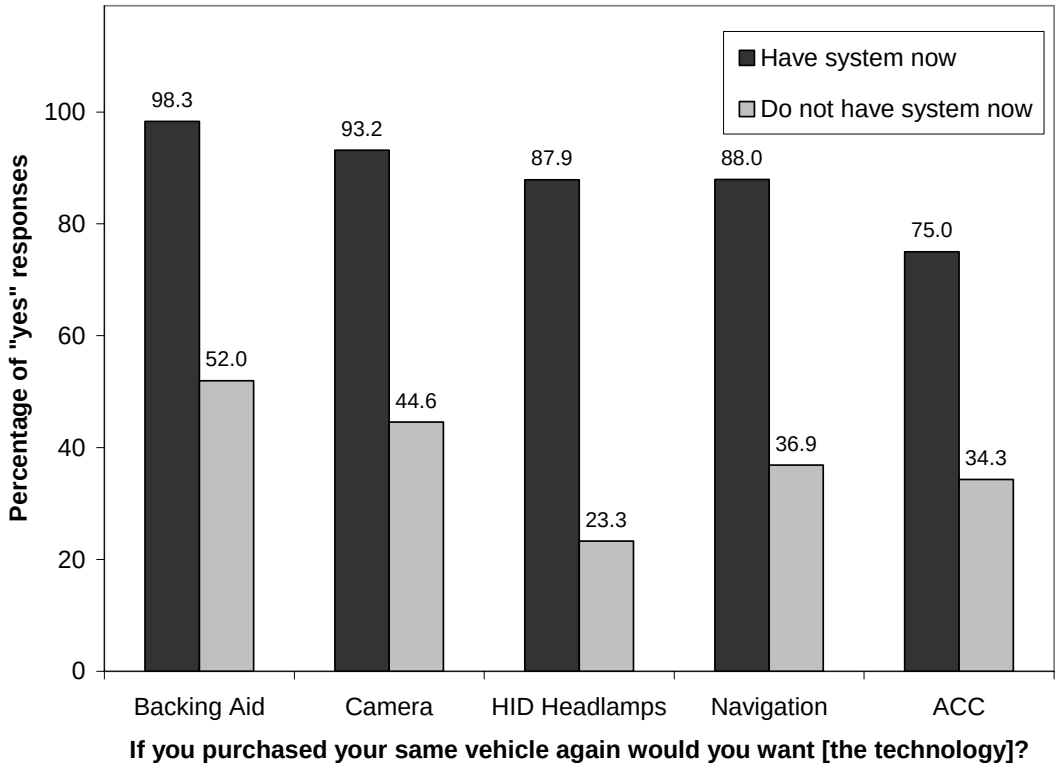

Figure 6. Desire to have in-vehicle technologies by those who currently have the technology and by those who do not have the technology

- On the backing aid survey, a higher percentage of older respondents (99.3%) than younger respondents (96.6%) said that they would want to have a backing aid system if they purchased their same vehicles again. There were no significant differences between male and female respondents in either age group.
- On the rear-view camera survey there was no statistically significant difference between older and younger system owners' responses to this item, nor were there any significant differences between male and female respondents in either age group.
- On the ACC survey there was no statistically significant difference between older and younger ACC owners' responses to this item, nor were there any significant differences between male and female ACC owners' responses in either age group. Among respondents who do not have the technology, younger men were more likely than younger women to say that they would want ACC (35% versus 30%).

For both navigation systems and HID headlamps, older system owners were less likely than younger system owners to say that they would want the technology if they purchased their same vehicles again. Table 2 shows the response frequencies for younger and older navigation systems owners to this question.

Table 2. Navigation system owners who would want to get a factory-installed navigation system if they purchased their same model vehicles again (by age group)

Frequency (Col. Pct.)	Younger than 65	65 or Older	Total
Yes	907 (90.34)	357 (82.45)	1264 (87.96)
No	44 (4.38)	44 (10.16)	88 (6.12)
Don't Know	53 (5.28)	32 (7.39)	85 (5.92)
Total Row Pct.	1004 69.87	433 30.13	1437 100.00

In addition to the differences between age groups, there were significant differences between male and female respondents on this item. Among younger navigation system owners, women were slightly less likely than men to say that they would want to get the system again (89 percent versus 91%), and younger women were twice as likely as younger men to say that they didn't know (8 percent versus 4%). Older owners of navigation systems had a similar pattern of results with respect to gender.

Responses to the headlamp survey to this item were similar to those from the navigation system survey. Table 3 shows the response frequencies for younger and older HID headlamp owners to the question about wanting to get HID headlamps if they were to purchase their same model vehicles again. Younger respondents were more likely than older respondents to say that they would want HID headlamps if they purchased their same model vehicles again.

Table 3. HID headlamp owners who would want to get HID headlamps if they purchased their same model vehicles again (by age group)

Frequency (Col. Pct.)	Younger than 65	65 or Older	Total
Yes	662 (90.07)	295 (83.33)	957 (87.88)
No	26 (3.54)	14 (3.95)	40 (3.67)
Don't Know	47 (6.39)	45 (12.71)	92 (8.45)
Total Row Pct.	735 67.49	354 32.51	1089 100.00

Among older, but not among younger, HID headlamp owners the responses depended significantly on gender of the respondent. Table 4 shows the number of older male and female HID headlamp owners who would want to get HID headlamps if they purchased their same model vehicles again. (Older respondents who did not report their gender were excluded from this analysis.) Men were more likely than women to say yes, and women were more than twice as likely as men to say that they didn't know.

Table 4. Older owners of HID headlamps who would want to get HID headlamps if they purchased their same model vehicles again (by gender)

Frequency (Col. Pct.)	Men	Women	Total
Yes	240 (87.59)	52 (68.42)	292 (83.43)
No	7 (2.55)	7 (9.21)	14 (4.00)
Don't Know	27 (9.85)	17 (22.37)	44 (12.57)
Total Row Pct.	274 78.29	76 21.71	350 100.00

<u>System use</u>

Only respondents to the navigation survey were asked how often that they use their vehicles' advanced technology. Thirty-two percent of respondents use their navigation systems less than once a month. Thirty percent use it 1 to 3 times per month, 16 percent use it once a week, 12 percent use it 2 or 3 times per week, and 10 percent use it 4 or more times per week. These responses depended significantly on age group, as shown in Figure 7. As compared to younger respondents, older respondents tended to use their navigation systems less frequently. Men and women did not differ significantly in their reported frequency of system use.

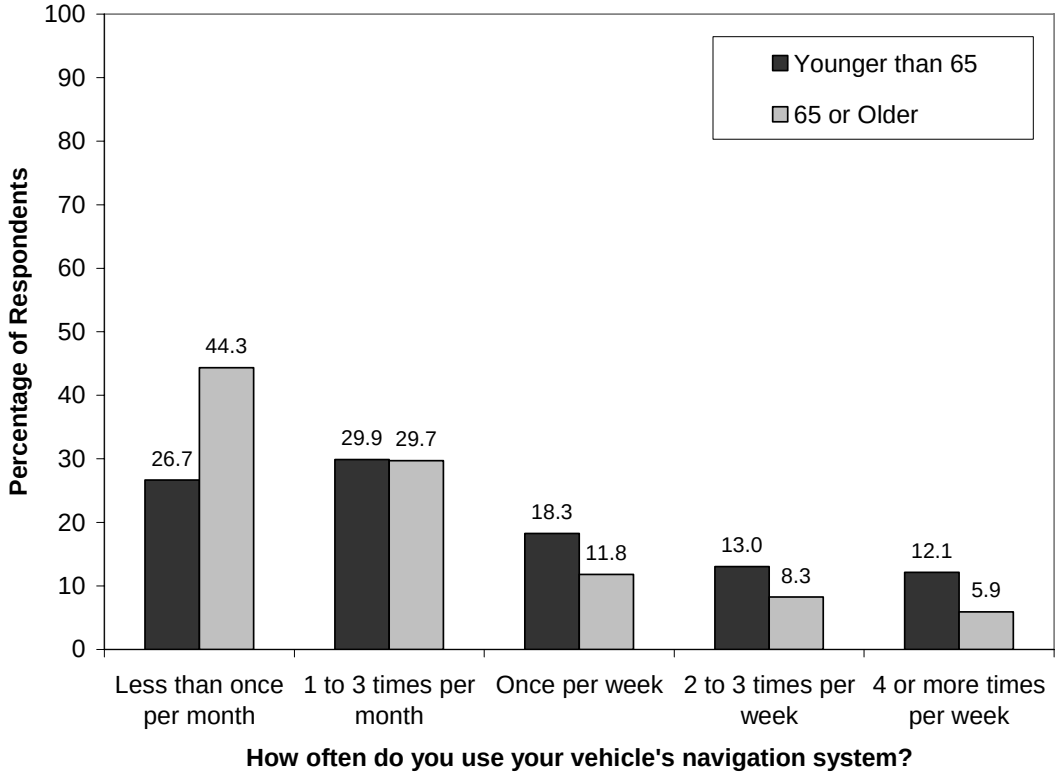

Figure 7. Frequency of navigation system use by younger and older drivers

3. Learning to Use the Technology

Respondents to four of the technology surveys (ACC, Backing Aid, Rear-View Camera, Navigation System) were asked to indicate which methods they used to learn how to use the technology. The use of different learning methods varied somewhat by technology. Table 5 shows the percentage of system owners who indicated that they used the learning methods listed. The vehicle owner's manual was more likely to have been used by respondents to the ACC and navigation system surveys than by respondents to the backing aid and rear-view camera surveys. Respondents to the navigation system survey were more likely than respondents to the other technology surveys to have received help from friends or relatives. The results show that owners often learned by more than one learning method, especially for navigation systems, presumably due to the greater complexity compared to the other technologies.

Table 5. Percentage of system owners who reported using each learning method

Percentage of system owners who reported using each learning method	ACC	Backing Aid	Rear-View Camera	Navigation System
Instructions from dealership, such as video, brochure, or demonstration	29.4	45.3	57.5	47.4
Vehicle owner's manual	67.2	43.5	31.8	64.6
Help from a friend or relative	5.0	3.5	3.1	12.7
Information on the Internet	1.1	0.8	1.3	0.9
On-road experience and practice (trial and error)	53.5	54.5	62.9	55.4
I have not yet learned how to use the [system]	7.8	1.1	0.9	4.9

Note: Percentages may add to more than 100 percent because participants could choose all responses that applied.

Age and gender differences in learning methods

On the navigation system survey, backing aid survey, rear-view camera survey, and ACC survey there were significant differences between the percentage of older respondents and younger respondents who said that they used the vehicle owner's manuals to learn about the technology. In each case, a greater percentage of older respondents than younger respondents used the owner's manuals. Generally, the increased usage of the vehicle owner's manuals by the older group was related to the large number of older men using the manuals. Some other interesting differences in responses between older and younger system owners include the following:

- Although older navigation system owners were more likely than younger navigation system owners to use the vehicle owner's manuals for learning how to use their systems, the younger respondents who used them were more likely than older respondents to say that the manuals were easy to use.
- A significantly higher percentage of younger respondents (61%) than older respondents (43%) said that they learned to use the navigation systems with on-road experience and practice. The backing aid and rear-view camera surveys showed this same pattern of results.
- Older owners of navigation systems were more likely than younger owners to say that they had not yet learned how to use their systems.

In some cases, overall differences between older and younger respondents in use of learning methods are complicated by interactions between age and gender. Table 6 shows where there were statistically significant differences between older male and female system owners' responses about their use of different learning methods. Where there was no statistically significant difference between genders, a single percentage number is given in the cell to represent the combined responses from both male and female system owners. In cases where the responses from male (M) and female (F) system owners differed significantly, the

percentages are given for each gender separately. The greater than (>) and less than (<) symbols indicate the direction of the difference between male and female responses.

- A higher percentage of older men than older women learned about their ACC and rear-view camera systems from the vehicle owner's manuals.
- For those with ACC or a backing aid system learning from on-road experience was more commonly reported by older men than by older women.
- Older women were more likely than older men to have learned how to use their navigation systems with the help of friends or relatives.
- Older women were much more likely than older men to report that they had not yet learned how to use their ACC systems.

Table 7 shows where there were statistically significant differences between younger male and female system owners in learning methods used.

- Younger men were more likely than younger women to have learned to use their ACC, rear-view camera, and navigation systems from the vehicle owner's manuals.
- Younger women were more likely than younger men to report learning to use their rear-view camera and navigation systems with the help of friends or relatives.

Table 6. Older male and female respondents' methods for learning to use in-vehicle technologies

Percentage of system owners who reported using the learning method	ACC	Backing Aid	Rear-View Camera	Navigation System
Instructions from dealership, such as video, brochure, or demonstration	31.4	46.8	62.8	49.7
Vehicle owner's manual	M > F 79.6 > 52.2	46.7	M > F 52.5 > 28.1	74.8
Help from a friend or relative	3.7	3.3	1.4	M < F 11.5 < 32.0
Information on the Internet	0.7	0.5	0.5	0.7
On-road experience and practice (trial and error)	M > F 55.6 > 26.1	M > F 52.1 > 40.6	50.2	42.9
I have not yet learned how to use the [system]	M < F 5.6 < 34.8	1.5	1.9	9.5

Table 7. Younger male and female respondents' methods for learning to use in-vehicle technologies

Percentage of system owners who reported using the learning method	ACC	Backing Aid	Rear-View Camera	Navigation System
Instructions from dealership, such as video, brochure, or demonstration	28.1	42.3	56.1	46.5
Vehicle owner's manual	M > F 69.2 > 52.0	37.6	M > F 32.5 > 24.7	M > F 63.6 > 54.4
Help from a friend or relative	6.0	3.7	M < F 1.5 < 5.5	M < F 7.6 < 17.4
Information on the Internet	1.4	1.3	1.6	0.9
On-road experience and practice (trial and error)	56.7	65.6	66.2	61.1
I have not yet learned how to use the [system]	5.5	0.5	0.6	2.9

Difficulty in learning to use in-vehicle technologies

Respondents to the ACC, navigation, rear-view camera, and backing aid questionnaires were asked, "Were there things that were especially difficult to learn about your vehicle's [system]?" The percentage of respondents who said yes to this question is shown for each system in Figure 8. Respondents to the navigation system survey were the most likely to say yes to this item (25%). Among those who responded affirmatively, 42 percent mentioned difficulties with learning to program the desired destinations. A significantly higher percentage of older system owners (32%) than younger system owners (22%) said that there were things about their navigation systems that were especially difficult to learn. There was also true for the rear-view camera systems, where 15 percent of older owners but only 8 percent of younger owners reported that there were things about their systems that were especially difficult to learn. There were no significant age differences for this item on the backing aid and ACC surveys, and no significant differences between male and female respondents on this item for any of the technology surveys.

