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Older Drivers' Acceptance of In-vehicle Systems and the Effect it has on Safety

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Older drivers make up the fastest growing segment of the driving population and are, in general, underrepresented in vehicle crashes due to their self-restrictive driving habits. However, as the baby-boomer generation ages into the population of older drivers, the presence of in-vehicle systems designed to counteract the physical and psychological changes of aging could change their habits. Using a literature review to identify systems, effects of aging, and crash statistics of older drivers, various in-vehicle system types were identified and rated for their potential to mitigate the effects of aging on driving performance and behavior. Focus groups were then held with two age groups of older drivers (55-64 and 65-75) to assess their acceptance of four different systems identified by the literature review. Data from the focus groups were factored into a final in-vehicle system matrix that rates system types’ benefits to older drivers based on their generalized ability to counteract the effects of aging, and older drivers’ acceptance of them. In-vehicle systems that alert drivers to potential hazards (e.g., a forward collision warning system) resulted in the highest safety rating while systems that facilitated a driver’s ability to control the vehicle (e.g., an anti-lock braking system) had the lowest safety rating. Overall, the younger age groups of older drivers were more trusting of the various safety systems and felt that drivers their age would want the various systems compared to the older age group. In contrast, the 65-75 year olds were less anxious and less concerned about becoming overly reliant on the different systems compared to the 55-64 year olds.</td></tr>
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List of Abbreviations

Mid-America Transportation Center (MATC)
Nebraska Transportation Center (NTC)
National Advanced Driving Simulator (NADS)

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Disclaimer

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Abstract

Drivers over the age of 65 make up the fastest growing segment of the driving population and are, in general, underrepresented in vehicle crashes due to their self-restrictive driving habits. However, as the baby-boomer generation ages into the population of older drivers, the presence of in-vehicle systems designed to counteract the physical and psychological changes of aging, could change their habits. Using a literature review to identify systems, effects of aging, and crash statistics of older drivers, various in-vehicle system types were identified and rated for their potential to mitigate the effects of aging on driving performance and behavior. Focus groups were then held with two age groups of older drivers (55-64 and 65-75) to assess their acceptance of four different systems identified by the literature review. The older driver age range for this project (55-75) was selected to represent the youngest age that the American Association of Retired Persons considers to be an older driver (lower bound), and for convenience purposes in recruiting (upper bound). Animations demonstrating each system in action were generated using a driving simulator then video recorded. The demonstration videos were shown during the focus groups. Qualitative data about participant opinions regarding the safety systems from the focus groups were gathered and analyzed for common themes, which were factored into a final in-vehicle system matrix.

The matrix rates the benefits of each system type in regards to older drivers based on the generalized ability of the system type to counteract the effects of aging, and on older drivers' acceptance of the system. In the matrix, in-vehicle systems that alert drivers to potential hazards (e.g., a forward collision warning system) resulted in the highest safety rating while systems that facilitated a driver's ability to control the vehicle (e.g., an anti-lock braking system) had the lowest safety rating. Overall, the younger age groups of older drivers were more trusting of the

various safety systems and felt that drivers their age would want the various systems compared to the older age groups. In contrast, the 65-75 year olds were less anxious and less concerned about becoming overly reliant on the different systems compared to the 55-64 year olds.

Executive Summary

Using information gathered from reviewing literature, a matrix was developed summarizing in-vehicle system types that could compensate for the effects of aging for older drivers. Focus groups were then conducted to adjust the matrix for factors expressed in the focus groups that could affect the use of in-vehicle systems.

Table A Matrix of effects of aging and in-vehicle system types

	Sensory Enhancement	Alerts	Vehicle Control	Fully Automated/ Connected Vehicles
Vision Loss	2	1	1	2
Hearing Loss	2	1	1	2
Neck Rotation Loss	1	2	0	2
Impaired Gap Detection	0	2	1	2
Slowed Response Time	1	2	2	2
Cognitive Decline	1	2	2	2
"Helps to detect hazard"	2	2	1	0
"It is a helping tool but I'm in control"	2	2	1	0
"I don't trust it"	0	-1	-1	-2
"It's distracting"	-2	-2	-1	0
"I might become over-reliant"	-1	-1	-2	-2
Final Safety Score	0.727	0.909	0.455	0.727

In-vehicle systems that alert drivers to potential hazards (e.g., a forward collision warning system) resulted in the highest safety rating while systems that facilitated a driver's ability to control the vehicle had the lowest safety rating in the matrix. Overall, the younger age groups of older drivers were more trusting of the various safety systems and felt that drivers their age would want the various systems compared to the older age groups. In contrast, the 65-75 year olds were less anxious and less concerned about becoming over reliant on the different systems compared to the 55-64 year olds.

Chapter 1 Older Drivers and Their Driving Habits

Drivers age 65 and over make up the fastest growing sector of the driving population in the United States (Stutts and Martell 1991). While these older drivers may have lower crash rates overall than younger drivers, they are over-represented in injuries due to crashes at intersections and crashes involving other road users (Chovan, Tijerina et al. 1994). Older drivers are more likely to be the cause of a crash while backing up, merging into traffic, and changing lanes (Winter 1985). Older drivers are most likely to get into a crash at an intersection and be at fault. They fail to notice the intersection, fail to judge an appropriate gap, and crash into other road users and pedestrians (Ostrow 1989). Many older drivers also report difficulty in parking and view it as a difficult driving task (Ball, Owsley et al. 1998). In-vehicle advanced driver assistance systems hold promise in reducing this disparity. These systems exist to offer alerts to drivers, take control of the vehicle to prevent a collision, enhance sensory information available to a driver, or even drive the vehicle themselves. By providing these services, the systems aim to reduce crashes.

Older drivers are at greater risk for injury from a vehicle collision due to a combination of a natural decline in physical, cognitive, and sensory functioning and increased frailty. Many older drivers are aware of their increased crash risk and so employ protective measures to minimize their exposure to what they perceive as dangerous driving situations. Normal decreases in leg mobility (Siren, Hakamies-Blomqvist et al. 2004) as well as vision, hearing, and cognitive decline (Ball, Owsley et al. 1998) are common reasons for drivers to avoid various situations. Because they avoid driving situations they perceive as more dangerous, the most common risks to older drivers may not be the same as that of the general driving population. Furthermore, technologies used to mitigate the risks posed to the general driving population may not be as effective in reducing crashes or injuries for older drivers as they are for younger drivers (Charness and Boot 2009). For example, older drivers crash more often at intersections and with other road users, so an alert system such as an intersection navigation system or blind spot detector may be more beneficial than a sensory enhancement system such as night vision. This study aims to identify which in-vehicle system types will be of particular benefit to older drivers.

Some of the physical and mental changes experienced by healthy older drivers may provide the potential for additional benefits from certain in-vehicle systems for this demographic compared to younger drivers, such as decrements in neck rotation (Isler, Parsonson et al. 1997), vision, hearing, and attention (Staplin, Lococo et al. 1998). For example, if a forward collision warning system utilizes a high pitched beep as a means to alert drivers of an impending collision at an intersection, seniors with hearing loss may have difficulty perceiving the alert, find the system less helpful, and be more likely to ignore, turn off, or disable the system. That same senior may benefit from an intersection navigation system that detects oncoming traffic and judges when an acceptable gap for turning presents itself before providing the driver with turning instructions. Seniors may also benefit from a night vision assistance system that detects other road users and intersections and displays them visually for the driver in an enhanced monitor. These safety technologies have varying potentials to prevent or reduce injuries given a crash as well as prevent crashes all together. Technologies could be used to augment an older driver's sensory capabilities, alert them to potential collisions, or help them control their vehicle.

Historically older people have been more resistant to innovative technologies than younger people (Tacken, Marcellini et al. 2005). While past generations of older drivers did not have high acceptance or desirability for new in-vehicle technologies, differences may exist for the baby boomer generation, which has had more experience with technology (Robertson 1976;

Owram 1996). Since the baby boomers were the first generation to be raised alongside digital technology they may be more accepting of in-vehicle systems. It is possible that the trends from past literature known to be reflective of older drivers have started to change with the aging baby boomer generation.

A literature review was conducted in order to determine under which conditions current older drivers typically crash and what in-vehicle systems will best prevent these crashes. Approximately 100 articles were reviewed for relevant information pertaining to older drivers' technology acceptance, safety benefits of in-vehicle systems, and effects of aging. Over 65 peer reviewed articles were used to create a matrix that will help rate individual systems on their safety benefits to older drivers in regards to the normal changes associated with aging. By rating in-vehicle systems by their relevance to older drivers and evaluating older drivers' acceptance of those systems, we were able to identify which systems older drivers are most likely to use and when used, which ones may be the most efficacious in reducing crashes for older drivers. It was discovered during the literature review that there are several driving situations that older drivers intentionally avoid (i.e. night, bad weather, distracted, rush hour, etc.). Previous studies have concluded that this self-restriction is due to awareness of a physical or mental health disparity compared to younger drivers.

1.1 Environmental Situations Older Driver Avoid

Older drivers have a high awareness of sensory decline and it is a main reason for driving cessation ahead of age, sex, physical impairment, or benzodiazepine use (Gilhotra, Mitchell et al. 2001). Drivers who continue to drive, despite being aware of a visual impairment avoid driving situations that may be more difficult to visually process such as night time driving and heavy traffic (Hakamies-Blomqvist 1999). This is likely because of their awareness of an objectively determined visual or attentive impairment. Drivers with higher levels of impairment were more avoidant of rush hour and dense traffic conditions (Ball, Owsley et al. 1998).

Similar to night time driving, older drivers avoid driving in adverse weather conditions (McGwin and Brown 1999). According to the Senior Driver Survey conducted by the American Automobile Association, 61% of senior drivers over the age of 65 avoid driving in any form of adverse weather (AAA 2012). This is most likely because seniors perceive the road condition as unsafe or have concern over visibility and the resulting desire to minimize exposure to those unsafe or uncomfortable situations (Langford, Koppel 2006).