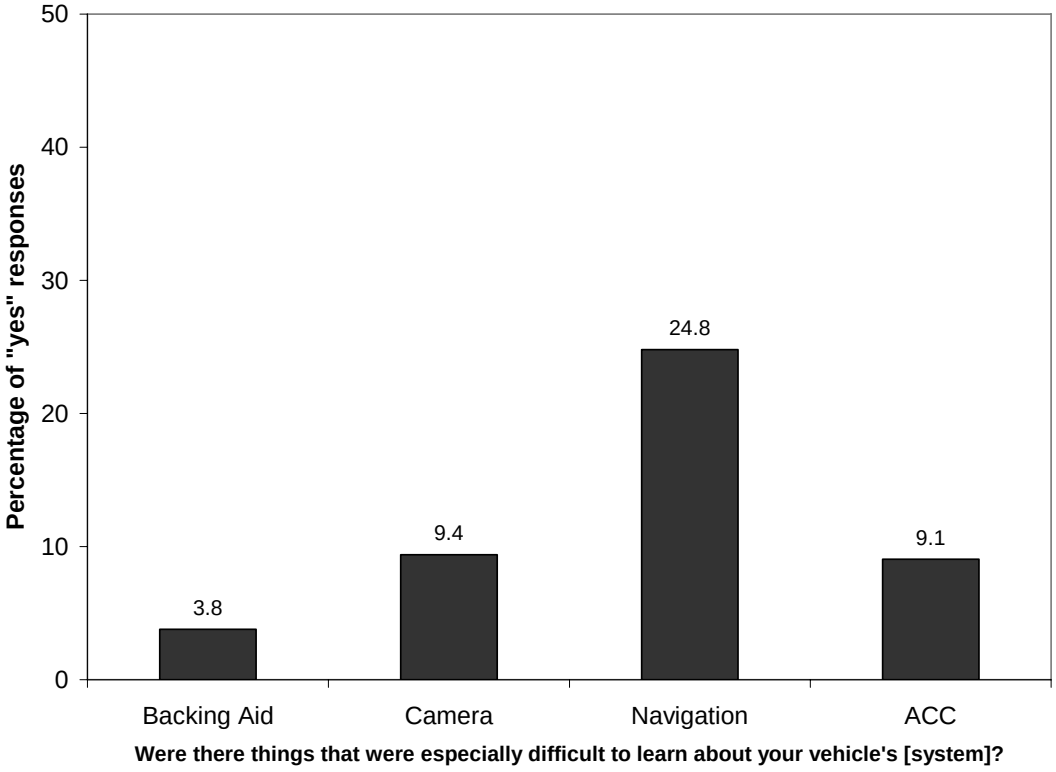

Figure 8. Vehicle owners who had difficulties learning to use their in-vehicle technology

4. Behavioral Adaptation

Usage patterns

Of the five technologies studied in this project, navigation systems have the most complicated user interface and largest number of available functions. Navigation systems are designed to be used in several different ways, and it is of interest to determine how often younger and older system owners choose to interact with their systems in these different ways.

On the navigation questionnaire, respondents were asked, "How frequently do you use your navigation system in the following ways?" The respondents were then given several situations where they may have used the navigation system, and a response scale which included "Never," "Rarely," "Occasionally," "Frequently," and "Not applicable." Responses to each situation were analyzed by age group. Some of these results are summarized below:

- Manually entering a new street address while driving. Older respondents (63%) were more likely than younger respondents (40%) to say they never entered new street addresses while driving. Older respondents were less likely than younger respondents to say they occasionally or frequently entered new street addresses while driving (8 versus 23%). The results reflected an interaction between age group and gender such that a lower percentage of younger men than younger women said that they never did

this (38 versus 43%) but a higher percentage of older men than older women said that they never did this (64 versus 56%).

- Looking at an area map on the navigation screen while driving. Sixty-five percent of respondents reported doing this activity "frequently" or "occasionally." Older respondents were more likely than younger respondents to say that they never looked at area maps on navigation screens while driving (22 percent versus 9%) and older respondents were less likely than younger respondents to say they do this activity frequently (17 percent versus 31%). Among younger respondents, men were more likely than women to say that they did this frequently (36 versus 22%).
- Reading turn-by-turn directions displayed on the navigation screen while driving. Forty-seven percent of respondents reported doing this activity "frequently" or "occasionally." Older respondents were less likely than younger respondents to say they do this activity frequently (14 versus 21%) and older respondents were more likely than younger respondents to say that they never read turn-by-turn directions displayed on navigation screens while driving (28 versus 19%). Younger women were less likely than younger men to say that they did this activity frequently (17 versus 23%) and younger women were more likely than younger men to say that they never did this activity (23 versus 16%).
- Asking your passenger to control or get information from the navigation system while you are driving. Fifty-nine percent of respondents said that they do this frequently or occasionally. The overall pattern of results did not depend significantly on age group or gender. However, older women were less likely than younger women to say that they did this frequently or occasionally (48 versus 65%) and older women were twice as likely as younger women to say that they never did this (23 versus 11%).
- Choosing a route to avoid major roadways. Only 33 percent of respondents said that they do this frequently or occasionally. Twenty-eight percent of respondents said that they never do this and an additional 9 percent of respondents said the question was not applicable. Surprisingly, older respondents were more likely than younger respondents to say that they never chose routes to avoid major roadways (33 versus 26%) and older respondents were less likely than younger respondents to say that they did this activity occasionally or frequently (28 versus 34%). More specifically, older and younger men's responses (27 versus 33%) differed more than older and younger women's responses (34 versus 36%). Overall, there was no statistically significant difference between the responses from younger male and female drivers nor was there a significance difference between the responses from older male and female drivers.

Changes in use of the technologies over time

On the navigation questionnaire and on the rear-view camera questionnaire drivers were asked, "How has your *usage* of the [navigation/rear-view camera] system changed since you first started driving the vehicle?" A similar item on the questionnaires for backing aid systems and ACC systems asked, "How has your *reliance* on [the backing aid/adaptive cruise control] system changed since you first drove the vehicle?"

The results to for these two similar questions are summarized in Figure 9. For each technology the majority of respondents said that their usage of (or reliance on) the system is

the same now as when they first started driving the vehicle. The rear-view camera system had the greatest percentage of respondents who said that their usage of the system had increased since they first started driving the vehicles, while the ACC and navigation systems had the greatest percentages of respondents who said that their use/reliance on the system had decreased.

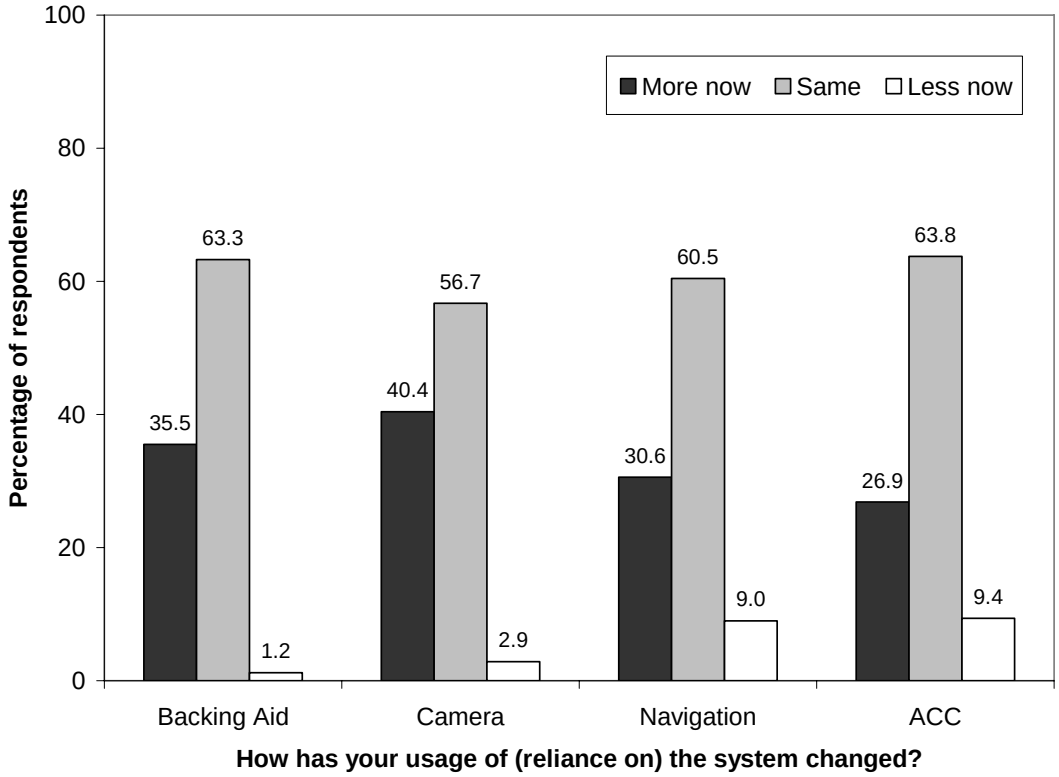

Figure 9. How has your use of (reliance on) your [system] changed since you first started driving the vehicle?

On the rear-view camera survey the responses to the item about changes in usage were not significantly different between older and younger drivers or between male and female drivers. Also, on the ACC survey and on the backing aid survey, there were no statistically significant differences between men and women or between older and younger system owners to the item that asked, "How has your *reliance* on adaptive cruise control changed since you first drove the vehicle?"

On the navigation system survey there was a significant difference between younger and older respondents to the item about changes in usage of the system. As shown in Table 8, younger respondents were more likely than older respondents to say that they use the navigation system more now than they did at first and younger respondents were less likely than older respondents to say that their usage had stayed the same.

Table 8. Navigation system usage changes by age group

Frequency (Col. Pct.)	Younger than 65	65 or Older	Total
I use it more now than I did in the beginning	342 (34.30)	93 (21.99)	435 (30.63)
I use it less now than I did in the beginning	81 (8.12)	46 (10.87)	127 (8.94)
My usage has stayed about the same	574 (57.57)	284 (67.14)	858 (60.42)
Total	997 70.21	423 29.79	1420 100.00

The responses of younger and older respondents are summarized by gender in Figure 10. Compared to men in their age group, higher percentages of both younger and older women said that they have increased their usage of the navigation systems since they first started driving their vehicles.

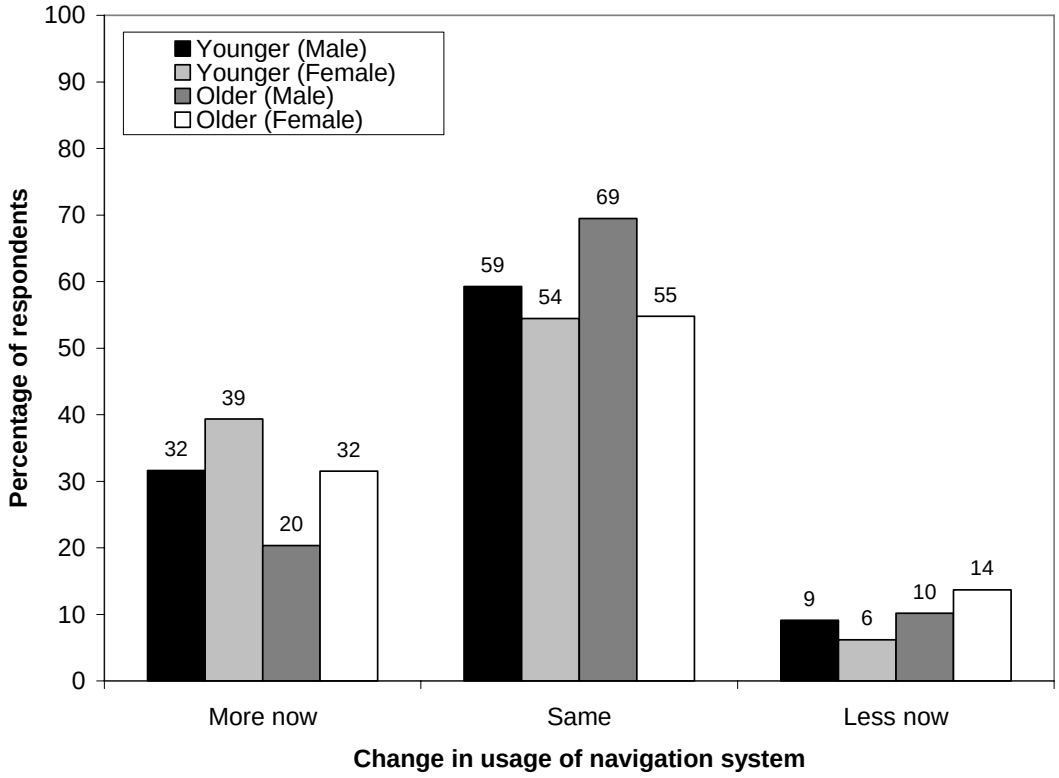

Figure 10. How has your usage of the navigation system changed since you first started driving the vehicle?

Changes in driving behavior

On the ACC questionnaire system owners were asked how their driving behavior would change if they could not use ACC anymore. Half of the respondents (50%) said that they would usually keep the same gap between their vehicles and the vehicles ahead as they do now using ACC. A slightly higher percentage of respondents (26.5%) said that they would keep a smaller gap as compared to those who said they would keep a larger gap (23.4%).

The responses to this item differed significantly based on the respondent's age group as shown in Figure 11. Younger respondents were more likely than older respondents to say that they would reduce their usual following distance (smaller gap) if they no longer had ACC. Older were more likely to say that they would increase their following distance (larger gap) without ACC. There was no statistically significant difference between younger male and female respondents to this item, nor was there any significant difference between older male and female respondents to this item.