1.2 Driving Behaviors Older Drivers Avoid

Older drivers are less likely to engage in driving behaviors that may put them at higher risk for crashes. In face-to-face interviews with older, middle, and younger drivers, Fofanova and Vollrath (2011) found that older drivers are less likely to engage in a distraction task, rated distracting activities as significantly more dangerous, and concluded that older drivers' underrepresentation in distraction-related vehicle collisions is likely due to self-regulation of what is viewed as dangerous or due to their "age related prudence." Similar investigations into alcohol impairment have shown older drivers to be less likely than younger drivers to drive while under the influence of alcohol. Examining police reports and autopsy records, one study found about 7% of older drivers involved in a collision had alcohol in their system, and whether or not the older driver had alcohol in his/her system at the time of the collision was not significantly related to responsibility for causing the crash. The younger comparison group reported 29.6% of cases involved alcohol and increased alcohol intoxication showed increased risk for being the cause of the crash (Hakamies-Blomqvist 1994). This indicates that older drivers are further restricting their exposure to dangerous driving situations by avoiding driving under the influence of alcohol. It also suggests that when they do drive under the influence of alcohol, they are either doing so at a lower blood alcohol level (Hakamies-Blomqvist 1994 only reported a blood alcohol content as being greater than 0.02%).

Older drivers are less likely to be in a hurry while driving than those that are younger or middle aged, and exceed the speed limit less often and are therefore less likely to be responsible for crashes attributable to speeding or loss of control of a vehicle (Hakamies-Blomqvist 1994). Furthermore, because older drivers are aware that they easily become fatigued, many restrict their long distance driving subsequently, the incidence of run-off-road crashes are also low for older drivers compared to control groups (Suen and Mitchell 1998).

Driving Situations in which Older Drivers Crash

Whether they are due to the decrements in physical or cognitive capabilities of older drivers, there are certain situations where older drivers experience a greater risk of crashing or being injured in a crash compared to other drivers. Older drivers are more likely to be reported as the cause of a crash while backing up than younger drivers (Winter 1985). Normal decreases in neck rotation range of motion and useful field of view put older drivers at a higher risk of colliding with an unseen object (Ostrow 1989). Similar to the task of backing up (either from a driveway or parking spot) which can be impaired due to decreased range of motion; changing lanes or merging into traffic can pose a great risk to older drivers who suffer from the same condition. Merging and changing lanes can become further complicated by decreases in peripheral vision and useful field of view (Winter 1985). Regardless of any underlying medical conditions, older drivers viewed parking as a difficult and potentially dangerous situation (Owsley 1999). However, unlike rush hour driving or driving in adverse weather, parking is much less avoidable.

Many of older drivers' collisions occur at intersections. They are much more likely than younger drivers to have a collision occur at an intersection and almost all of these types of crashes were attributed to human error by older drivers (Langford and Koppel 2006). Driver observation and estimation errors were the main causes of collisions, not errors while handling the vehicle: drivers had specific general inattention, had faulty perceptions of hazards in the intersections, or they failed to correctly estimate theirs or other vehicles' speed and behaviors (Hakamies-Blomqvist 1993). One study examining 100 crashes at a stop sign controlled intersection identified two major sub-types of crashes at intersections. Either the driver was unaware of or did not see the intersection, its stop sign or the potential collision hazards within the intersection; or the driver stopped, but mistakenly believed it safe to transverse the intersection failing to notice the speed of travel or the behavior of a potential collision hazard (Chovan, Tijerina et al. 1994). The latter is due to a misjudgment of gap or velocity of vehicles and pedestrians at the intersection (Laberge, Creaser et al. 2006).

Older drivers could pose a risk not only to themselves and other drivers, but to other types of road users such as pedestrians and bicyclists. Normal declines in cognitive ability and visual search and processing make identification of pedestrians and other road users difficult for older drivers (Suen and Mitchell 1998). Older drivers have more insurance claims addressing injuries of other road users for which they are at fault than other age groups (Braver and Trempel 2004).

Many of the older drivers described in current literature limit their exposure to situations they perceive to be more dangerous to them due to having various cognitive or physical decrements associated with aging. Historically, the same age group has also been thought to be averse to new technologies, preferring to use equipment with which they are more familiar.

While older drivers have lower crash rates in newer vehicles that tend to be more instrumented with safety features, prior acceptance of these safety technologies were low; they did not trust them (Stamatiadis, Jones et al. 2007).

1.4 A New Generation of Older Drivers

The baby boomer generation (born between 1945-1964) is the largest, most educated, and wealthiest generation to start reaching retirement age and as such could have a profound influence on the acceptance of technology and how we characterize senior citizens (Owram 1996). When computers began emerging, this generation was in their teenage years to early thirties, making them the primary adopters of the new technologies at that time. Having been raised alongside technology and educated about its use and benefit, baby boomers are more familiar with and thus more likely to trust in-vehicle systems to help them compensate for aging effects on driving performance as they become the new "older driver."

Technologies that prevent crashes in situations previously avoided by older drivers may support the emerging population of older drivers (the baby boomers), allowing them to continue to drive without the same self-restrictions (Spain 1997). The baby boomer generation is the best fed, educated, healthiest, and most economically secure generation to date and therefore expect to live longer while maintaining higher quality of life as they age (Owram 1996). From this it is reasonbable to assume that individuals in the baby boomer generation will expect to maintain their driving habits without self-restriction as they age as a key component of quality of life.

Chapter 2 Identifying In-vehicle Systems that may Help Older Drivers

2.1 Relevant Technologies for Older Drivers

Because older drivers are over-represented in certain types of vehicle collisions but under-represented in others, it stands to reason that technologies that help prevent collisions in the situations more commonly experienced by older drivers will have a greater effect at reducing total numbers of collisions, injuries, and deaths involving older drivers. However, if the reason for older drivers' under representation in certain crash situations is related to avoiding driving in situations they perceive to be more dangerous as it appears to be, then technologies that combat these age effects may increase their exposure to these situations as older drivers could become more comfortable driving under those circumstances.

Sensory enhancement systems, such as night vision assistance and back up cameras, enhance drivers' search capabilities enabling an increased awareness of potential hazards helping them notice other road users and objects. A night vision assistance system may increase older drivers' willingness to drive at night and simultaneously decrease their at-fault involvement for crashes involving other road users as they are better able to see objects in their path in dark conditions. Alert systems, such as the forward collision warning and intersection navigation systems issue an alert to orient the driver to a detected threat or when they should perform an action. Older drivers may become more comfortable while driving in high density traffic and their overrepresentation at intersection crashes may diminish if they have systems that will help them notice and integrate the various elements of the driving environment. Vehicle control systems such as anti-lock braking systems and adaptive cruise control remove or lessen human error given a hazardous situation and actively prevent or lessen the severity of a crash.

Connected vehicles and fully automated vehicle technology will also benefit older drivers as the cognitive and physical ability of the driver can be compensated for by these devices.

2.2 Constructing an In-vehicle System Safety Rating Matrix

Using information about various systems gathered from the literature review, an initial technology matrix was developed to rate current systems in regards to their potential to counteract various changes in driving performance associated with ageing (

).

Table 0.1 Initial matrix of ratings of individual in-vehicle systems by how well they compensate for age effects

Rating Scale: 0=no increased benefit, 1= some benefit, 2= large benefit							
	Vision Loss	**Hearing Loss**	**Decrease Range of Motion**	**Impaired Gap Detection**	**Slowed Reaction Time**	**Cognitive Decline**	**Mean**
Back up assist	0	0	2	1	0	0	0.5
Park assist	2	0	2	2	0	2	1.33
Blind spot detection	2	1	2	2	1	0	1.33
Lane departure warning system	2	0	2	0	1	2	1.17
Forward collision warning	2	0	0	2	1	2	1.17
Forward collision mitigation	2	2	2	2	2	2	2
Night vision assistance	2	0	0	1	1	1	0.83
Adaptive head lighting	2	0	0	0	1	0	0.5
Lane change collision mitigation	2	2	2	2	2	2	2
Upcoming intersection warning	2	0	0	0	1	1	0.67
Post drive assessment systems	0	0	0	0	0	1	0.17
Fully automated vehicles	2	2	2	2	2	2	2
Connected vehicles	2	2	2	2	2	2	2
Electronic stability control	0	0	0	0	1	1	0.33
Anti-lock braking	0	0	0	0	1	1	0.33
Intersections navigation	2	0	1	2	2	2	1.5
Seat belt	0	0	0	0	0	0	0
Air bag	0	0	0	0	0	0	0

Pedestrian detector	2	1	2	0	2	1	1.33
In-vehicle info systems	1	0	0	0	1	1	0.5
Intoxication/impairment detectors	0	0	0	1	2	2	0.83

Systems were then grouped into a one of four system types: sensory enhancement, alerts, vehicle control systems, or fully automated/connected vehicles. Based on the reviewed literature, each system type was rated by the research team on a 3-point rating scale (0=no increased safety benefit, 1= slight safety benefit, 2=large safety benefit) in regards to its speculated ability to counteract each impairment type based on the literature review. Each system was rated first on whether or not it would have a benefit for a particular age effect. A system would not benefit an older driver for a given effect that system received a score of 0 (zero). Systems that had been shown to benefit older drivers were given a relative score of either 1 for a slight safety benefit when compared to other systems, or a 2 for a large safety benefit when compared to other systems. The average score was then calculated for each system type in terms of overall safety benefits (Table 0.2). However, it should be noted that while two types of systems may have the same score, the individual benefits they pose to older adults with different physical and cognitive impairments will vary. For example, a sensory enhancement system such as night vision would likely be more beneficial for older drivers with vision loss than for older drivers with hearing loss. A system that takes control of the vehicle, such as adaptive cruise control, is more beneficial for older drivers with slower reaction times or cognitive decline. Both system types have an average safety score of 1.17, but the adaptive cruise control system responds to the hazard automatically, negating the effect of a slower response time, while a night vision system may only present the hazard in a different way in the hopes that the driver will notice it more easily and react fast enough on their own. Other system types included in the summary matrix are alert systems, which issue a warning or alert when the system detects a threat, and the fully automated or connected vehicle systems, where the vehicle is in control a majority of the time.

Table 0.2 Initial matrix of ratings of in-vehicle system types by how well they compensate for age effects on a 0-2 scale

Rating scale: 0=no increased benefit, 1=some benefit, 2= large benefit							
	Vision Loss	**Hearing Loss**	**Decreased Range of Motion**	**Impaired Gap Detection**	**Slowed Reaction Time**	**Cognitive Decline**	**Average Score**
Sensory Enhancement	2	2	1	0	1	1	1.17
Alerts	1	1	2	2	2	2	1.67
Vehicle Control	1	1	0	1	2	2	1.17
Fully Automated/ Connected Vehicles	2	2	2	2	2	2	2

2.3 Focus Groups with Older Drivers about In-vehicle System Acceptance

Experience and trust can affect acceptance and use of a technology that has been previously shown to provide safety benefits. One historical example is the use of safety belts. Safety belts were repeatedly shown to lessen fatalities in collisions for all ages of drivers (Robertson 1976). Initially, seat belt use was low, but with primary enforcement laws, publicity events, and public awareness campaigns seat belt usage climbed 22% in one month (Williams, Lund et al. 1986). Consistent with historical trends of older drivers' resistance to technology, a study conducted in Michigan found that while use rates overall increased with time and exposure, over about 25% of drivers 65 and over were not wearing seatbelts (Eby, Molnar et al. 2000). This could be due to drivers viewing safety belts as uncomfortable and inconvenient (Jonah and Dawson 1982). Because the acceptance of technologies could be changing with the baby boomer generation of older drivers, as described earlier, this kind of resistance to technology may be less for older drivers in the future. Focus groups were held to assess the potential change in trends using two age groups of older drivers that include both those in the baby boomer generation and older individuals.

Four in-vehicle systems were demonstrated to focus group participants. An intersection navigation system and a blind spot detection system were demonstrated to assess older drivers' acceptance of in-vehicle systems that prevent crashes in situations in which they are overrepresented. A night vision assistance system and forward collision warning system were demonstrated to assess how self-restrictive driving habits may change with implementation of technology that could combat the effects of aging.

2.3.1 Focus Group Methods

Drivers were recruited from the local Iowa City, IA population through advertisements, contacts with past research participants, and using the NADS participant registry. Participants were male and female drivers between the ages of 55 and 75. All participants had a valid driver's license and drove at least once per week or an average of 3,000 miles per year. Participants were excluded from participating in the focus group if they had participated in any research studies about in-vehicle systems in the past year. Participants that met the inclusion and exclusion criteria were scheduled for a two hour focus group based on their age. Males and females between the ages of 55 and 64 were categorized as the younger group while 65-75 year olds made up the older group. The older driver age range for this project (55-75) was selected to represent the youngest age that the American Association of Retired Persons considers to be an older driver (lower bound), and for convenience purposes in recruiting (upper bound). Dividing the overall sample at age 65 provided a balanced age range for the focus groups. A total of 51 individuals participated in six different focus groups, three with each age group, with 5 to 12 participants in each group. All focus groups consisted of both men and women with a minimum of two of each gender in each group. Twenty-four (47.1%) were women and almost half (47.1%) of participants were between 55 and 64 years of age. This study was deemed exempt from documentation of consent by the University of Iowa Institutional Review Board. Upon arrival at the focus group, participants were read and summary of what would happen and it was explained that by staying to participate in the focus group they were providing consent for data to be collected. Participants were also asked to sign a form giving permission for video data of the focus group for data analysis purposes.

After a short warm-up topic was presented and discussed, participants were shown short video clips of a simulated driving environment demonstrating four different in-vehicle systems one at a time (Appendix A Tracking Information from Literature Review

<u>**First Author**</u>	<u>**Year**</u>	<u>**Title**</u>	<u>**Topic/Category**</u>	<u>**Summary**</u>	<u>**Found through**</u>
Marshall	2010	Enhancing the Effectiveness of Safety Warning Systems for Older Drivers	Warning	Failure to Obey in-vehicle warning system evaluated one third fewer stop sign or red light violations with system benefit to all three age groups Normal middle aged	Google Scholar

				drivers, normal older drivers, at risk older drivers	
Schall	2013	Augmented Reality Cues and Elderly Driver Hazard Perception.	Hazard Perception	Augmented reality cues did not impair older divers' ability to maintain safe headway	Academic Search elite
Yannis	2010	Older Drivers' Perception and Acceptance of In-Vehicle Devices for Traffic Safety and Traffic Efficiency.	Older driver's acceptance of tech.	Older drivers have problems adopting new technology but study found older Greek drivers are supportive of them.	Academic Search elite
Llaneras	2000	Attention Demand of IVIS Auditory Displays: An On-Road Study Under Freeway Environments	Technology: IVIS	IVIS auditory system improved driving performance for older drivers except when there was background noise (>80dB) present	Older Drivers' Perception and Acceptance of In-Vehicle Devices for Traffic Safety and Traffic Efficiency.
Strayer	2004	Profiles in Driver Distraction: Effects of Cell Phone Conversations on Younger and Older Drivers	Distracted driving	Found two-fold increase in number of rear-end collisions involving cell phones. Older drivers do not suffer greater penalty while driving and talking on cell phone then do younger drivers, nor they do not have as	Google Scholar

				many crashes over all	
Yanko	2013	Driving with a wandering mind the Effect that Mind Wandering Has On Driving Performance	Age related changes	Mind-wandering impairs driving performance	Google Scholar
Charness	2009	Aging and Information Technology Use Potential and Barriers	Older driver's acceptance of tech.	Older adults less likely to use technology then younger adults. Older aversion will not disappear in future generations.	Google Scholar
Ball	1998	Driving Avoidance and Functional Impairment in Older Drivers	Older driver's avoidance	Older drivers with visual or cognitive impairments reported higher levels of driving avoidance	Google Scholar
Kline	1992	Vision, Aging, and Driving: The Problems of Older Drivers	Older driver crash types + age related changes	Age related changes in vision were related to types of car crashes.	Google Scholar
Hakamies-Blomqvist	1994	Compensation in older drivers as reflected in their fatal accidents	Older driver compensation	Older drivers less likely to be in a hurry, intoxicated or distracted then younger groups. Probability for being at fault in a collision was independent of these.	Google Scholar
Hakamies-Blomqvist	1996	Research on Older Drivers: A Review	Older driver trends	In order to asses crash risk for older drivers, researchers need to assess tasks of driving,	Google Scholar

				gerontological data about age related changes in functioning, and accident statistics	
Hakamies-Blomqvist	1993	Fatal Accidents of Older Drivers	Older driver trends	Older drivers typically collided with a vehicle at an intersection which they did not notice at all or saw too late and couldn't react fast enough	Google Scholar
Ball	1986	Improving Visual Perception in Older Observers	Age related changes	Older people have a hard time discriminating one direction of motion from another, similar one.	Fatal Accidents of Older Drivers
Aksan	2012	Naturalistic Distraction and Driving Safety in Older Drivers	Distracted driving	Older drivers had more safety errors than younger ones when distracted. Distraction disproportionally affects older drivers with visual, motor, and cognitive declines	Google Scholar
Rizzo	1997	Simulated car crash and crash predictors in drivers with Alzheimer disease.	Cognitive decline	Useful field of view, visuospatial impairment, reduced perceptions of 3-d structure from motion	Google Scholar
Anstey	2004	Cognitive, Sensory and Physical factors enabling driving safety in older adults	Factors predicting driving ability	Attention, reaction time, memory, executive function, mental status, visual function, physical function and self-monitoring all were factors that influenced driving behavior.	Google Scholar

				Therefore three functions: cognition, sensory function, and physical function predict driving ability.	
McKnight	1999	Multivariate Analysis of Age-related Driver Ability and Performance Deficits	Cognitive decline	Deficiencies in attentional, perceptual, cognitive, visual and psychomotor categories resulted in less safe driving practices	Google Scholar
Stutts	1998	Cognitive Test Performance and Crash Risk in an Older Driver Population	Cognitive decline	Older drivers who scored lowest on the cognitive tests were 1.5 times more likely to be in crashes	Google Scholar
Lyman	2002	Older Drivers Involvements in Police Reported Crashes and Fatal Crashes: Trends and Projections	Older driver trends	Older drivers are at less risk of being involved in police reported crashes but more likely to be in fatal crashes	Google Scholar
Miller	1998	Highway Crash Costs in the United States by Driver Age, Blood Alcohol Level, Highway Crash Costs in the United States by Driver Age, Blood Alcohol Level, Victim Age, and Restraint Use	Older driver trends	Older drivers still least likely to wear safety belts. Significant health and financial burdens from older driver crashes	Google Scholar

Gilhotra	2001	Impaired vision and other factors associated with driving cessation in the elderly: the Blue Mountains Eye Study	Older driver trends	Sensory impairment affecting vision and hearing was associated with driving cessation	Google Scholar
James	2012	Car Design for All Ages	Technology acceptance	Cars get more technologically advanced each year. Alienation of the senior driver is a big risk with the technologies	Google Scholar
Fofanova	2011	Distraction in Older Drivers-A Face-to-Face Interview Study	Distracted driving	Older drivers do not engage in distracting tasks while driving due to age related prudence	Google Scholar
Robertson	1976	Estimates of motor vehicle seat belt effectiveness and use: implications for occupant crash protection.	Seat belt use	Seat belts would be 60% effective with 100% use. Substantial injury reductions being seen when used	Google Scholar
Winter	1985	Learning and motivational characteristics of older people pertaining to traffic safety	Older driver trends	Older drivers are more likely to crash while backing up than younger drivers	Google Scholar
Ostrow	1989	The relationship of joint flexibility to older driver performance	Age related changes	Normal decreases in neck rotation range of motion and useful field of vision put older rivers at a higher risk of crash	Google Scholar

Ball	1993	Visual attention problems as a predictor of vehicle crashes in older drivers.	Older driver trends	Useful field of view and visual attention were significant predictors of crash risk for older drivers	Google Scholar
Chovan	1994	Examination of Unsignalized Intersection, Straight Crossing Path Crashes and Potential IVHS Countermeasures	Older driver trends	Only 42% of intersection crashes was from running the stop sign, the rest were from mistakes after stopping	Google Scholar
Owram	1996	Born at the Right Time	Baby-boomers	History of the baby boomers: raised with technology, best educated, richest and healthiest generation ever	Google Scholar
Isler	1997	Age Related Effects of Restricted Head Movements on the Useful Field of View of Drivers	Age related changes	Relates restricted neck rotation and UFOV associated with aging to older driver's involvement in intersection crashes	Google Scholar
Staplin	1998	OLDER DRIVER HIGHWAY DESIGN HANDBOOK	Age related changes and older driver trends	Functional capabilities become diminished with age and discusses how passing zones, intersections and interchanges can be improved to accommodate them	Google Scholar