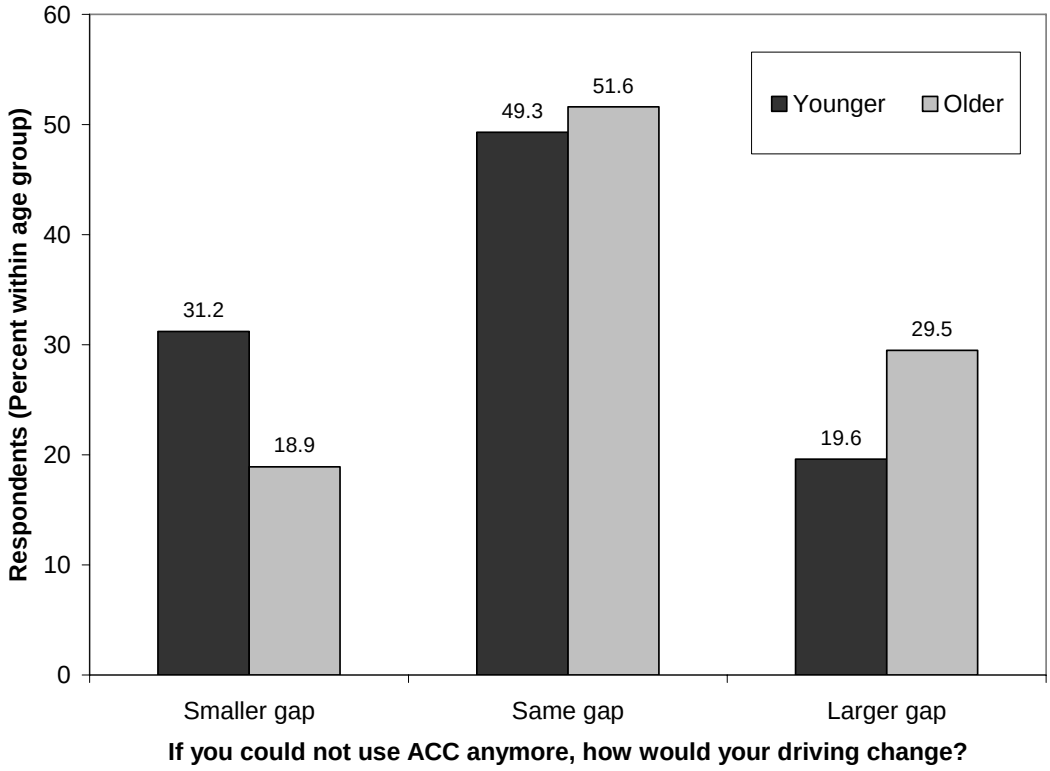

Figure 11. How younger and older respondents would change their usual following distance if they no longer had ACC.

On the headlamp survey, reliance on HID headlamp technology was assessed by an item that asked, "If your headlight system had to be replaced with conventional headlights, how would your driving behavior change? Among the several response options preprinted on the questionnaire only the results for one of these differed significantly by age group: A higher percentage of older drivers than younger drivers said that they would, "Limit my night driving more than I do now" (13 versus 7%). There was no statistically significant difference between the percentage of older male and older female respondents who chose that response.

However, there were significant differences between men and women for several other responses to this item:

- Among older drivers, women were twice as likely as men to say that they would, "Avoid going to unfamiliar places more than I do now" (20 versus 9%) if they had conventional headlamps. Older women were also twice as likely as older men to say that they would, "Avoid dark roads more than I do now" (20 versus 9%).
- Among younger drivers, women were twice as likely as men to say that they would, "Avoid going to unfamiliar places more than I do now" (16 versus 7%) if they had conventional headlamps. Younger women were also more likely than younger men to say that they would, "Avoid dark roads more than I do now" (16 versus 9%), "Drive more slowly at night than I do now" (20 versus 14%), and "Limit my night driving more than I do now" (10 versus 6%). Younger men were more likely than younger women to say that, "My driving behavior would not change" (76 versus 63%).

On both the backing aid and rear-view camera questionnaires over-reliance on the technology was assessed by asking respondents whether, within the last two weeks, they had ever used just the (backing aid system/rear-view camera) when backing without checking their mirrors or turning to look out the rear-view mirrors. Approximately 17 percent of rear-view camera owners and 12 percent of backing aid system owners admitted that they had done this.

- Among rear-view camera owners the percentage of respondents who said "Yes" to this question was significantly higher for younger drivers than for those 65 or older (19 versus 10%). There were no significant differences between the responses of male and female camera owners to this item.
- Among backing aid owners, there was no statistically significant difference between age groups on this item, but older men were more likely than older women to say that they had relied exclusively on the system when backing (13 versus 7%).

5. Perceived Effectiveness of the Technology for Avoiding Collisions

Respondents' perception that ACC helps them avoid collisions

A series of three survey items asked respondents to judge how well their ACC system would help them to avoid colliding in several different situations. These scenarios were written to cover circumstances where ACC is not likely to work well and they are usually included as warnings in the vehicle owner's manuals. Despite these warnings, many respondents indicated that their ACC systems would work fairly well or perfectly to assist them to avoid colliding with the vehicle ahead in the following situations:

- 24 percent – Following a vehicle in stop-and-go traffic (Situation A);
- 43 percent – Encountering a stopped car in your lane ahead (Situation B);
- 27 percent – Following a vehicle on a curvy road (Situation C); and
- For all three situations, a large percentage of respondents (35 to 40%) said that they didn't know. Women were more likely than men to say that they didn't know.

None of the results for these three items depended significantly on the respondent's age group. However, the results for Situation A depended significantly on the respondent's level of experience with the vehicle, as did the results for Situation B. At higher levels of experience respondents are more likely to say that their systems work "fairly well" or "perfectly" to help them avoid collisions in these situations (see Figure 12).

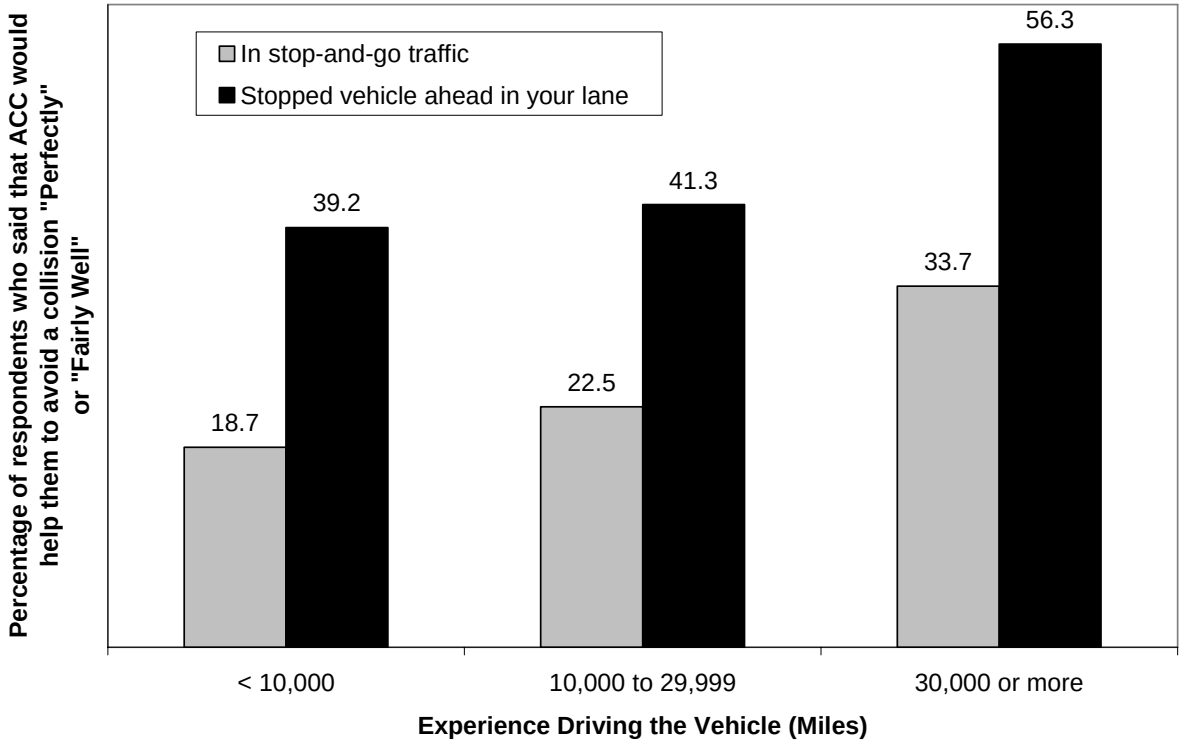

Figure 12. Respondents who believe that their ACC system would help them to avoid a collision when following a vehicle in stop-and-go traffic and when encountering a stopped vehicle in the lane ahead.

Respondents' perception that their backing aid systems helps them avoid collisions

The perceived effectiveness of sensor-based backing aids was evaluated by survey items that asked respondents to rate how well their system would help them to avoid colliding in six different scenarios (A to F). Most of these scenarios were written to cover circumstances where the system may not work, including conditions that are often included as warnings in vehicle owner's manuals. Scenario F, which involves backing into a parallel parking space where it is necessary to back very close to the car immediately behind, is the only scenario where the backing aid system should be expected to work perfectly. In fact, 93 percent of respondents reported that their systems work either perfectly or fairly well in this situation.

A large percentage of respondents also thought that their backing aid systems would help them to avoid colliding under circumstances where the system probably would work poorly or not at all. Overall, 68 percent of respondents thought that the systems would help them avoid colliding with an unseen bicycle if they were backing quickly (10 mph) down a long driveway

(Scenario B) despite the fact that most backing aid systems do not operate at speeds over 3 to 6 mph. Even for systems which continue to operate at speeds of 10 mph or more, the typically limited detection range of the ultrasonic sensors makes it unlikely that a driver backing quickly would be alerted with enough time to stop before colliding with the unexpected bicycle. An exception may be the extended rear parking assistance system available on Lincoln vehicles. This system provides radar-based detection (up to 20 feet). Among Lincoln owners, 75.3 percent thought that their systems would work fairly well or perfectly for assisting them to avoid colliding in the bicycle scenario. Among non-Lincoln owners, 66.7 percent of respondents thought that their system would help them avoid colliding in this scenario.

A majority of respondents also thought that their backing aid systems would help them either "fairly well" or "perfectly" to avoid colliding under each of the scenarios:

- Backing out of a driveway into the street and into the path of an oncoming car (53%, Scenario A);
- Backing quickly (10 mph) down a long driveway with a bicycle in their path (68%, Scenario B);
- Backing out of a garage when there is a child immediately under the rear bumper (53%, Scenario C);
- Backing out of a parking space and there is a pedestrian standing 10 feet behind the rear bumper (78%, Scenario D). This includes 88 percent of Lincoln owners and 75 percent of all respondents excluding Lincoln owners.
- Backing up to a narrow sign post (87%, Scenario E).
- Backing into a parallel parking space where it is necessary to back very close to the car immediately behind (93%, Scenario F)

The percentage of younger and older male and female respondents who said that their backing aid systems would help them to avoid colliding in the six scenarios mentioned above is shown in Figure 13. Women were more likely than men to think that their backing aid systems would help them avoid a collision especially in Scenarios A and B. Younger respondents were more likely than older respondents to think that their systems would help them avoid a collision in Scenarios C, D and F.

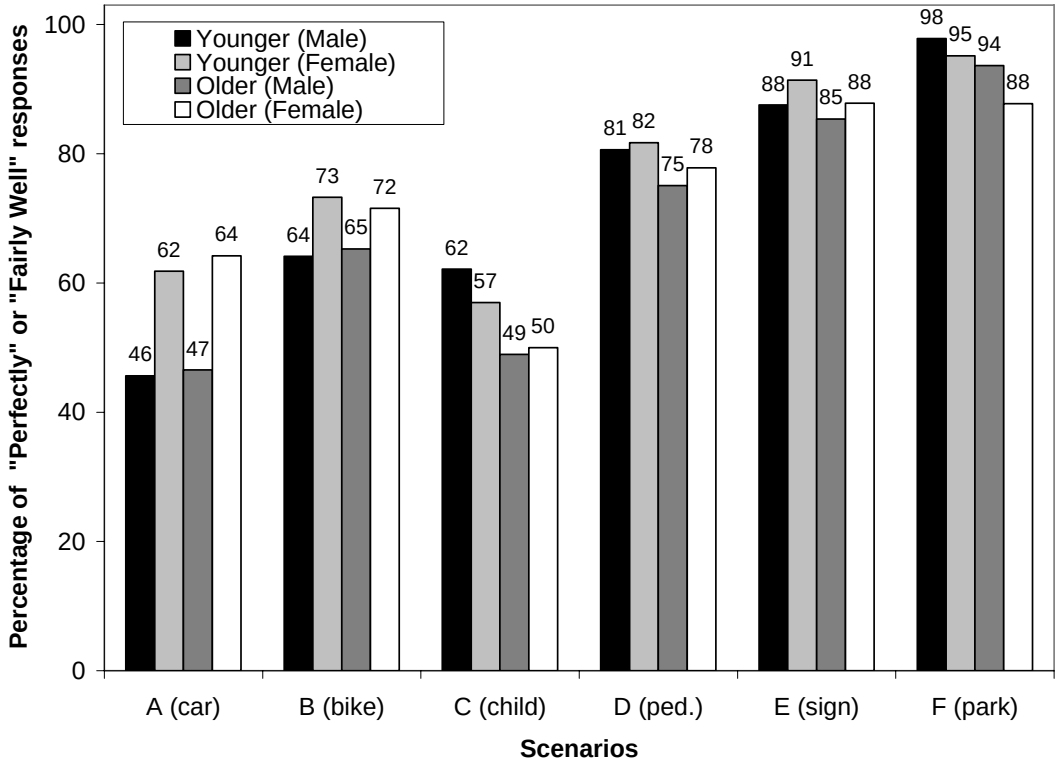

Figure 13. Younger and older male and female respondents who said that their backing aids would work perfectly or fairly well to help them avoid collisions in six different scenarios

6. User Interface and Usability

Visual displays

In general, older respondents expressed more concern than younger respondents about the visibility of user interface elements in the vehicle. On many survey items, older respondents were less likely to select the extreme responses on the response scales provided. For many items, older respondents were less likely to say that something was "very easy" or "very difficult" to see, hear, etc., and they were less likely to "strongly disagree" or "strongly agree" with statements.