Suen	1998	The Value of Intelligent Transport Systems to Elderly and Disabled Drivers	Older driver trends	Older drivers are aware of fatigue susceptibility and self-restrict driving, thus have lower run offs	Google Scholar
Hakamies-Blomqvist	1999	Safety of Older Persons in Traffic in Transportation in an Aging Society: A Decade of Experience.	Older driver trends	Drivers who do not cease driving when they learn of a visual impairment typically avoid visually difficult situations. Avoid night, weather, heavy traffic	Google Scholar
Ball	2002	Advances in Technology Used to Assess and Retrain Older Drivers	Age related changes	UFOV decreased with age due to decrease in visual processing speed, reduced attention, inability to ignore distractors	Google Scholar
Braver	2004	Are Older Drivers Actually at Higher Risk of Involvement in Collisions Resulting in Deaths or Non-fatal Injuries Among Their Passengers and Other Road Users?	Older driver trends	Older drivers have more insurance claims addressing injuries of other road users for which they are at fault.	Google Scholar
Siren	2004	Driving Cessation and Health in Older Women	Older driver trends	Driving cessation occurred in populations still fit to drive, impairments would not have affected specific aspects of driving, but	Google Scholar

				general wellbeing. Cessation/compensation choices common, especially among women	
Tacken	2005	Use and acceptance of new technology by older people. Findings of the international MOBILATE survey: 'Enhancing mobility in later life'	Technology acceptance	Use of technologies such as pc, internet, e-banking is low among those 55+	Google Scholar
Laberge	2006	E-sign of an intersection decision support (IDS) interface to reduce crashes at rural stop-controlled intersections	Gap acceptance, technology info	Role of gap acceptance in intersection crashes, intersection alert system	Google Scholar
Langford	2006	Epidemiology of older driver crashes – Identifying older driver risk factors and exposure patterns	Older driver trends, age related changes	Risks and exposures of older drivers involved in crashes: increased reaction time, difficult to divide attention between tasks, decrease vision, especially at night, decrease ability to judge speed and distance, difficulty turning head, difficulty perceiving and analyzing situations, reduced peripheral vision, prone to fatigue, increased anxiety over	Google Scholar

				ageing	
NHTSA	2009	Traffic Safety Facts: Older Population	Older driver trends	2008 data: least likely to be intoxicated, least likely to crash, most likely to be injured or struck by other driver	Google Scholar
AAA	2012	Senior Driver Survey	Older driver trends	61% of older drivers avoid driving in bad weather. 80% report not driving in one of several conditions	Google
Tseng	2004	Vehicle Back Up Camera	Technology-back up	Patent and system info example	Google Scholar
McClanahan	1998	Back-up protection sensor for a vehicle	Technology-back up	Patent and system info example	Google Scholar
Tanaka	2003	Parking assist device	Technology-park assist	Patent and system info example	Google Scholar
Shyu	1988	Automatic parking device for automobile	Technology-park assist	Patent and system info example	Google scholar
Schofield	1996	Vehicle blind spot detection system	Technology -blind spot detection	Patent and system info example	Google scholar
Lo	2009	Lane departure warning system	Technology-ldw	Patent and system info example	Google scholar
Yanagi	1999	Vehicle collision warning system	Technology-fcw	Patent and system info example	Google scholar
Labuhn	1993	Adaptive cruise	Technology-acc	Patent and system info	Google

		control		example	scholar
Burley	1985	Night vision system with color video camera	Technology-night vision	Patent and system info example	Google scholar
Beam	1996	Adaptive/anti-blinding headlights	Technology-adaptive headlights	Patent and system info example	Google scholar
Sadano	2004	Lane departure prevention apparatus	Technology lane departure mitigation	Patent and system info example	Google Scholar
Kaneko	1996	Navigation system and intersection guidance method	Technology-intersection navigation	Patent and system info example	Google Scholar
Harrison	2002	Intersection traffic control apparatus	Technology-intersection navigation	Patent and system info example	Google Scholar
Runyon	2001	System for tracking vehicle and driver location and mileage and generating reports therefrom	Technology-driver report card	Patent and system info example	Google Scholar
Bishop	2000	A survey of intelligent vehicle applications worldwide	Technology-fully automated vehicle	Describes the use and safety benefits of fully automated and intelligent vehicle designs	Google Scholar

Dimitrakopoulos	2011	Intelligent transportation systems based on internet-connected vehicles: Fundamental research areas and challenges	Technology-connected vehicles	Looks at intelligent transport systems that communicate using internet to form vehicle-infrastructure networks	Google Scholar
Rajamani	2012	Electronic Stability Control	Technology-electronic stability control	Describes how ESC prevent spinning and drifting out	Google scholar
Brosnan	2013	Anti-lock Braking Systems	Technology-anti-lock brakes	Describes how ABS systems prevent front wheels from locking and no longer need to pump	Google Scholar
Crandall	2000	Mortality reduction with air bag and seat belt use in head-on passenger car collisions	Technology-seat belts and air bags	Discusses the reduction in mortality and injury associated with proper use of seat belts and or air bags	Google Scholar
Bartlett	1967	Pedestrian detection system	Technology-pedestrian detection system	System uses sensors to detect and relay information about pedestrians	Google scholar
Kaplan	1996	Alertness and drowsiness detection and tracking system	Technology-impairment detector	Describes a system that detects if drivers are drowsy and issues an alert	Google scholar
Wang	1996	The role of driver inattention in crashes: New statistics from the 1995 Crashworthiness	Intersections crashes	Subtypes of intersection crashes	Google Scholar

		Data System			
Evansm	1982	Compulsory Seat Belt Usage and Driver Risk-Taking Behavior	Technology-seat belts	Seat belt use does not increase risk taking behaviors	Google Scholar
Williams	1986	RESULTS OF A SEAT BELT USE LAW ENFORCEMENT AND PUBLICITY CAMPAIGN IN ELMIRA, NEW YORK	Seat belt	Publicity campaign increased use rates by 22%	Google Scholar
Jonah	1982	Predicting reported seat belt use from attitudinal and normative factors	Technology acceptance	Comfort and convenience affected seat belt use	Google Scholar

Appendix B: In-Vehicle System Video Demonstration Screen Shots). The blind spot detection system is shown as an example in **Error! Reference source not found.**. This system causes lights on the side mirrors to light up any time a car or object is in the blind spot. The auditory alert activates when the turn signal is activated while an object was within the blind spot. The order in which the systems were presented was counter balanced in an effort to reduce the effect of fatigue on participant contribution.

Figure 2.1 Video demonstration screen capture of a blind spot detection system.

Following the video of an individual system was shown, participants were asked to fill out a out a short survey (Appendix A Tracking Information from Literature Review

First Author	**Year**	**Title**	**Topic/Category**	**Summary**	**Found through**

Marshall	2010	Enhancing the Effectiveness of Safety Warning Systems for Older Drivers	Warning	Failure to Obey in-vehicle warning system evaluated one third fewer stop sign or red light violations with system benefit to all three age groups Normal middle aged drivers, normal older drivers, at risk older drivers	Google Scholar
Schall	2013	Augmented Reality Cues and Elderly Driver Hazard Perception.	Hazard Perception	Augmented reality cues did not impair older divers' ability to maintain safe headway	Academic Search elite
Yannis	2010	Older Drivers' Perception and Acceptance of In-Vehicle Devices for Traffic Safety and Traffic Efficiency.	Older driver's acceptance of tech.	Older drivers have problems adopting new technology but study found older Greek drivers are supportive of them.	Academic Search elite
Llaneras	2000	Attention Demand of IVIS Auditory Displays: An On-Road Study Under Freeway Environments	Technology: IVIS	IVIS auditory system improved driving performance for older drivers except when there was background noise (>80dB) present	Older Drivers' Perception and Acceptanc e of In-Vehicle Devices for Traffic Safety and Traffic Efficiency.

Strayer	2004	Profiles in Driver Distraction: Effects of Cell Phone Conversations on Younger and Older Drivers	Distracted driving	Found two-fold increase in number of rear-end collisions involving cell phones. Older drivers do not suffer greater penalty while driving and talking on cell phone then do younger drivers, nor they do not have as many crashes over all	Google Scholar
Yanko	2013	Driving with a wandering mind the Effect that Mind Wandering Has On Driving Performance	Age related changes	Mind-wandering impairs driving performance	Google Scholar
Charness	2009	Aging and Information Technology Use Potential and Barriers	Older driver's acceptance of tech.	Older adults less likely to use technology then younger adults. Older aversion will not disappear in future generations.	Google Scholar
Ball	1998	Driving Avoidance and Functional Impairment in Older Drivers	Older driver's avoidance	Older drivers with visual or cognitive impairments reported higher levels of driving avoidance	Google Scholar
Kline	1992	Vision, Aging, and Driving: The Problems of Older Drivers	Older driver crash types + age related changes	Age related changes in vision were related to types of car crashes.	Google Scholar
Hakamies-Blomqvist	1994	Compensation in older drivers as reflected in their fatal accidents	Older driver compensation	Older drivers less likely to be in a hurry, intoxicated or distracted then younger groups. Probability for being at fault in a collision was	Google Scholar

				independent of these.	
Hakamies-Blomqvist	1996	Research on Older Drivers: A Review	Older driver trends	In order to asses crash risk for older drivers, researchers need to assess tasks of driving, gerontological data about age related changes in functioning, and accident statistics	Google Scholar
Hakamies-Blomqvist	1993	Fatal Accidents of Older Drivers	Older driver trends	Older drivers typically collided with a vehicle at an intersection which they did not notice at all or saw too late and couldn't react fast enough	Google Scholar
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Miller	1998	Highway Crash Costs in the United States by Driver Age, Blood Alcohol Level, Highway Crash Costs in the United States by Driver Age, Blood Alcohol Level, Victim Age, and Restraint Use	Older driver trends	Older drivers still least likely to wear safety belts. Significant health and financial burdens from older driver crashes	Google Scholar
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		rural stop-controlled intersections			
Langford	2006	Epidemiology of older driver crashes – Identifying older driver risk factors and exposure patterns	Older driver trends, age related changes	Risks and exposures of older drivers involved in crashes: increased reaction time, difficult to divide attention between tasks, decrease vision, especially at night, decrease ability to judge speed and distance, difficulty turning head, difficulty perceiving and analyzing situations, reduced peripheral vision, prone to fatigue, increased anxiety over ageing	Google Scholar
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Labuhn	1993	Adaptive cruise control	Technology-acc	Patent and system info example	Google scholar
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Beam	1996	Adaptive/anti-blinding headlights	Technology-adaptive headlights	Patent and system info example	Google scholar
Sadano	2004	Lane departure prevention apparatus	Technology lane departure mitigation	Patent and system info example	Google Scholar
Kaneko	1996	Navigation system and intersection guidance method	Technology-intersection navigation	Patent and system info example	Google Scholar
Harrison	2002	Intersection traffic control apparatus	Technology-intersection navigation	Patent and system info example	Google Scholar

Runyon	2001	System for tracking vehicle and driver location and mileage and generating reports therefrom	Technology-driver report card	Patent and system info example	Google Scholar
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Rajamani	2012	Electronic Stability Control	Technology-electronic stability control	Describes how ESC prevent spinning and drifting out	Google scholar
Brosnan	2013	Anti-lock Braking Systems	Technology-anti-lock brakes	Describes how ABS systems prevent front wheels from locking and no longer need to pump	Google Scholar
Crandall	2000	Mortality reduction with air bag and seat belt use in head-on passenger car collisions	Technology-seat belts and air bags	Discusses the reduction in mortality and injury associated with proper use of seat belts and or air bags	Google Scholar

Bartlett	1967	Pedestrian detection system	Technology-pedestrian detection system	System uses sensors to detect and relay information about pedestrians	Google scholar
Kaplan	1996	Alertness and drowsiness detection and tracking system	Technology-impairment detector	Describes a system that detects if drivers are drowsy and issues an alert	Google scholar
Wang	1996	The role of driver inattention in crashes: New statistics from the 1995 Crashworthiness Data System	Intersections crashes	Subtypes of intersection crashes	Google Scholar
Evansm	1982	Compulsory Seat Belt Usage and Driver Risk-Taking Behavior	Technology-seat belts	Seat belt use does not increase risk taking behaviors	Google Scholar
Williams	1986	RESULTS OF A SEAT BELT USE LAW ENFORCEMENT AND PUBLICITY CAMPAIGN IN ELMIRA, NEW YORK	Seat belt	Publicity campaign increased use rates by 22%	Google Scholar
Jonah	1982	Predicting reported seat belt use from attitudinal and normative factors	Technology acceptance	Comfort and convenience affected seat belt use	Google Scholar

Appendix B: In-Vehicle System Video Demonstration Screen Shots

Video demonstration screen capture of night vision assistance system.

This system is displays a live feed in black and white on a monitor in the dashboard. If a pre-identified hazard is detected, that object will be displayed in color on the monitor or within a box.

Video demonstration screen capture of a blind spot detection system.

This system causes lights on the side mirrors to light up any time a car or object is in the blind spot, the auditory alert activates when the turn signal is activated while an object is within the blind spot.

Video demonstration screen capture of the forward collision warning system.

The audio alert activates when the vehicle get too close to a vehicle or other object in front of the car based on speed.

Video demonstration screen capture of the left turn assistance system.

This system provides an auditory guidance system for safely navigating intersections. This same system can also provide assistance for other types of intersections.

before engaging in the focus group discussion. Survey questions asked about trust levels, prior self confidence in performing driving tasks, system desirability, reliance on the system, anxiety regarding the system, and cost of the system. Responses to survey questions were level of agreement with a statement using a 5-point Likert-style scale (0 =not at all, 1=slightly, 2=moderately, 3=very much, or 4=extremely) and yes/no/unsure response options. Questions posed during the focus groups were open-ended and followed a script to keep discussion flowing (Appendix G: Focus Group Script). A research assistant took notes during the focus groups and each focus group was video recorded which were later used for a qualitative analyses.

2.3.2 Analysis of Focus Group Data

General descriptive statistics were applied to the survey data and data was stratified by age group and gender. Focus group recordings and notes were analyzed for common themes using content analysis. If an aspect of driving or an aspect of a safety system being discussed was mentioned in four or more of the focus groups it was considered to be a common aspect. Later, aspects were condensed into common overarching themes that may affect acceptance. For example, common aspects may have included that a system serves as an extra set of eyes, it is “helpful,” or it should be used in driver education courses. All of these aspects convey the theme of using the system as a tool. Aspects such as annoyance or a system that takes the driver’s eyes off the road would be grouped into the theme of distraction. Themes were then added to the matrix and ratings of systems were adjusted for these new factors.

2.3.3 Focus Group Results

Analysis of survey data revealed that trust in the in-vehicle systems is low (Table 0.1). Of the four systems demonstrated in the focus groups, only the blind spot detection system was “very much” trusted and only by females age (55-64) (mean=3.08) and males age (65-75) (mean=3.0). The *combined* average trust rating for all systems across all ages and genders was just above moderate (2.26). Other systems’ trustworthiness was rated as slightly trustworthy (intersection navigation=1.67) or moderately trustworthy (night vision=2.14, blind spot detection=2.98, forward collision warning=2.28). In general, a driver’s prior self-confidence when performing various driving tasks was not significantly correlated to the related systems’ desirability (Table 0.1 **Survey summary data**), except for the forward collision warning system (r=.95) (self-confidence = 2.71, system desirability = 0.88). However, it should be noted that although prior self-confidence while performing driving maneuvers was highest for navigating intersections regardless of older drivers being overrepresented in crashes occurring at intersections, the desirability of the intersection navigation system was the lowest of all systems. Overall, the 55-64 age group had higher levels of anxiety (mean=.46) than did the 65-75 group (mean=.24). However, they also had higher levels of overall trust (mean=2.31) and desirability (mean=.83) for the systems in general.

Table 0.1 Survey summary data using a 0-4 scale with 4 being more likely to occur

			Trust		**Good Prior Self-Confidence**		**Desirability**		**Over-Reliance**		**Anxiety**	
			Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Night Vision	55-64	M	2.33	0.89	2.33	1.07	1.00	0.00	0.60	0.55	0.57	0.53
		F	2.42	0.67	1.58	0.79	0.88	0.35	0.40	0.50	0.67	0.50
	65-75	M	2.07	0.88	1.69	1.03	0.80	0.42	0.50	0.55	0.42	0.51
		F	1.75	0.97	1.33	0.78	1.00	0.00	0.00	0.00	0.44	0.53
Blind Spot Detection	55-64	M	2.92	1.00	2.75	0.97	1.00	0.00	0.43	0.53	0.10	0.32
		F	3.08	0.51	1.58	0.90	1.00	0.00	0.40	0.55	0.11	0.33
	65-75	M	3.00	0.38	2.33	0.90	1.00	0.00	0.60	0.52	0.00	0.00
		F	2.92	0.51	1.67	0.65	1.00	0.00	0.40	0.55	0.00	0.00
Forward Collision Warning	55-64	M	2.25	0.75	3.00	0.60	1.00	0.00	0.67	0.52	0.60	0.55
		F	2.58	0.67	2.83	0.83	1.00	0.00	0.60	0.55	0.14	0.38
	65-75	M	2.33	0.72	2.67	0.72	0.82	0.40	0.45	0.52	0.10	0.32
		F	1.92	1.00	2.33	0.49	0.71	0.49	0.43	0.53	0.33	0.53
Intersection Navigation	55-64	M	1.33	0.65	3.08	1.31	0.17	0.41	0.43	0.53	1.00	0.00
		F	1.58	0.79	2.83	1.11	0.57	0.53	0.60	0.55	0.50	0.55
	65-75	M	1.67	0.98	3.20	1.08	0.44	0.53	0.55	0.51	0.20	0.45
		F	2.08	0.67	2.83	0.94	0.67	0.52	0.50	0.53	0.40	0.52

The themes most commonly discussed in the focus groups were related to hazard detection, distraction, fears of over-reliance, using in-vehicle systems as helping tools, trust issues, alert modality, and general concerns over how systems function (Table 0.2). When asked if they would like the car to take control and prevent collisions most drivers were against the idea or unsure if they would want to give up control. Only one person was willing to allow the blind spot detection system to automatically prevent a crash, and ten people (five from each age group) were willing to allow the forward collision warning system to take control.

Table 0.2 Common themes and factors leading to themes from focus group discussions

Hazard Detection	Reliance/Over-reliance
Object/animal identification	Over reliance + system failure=bad
Pedestrians	Wouldn't know if systems were failing
Color coding	**Tool**
Sensitivity control	Good Aid/extra set of eyes
Blind spots are major problem	Driver's education tool
Incorporate other infrastructure/traffic info	Don't have to turn head as much
Alert	Helpful
Like audio alerts	Good for drivers with bad vision
Like heads up displays	Good for others (no self-committal)
Mode preference varies	**Human/system Error Concerns**
Loudness control	BS requires turn signal
Like clear/concise alert	BS needs to activate with steering wheel
Visual alerts of BS liked	Technical/electrical failure
Graduated alerts	Won't work in bad weather
May become confusing with multiple systems	Concerned about HOW sensors work
Trust	**Distracting**
Would make them comfortable driving at night	NV causes Eyes off road
Would need to learn system	FCW helps with distracted drivers
Would make it easier to drive at night	Constant alert in dense traffic
Would make more confident changing lanes	Annoying
System will prevent "accident" (unknown how)	
FCW would not have an effect on the way they drive	
Dislike being told what to do	
Not change the way they drive	
Would turn off	

Chapter 3 Using Focus Group Data to Revise In-vehicle System Type Safety Matrix

Themes identified in the focus group were added to the system rating matrix and each of the system types were rated for the themes (**Error! Reference source not found.**). Themes with negative connotations such as the system itself being distracting were negatively scored by multiplying each rating by -1. Theme scores were then averaged and added to the original safety score with equal weight to yield the final safety rating. In the original matrix, fully automated vehicle systems and connected vehicle systems had the highest safety rating; however, after discussing different systems with the focus groups and their scores for various themes of acceptance were factored into the matrix, systems that alert drivers to potential hazards had the highest safety rating.