One area of comparison across surveys concerns the visibility of the video display screen. It is common for in-vehicle navigation systems and rear-view cameras to share the same display screen in the dash. In these cases, the rear camera view comes on the screen automatically when the vehicle is put in reverse gear. Both the rear-view camera survey and the navigation system survey included an item about the potential problem of sun glare on the screen.

On the rear-view camera survey, 27 percent of respondents either agreed or strongly agreed with the statement that, "Sun glare on the video display makes it hard for me to see objects or people." The responses to this item depended significantly on age group with older respondents being more likely than younger respondents to report a problem with glare. The results for younger and older respondents are shown in Table 9.

On the navigation survey, 24 percent of respondents either agreed or strongly agreed with the statement that, "Sun glare or reflections on the navigation screen often make it difficult to see maps or directions." There was a significant difference between younger and older respondents on this item as shown in Table 10. Younger respondents were more likely than older respondents to disagree or strongly disagree with this statement. Older respondents were more likely than younger respondents to agree.

Table 9. Sun glare on the video display makes it hard for me to see objects or people (by age group)

Frequency (Col. Pct.)	Younger than 65	65 or Older	Total
Strongly Disagree or Disagree	463 (56.88)	83 (40.69)	546 (53.64)
Neutral	154 (18.92)	46 (22.55)	200 (19.65)
Agree or Strongly Agree	197 (24.20)	75 (36.77)	272 (26.72)
Total Row Pct.	814 79.96	204 20.04	1018 100.00

Table 10. Sun glare often makes it difficult to see maps or directions by age group

Frequency (Col. Pct.)	Younger than 65	65 or Older	Total
Strongly Disagree or Disagree	575 (58.03)	175 (41.56)	750 (53.11)
Neutral	175 (17.66)	91 (21.62)	266 (18.84)
Agree or Strongly Agree	201 (20.28)	135 (32.07)	336 (23.80)
Not Applicable	40 (4.04)	20 (4.75)	60 (4.25)
Total Row Pct.	991 70.18	421 29.82	1412 100.00

Auditory displays

Given the fact that more older than younger survey respondents reported hearing difficulties, it is not surprising that on the backing aid survey a higher percentage of younger drivers (78.3%) as compared to older drivers (67.0%) strongly agreed with the statement that, "It's easy to hear the sounds made by the backing aid system." Older drivers (29.9%) were more likely to simply agree with the statement than were younger drivers (17.7%). Less than 2 percent of older and younger respondents disagreed or strongly disagreed with the statement.

An item on the navigation survey asked drivers whether they preferred to listen to spoken turn-by-turn directions, preferred to view directions on the screen, or preferred both together. Most respondents (61%) preferred both together, whereas 26 percent preferred listening to directions and only 13 percent preferred viewing directions on the screen. There was a significant difference between younger and older respondents on this item as shown in Table 11. Younger respondents were more likely than older participants to prefer viewing directions and slightly more likely to say both together. Older respondents were more likely than younger respondents to say that they prefer listening to directions.

Table 11. Preferences for listening to or viewing directions by age group

Frequency (Col. Pct.)	Younger than 65	65 or Older	Total
View directions	148 (15.37)	31 (7.64)	179 (13.08)
Listen to directions	210 (21.81)	149 (36.70)	359 (26.22)
Both together	605 (62.82)	226 (55.67)	831 (60.70)
Total Row Pct.	963 70.34	406 29.66	1369 100.00

Features and complexity of the user interface

Among the technologies studied in this project, the type of system with the most complex user interface was the navigation system. An item on the navigation survey asked respondents how they felt about the complexity of their navigation system (based on the number or features/functions). Younger respondents were much more likely than older respondents to say their systems were too simple and wished more things could be done with them. In contrast, older respondents were more likely than younger respondents to say that the systems were too complex, and wished they didn't have so many different functions. Table 12 summarizes these responses by age group. Among the younger group, male respondents were more likely than female respondents to say that their systems were too simple (22 versus 15%).

Table 12. Perceived complexity of the navigation system by age group

Frequency (Col. Pct.)	Younger than 65	65 or Older	Total
Too simple, I wish I could do more things with it.	190 (19.19)	38 (8.90)	228 (16.09)
About right in terms of complexity and number of features/functions.	647 (65.35)	277 (64.87)	924 (65.21)
Too complex, I wish that it didn't have so many different functions.	153 (15.45)	112 (26.23)	265 (18.70)
Total Row Pct.	990 69.87	427 30.13	1417 100.00

On the ACC survey respondents were asked if they had been confused about the speed and following distance settings on their system. Overall, 78 percent of respondents said that they were "not at all" confused about their ACC setting for speed and 75 percent said that they were "not at all" confused about their ACC setting for following distance. The results did not depend significantly on the respondent's age group. The likelihood of being confused about ACC following distance settings decreased with the respondent's level of experience. Among younger but not older drivers confusion about speed settings was related to gender. As

compared to female respondents, a higher percentage of young male respondents said that they were "not at all" confused about their ACC setting for speed (67 versus 85%).

Perceived demands of various navigation system activities

Respondents to the navigation survey were asked, "How demanding are each of these navigation system activities while you are driving?" They were then given a list of six activities where they may have used the navigation system while driving, and a response scale which included "Not at All Demanding," "Slightly Demanding," "Somewhat Demanding," "Very Demanding," "Extremely Demanding," and "Not Applicable." For each activity, the perceived demand was compared between older and younger respondents. For several of the items, older respondents were more likely than younger respondents to say that the activity described was not applicable to them, and as compared to younger respondents, older respondents tended to say that the activities were more demanding. One exception to this pattern of results was the activity of listening to turn-by-turn directions while driving. As compared to older respondents, a greater percentage of younger respondents found this activity to be demanding.

- Manually entering a new street address while driving. A third of the respondents (34%) said that this item was not applicable. Thirty-one percent found the activity to be very demanding or extremely demanding. Twenty percent found it to be not all demanding or only slightly demanding. Younger respondents were more likely to say this activity was somewhat or slightly demanding. In contrast, older respondents were more likely to say this activity was extremely demanding. Furthermore, older respondents were more likely to respond, "Not applicable." This result may indicate that older respondents have been reluctant to even attempt this activity, or that their vehicles do not permit this action while in motion.
- Looking at an area map on the navigation screen while driving. A majority of respondents (59%) found this activity to be either not at all demanding or only slightly demanding. However, nearly 13 percent of respondents found it to be either very demanding or extremely demanding. Younger respondents were more likely to say that this activity was not at all demanding. Also, older respondents were more likely than younger respondents to respond, "Not applicable," possibly indicating that they do not use the system in this way.
- Reading turn-by-turn directions displayed on the navigation screen while driving. About half (51%) of the participants said that this activity was not at all demanding or only slightly demanding, whereas 15 percent of respondents found it to be either very demanding or extremely demanding. Younger respondents were more likely to say this activity was not at all or slightly demanding. Older respondents were more likely to feel this task is very demanding or extremely demanding. Also, older respondents were more likely to respond, "Not applicable."
- Listening to turn-by-turn directions while driving. Sixty-three percent of respondents found this activity to be not at all demanding and an additional 11 percent said that it was only slightly demanding. Approximately 10 percent found it to be either very demanding or extremely demanding. Younger respondents were more likely than

older respondents to say that this activity was somewhat demanding, very demanding, or extremely demanding.

A separate item on the navigation system survey asked respondents how much they agreed or disagreed with the statement, "I find that the navigation system distracts me too much from the task of driving." Overall, 7.5 percent of system owners agreed or strongly agreed with the statement. Older respondents were more likely than younger respondents to agree or strongly agree that the navigation system distracts them too much (10 versus 6%). Older men were the most likely to find the navigation system too distracting (10.1%), followed by older women (8.6%), younger men (6.4%), and younger women (5.7%).

7. Safety

Perceived safety of in-vehicle systems

In each of the five technology surveys, respondents were asked a similar question about their perceived safety using the system. The exact wording of this item varied slightly by survey:

- Overall, does having the backing aid make you a safer driver?
- Overall, does having the rear-view camera make you a safer driver?
- Overall, does having your HID and/or adaptive headlights make you a safer driver than if you had conventional headlights?
- Overall, does having the navigation system make you a safer driver?
- Overall, are you a safer driver using adaptive cruise control than you would be if you only used conventional cruise control?

Although no respondents were asked to directly compare the different target technologies to each other, the results of the different surveys are compared in Figure 14. A higher percentage of backing aid owners thought that their systems made them safer drivers than did owners of any other technologies. Owners of ACC systems were the least likely to say that their systems made them safer drivers.

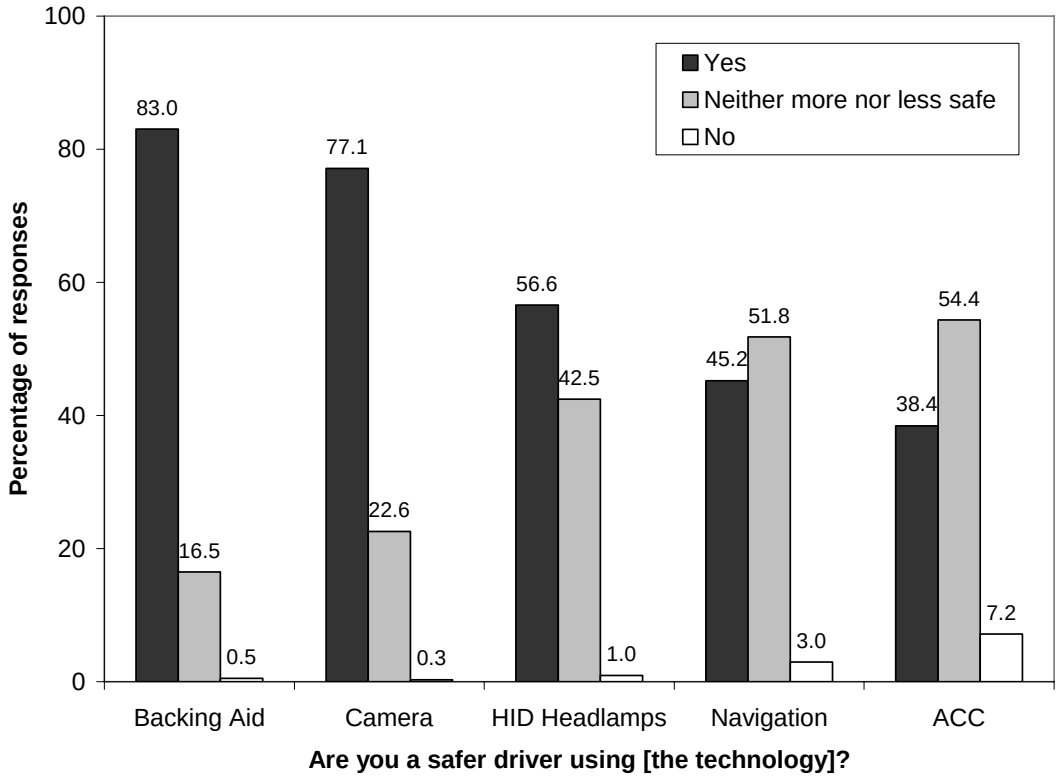

Figure 14. Perceived safety benefit of five in-vehicle technologies

Among navigation system owners and rear-view camera owners, the responses differed significantly by age group. Older respondents were less likely than younger respondents to say that having the technology made them safer drivers. On the navigation system survey, 48 percent of younger respondents and 39 percent of older respondents said that the navigation system made them safer drivers, while on the rear-view camera survey, 79 percent of younger respondents and 71 percent of older respondents said that the camera system made them safer drivers.

There were no statistically significant differences between the responses from men and women on the navigation, backing aid, and rear-view camera surveys, but there were some significant differences on the ACC and headlamp surveys:

- On the ACC survey, younger men were more than twice as likely as younger women to say that their ACC system made them a safer driver (45 versus 20%), and younger women were twice as likely as younger men to say that their ACC system made them less safe (12 versus 6%).
- On the headlamp survey, older men were more likely than older women to say that their HID headlamps made them safer drivers (56 versus 45%).

Safety concerns with in-vehicle systems

In four of the technology surveys respondents were asked whether using their system created any new driving problems or safety concerns for them. The exact wording of this item varied slightly by survey:

- Does using the backing aid create any new driving problems or safety concerns for you?
- Does using the rear-view camera create any new driving problems or safety concerns for you?
- Does using the navigation system create any new driving problems or safety concerns for you?
- Does your adaptive cruise control system create any new driving problems or safety concerns for you?

The percentage of respondents who said "yes" to this item was different on the four surveys as shown in Figure 15. Nearly 14 percent of respondents with ACC systems said "yes," while less than 3 percent of respondents with backing aid systems said "yes."

On the navigation system survey and rear-view camera survey, responses to this item were not significantly related to age group. However, on both the backing aid survey and the ACC survey, a higher percentage of younger than older drivers said that they had safety concerns about their systems. Approximately 4 percent of younger drivers had safety concerns about their backing aid systems and 18 percent of younger drivers had safety concerns about their ACC systems. Responses to this item were not significantly related to gender for any of the technology surveys.