Table 0.1 Final rating matrix of in-vehicle system types adjusted to include focus group data

	Vision Loss	Hearing Loss	Neck Rotation Loss	Impaired Gap Detection	Slowed Response Time	Cognitive Decline	"Helps to detect hazard"	"It is a helping tool but I'm in control"	"I don't trust it"	"It's distracting"	"I might become over-reliant"	Final Safety Score
Sensory Enhancement	2	2	1	0	1	1	2	2	0	-2	-1	.727
Alerts	1	1	2	2	2	2	2	2	-1	-2	-1	.909
Vehicle Control	1	1	0	1	2	2	1	1	-1	-1	-2	.455
Fully Automated/ Connected Vehicles	2	2	2	2	2	2	0	0	-2	0	-2	.727

Chapter 4 Conclusion

The systems most beneficial to older drivers are ones that issue an alert but allow the driver to remain in control, those that enhance sensory information, and those that are fully automated or use connected vehicle technology. These systems have been shown to significantly reduce injuries and collisions for situations where older drivers experienced crashes in past literature. Of these system types, alert systems are likely to be the most efficacious for older drivers as their trust of these system types are also high. Older drivers in the focus groups reported higher levels of desirability and trust for these systems and overall seemed more willing to use them. The difference in preferences between the older males and the younger female groups in regards to trust are indicative of a changing trend of acceptance. Males are historically more trusting of technology (Gefen 2000). As females in the baby boomer generation age, their acceptance of this in-vehicle system changes to be more like their male counterparts.

The final matrix confirms that the high acceptance rate of alert systems combined with their ability to prevent injuries, as shown in the literature, makes these systems most relevant to older drivers compared to the sensory enhancement systems, systems that take control, or fully automated/connected systems. The matrix also shows which system types are most beneficial for a given effect of age on driving performance. For example, if an older driver was experiencing vision loss, a sensory enhancement system or fully automated vehicle would be the most beneficial, but if the driver is experiencing neck rotation loss, an alert system or fully automated vehicle may be more beneficial.

While the focus groups were generous in size for the method of data collection, one limitation of this work is that no driver performance data or actual system use and acceptance data was collected over time. The adjustments to the final rating matrix were based on drivers' predictions and ideas of how they would behave rather than actual observations of their system use and potential changes in their driving habits. A limited number of example systems, four, were demonstrated to the focus groups and those the demonstrations provided one example of the wide range of the potential features for each type of system. The systems and features demonstrated were chosen to be as representative as possible, however, other systems or features may elicit different views and themes from similar focus groups. Also, updating the rating matrix using the options of multiple in-vehicle system experts may enhance its usefulness.

Future research should focus on additional systems that can benefit older drivers as those systems emerge particularly in regards to systems that alert the driver to potential hazards and the type of alert issued. Ongoing monitoring of this generation's driving habits is also necessary as they will likely age differently from their predecessors. In general, older drivers seemed open to the idea of systems that will facilitate their ability to drive but are not ready to give up full control of the vehicle.

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Appendix A Tracking Information from Literature Review

First Author	Year	Title	Topic/Category	Summary	Found through
Marshall	2010	Enhancing the Effectiveness of Safety Warning Systems for Older Drivers	Warning	Failure to Obey in-vehicle warning system evaluated one third fewer stop sign or red light violations with system benefit to all three age groups Normal middle aged drivers, normal older drivers, at risk older drivers	Google Scholar
Schall	2013	Augmented Reality Cues and Elderly Driver Hazard Perception.	Hazard Perception	Augmented reality cues did not impair older divers' ability to maintain safe headway	Academic Search elite
Yannis	2010	Older Drivers' Perception and Acceptance of In-Vehicle Devices for Traffic Safety and Traffic Efficiency.	Older driver's acceptance of tech.	Older drivers have problems adopting new technology but study found older Greek drivers are supportive of them.	Academic Search elite
Llaneras	2000	Attention Demand of IVIS Auditory Displays: An On-Road Study Under Freeway Environments	Technology: IVIS	IVIS auditory system improved driving performance for older drivers except when there was background noise (>80dB) present	Older Drivers' Perception and Acceptance of In-Vehicle Devices for

					Traffic Safety and Traffic Efficiency.
Strayer	2004	Profiles in Driver Distraction: Effects of Cell Phone Conversations on Younger and Older Drivers	Distracted driving	Found two-fold increase in number of rear-end collisions involving cell phones. Older drivers do not suffer greater penalty while driving and talking on cell phone then do younger drivers, nor they do not have as many crashes over all	Google Scholar
Yanko	2013	Driving with a wandering mind the Effect that Mind Wandering Has On Driving Performance	Age related changes	Mind-wandering impairs driving performance	Google Scholar
Charness	2009	Aging and Information Technology Use Potential and Barriers	Older driver's acceptance of tech.	Older adults less likely to use technology then younger adults. Older aversion will not disappear in future generations.	Google Scholar
Ball	1998	Driving Avoidance and Functional Impairment in Older Drivers	Older driver's avoidance	Older drivers with visual or cognitive impairments reported higher levels of driving avoidance	Google Scholar
Kline	1992	Vision, Aging, and Driving: The Problems of Older Drivers	Older driver crash types + age related changes	Age related changes in vision were related to types of car crashes.	Google Scholar

Hakamies-Blomqvist	1994	Compensation in older drivers as reflected in their fatal accidents	Older driver compensation	Older drivers less likely to be in a hurry, intoxicated or distracted then younger groups. Probability for being at fault in a collision was independent of these.	Google Scholar
Hakamies-Blomqvist	1996	Research on Older Drivers: A Review	Older driver trends	In order to asses crash risk for older drivers, researchers need to assess tasks of driving, gerontological data about age related changes in functioning, and accident statistics	Google Scholar
Hakamies-Blomqvist	1993	Fatal Accidents of Older Drivers	Older driver trends	Older drivers typically collided with a vehicle at an intersection which they did not notice at all or saw too late and couldn't react fast enough	Google Scholar
Ball	1986	Improving Visual Perception in Older Observers	Age related changes	Older people have a hard time discriminating one direction of motion from another, similar one.	Fatal Accidents of Older Drivers
Aksan	2012	Naturalistic Distraction and Driving Safety in Older Drivers	Distracted driving	Older drivers had more safety errors than younger ones when distracted. Distraction disproportionally affects older drivers with visual, motor, and cognitive declines	Google Scholar
Rizzo	1997	Simulated car crash and crash predictors in	Cognitive decline	Useful field of view, visuospatial impairment, reduced perceptions of	Google Scholar

		drivers with Alzheimer disease.		3-d structure from motion	
Anstey	2004	Cognitive, Sensory and Physical factors enabling driving safety in older adults	Factors predicting driving ability	Attention, reaction time, memory, executive function, mental status, visual function, physical function and self-monitoring all were factors that influenced driving behavior. Therefore three functions: cognition, sensory function, and physical function predict driving ability.	Google Scholar
McKnight	1999	Multivariate Analysis of Age-related Driver Ability and Performance Deficits	Cognitive decline	Deficiencies in attentional, perceptual, cognitive, visual and psychomotor categories resulted in less safe driving practices	Google Scholar
Stutts	1998	Cognitive Test Performance and Crash Risk in an Older Driver Population	Cognitive decline	Older drivers who scored lowest on the cognitive tests were 1.5 times more likely to be in crashes	Google Scholar
Lyman	2002	Older Drivers Involvements in Police Reported Crashes and Fatal Crashes: Trends and Projections	Older driver trends	Older drivers are at less risk of being involved in police reported crashes but more likely to be in fatal crashes	Google Scholar

Miller	1998	Highway Crash Costs in the United States by Driver Age, Blood Alcohol Level, Highway Crash Costs in the United States by Driver Age, Blood Alcohol Level, Victim Age, and Restraint Use	Older driver trends	Older drivers still least likely to wear safety belts. Significant health and financial burdens from older driver crashes	Google Scholar
Gilhotra	2001	Impaired vision and other factors associated with driving cessation in the elderly: the Blue Mountains Eye Study	Older driver trends	Sensory impairment affecting vision and hearing was associated with driving cessation	Google Scholar
James	2012	Car Design for All Ages	Technology acceptance	Cars get more technologically advanced each year. Alienation of the senior driver is a big risk with the technologies	Google Scholar
Fofanova	2011	Distraction in Older Drivers-A Face-to-Face Interview Study	Distracted driving	Older drivers do not engage in distracting tasks while driving due to age related prudence	Google Scholar
Robertson	1976	Estimates of motor vehicle seat belt effectiveness and use: implications for occupant crash protection.	Seat belt use	Seat belts would be 60% effective with 100% use. Substantial injury reductions being seen when used	Google Scholar

Winter	1985	Learning and motivational characteristics of older people pertaining to traffic safety	Older driver trends	Older drivers are more likely to crash while backing up than younger drivers	Google Scholar
Ostrow	1989	The relationship of joint flexibility to older driver performance	Age related changes	Normal decreases in neck rotation range of motion and useful field of vision put older rivers at a higher risk of crash	Google Scholar
Ball	1993	Visual attention problems as a predictor of vehicle crashes in older drivers.	Older driver trends	Useful field of view and visual attention were significant predictors of crash risk for older drivers	Google Scholar
Chovan	1994	Examination of Unsignalized Intersection, Straight Crossing Path Crashes and Potential IVHS Countermeasures	Older driver trends	Only 42% of intersection crashes was from running the stop sign, the rest were from mistakes after stopping	Google Scholar
Owram	1996	Born at the Right Time	Baby-boomers	History of the baby boomers: raised with technology, best educated, richest and healthiest generation ever	Google Scholar
Isler	1997	Age Related Effects of Restricted Head Movements on the Useful Field of View of	Age related changes	Relates restricted neck rotation and UFOV associated with aging to older driver's involvement in intersection crashes	Google Scholar