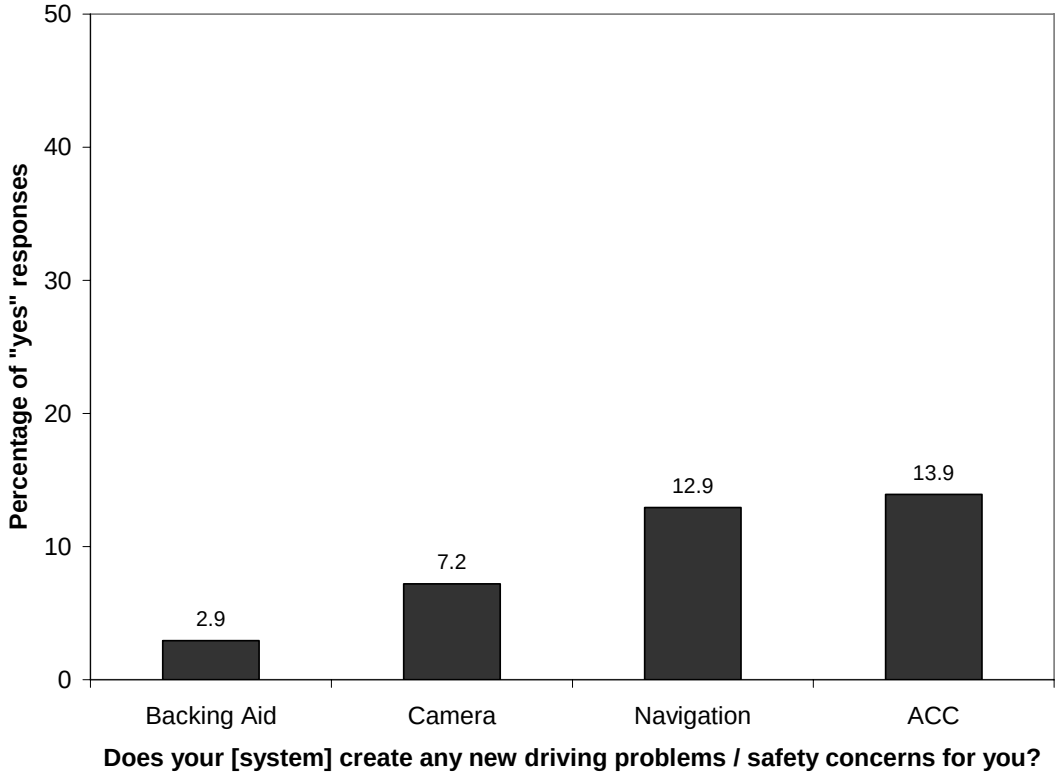

Figure 15. Owners' safety concerns with four in-vehicle technologies

8. Need for Improvements to In-Vehicle Technologies

Survey respondents were asked whether there is anything about their systems (targeted technology) that should be improved or changed. For each survey, the percentage of system owners who said "yes" to this question is shown in Figure 16. Owners of HID headlamps were the least likely to report a need for improvements and owners of navigation systems were the most likely to report a need for improvements. Responses to this item did not depend significantly on the system owner's gender or age group for any of the technologies studied, except for the backing aid. As compared to older owners of backing aids, a higher percentage of younger owners said that there was a need for improvements (22 versus 28%).

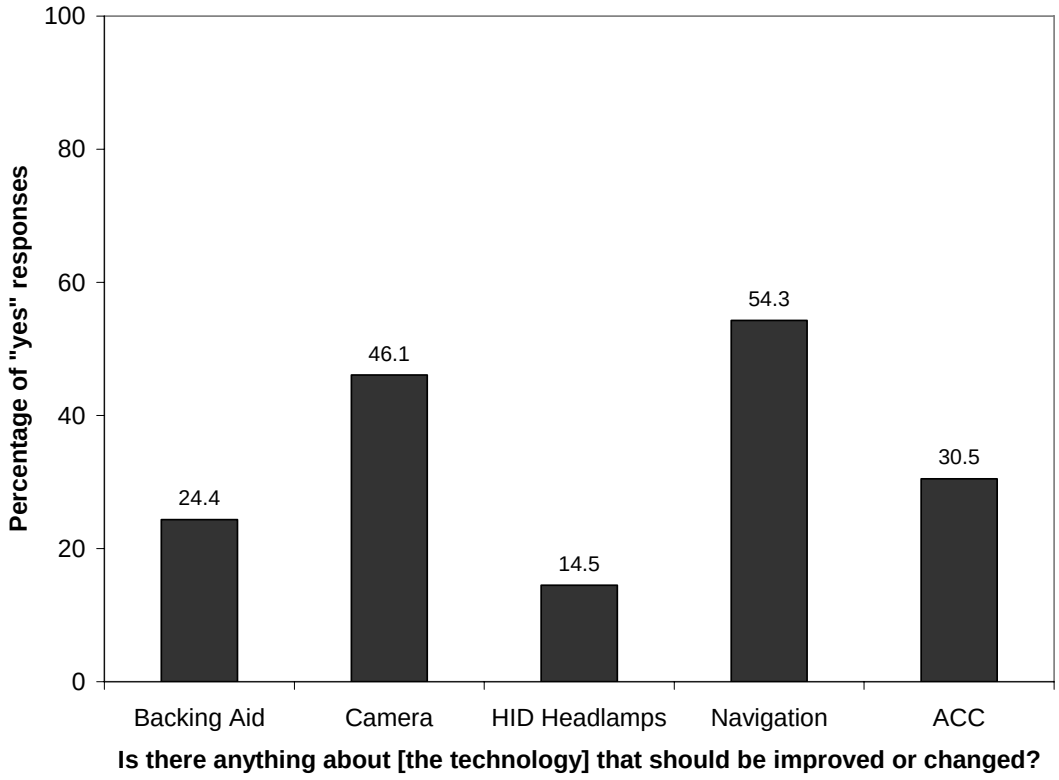

Figure 16. Need for improvements for five in-vehicle technologies

9. Are Automobile Manufacturers Meeting the Needs of Older Drivers?

Each the five technology questionnaires included the item: "In general, do you believe that car manufacturers are doing enough to design vehicles to accommodate an aging population?" Although the wording of this question was the same for all five surveys, the availability of "Don't know" as a listed response option on the questionnaire apparently had a strong influence on the results. On the questionnaires for backing aid systems, rear-view camera systems, adaptive cruise control systems, and navigation systems, the only response options listed for this item were, "Yes" and "No." Instead of choosing one of these two options, some respondents wrote in the response, "Don't know" for this item. For the headlamp survey, "Don't know" was listed on the questionnaire as a third valid response option.

The responses from the surveys on backing aids, rear-view cameras, navigation systems, and adaptive cruise control were very similar and have been combined in Table 13. Results from the headlamp survey are also shown. Nearly three times as many respondents said, "yes" as opposed to "no," in the combined survey results but less than twice as many respondents said "yes" as opposed to "no" on the headlamp survey. It seems likely that many people who said "yes" to this item when given only yes/no alternatives would have preferred to say that they didn't know if they were given this response choice. In retrospect, it doesn't seem like most respondents would have a good factual basis for answering this question.

Table 13. Perception of whether vehicle manufacturers are doing enough to design vehicles to accommodate an aging population

Frequency (Col. Pct.)	Backing Aid, Camera, Navigation, & ACC Surveys	Headlamp Survey
Yes	4110 (72.11)	701 (35.66)
No	1374 (24.11)	385 (19.58)
Don't Know	*216 (3.79)	880 (44.76)
Total	5700 (100.00)	1966 (100.00)

*Don't Know was not offered as a response category; these people wrote, "don't know" on their questionnaires

DISCUSSION OF SURVEY RESULTS

The first part of this report focused on selected results from five targeted surveys of vehicle owners who had a sensor-based backing aid system, a rear-view video camera, HID headlamps, adaptive cruise control, or a factory-installed navigation system. The complete set of results for each item in each of the five technology surveys can be found in the other reports in this series on backing aids (including sensor-based systems and rear-view video systems), advanced headlamp systems, adaptive cruise control, and navigation systems (Jenness et al., 2007, 2008a, 2008b, 2008c).

A goal of this report was to compare the technologies where possible. Differences between drivers' experiences with the technologies were emphasized by comparing answers to similar questions from the different surveys. This method of comparison has the disadvantage that different samples of vehicle owners responded to the five different surveys, so no respondents were asked to directly compare one technology to another. Nevertheless, several interesting differences between respondents' perceptions of the different in-vehicle technologies emerged. For example, owners were most likely to have safety concerns about ACC and navigation systems. The backing aid system seems to be the most well-liked technology overall, as it had the highest percentage of system owners who would want to get the system again. The technology with the lowest percentage of respondents who cited a need for improvements was HID headlamps.

A second goal of this report was to consider differences between older and younger system owners. Understanding the impact of age and the differences between technologies was complicated by the fact that the distribution of ages and gender were different across the five surveys. For example, the respondents with a backing aid system tended to be older (median age = 69 years) than the respondents with a rear-view camera (median age = 51 years). In addition, across all the technologies, the older respondents were more likely to be male. The largest difference was on the ACC survey, where the mean age of males was 63 compared to 50 for females. If women and men generally have different responses to, or experiences with the technologies, then these differences will likely affect the bivariate relationship between age group and other variables. In fact, several interesting differences in responses were found between older and younger drivers and between male and female drivers. The Executive Summary, above, provides a concise summary of key findings by topic area.

Although backing aid systems, adaptive cruise control systems, rear-view camera systems, navigation systems and HID headlamps have been marketed primarily as convenience features rather than safety systems, it is clear that many drivers believe that these systems make them safer drivers. Unfortunately, system owners often do not understand the limitations and manufacturers' warnings. Both the backing aid systems and the ACC systems suffer from misconceptions about how well the systems will help the driver avoid collisions under circumstances where the systems were not designed to work, or are not capable of reliably assisting.

There are several related findings that suggest a need for additional research. For example, for some men tended to be more aware than women of system limitations, and men (particularly older men) were also more likely to have learned about their systems from reading the vehicle owner's manuals, where these warnings and limitations are spelled out.

On the other hand, for some men were more likely than women to have learned about their systems from on-road experience (trial and error), and there is some indication that the apparent misconceptions about situations where ACC would be help drivers to avoid collisions is greater among drivers who have more experience with their vehicles (miles driven). It is also possible that although manufacturers provide warnings about certain situations where the systems may not function reliably, experienced drivers may find that the systems do provide some benefit even if they don't function perfectly in these circumstances.

Although this study did not examine which are the best ways to communicate information to vehicle owners about system limitations, safety warnings, and general tips about how to use the technologies, it is clear from the results that older and younger drivers and men and women have different preferences for how they like to learn about the systems. Older men tend to read the vehicle owner's manuals while women are more likely than men to get help from a friend or relative. Perhaps women in particular would benefit from more time spent learning about the technologies with hands-on instruction at the dealership. Alternatively, perhaps vehicle owner's manuals could be better designed to appeal to women, or written with older drivers in mind, such as with larger typefaces.

Navigation systems have the most complex user interface and greatest number of functions of any of the technologies studied. Older respondents were more likely than younger respondents to say that their system was too complex. This may be reflected in their reduced rate of system usage as compared to younger drivers, and their reduced usage of several specific navigation system functions as compared to younger drivers. Although a majority of older and younger drivers found the level of complexity of their systems to be "just right," there are a substantial number of drivers who would likely benefit from a simpler user interface on the navigation systems.

THE ROLE OF THE AUTOMOBILE INDUSTRY IN ADDRESSING OLDER-DRIVER ISSUES: INPUT FROM EXPERTS AND STAKEHOLDERS

In recent years, a national debate has emerged regarding older drivers, with much of it focused on driver screening, training, and road improvements. In addition, vehicle manufacturers indicate that they are making plans to better accommodate and serve the aging population. However—at least anecdotally—many experts are disappointed with progress of government and private sector efforts to address older-driver issues. Thus, this portion of the study sought to determine how, and the extent to which, automobile manufacturers take the needs of the aging population into account when planning and designing new vehicles and new in-vehicle technologies. Additionally, it investigated what barriers automobile manufacturers perceived to introducing new designs or technologies that they believed would be beneficial. Interviews with other experts and stakeholders (outside of manufacturers) were also conducted to add perspective regarding what they believed the automobile industry could be doing—or should be doing—to accommodate the aging population.

Whereas the first part of this report describes input from drivers regarding their experiences with specific in-vehicle technologies, this chapter describes experts' input on the extent to which the automobile industry takes into account specific needs of the growing population of older drivers. This chapter is based on semi-structured interviews with representatives of automobile manufacturers, stakeholders, and other experts.

Methodology

A series of interviews were conducted with representatives of original equipment manufacturers (OEMs), regulators, medical practitioners, and professionals in the older-advocacy area. The potential interviewees were identified in an initial list compiled by the study partners (AAAFTS, ACSC, NHTSA, and Westat). Potential interviewees were contacted to request interviews, and were asked if they had recommendations for other people who should be interviewed as a part of this study. In all, 18 interviews were conducted with one or more participants from various organizations. People interviewed (hereafter "respondents"), their affiliations, and the interview dates are listed in Appendix B.

All interviews were conducted by Steven D. Mazor, manager of the Automotive Research Center of the Automobile Club of Southern California. To provide some structure and help respondents prepare for the interviews, the respondents were given written questions (see Appendix C) prior to the interview. However, the discussions were kept as informal as possible to foster an open exchange of ideas.

The purpose of these interviews was to explore the following issues:

- What additional in-vehicle technologies are being considered?
- Does consideration of the growing older-driver population play a role in what features are provided in each model?
- Are the OEMs doing enough to accommodate the aging population?
- What new features are coming in the next few model years?

- Is anything being done differently in other markets (e.g., Europe, Asia) with regard to vehicle design and accommodating the aging population?
- What can government agencies do to help enhance safety and ensure vehicles are designed with older drivers in mind, and what can government do to educate the public?
- Will new safety technologies result in motorists driving longer, even when it is no longer safe for them to drive?

Respondents were asked for consent to have their interviews recorded on audiotape, and the interviews of those who consented were recorded. Respondents were also asked for consent to have their responses attributed to them in this report; all respondents who are identified by name in this report consented to having their responses attributed to them.

Findings

In general, the respondents considered "older drivers" to be people 65 and older. Some respondents reported that for marketing purposes, older drivers may be segmented into "early seniors" (age 65 to 74) and "older seniors" (75 and older). However, many respondents said that they consider age to be a poor predictor of degrading driving skills, and that different levels of functional capabilities were more important than chronological age when determining a person's ability to drive a vehicle safely.

The main areas of concern that respondents mentioned with regard to older drivers' driving ability were: reaction time, vision deficits, sensitivity to glare, difficulty with multitasking, and decreased strength and flexibility. Respondents also mentioned that some older drivers lose confidence in their own driving ability, and that there is a "stigma" associated with being an older driver.

There appeared to be general consensus among respondents that not enough was being done to meet the mobility needs of older drivers. Respondents mentioned concerns that some older drivers lacked alternative modes of transportation and thus would have difficulty restricting their driving or ceasing to drive even if they felt that it was no longer safe. More on point for the study, respondents suggested a variety of adaptive technologies and other vehicle design issues that they believed could be beneficial to older drivers (AAA has a consumer guide called "Smart Features for Mature Drivers," which is available at: www.AAA.com/Seniors). Respondents discussed vehicle safety, and others raised issues pertaining more to the comfort and convenience of older drivers.

In the safety realm, respondents mentioned physical fragility and concerns about the greater likelihood of older drivers being injured when involved in crashes. They mentioned collision avoidance systems that would enable vehicles to avoid crashing altogether, and also improved crashworthiness, which was noted to be of particular concern to older occupants due to their increased fragility and increased risk of being injured in crashes. A representative of AARP specifically recommended that vehicles should be crash-tested using dummies that would simulate older occupants, and that more air bags (especially side air bags) are needed.

Comfort- and convenience-related technologies that respondents suggested would be useful for older drivers were mainly of the variety that would compensate for diminished strength and flexibility. These included "smart seats," mirrors, steering wheels, etc., that would

automatically move to pre-set positions in response to the driver's key fob, seat belts that were easier to buckle, improved ease of entry and exit from vehicles, lighter-weight doors, and adjustable pedals.

Despite the general consensus that not enough was being done to address the needs of older drivers, representatives from the automobile manufacturers reported that their companies do not tailor models, features, or technologies to older drivers or to any specific age group. In general, they reported that their companies offered technologies intended to assist all drivers, and many commented that such technologies were likely to be particularly helpful for older drivers.

Several of the respondents discussed the pitfalls of having models that appeared to be designed for older drivers. This was attributed in part to their perception that the market is youth-oriented and that being labeled an older person's vehicle would result in low sales, even among older drivers. However, some noted specific counterexamples to this general practice of not marketing to any specific age group. For example, the Toyota representative noted that Toyota's Scion Division is aimed at younger drivers specifically. The Infiniti representative mentioned that older drivers unexpectedly liked Infiniti's FX, which he characterized as a sporty SUV.

Several of the respondents outside the automotive industry gave examples of age-specific technologies as well. For example, Jeff Finn, a consultant for the American Society on Aging, noted that adjustable pedals have been well received. Bruce Kynaston of the California Highway Patrol said he believed navigation systems could be beneficial for older drivers, but that older drivers have been hesitant to embrace this technology. He also noted that rear-view cameras have been embraced by older drivers.

What new technologies are on the horizon?

Representatives of automobile manufacturers were asked what new technologies their companies were considering or planning to introduce into their vehicles in the future. Most of the technologies that they mentioned were either intended to improve driver comfort or help avoid crashes, but again, none of these were designed specifically for older drivers.

- Volvo mentioned a technology called the Intelligent Driver Information System, or IDIS, which monitors the driver's level of activity (e.g., changes in speed, steering wheel activity) and withholds information (e.g., a cell phone call or route guidance information) during driving conditions determined to be demanding; the system presents that information to the driver when there are fewer demands, such as on straight road segments or at constant-speed driving. Volvo also mentioned that it was considering including a forward collision warning system on some vehicles in the future. Such a system would provide some sort of warning (e.g., an audible warning) to the driver if the system detected there was danger of a frontal collision. Volvo also mentioned a technology called Driver Alert, which monitors the vehicle's position within the lane, and provides a warning if it detects that the driver is deviating from usual behavior.
- Representatives of Infiniti and Ford mentioned they were considering forward collision avoidance systems that would apply the vehicle's brakes in the event that the system detected that there was danger of a frontal collision. These systems are

different from ACC in that the cruise control does not need to be operating; the collision avoidance system is always on.

- Infiniti and Ford representatives also mentioned a lane departure warning system, which would provide a warning to the driver if the system detected that the driver was in danger of driving out of the vehicle's lane without applying the turn signal. Ford also noted that it was considering lane departure prevention systems that would keep the vehicle in its current lane unless the driver applied the turn signal or manually overrode the system. The representative of Nissan/Infiniti also noted that it was considering lane departure prevention systems.
- The Lexus representative mentioned that Lexus was considering including double-chamber air bags on more vehicles in the future. These would reduce injuries when vehicle occupants collide with the air bag in lower-severity collisions.
- DaimlerChrysler (now split into separate Chrysler and Daimler companies) mentioned that it was considering incorporating four-point seat belts in some vehicles.
- All manufacturers noted plans to improve or expand the deployment of electronic stability control systems. These systems use sensor-based technology similar to that used in anti-lock brakes, but in this application, they are intended to prevent the vehicle from skidding sideways or spinning out of control.
- Toyota mentioned "four corners" rear-view sensors (already available on the Sienna minivan), which would detect objects to the sides and rear of the vehicle when the vehicle is backing up.
- DaimlerChrysler and Ford both mentioned raising the seating position to improve the driver's visibility, and DaimlerChrysler also mentioned improving night vision technology (anti-glare).

How do older drivers deal with new technologies?

In response to questions regarding whether or not respondents felt that older drivers were comfortable using new technologies, respondents indicated that they believed that older drivers were comfortable approaching new technologies provided the technologies were intuitive and not too complicated to learn how to use. However, respondents also noted that some older drivers tend not to embrace new technology, and that some view new technologies as "just something else to break."

A common thread across interviews was the belief that the next cohort of older drivers (the baby boomers) would be more likely to embrace new technologies. The thinking was that baby boomers have been exposed to computers, whereas, in general, the current older-driver cohort has not had as much exposure to computers and computer-based technologies.

Obstacles to adoption of new technologies

A variety of responses were obtained when respondents were asked what obstacles they believed stood in the way of offering more vehicle technologies for older drivers in the United States. Obstacles included: senior's vision limitations; the cost of new technologies; lack of

educational options to train older drivers about their deficiencies, inform them about new technologies, and how to use them; and a sense that many older drivers are already feeling overwhelmed and have lost confidence in their abilities to take on new things. One automobile manufacturer suggested that the Federal Motor Vehicle Safety Standards should be more "performance-based," and that the existing standards acted to stifle innovation.

Several of the respondents representing automobile manufacturers stated that motorists do their own cost/benefit analysis when deciding which options to purchase. For example, customers may be willing to pay for an entertainment system that they expect to use regularly but will not pay the same amount for a safety system that may never be used. Manufacturing representatives mentioned the downside of bundling safety technologies such as lane departure warning and rear view cameras, as this can result in expensive option packages that lower market penetration.

All respondents were also asked if there were technologies that could potentially benefit older drivers, but that would likely not be accepted by the market. Respondents felt that technologies that would take control of the vehicle completely away from the driver (e.g., automated driving) could be beneficial to safety, but would not be accepted. Telematics systems that constantly transmit information about the vehicle, such as its location and speed, were mentioned by some respondents who felt they might not be accepted.

Will technologies result in more people driving when it's no longer safe?

Respondents were also asked whether or not they believed that technologies might encourage older drivers to continue driving even when it was no longer safe for them to do so. Responses varied; some responded "no," the technologies will not cause people to drive when it was no longer safe, and some said "yes," it might happen." Debbie Ricker, then an occupational therapist and director of Driving Testing Program at Leisure World in Orange County, California, provided an example of an elderly woman who continued driving because "her car [which had a navigation system] knew where it was going." Several respondents mentioned that too much technology could lead to overconfidence not only in older drivers but also in other groups, including people with disabilities, younger drivers, and those who tend to drive aggressively.

What can the government do to improve senior safety and mobility?

Respondents were asked what they believed the government could do to improve senior safety and mobility. A couple of respondents took issue with the way NHTSA sets standards and the way they determine compliance, but not with the standards themselves. For instance, Volvo suggested that NHTSA standards are not as "performance-based" as they could be and that NHTSA test methods often stand in the way of new developments that could improve safety.

There seemed to be a general consensus that improved mobility management and more transportation services for older drivers are necessary. Specific responses dealt with vehicle technologies, road design, and licensing policies, as well as the need for supplemental transportation programs (see Supplemental Transportation Systems for Seniors II, http://www.aaafoundation.org/reports).

For example, Patti Yanochko Horsley, project coordinator at the Center of Injury Prevention Policy and Practice at San Diego State University, indicated that more training is needed for healthcare providers on screening and referrals, and she also mentioned that engineering

modifications such as the size and retro-reflectivity of roadway signage and vehicle crashworthiness could benefit older drivers. Dr. Jan Polgar, chair of the health and rehabilitation sciences department at the University of Western Ontario, recommended standardization of vehicle controls and displays. Another example mentioned by one respondent was that in Belgium the government helps older drivers obtain adaptive equipment for their vehicles.

DISCUSSION OF INTERVIEWS

Are manufacturers doing enough to design vehicles to accommodate older drivers? Answers seemed to depend on who was asked. Responses from the representatives of auto manufacturers suggested that they thought they were doing enough, not by specifically designing cars for older drivers, but by considering safety in general, which they expected would help all drivers, including older drivers. Responses from experts who were not representing the manufacturers generally suggested that more could and should be done to specifically design vehicles, technologies, and roads, and to provide supplemental transportation systems for older drivers that would improve safety and mobility.

In contrast, in the mailed surveys, when Auto Club members were asked whether auto manufacturers were "doing enough" to accommodate the aging population, the majority of respondents to the backing aids, camera, navigation, and adaptive cruise control surveys responded affirmatively, that is, that vehicle manufacturers were doing enough. However, although only speculation, it is possible that respondents who had never before thought about the issue were unable to imagine what else could be done, and thus did not think that they had any reason to respond negatively. In retrospect, it doesn't seem like most respondents had a good basis for answering the question. In the headlamp survey – the only survey that included a "don't know" category – 45 percent of respondents answered, "don't know."

Although for the most part, representatives from auto manufacturers reported vehicle designs were rarely if ever done specifically for older drivers, that's not to say they haven't done age-based research. For instance, one Ford representative noted that Ford has done considerable research differentiating between young and older drivers, and indicated that younger drivers have higher levels of skill and faster "transactions," but older drivers have more experience to draw on and better compensatory skills. Younger drivers tend to learn how to use new technology faster, but older drivers can integrate it into their driving better, according to the Ford representative. It's likely that all the manufacturers do similar research, but the Ford representative was the only one who actually mentioned any such age-specific research.

Again, many of the respondents' suggestions regarding what could be done to improve senior safety and mobility included recommendations that could arguably be beneficial to all drivers (e.g., improved vehicle crashworthiness, easier-to-read road signs, and standardization of vehicle controls). As several manufacturers' representatives noted in their interviews, many technologies that are designed to be helpful for all drivers may be particularly helpful to older drivers, and likewise, many technologies that are helpful to older drivers are likely to be beneficial to all road users.

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APPENDIX A. QUESTIONNAIRE ITEMS

All questionnaire items for the five in-vehicle technology surveys are shown in Tables A-1 to A-5. Items are grouped by their key topic area. Note that some items may apply to more than one topic area, but they are listed here only under their primary topic area. The number preceding each item indicates the order of the item as it appeared on the original questionnaire.

Table A-1. Backing aid system questionnaire: Content areas and associated items

Background	1. Age 2. Gender 3. Do you have physical conditions which make driving more difficult? 4. A backing aid system helps the driver back up by providing sounds, lights or symbols when the vehicle is near an obstacle. Does your vehicle have a system like this? 4A. If no, then why not? 4B. If you purchased this same vehicle again would you want the backing aid system? (for those who do not currently have a backing aid system) 6. Approximately how many miles have you personally driven this vehicle?
Acceptance	5. If you purchased this same vehicle again would you want the backing aid system? (for those who currently have a backing aid system)
Learning	7. How did you learn to use your vehicle's backing aid system? 9. How easy was it to learn how to use your vehicle's backing aid system to judge the distance to objects behind your vehicle? 10. Were there things that were especially difficult to learn about your vehicle's backing aid system? 10A. If yes, please explain.
Behavioral Adaptation to System	11. In the last two weeks, did you ever use just the backing aid system when backing without checking the mirrors or turning to look out the rear view window? 12. Imagine that your vehicle's backing aid system broke down. How would your driving behavior change if you could not use your vehicle's backing aid system? 18C. When I use the backing aid, I use my mirrors less often than I would if I did not have the backing aid (strongly disagree, disagree, neutral, agree, strongly agree, not applicable). 18D. When I use the backing aid, I look over my shoulder less often than I would if I did not have the backing aid (strongly disagree, disagree, neutral, agree, strongly agree, not applicable). 18E. I am more confident in my ability to detect pedestrians when I use the backing aid (strongly disagree, disagree, neutral, agree, strongly agree, not applicable). 18F. I am more willing to park in small or difficult parking spaces when I use the backing aid (strongly disagree, disagree, neutral, agree, strongly agree, not applicable). 19. How has your reliance on the backing aid system changed since you first got the vehicle?
Perceived Effectiveness	13. Please rate how well the backing aid would assist you to avoid colliding under the following circumstances 13A. You are slowing backing out of a driveway into the street. There is a car that you can't see approaching on the street as you begin to back into its path. 13B. You are backing quickly down a long driveway, going about 10mph. There is a bicycle behind you that you didn't see. 13C. You begin to back out of a garage and there is a child immediately under the rear bumper. 13D. You are slowly backing out of a parking space and there is a pedestrian standing 10 feet behind your rear bumper. 13E. You are backing up to a narrow sign post 13F. You are backing into a parallel parking space. The space is tight and you have to back very close to the car behind you.