		Drivers			
Staplin	1998	OLDER DRIVER HIGHWAY DESIGN HANDBOOK	Age related changes and older driver trends	Functional capabilities become diminished with age and discusses how passing zones, intersections and interchanges can be improved to accommodate them	Google Scholar
Suen	1998	The Value of Intelligent Transport Systems to Elderly and Disabled Drivers	Older driver trends	Older drivers are aware of fatigue susceptibility and self-restrict driving, thus have lower run offs	Google Scholar
Hakamies-Blomqvist	1999	Safety of Older Persons in Traffic in Transportation in an Aging Society: A Decade of Experience.	Older driver trends	Drivers who do not cease driving when they learn of a visual impairment typically avoid visually difficult situations. Avoid night, weather, heavy traffic	Google Scholar
Ball	2002	Advances in Technology Used to Assess and Retrain Older Drivers	Age related changes	UFOV decreased with age due to decrease in visual processing speed, reduced attention, inability to ignore distractors	Google Scholar

Braver	2004	Are Older Drivers Actually at Higher Risk of Involvement in Collisions Resulting in Deaths or Non-fatal Injuries Among Their Passengers and Other Road Users?	Older driver trends	Older drivers have more insurance claims addressing injuries of other road users for which they are at fault.	Google Scholar
Siren	2004	Driving Cessation and Health in Older Women	Older driver trends	Driving cessation occurred in populations still fit to drive, impairments would not have affected specific aspects of driving, but general wellbeing. Cessation/compensation choices common, especially among women	Google Scholar
Tacken	2005	Use and acceptance of new technology by older people. Findings of the international MOBILATE survey: 'Enhancing mobility in later life'	Technology acceptance	Use of technologies such as pc, internet, e-banking is low among those 55+	Google Scholar
Laberge	2006	E-sign of an intersection decision support (IDS) interface to reduce crashes at	Gap acceptance, technology info	Role of gap acceptance in intersection crashes, intersection alert system	Google Scholar

		rural stop-controlled intersections			
Langford	2006	Epidemiology of older driver crashes – Identifying older driver risk factors and exposure patterns	Older driver trends, age related changes	Risks and exposures of older drivers involved in crashes: increased reaction time, difficult to divide attention between tasks, decrease vision, especially at night, decrease ability to judge speed and distance, difficulty turning head, difficulty perceiving and analyzing situations, reduced peripheral vision, prone to fatigue, increased anxiety over ageing	Google Scholar
NHTSA	2009	Traffic Safety Facts: Older Population	Older driver trends	2008 data: least likely to be intoxicated, least likely to crash, most likely to be injured or struck by other driver	Google Scholar
AAA	2012	Senior Driver Survey	Older driver trends	61% of older drivers avoid driving in bad weather. 80% report not driving in one of several conditions	Google
Tseng	2004	Vehicle Back Up Camera	Technology-back up	Patent and system info example	Google Scholar
McClanahan	1998	Back-up protection sensor for a vehicle	Technology-back up	Patent and system info example	Google Scholar

Tanaka	2003	Parking assist device	Technology-park assist	Patent and system info example	Google Scholar
Shyu	1988	Automatic parking device for automobile	Technology-park assist	Patent and system info example	Google scholar
Schofield	1996	Vehicle blind spot detection system	Technology -blind spot detection	Patent and system info example	Google scholar
Lo	2009	Lane departure warning system	Technology-ldw	Patent and system info example	Google scholar
Yanagi	1999	Vehicle collision warning system	Technology-fcw	Patent and system info example	Google scholar
Labuhn	1993	Adaptive cruise control	Technology-acc	Patent and system info example	Google scholar
Burley	1985	Night vision system with color video camera	Technology-night vision	Patent and system info example	Google scholar
Beam	1996	Adaptive/anti-blinding headlights	Technology-adaptive headlights	Patent and system info example	Google scholar
Sadano	2004	Lane departure prevention apparatus	Technology lane departure mitigation	Patent and system info example	Google Scholar
Kaneko	1996	Navigation system and intersection guidance method	Technology-intersection navigation	Patent and system info example	Google Scholar
Harrison	2002	Intersection traffic control apparatus	Technology-intersection navigation	Patent and system info example	Google Scholar

Runyon	2001	System for tracking vehicle and driver location and mileage and generating reports therefrom	Technology-driver report card	Patent and system info example	Google Scholar
Bishop	2000	A survey of intelligent vehicle applications worldwide	Technology-fully automated vehicle	Describes the use and safety benefits of fully automated and intelligent vehicle designs	Google Scholar
Dimitrakopoulos	2011	Intelligent transportation systems based on internet-connected vehicles: Fundamental research areas and challenges	Technology-connected vehicles	Looks at intelligent transport systems that communicate using internet to form vehicle-infrastructure networks	Google Scholar
Rajamani	2012	Electronic Stability Control	Technology-electronic stability control	Describes how ESC prevent spinning and drifting out	Google scholar
Brosnan	2013	Anti-lock Braking Systems	Technology-anti-lock brakes	Describes how ABS systems prevent front wheels from locking and no longer need to pump	Google Scholar
Crandall	2000	Mortality reduction with air bag and seat belt use in head-on passenger car collisions	Technology-seat belts and air bags	Discusses the reduction in mortality and injury associated with proper use of seat belts and or air bags	Google Scholar

Bartlett	1967	Pedestrian detection system	Technology-pedestrian detection system	System uses sensors to detect and relay information about pedestrians	Google scholar
Kaplan	1996	Alertness and drowsiness detection and tracking system	Technology-impairment detector	Describes a system that detects if drivers are drowsy and issues an alert	Google scholar
Wang	1996	The role of driver inattention in crashes: New statistics from the 1995 Crashworthiness Data System	Intersections crashes	Subtypes of intersection crashes	Google Scholar
Evansm	1982	Compulsory Seat Belt Usage and Driver Risk-Taking Behavior	Technology-seat belts	Seat belt use does not increase risk taking behaviors	Google Scholar
Williams	1986	RESULTS OF A SEAT BELT USE LAW ENFORCEMENT AND PUBLICITY CAMPAIGN IN ELMIRA, NEW YORK	Seat belt	Publicity campaign increased use rates by 22%	Google Scholar
Jonah	1982	Predicting reported seat belt use from attitudinal and normative factors	Technology acceptance	Comfort and convenience affected seat belt use	Google Scholar

Appendix B: In-Vehicle System Video Demonstration Screen Shots

Video demonstration screen capture of night vision assistance system.

This system is displays a live feed in black and white on a monitor in the dashboard. If a pre-identified hazard is detected, that object will be displayed in color on the monitor or within a box.

Video demonstration screen capture of a blind spot detection system.

This system causes lights on the side mirrors to light up any time a car or object is in the blind spot, the auditory alert activates when the turn signal is activated while an object is within the blind spot.

Video demonstration screen capture of the forward collision warning system.

The audio alert activates when the vehicle get too close to a vehicle or other object in front of the car based on speed.

Video demonstration screen capture of the left turn assistance system.

This system provides an auditory guidance system for safely navigating intersections. This same system can also provide assistance for other types of intersections.

Appendix C: Blind Spot Detection Questionnaire

Study: MATC-Focus
Participant: ___________
Date: ___________

Blind Spot Detection Questionnaire

The following questions address ONLY the **Blind Spot Detection System**. This system causes lights on your side mirrors to light up any time a car or object is in your blind spot, the auditory alert activates when you activate your turn signal while an object was within your blind spot. Please read each question carefully and mark your response. If something is unclear ask the research assistant for help. Your participation is voluntary, and you have the right to omit questions you choose not to answer.

1. To what extent would people your age trust the **Blind Spot Detection system**?
   - ❐ Not at all
   - ❐ Slightly
   - ❐ Moderately
   - ❐ Very Much
   - ❐ Extremely

2. What was your degree of *self- confidence* to **detect objects in your blind spot while changing lanes without this system**?
   - ❐ Not at all confident
   - ❐ Slightly confident
   - ❐ Moderately confident
   - ❐ Very confident
   - ❐ Extremely confident

3. Would people your age want this system in their car/vehicle?
   - ❐ Yes
   - ❐ No
   - ❐ Unsure

4. Would people your age become over reliant on this system?
   - ❐ Yes
   - ❐ No
   - ❐ Unsure

5. Would this system make people your age anxious/nervous?
   - ❐ Yes
   - ❐ No
   - ❐ Unsure

6. How much would you be willing to pay for a **Blind Spot Detection** system?

   $__________________________

Appendix D: Forward Collision Questionnaire

Study: MATC-Focus
Participant: ___________
Date: ___________

Forward Collision Warning Questionnaire

The following questions address ONLY the **Forward Collision Warning:** The alert activates when you get too close to the vehicle or other object in front of you based on how fast you are going. Please read each question carefully and mark your response. If something is unclear ask the research assistant for help. Your participation is voluntary, and you have the right to omit questions you choose not to answer.

1. To what extent would people your age trust the **Forward Collision Warning** system?
   - ❐ Not at all
   - ❐ Slightly
   - ❐ Moderately
   - ❐ Very Much
   - ❐ Extremely

2. What was your degree of *self confidence* in **maintaining a safe following distance without this system**?
   - ❐ Not at all confident
   - ❐ Slightly confident
   - ❐ Moderately confident
   - ❐ Very confident
   - ❐ Extremely confident

3. Would people your age want this system in their car/vehicle?
   - ❐ Yes
   - ❐ No
   - ❐ Unsure

4. Would people your age become over reliant on this system?
   - ❐ Yes
   - ❐ No
   - ❐ Unsure

5. Would this system make people your age anxious/nervous?
   - ❐ It would make me very much **more** anxious/nervous
   - ❐ It would make me slightly **more** anxious/nervous while driving
   - ❐ It would neither make me anxious/nervous **NOR** relieve my anxiety/nervousness
   - ❐ It would make me slightly **less** anxious/nervous
   - ❐ It would make me very much **less** anxious/nervous

6. How much would you be willing to pay for a **Forward Collision Warning** system?

   $___________________________

Appendix E: Left Turn Assistance Questionnaire

Study: MATC-Focus
Participant: __________
Date: __________

Left Turn Assistance Questionnaire

The following questions address ONLY the **Left Turn Assistance System**. This system provides an auditory guidance system for safely navigating intersections. This same system can also provide assistance for other types of intersections (right turn, going straight, etc). If something is unclear ask the research assistant for help. Your participation is voluntary, and you have the right to omit questions you choose not to answer.