	14. How well does your vehicle's backing aid system work in the following weather conditions? 14A. Darkness 14B. Fog 14C. Cold temperatures 14D. Rain 14E. Snow 14F. Bright sun 14G. Are there any other conditions where your vehicle's backing aid system does not work well? 18G. The backing aid gives me a good idea of my distance from an obstacle (strongly disagree, disagree, neutral, agree, strongly agree, not applicable). 18H. The backing aid gives alerts with enough time to avoid hitting an obstacle (strongly disagree, disagree, neutral, agree, strongly agree, not applicable). 18I. The backing aid gives too many false warnings when I am not in danger of hitting anything (strongly disagree, disagree, neutral, agree, strongly agree, not applicable). 18J. The backing aid fails to warn me about an obstacle when it should have (strongly disagree, disagree, neutral, agree, strongly agree, not applicable). 22. Suppose the diagram below shows an overhead view of your vehicle. Based on your experience, write an "X" in all rectangles where you think your backing aid system would detect a small child and give you a warning. (diagram shown).
User Interface and Usability	15. If your vehicle's backing aid system has both lights/symbols and sounds, which do you rely on more? 18A. It's easy to hear the sounds made by the backing aid system (strongly disagree, disagree, neutral, agree, strongly agree, not applicable). 18B. It's easy to see the lights/symbols on the backing aid system (strongly disagree, disagree, neutral, agree, strongly agree, not applicable).
Safety	8. Are you aware of any warnings or limitations about your vehicle's backing aid system? 8A. If yes, please explain. 16. Have you ever unintentionally backed into something or had a "close call" since you started driving this vehicle? 16A. If yes, please describe the situation. 17. Since you have owned this vehicle, have you driven another vehicle without a backing aid system and backed into something or had a "close call" because you expected the vehicle to give you a warning? 20. Have you ever received an unexpected warning when backing because you didn't know what was behind your vehicle? 20A. If yes, then how did you react the last time this happened? 20B. If yes, what was the reason for the last unexpected warning? 21. Overall, does having the backing aid system make you a safer driver? 23. Does using the backing aid create any new driving problems or safety concerns for you? 23A. If yes, please explain.
Need for Improvements	24. Is there anything about the way that the backing aid system works that you think should be improved? 24A. If yes, please explain. 25. In general, do you believe that car manufacturers are doing enough to design vehicles to accommodate an aging population? 25A. If you answered "no" then what more do you believe could be done?

Table A-2. Rear-view camera questionnaire: Content areas and associated items

Background	1. Age 2. Gender 3. Do you have any physical conditions which make driving difficult? 4. A rear-view video camera shows the driver the area behind the vehicle when you are backing on a screen inside the vehicle. Does your vehicle have a rear-view video camera? 4A. If no, then why not? 4B. If you purchased the same model vehicle again would you want a rear-view camera? (for those who do not currently have a camera) 6. Approximately how many miles have you personally driven this vehicle?
Acceptance	5. If you purchased this same model again would you want a rear-view camera? (for those who currently have a camera)
Learning	7. How did you learn to use your vehicle's rear-view camera? 9. How easy was it to learn how to use your vehicle's rear-view camera to judge the distance to objects behind your vehicle? 10. Were there things that were especially difficult to learn about your vehicle's rear- view camera? 10A. If yes, please explain.
Behavioral Adaptation to System	11. In the last two weeks, did you ever use just the camera when backing without checking the mirrors or turning to look out the rear window? 12. Which of the following best describes how much you would normally pay attention to the rear-view camera when backing? 13. Imagine that your vehicle's rear-view camera broke down. How would your driving behavior change if you could not use your vehicle's rear-view camera any more? 17. How has your usage of the rear-view camera changed since you first got the vehicle? 19B. I am more confident in my backing abilities when I use the rear-view camera (strongly disagree, disagree, neutral, agree, strongly agree). 19C. I am more willing to park in small or difficult parking spaces when I use the rear-view camera (strongly disagree, disagree, neutral, agree, strongly agree).
Perceived Effectiveness	15. How well does your vehicle's rear-view camera work in the following weather conditions? 15A. Darkness 15B. Fog 15C. Cold temperatures 15D. Rain 15E. Snow 15F. Bright sun 15G. Are there any other weather conditions where your vehicle's rear-view camera does not work well? 18. Suppose that the diagram below shows an overhead view of your vehicle and areas labeled "A" – "Q". Based on your experience, please circle the letters for all areas where your rear-view camera would show you obstacles such as a small child sitting on the ground (diagram shown).
User Interface and Usability	14. If your vehicle's rear-view camera display has lines, graphics or text information on the screen, do you find these useful? 16. Overall, how easy is the rear-view camera to use when backing out of a driveway? 19A. The rear-view camera is in a location where it is easy to see when I am backing (strongly disagree, disagree, neutral, agree, strongly agree). 19D. It's easy to tell how close I am to an obstacle by looking at the rear-view camera display (strongly disagree, disagree, neutral, agree, strongly agree). 19E. The rear-view camera does not show the entire area behind the vehicle that I need to see when backing, in other words there is a blind spot (strongly disagree, disagree, neutral, agree, strongly agree). 19F. The rear-view camera display gets blurry or hard to see if I am moving (strongly disagree, disagree, neutral, agree, strongly agree).

	19G. The rear-view camera gets dirty and makes obstacles hard to see (strongly disagree, disagree, neutral, agree, strongly agree). 19H. Sun glare on the video display makes it hard for me to see objects or people (strongly disagree, disagree, neutral, agree, strongly agree). 19I. It's hard to distinguish something or someone who may be in the shadow area behind my vehicle (image contrast level is poor in the camera) (strongly disagree, disagree, neutral, agree, strongly agree).
Safety	8. Are you aware of any warnings or limitations about your vehicle's rear-view camera? 8A. If yes, please explain. 19J. My risk of hitting somebody while backing is lower with the rear-view camera than without it (strongly disagree, disagree, neutral, agree, strongly agree). 20. Have you ever unintentionally backed into something or had a "close call" since you started driving this vehicle? 20A. If yes, were you using the camera at the time? Please describe the situation. 21. Does using the rear-view camera create any new driving problems or safety concerns for you? 21A. If yes, please explain. 22. Overall, does having the rear-view camera make you a safer driver?
Need for Improvements	23. Is there anything about the rear-view camera that you think should be improved? 23A. If yes, please explain. 24. In general, do you believe that car manufacturers are doing enough to design their vehicles to accommodate an aging population? 24A. If you answered "no" then what more do you believe could be done?

Table A-3. Headlamp systems questionnaire: Content areas and associated items

Background and Knowledge about Headlamps	1. Age 2. Gender 3. Which of the following statements describe your vision? 4. Approximately how many miles have you personally driven this vehicle? 5. Did you test drive the vehicle at night prior to purchasing it? 14. Is your low beam headlight small and round, with an opaque lens (that you can't see though) similar to the one shown by the arrow? 15. Which photo looks more like the light pattern your headlights would project on a wall? 16. High Intensity Discharge (HID) (sometimes called Xenon headlights)-HID headlights appear slightly bluish-white as compared to the yellowish-white light of conventional Halogen headlights. Does your vehicle have HID or Xenon headlights? 16B. If no, then why didn't you choose to get a vehicle with HID headlights? 18. Adaptive (or "active") headlights can automatically change the direction of the light beam when you steer left or right on curved roads. On your vehicle, these headlights may be called "steerable headlights" or something similar. Does your vehicle have adaptive (or "active") headlights? 18B. If no, then why didn't you choose to get a vehicle with adaptive headlights?
Acceptance	17. If you purchased this same model vehicle again, would you want HID headlights? 19. If you purchased this same model vehicle again, would you want adaptive headlights? 22E. I prefer my headlights to conventional headlights
Behavioral Adaptation to System	6. Have you ever had the aim of your headlights checked or adjusted on this vehicle? 6B. If yes, why? 7. During the winter months, how often do you drive when it is dark outside? 21. If your headlight system had to be replaced with conventional headlights, how would your driving behavior change? 22A. I use the high beams less often than I would if I had conventional headlights (strongly disagree, disagree, neutral, agree, strongly agree) 22C. I am more willing to drive at night with my headlights than with conventional headlights (strongly disagree, disagree, neutral, agree, strongly agree). 22D. I am more willing to drive faster using my headlights' low beams than with the low beams from conventional headlights (strongly disagree, disagree, neutral, agree, strongly agree).
Perceived Effectiveness	9. How easy is it for you to see each of the following while driving at night? 9A. On curved roads, how easy is it for you to see lane lines using your low beams? 9B. How easy is it for you to read overhead road signs that are not lighted except by your headlights' low beams? 9C. On roads without street lights, how easy is it for you to see pedestrians on or near the road using your low beams? 9D. When you approach a hill how easy is it for you to see the roadway up the hill ahead using your low beams? 22B. I feel less eye strain driving at night with my headlights than with conventional headlights (strongly disagree, disagree, neutral, agree, strongly agree).
Safety and Headlamp Glare	8. When you drive at night, how often do other drivers "flash" their high beams at you even though you have your low beams on? 10. In the last six months, while driving at night, the light from oncoming vehicles generally has been: (Blinding/Disturbing, Annoying, Acceptable). 11. In the last six months, the light from oncoming vehicles has caused me to: (Block the light with my hands, Look to the right side of the roadway, away from the roadway directly ahead, Slow down or stop until the oncoming light has passed, Unintentionally drive off the edge of the road, Have a crash or close call, Limit the amount of driving that I do at night, avoid driving on unlighted two-lane roads, None of the above). 12. In the last six months, while driving at night, the light from vehicles behind me generally has been: (Blinding/Disturbing, Annoying, Acceptable).

	13. In the last six months, while driving at night, the light from oncoming vehicles behind me has caused me to: (Block the light with my hands, Move my head or eyes away from the light reflected from my mirrors, Turn the inside rear-view mirror to the "dim" position, or move the mirror itself, Slow down or stop until the vehicle has passed, or turned off the road, Unintentionally drive off the edge of the road, Have a crash or close call, Limit the amount of driving that I do at night, None of the above). 23. Overall, do your HID and/ or adaptive headlights make you a safer driver than if you had conventional headlights?
Need for Improvements	20. Is there anything about your headlights that you think should be improved? 20A. If yes, please explain. 24. In general, do you believe that car manufacturers are doing enough to design vehicles to accommodate an aging population? 24A. If you answered "no" then what more do you believe could be done?

Table A-4. Navigation system questionnaire: Content areas and associated items

Background	1. Age 2. Gender 3. Do you have physical conditions which make driving more difficult? 4. A navigation system shows maps on a screen and/or provides step by step driving directions to help the driver get to a chosen destination. Does your vehicle have a navigation system installed by the manufacturer? 4A. If no, then why not? 4B. If you purchased this same model again would you want a factory installed navigation system? (for those who do not currently have a navigation system) 6. Approximately how many miles have you personally driven this vehicle?
Acceptance	5. If you purchased this model again would you want a factory installed navigation system? (for those who currently have a navigation system) 7. How often do you use your vehicle's navigation system?
Learning	8. How did you learn to use your vehicle's navigation system? 10. Were there things that were especially difficult to learn about your vehicle's navigation system? 10A. If yes, please explain.
Behavioral Adaptation to System	14. Imagine that your navigation system broke down. How would you change the way you drive if you could not use your navigation system anymore? 16. How has your usage of the navigation system changed since you first started driving this vehicle? 21. For what types of trips do you use your navigation system? 22. How frequently do you use your navigation system in the following ways? 22A. Manually entering a new street address while parked. 22B. Manually entering a new street address while driving. 22C. Verbally entering destination information while parked. 22D. Verbally entering destination information while driving. 22E. Looking at an area map on the navigation screen while driving 22F. Reading turn-by-turn directions displayed on the navigation screen while driving. 22G. Listening to turn-by-turn directions while driving. 22H. Asking your passenger to control or get information from the navigation system while you are driving. 22I. Choosing the route that will take the shortest time. 22J. Choosing the route that is the shortest distance. 22K.Choosing a route to avoid major roadways. 22L.Choosing a route that will avoid traffic problems and congestion.
Perceived Effectiveness	12B. Does listening to voice directions reduce the amount of time that you look at the navigation screen? 15F. My risk of getting lost is lower with the navigation system than without it (strongly disagree, disagree, neutral, agree, strongly agree, not applicable). 15H. The navigation system does a good job rerouting me when I miss a turn (strongly disagree, disagree, neutral, agree, strongly agree, not applicable).
User Interface and Usability	11. Does your navigation system respond to spoken commands? 11A. Do you find this feature useful? 11B. How well does the system understand what you say? 12. While driving, do you prefer to listen to spoken turn-by-turn directions from the navigation system, or do you prefer to view directions on the screen? 12A. Why don't you prefer to listen to voice directions? 13. Thinking about the number of features/functions and complexity of your navigation system, would you say that your system is: (Too simple, I wish I could do more things with it, About right in terms if complexity and number of features/functions, Too complex, I wish that it didn't have so many different functions) 15A.The navigation system is in a location where it is easy to see when I am driving (strongly disagree, disagree, neutral, agree, strongly agree, not applicable).

	15B. The navigation screen is large enough to see easily (strongly disagree, disagree, neutral, agree, strongly agree, not applicable). 15E. Sun glare or reflections on the navigation screen often make it difficult to see maps or directions (strongly disagree, disagree, neutral, agree, strongly agree, not applicable). 23. How demanding are each of these navigation system activities while you are driving? 23A. Manually entering a new street address while driving. 23B. Verbally entering destination information while driving. 23C. Looking at an area map on the navigation screen while driving. 23D. Reading turn-by-turn directions displayed on the navigation screen while driving. 23E. Listening to turn-by-turn directions while driving. 23F. Choosing an alternative route while driving.
Safety	9. Are you aware of any warnings or limitations about your vehicle's navigation system? 9A. If yes, please explain. 15C. Using my in-vehicle navigation system is less distracting than using a paper map or road atlas (strongly disagree, disagree, neutral, agree, strongly agree, not applicable). 15D. Using my in-vehicle navigation system is less distracting than following printed directions (strongly disagree, disagree, neutral, agree, strongly agree, not applicable). 15G. I find that the navigation system distracts me too much from the task of driving (strongly disagree, disagree, neutral, agree, strongly agree, not applicable). 17. Does your current navigation system allow you to manually enter a new destination while you are driving? 18. Some navigation systems do not allow the driver to manually enter a new destination address while the vehicle is moving. Is this restriction acceptable to you? 19. Does using the navigation system create any new driving problems or safety concerns for you? 19A. If yes, please explain. 20. Overall, does having the navigation system make you a safer driver?
Need for Improvements	24. Is there anything about the navigation system that you think should be improved or changed? 24A. If yes, please explain. 25. In general, do you believe that car manufacturers are doing enough to design vehicles to accommodate an aging population? 25A. If you answered "no" then what more do you believe could be done?