1. To what extent would people your age trust the **Left Turn Assistance** system to instruct them when to go?
   - ❒ Not at all
   - ❒ Slightly
   - ❒ Moderately
   - ❒ Very Much
   - ❒ Extremely

2. What was your degree of *self-confidence* to **navigate intersections without this system**?
   - ❒ Not at all confident
   - ❒ Slightly confident
   - ❒ Moderately confident
   - ❒ Very confident
   - ❒ Extremely confident

3. Would people your age want this system in their car/vehicle?
   - ❒ Yes
   - ❒ No
   - ❒ Unsure

4. Would people your age become over reliant on this system?
   - ❒ Yes
   - ❒ No
   - ❒ Unsure

5. Would this system make people your age anxious/nervous?
   - ❒ It would make me very much **more** anxious/nervous
   - ❒ It would make me slightly **more** anxious/nervous while driving
   - ❒ It would neither make me anxious/nervous **NOR** relieve my anxiety/nervousness
   - ❒ It would make me slightly **less** anxious/nervous
   - ❒ It would make me very much **less** anxious/nervous

6. How much would you be willing to pay for a **Left Turn Assistance** system?

   $_________________________

Appendix F: Night Vision Assistance Questionnaire

Study: MATC-Focus
Participant: __________
Date: __________

Night Vision Assistance Questionnaire

The following questions address ONLY the **Night Vision Assistance System**. This system is always displaying a live feed in black and white on a monitor in the dashboard. If a pre-identified hazard is detected, that object will be displayed in color on the monitor. Please read each question carefully and mark your response. If something is unclear ask the research assistant for help. Your participation is voluntary, and you have the right to omit questions you choose not to answer.

1. To what extent would people your age trust the **Night Vision Assistance** system?
   - ❒ Not at all
   - ❒ Slightly
   - ❒ Moderately
   - ❒ Very Much
   - ❒ Extremely

2. What was your degree of *self-confidence* to detect **hazardous objects at night without this system**?
   - ❒ Not at all confident
   - ❒ Slightly confident
   - ❒ Moderately confident
   - ❒ Very confident
   - ❒ Extremely confident

3. Would people your age want this system in their car/vehicle?
   - ❒ Yes
   - ❒ No
   - ❒ Unsure

4. Would people your age become over reliant on this system?
   - ❒ Yes
   - ❒ No
   - ❒ Unsure

5. Would this system make people your age anxious/nervous?
   - ❒ It would make me very much **more** anxious/nervous
   - ❒ It would make me slightly **more** anxious/nervous while driving
   - ❒ It would neither make me anxious/nervous **NOR** relieve my anxiety/nervousness
   - ❒ It would make me slightly **less** anxious/nervous
   - ❒ It would make me very much **less** anxious/nervous

6. How much would you be willing to pay for a **Night Vision Assistance** system?

   $________________________

Appendix G: Focus Group Script

I first want to thank you all for participating in this focus group, we appreciate your commitment to this study. Also, thank you for filling out our demographic survey. As I explained during the consent process, the purpose of this study is to evaluate some in-vehicle safety systems that may or may not help “older” drivers. First we will have a short discussion, then I will be showing you four different short videos that demonstrate what various safety technologies are designed to do. The videos consist of a computer simulated environment. These are new technologies and most people do not know much about them so please, don’t feel embarrassed to speak up. After each video I will have you fill out a brief survey and then I will ask some questions for which I would like your honest opinions. We are going to set up some guidelines/ground rules to assure that this is a productive and friendly environment.

There is no right or wrong answer, so please, don’t hold back. If you are thinking about it, we want to hear it.

Please engage in constructive dialogue and feedback with each other and the research assistant.

Please do not have side conversations during this focus group. It is important that you share your thoughts, but side conversations can be distracting to both the focus group and the person who will be transcribing this meeting.

If you do not understand the question or what the technology is showing, please ask.

Please allow time for others to voice their opinions as well.

We will have a short break during this group but if you need to use the restroom or get a drink please ask the research assistant.

Now that we have gone over the purpose of this study and some rules are there any questions?

Ok so first we are just going to go around and introduce ourselves by say our first name and our favorite restaurant in the area.

Good discussion, now for the study questions:

PRE-VIDEO QUESTIONS

Who can tell me about warning systems in cars?

Prompt: has anyone seen or heard a warning system advertised on tv or seen one in action?
By a show of hands, who here has an anti-lock braking system in their car? ***make sure to state for recording how many hands are up***
Prompt: Is anyone unsure?

How if at all have any of your driving habits changed since you started driving a car with anti-locking brakes?
Prompt: Has having an anti-lock braking system made you feel more comfortable driving in certain weather conditions?

Where would you go to find information on a vehicle safety system that you didn't know about?
Prompt: internet, friend, mechanic, dealership, etc

LEFT TURN ASSISTANCE

The final technology demonstration is of a Left Turn System:
This system provides an auditory guidance system for safely navigating intersections. This same system can also provide assistance for other types of intersections (right turn, going straight, etc).

show left turn video

Give left turn survey
What do and don't you like about this technology?
Prompt: Is it too confusing/descriptive? Would it make it easier for you to safely navigate the intersection?

How if at all, would this change the way people your age drive?
Prompt: Would this change the way people your age drive in high density traffic/rush hour situations? Would you be less cautious?

How if at all would you change this system?

Prompt: not at all? Make sure there is a bigger gap to turn?

How difficult is it to tell what is going on at the intersection?
Prompt: Very difficult, Very easy?

How if at all do you think this will help prevent a collision?
Prompt: Will it not? Will it make people go at an unsafe time?

Do you view this technology as an effective safety system or more of a convenience system?
Prompt: Does it take away "human error/judgment mistakes?" Does it just make it easier to not pay attention?

How could this system fail?
Prompt: Uncontrolled intersections? When not at an intersection?

Would you want the vehicle to navigate itself through the intersection and turn and why?
Prompt: Would it eliminate human error/judgment mistakes? Would it startle you?

FORWARD COLLISION WARNING

This next technology demonstration is of a Forward Collision Warning System:
The alert activates when you get too close to the vehicle or other object in front of you based on how fast you are going.

show FCW video

give FCW survey
What do and don't you like about this technology?

Prompt: Does it remove some of the stress of dense traffic? Will it make it too easy for people your age to speed?

How if at all, would this change the way people your age drive?
Prompt: Would it make them more likely to drive in rush hour situations? Would they be more likely to speed?

How if at all would you change this system?
Prompt: Would you want more/less time to react?

How difficult is it to tell what is going on in the driving environment?
Prompt: very difficult, very easy

How if at all do you think this will help prevent a collision?
Prompt: Will it not? Will it stop you from "rear-ending" someone?

Do you view this technology as an effective safety system or more of a convenience system?
Prompt: Will it reduce forward collisions? Will it make it easier to speed or not pay attention?

How could this system fail?
Prompt: while changing lanes? False alarms?

Would you want the vehicle itself to brake for you and why?
Prompt: Would you be injured (whip lash) if it did? Would it be less likely to brake too hard?

BLIND SPOT DETECTION

The next technology demonstration is of a Blind Spot Detection system:
This system causes lights on your side mirrors to light up any time a car or object is in your blind spot, the auditory alert activates when you activate your turn signal while an object was within your blind spot.

Show Blind spot video

Give Blind Spot Detection Survey
What do and don’t you like about this technology?
Prompt: Hard to turn head so this makes it easy to see objects? Annoying?

How if at all, would this change the way people your age drive?
Prompt: Would you be more likely to pass vehicles in front of you? Not at all?

How if at all would you change this system?
Prompt: Only alert if blinker is on? Make the audio alert get louder if being ignored?

How difficult is it to tell what is going on in the driving environment?
Prompt: Very easy? Very difficult?

How if at all do you think this will help prevent a collision?
Prompt: will it not? Will it make it worse by startling you? Will you see the cars sooner?

Do you view this technology as an effective safety system, or more of a convenience system and why?
Prompt: Will it reduce sideswipe collisions? Will it make it so people don’t need to look **over** the shoulder?

How could this system fail?
Prompt: Forget turn signal? Motorcycles? False alarms

Would you want the vehicle to force you to remain in your lane if there was a threat?
Prompt: Would it scare you? Would it do a better job of safely making you stay in your lane?

NIGHT VISION ASSISTANCE

Now we are going to watch some short video demonstrations of some safety technologies.
The first system is a Night Vision Assistance System:
This system is always displaying a live feed in black and white on a monitor in the dashboard. If a pre-identified hazard is detected, that object will be displayed in color on the monitor.

Show Night Vision video

Give Night Vision Assistance Survey
What do and don't you like about this technology?
Prompt: Helps see people/hazards? Distracting?

How if at all, would this change the way people your age drive?
Prompt: night-time driving? Not at all?

How if at all would you change this system?
Prompt: Different alert? More/less sensitive?

How difficult is it to tell what is going on in the driving environment?
Prompt: very difficult, very easy?

How if at all do you think this will help prevent a collision?

Prompt: Will it not? Prevent pedestrian collision? Vehicle collision?

Do you view this technology as an effective safety system, or more of a convenience system and why?
Prompt: Will it reduce crashes? Will it be easier to drive while tired since you only need to worry about lane position and speed?

How could this system fail?
Prompt: Bad weather? Lit roadways vs very dark road?

AFTER ALL VIDEOS AND QUESTIONS HAVE BEEN ANSWERED:
That concludes our video demonstrations;
I just have a couple last questions:
What types of driving safety technology would you like to see emerge?
Prompt: what technologies mentioned or not mentioned would change the way you restrict your driving?

Which was your favorite safety system that we talked about today and why?
Prompt: ABS, Night vision, Blind Spot, FCW, Left Turn, The systems that could be fully automated?

Does anyone have anything else they would like to say before we finish today?

Thank you again for participating in this study. Your checks will arrive in the mail to the address you provided on your compensation voucher. The process usually takes about 3-6 weeks. If you have any questions please contact Kayla Smith at 319-335-4672, her number and contact information are located on the front page of your informed consent.