Table A-5. Adaptive Cruise Control questionnaire: Content areas and associated items

Background	1. Age 2. Gender 3. Do you have physical conditions which make driving more difficult? 4. Conventional cruise control systems allow you to maintain a constant vehicle speed without keeping your foot on the accelerator pedal. Some newer vehicles also have adaptive cruise control (ACC). ACC adjusts your vehicle speed automatically to maintain a constant gap (headway) between your vehicle and the vehicle ahead. Does your vehicle have adaptive cruise control? 4A. If no, then why not? 4B. If you purchased this same vehicle again would you want adaptive cruise control? (for those who do not currently have ACC) 6. Approximately how many miles have you personally driven this vehicle? 27. Have you recently stopped (given up) driving?
Desire to Have System	5. If you purchased this same vehicle again would you want adaptive cruise control? (for those who currently have ACC)
Learning	7. How did you learn to use your adaptive cruise control system? 9. Were there things that were especially difficult to learn about your adaptive cruise control system? 9A. If yes, please explain.
Behavioral Adaptation to System	11. Does your vehicle have the option of using conventional cruise control without adaptive cruise control? 11A. If yes how, frequently have you been confused about which system is operating? 12. Compared to driving with cruise control off, how quickly do you notice and respond to unexpected road hazards when the adaptive cruise control is engaged (turned on)? 13A. If you could not use adaptive cruise control any more how would your driving change? 13B. If you could not use adaptive cruise control any more how much would you use conventional cruise control (constant speed control)? 14C. Using adaptive cruise control relieves me of stress when driving (strongly disagree, disagree, neutral, agree, strongly agree, not applicable). 14D. I tend to change lanes less frequently when using adaptive cruise control (strongly disagree, disagree, neutral, agree, strongly agree, not applicable). 14E. I tend to follow the vehicle ahead more closely when using adaptive cruise control (strongly disagree, disagree, neutral, agree, strongly agree, not applicable). 14F. I tend to set adaptive cruise control to a shorter gap (closer following distance) in heavy traffic than in light traffic (strongly disagree, disagree, neutral, agree, strongly agree, not applicable). 17. Do you normally use the same gap (headway) setting or do you adjust the gap based on driving conditions? 18. At what gap (headway) setting do you usually have the adaptive cruise control system set? 23. How has your reliance on adaptive cruise control changed since you first drove the vehicle?
Perceived Effectiveness	10. Under what conditions do you avoid using the adaptive cruise control system? 10A. Rain 10B. Snow 10C. At night 10D. In congested, “stop-and-go” traffic 10E. In heavy traffic that is flowing 10F. On interstate highways 10G. Freeways off ramps, or when exiting highways 10H. On curvy roads 10I. On neighborhood or city streets with traffic lights 10J. Are there any other conditions where you avoid using the adaptive cruise control system? 14G. My adaptive cruise control sometimes locks on to a vehicle other than the vehicle immediately in front of me(strongly disagree, disagree, neutral, agree, strongly agree,

	not applicable). 15. Please rate how well your adaptive cruise control would assist you to avoid colliding with the vehicle in front of you under the following circumstances 15A. You are following a vehicle in stop-and-go traffic. 15B. You encounter a stopped car in your lane ahead. 15C. You are following a vehicle on a curvy road. 16. How often have you encountered each of these situations? 16A. The adaptive cruise control system would slow unexpectedly when there was no vehicle immediately ahead of you. 16B. The adaptive cruise control system would brake abruptly or brake hard causing the vehicle behind you to get uncomfortably close, or to brake hard. 16C. The adaptive cruise control system would accelerate unexpectedly. 16D. You forgot to turn off the system. 16E. The system shut off unexpectedly.
User Interface and Usability	14A. The lights/symbols on the adaptive cruise control system are easy to understand (strongly disagree, disagree, neutral, agree, strongly agree, not applicable). 14B. The sounds made by the adaptive cruise control system are easy to understand (strongly disagree, disagree, neutral, agree, strongly agree, not applicable). 21. To what extent have you been confused about what speed the adaptive cruise control is set to? 22. To what extent have you been confused about what following distance the adaptive cruise control is set to?
Safety	8. Are you aware of any warnings or limitations about your adaptive cruise control system? 8A. If yes, please explain. 14H. More cars cut me off or pull in front of me when I am using adaptive cruise control (strongly disagree, disagree, neutral, agree, strongly agree, not applicable). 19. Since you have owned your vehicle with adaptive cruise control, have you driven any other vehicle equipped with only conventional cruise control and had a collision or a “close call” because you expected the vehicle you were driving to automatically slow down? 20. Does your adaptive cruise control system create any new driving problems or safety concerns for you? 20A. If yes, please explain. 24. Have you ever unintentionally collided with something when you had the adaptive cruise control system engaged (turned on)? 24A. If yes, please describe the situation 25. Overall, are you a safer driver using adaptive cruise control than you would be if you only used conventional cruise control?
Need for Improvements	26. Is there anything about the way the adaptive cruise control system works that you think should be improved or changed? 26A. If yes, please explain. 28. In general, do you believe that car manufacturers are doing enough to design vehicles to accommodate an aging population? 28A. If you answered “no” then what more do you believe could be done?

APPENDIX B. EXPERTS INTERVIEWED

Participants of AAAFTS Interviews:

Date	Participant	Title	Organization
2/15/2006	Bill Kwong	Senior Product Communication Technical Administrator	Toyota
2/24/2006	Bob Yakushi	Director, Product Safety & Regulatory Issues	Nissan
	Sumiyuki Shimizu	Manager, Technology & Global Communications	
3/3/2006	Dr. James Grisolia, M.D.	Co-Chairman of the Older California Traffic Safety (OCTS) Task Force	California Medical Association
3/7/2006	Jeff Finn	Senior Communications Consultant on special projects	American Society on Aging
3/8/2006	Patti Yanochko-Horsley, MHP	Program Manager, Center of Injury Prevention Policy and Practice	San Diego State University
3/9/2006	Thomas Broberg	Senior Technical Adviser	Volvo Safety Center, Sweden
	Dan Johnston	Volvo Product Communications	U.S. Volvo Public Relations
3/10/2006	Nina Weiler-Harwell	Program Coordinator	California AARP
	Audrey Straight	Coordinator	National Office of AARP
3/13/2006	Greg Thome	Lexus Publications Administrator	Lexus
3/16/2006	Dr. Jan Polgar	Chair of the Health and Rehabilitation Sciences Department	University of Western Ontario
3/20/2006			University of California, Irvine Healthcare, Orange, CA
	Camille Fitzpatrick, N.P., MSN	Health Sciences Clinical Professor, Family Medicine, Program in Geriatrics	
	Dr. Shahram Lotfipour, M.D.	Injury Control Research Assistant Clinical Professor, Director of Undergraduate Medical Education	
	Diane Winn, R.N., MPH	Center for Trauma & Injury Prevention Research, Child Injury & Traffic Safety Research Group	
3/22/2006	Debbie Ricker	Occupational Therapist & Director of Driving Testing Program	Leisure World, South Orange County, CA
	Dr. David Eby	Research Professor and Head of Social & Behavioral	University of Michigan Transportation Institute

		Analysis	
3/22/2006	Craig Copland		CALTRANS
3/23/2006	Lt. Bruce Kynaston	Commercial Vehicle Section	California Highway Patrol
	Paul Cooper	Certified Driver rehabilitation Specialist	Adaptive Driving School Program (subcontracts to hospitals throughout California)
3/28/2006	Kent Milton	Member of the Older California Traffic Safety Task Force	California Highway Patrol
3/29/2006	Richard Deering	Manager for Crash Avoidance Safety Integration Center	General Motors
	Tom Creech	Manager of Human Factors, Vehicle Engineering Organization	
	Brian Reba	Senior Technologist, Human Vehicle Interface in R&D Center	
3/30/2006	Heather May	Manager, Engineering Communications	DaimlerChrysler
	Steve Speeh	Director of Vehicle Safety Group	
3/31/2006	Prasad Venkatesh	Researcher for Advance Engineering Organization	Ford
	Mickey D'Armi	Advanced Product Strategy	
	Mike Shulman	Active Safety Research & Advanced Engineering	
	Jeff Greenberg	Researcher in Advanced Activity (studies driver behavior)	
	Andy Kozletski	Ford Public Relations	Ford
8/3/2006	Dennis McCarthy	National Older Driver Research and Training Center	University of Florida

APPENDIX C. EXPERT INTERVIEW PLAN

AAA Foundation for Traffic Safety
Emerging In-Vehicle Technologies and Driver Age Study

EXPERT INTERVIEW PLAN

This work product includes information about this study that will be provided to interviewees in advance of interviews, an interview guide and list of questions for use during the interviews.

Information for Interviewees

The Automotive Research Center of the Automobile Club of Southern California is collaborating with the AAA Foundation for Traffic Safety and the National Highway Traffic Safety Administration to study the use and user perceptions of selected current and emerging in-vehicle technologies that may have an impact on safety and mobility, with an emphasis on the needs of older drivers (65 and up). The project will address two distinct areas of inquiry:

- Identify and research existing and emerging in-vehicle technologies relevant to safer driving, with an emphasis on older drivers. This effort will address technologies that are currently available, those planned to be introduced, and others that should be considered in the future.

- Survey users of specific technologies to gain insight into their knowledge, understanding, use of, and satisfaction with these technologies.

In recent years, a national debate has emerged regarding senior driver issues, with much of it focused on driver screening, training, and road improvements. In addition, vehicle manufacturers indicate that they are making plans to better accommodate and serve the aging population. However, many experts are disappointed with the progress of government and private sector efforts to address senior driver issues, including the safety, consumer understanding, and proper use of new technologies.

When new in-vehicle technologies emerge on the market, they usually appear first on “top of the line” cars, which are often purchased by older drivers who can afford them. Thus, by default, a large proportion of drivers who have the first opportunity to experience and “test” emerging in-vehicle technologies tend to be older, potentially creating a safety problem for this growing segment of the motoring public, some of whom may have difficulty adapting to new technologies.

This project will produce the most comprehensive and up-to-date analysis of vehicle technologies that are available and describe what is known about their safety impacts. In addition, thousands of drivers who have experience with selected technologies will be surveyed to gain insight into any age-related differences in their understanding, acceptance, and use of the technologies. The project will increase

expert and public understanding of the safety implications of new in-vehicle technologies and provide information for automobile manufacturers and others regarding what consumers want, need, and should have in their vehicles.

Interview Guide and Questions

Our plan is to interview representatives of several key groups involved in vehicle technology and senior driver issues. These groups will include product planners from Original Equipment Manufacturers (OEMs), regulators and other government agencies involved with motor vehicles or senior drivers, and other professionals and academics concerned with senior advocacy, services, and studies.

The following list of questions is not a survey instrument, but instead it is a guide for interviewers on the topics to be addressed during each interview. (Part Two of the project includes a written survey that will be administered to over 40,000 consumers, including senior and other drivers, to ascertain their understanding and use of the selected technologies and need for other vehicle advancements.) The primary objective of the interviews is to better understand the roles, intents, and desires of the identified groups regarding relevant vehicle technologies and related issues, to inform the development of the consumer survey instrument, and to validate the list of selected, focus vehicle technologies.

Many of the following questions are appropriate for all groups. Some questions focus on the specific knowledge or point-of-view of a particular interviewee group and are categorized accordingly. However, interviewers will have the flexibility to draw on all appropriate questions and will pose additional questions as follow-ups to answers provided and/or to delve into relevant topic areas that surface during the interview.

<u>All Interviewees</u>

- How do you define a “senior” driver?
- What are your greatest concerns regarding senior drivers?
- Is enough being done to address the specific needs of senior drivers? If not, what else should be done?
- In general, how do you think senior drivers approach using new technologies?
- Are there obstacles to offering more vehicle technologies designed to aid senior drivers? If so, what are they and what can be done to overcome them?
- Are there technologies that you believe could help senior safety and/or mobility, but aren’t worth pursuing because seniors (or the public in general) simply won't use them?

- Are there cultural differences among senior drivers we should be considering, for instance, between Latinos, Whites, or Blacks?

- What are some examples of particularly successful or unsuccessful introductions of new technologies with regard to consumer acceptance and consumer understanding? What were the primary drivers of success or failure?

- What are some specific examples of technologies that have been unexpectedly embraced or rejected by drivers? Were their demographic trends or surprises in how drivers responded? Did older drivers respond differently than other drivers?

- What can government agencies do to help enhance the safety of senior mobility? What can they do regarding vehicle design/technology and related educations and use?

- Are you concerned that additional safety/convenience technologies may keep motorists driving longer than they should?

- When is it no longer safe for a senior to drive?

- Is anything being done differently to assist senior drivers in other parts of the world (Europe, China, or others)?

- Would you recommend someone else that works in this field or is knowledgeable in this area that we should speak with?

<u>Automobile Manufacturers</u>

- What role did consideration of the growing senior population play in the features and technologies offered on your vehicles? Are features and attributes of motor vehicles designed with specific age or driver ability groups in mind?

- Describe the “design user” for several of your most popular vehicles.

- Describe the “design user” for _____. [List each of this study’s focus technologies that are offered by the manufacturer being interviewed. Possible technologies: navigation systems, voice recognition, parking aids, adaptive cruise control, night vision, emergency brake assist, auto dimming rear view mirrors, lane departure warning systems, adaptive headlights, and HID headlights.]

- What role does the price of optional equipment play in the popularity and usage of new technologies?

- What technologies have you considered but did not include in vehicles because you believed seniors (or other drivers) simply wouldn’t use them?

- What new features or technologies are you planning for the next few model years that are likely to be attractive to seniors? Was the anticipated reaction of seniors taken into consideration in the development of the new features or technologies?

Senior Advocates, Service Providers, Researchers, and Government Agencies

- What would you like to see happen in automotive technology in the next few years that could be helpful to senior drivers?

- Are seniors more resistant to new technologies than the public in general? If so, in what ways? What can be done to overcome senior resistance and better enable them to learn about and properly use new technologies that may aid their driving?

- What are the greatest problems that seniors have in driving that are not addressed by current vehicle and technologies?

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