2006-21-0008

New Demands from an Older Population: An Integrated Approach to Defining the Future of Older Driver Safety

Joseph F. Coughlin and Bryan Reimer
Massachusetts Institute of Technology

ABSTRACT

The nearly 77 million baby boomers, born between 1946 and 1964, can say that they are *the* automobile generation. Now turning 60 one every seven seconds, what are the new safety challenges and opportunities posed by the next generation of older adults? This paper presents a modified Haddon matrix to identify key product development, design and liability issues confronting the automobile industry and related stakeholders. The industry is now at a critical juncture to address the development of key technological innovations as well as the changing policy and liability environments being reshaped by an aging population.

INTRODUCTION

January 2006 the baby boomers began turning 60. Born between 1946 and 1964 the nearly 77 million adults can say that they are *the* automobile generation. From cradle – some may even suggest from conception – to grave the baby boomers have defined and driven innovation in the car. Innovations in power and control to meet the needs of their fast paced lives, design to match their penchant for redefining lifestyles, economy and quality to respond to their changing needs and fickle brand loyalties. Whether discussing the baby boomers in North America, Europe or the Dan Kai in Japan, the aging of the once perpetually youthful automobile market is posing new challenges for the automobile industry. While safety has always been important, the aging of the boomers is making safety a greater priority for older consumers, insurers and governments.

Aging boomers will present many of the same safety issues posed by their parents, such as improved safety restraint systems. Next generation safety restraint systems with older occupants in mind are already in many of today's vehicles or in future deployment plans. Active safety for older operators and passengers may hold still greater promise and challenge. However, the next generation of older consumers will also introduce novel expectations for safety-inspired design, engineering and services. The baby boomers will demand an integrated systematic response to their multiple safety needs which will be defined by the profound impact of in-vehicle warning/informatics on older operators, the largest generation of older women drivers in history, mass awareness of health and medical conditions on driver performance, and the unique trauma needs presented by older people.

This paper suggests that a more complete look at the older consumer is needed to reconcile the car as a mobility, safety and service platform. Future automobile safety systems will require special attention to the impact of warning and information systems on the older user, the integration of personalized monitoring and safety systems, and the introduction of information-rich links to emergency and trauma services in the event of a crash. The automobile industry is now at a unique juncture to address these issues and respond to growing interest and concern related to older drivers in insurer and legal communities as well as among government regulators in North America and beyond.

NEW AUTOMOBILE SAFETY DEMANDS FROM AN OLDER POPULATION

Over the next ten years, at least 25 percent of automobile buyers will be over age 50. These "older" consumers purchase the majority of premium luxury vehicles – platforms that deliver the industry's highest profits margins (Coughlin, 2005). Of all the highly motorized nations, the United States is most likely have the largest

number of oldest older consumers that will drive more and longer than similar cohorts throughout the world. Over the last decade, the number of Americans age 70+ grew four percent higher than the national average growth across all age groups. Moreover, according to the US Department of Transportation, the number of drivers 70 and older rose by 27 percent, more than double the 13 percent national average for drivers of all ages between 1994 and 2004 (USDOT, 2004).

The growth in the number of older drivers reflects both demographic trends and the new mobility lifestyles of older people. The driving patterns of today's older driver and aging baby boomers reflect lives that are predicated on 'automobility' (Cobb & Coughlin, 2004). Better health, increased levels of education and larger incomes are key drivers of activity and related mobility demands. However, these lives and lifestyles are primarily located in suburban and rural areas where public transportation is often not a viable option to the car. Nearly 70 percent of older Americans live where transit either does not provide service or does not provide adequate responsiveness (Rosenbloom, 2003). As observers might assume from these data alone, forecasts of future older adult mobility demand include more trips, more miles and more reliance on the automobile (Bush, 2003; Burkhardt, et al.,1998).

Although there is some confidence that older baby boomers will be doing and driving more in old age, the future of their safety is less clear. Over the last decade, drivers 70 and older have consistently maintained the second highest fatality rate – second only to younger drivers age 16-20 – based upon deaths per 100,000 people. Twice as likely to be driving the car that is struck compared to the youngest driver cohort, older adult fragility and related co-morbidity conspire to diminish their capacity to survive a crash. In 2004, nearly 141,000 older people were injured in car accidents. Although 10 percent of the driving population, people age 70+ comprise approximately 11 percent of all vehicle occupant deaths (USDOT, 2004). While improvements in vehicle technology, road infrastructure and driving behavior should have some safety impact, Burkhardt et al.(1998), estimates that if today's traffic fatality rate for older people continues into the baby boomer's golden years, the number of older occupant fatalities could approach nearly 20,000 per year – nearly equal to the number of drunken driver deaths currently experienced annually on the nation's highways.

While the safety of older drivers is frequently on the public agenda, it is most often defined around how best to manage the risks perceived to be posed by older operators to other road users, e.g., adequacy of age-based licensing and testing laws, how old is an older driver, etc. (Cobb & Coughlin, 1997). However, new attention is being given to the safety of older drivers and passengers. As the baby boomers begin turning 60, the generation that gave birth to automobile safety as a consumer value is now looking beyond the safety of their mostly grown children, and at the safety of their parents and themselves as a critical "buy" criteria.

Likewise, the convergence of auto safety and aging as a policy issue is receiving more attention from government as well. The 2005 White House Conference on Aging, a decennial national discussion of policy issues confronting America's older population, placed mobility, particularly driving, among the top issues to be addressed. The 2005 White House event marks the first time transportation, specifically driving, made the top 50 priorities list since the Conference's inception nearly four decades ago.

An Integrated Approach Toward Vehicle and Older Driver Safety

While consumers and policy makers are taking a new look at older drivers and automobile safety, the industry needs to develop an integrated and proactive approach to identify the opportunities for innovation; the special needs of older drivers and passengers; and, the possible risks posed by an increasingly older automobile driving population. In this paper, we present a modified Haddon matrix as a framework to identify and organize some of these opportunities and challenges. As most safety professionals are familiar, the Haddon matrix presents a 3X3 classification that includes all factors associated with an accident, depicting drivers, vehicles and the infrastructure on one column and three temporal categories on the corresponding row – pre-crash, crash and post-crash (Haddon, 1972).

Admittedly incomplete, Figure 1 presents an integrated approach to older driver safety opportunities and challenges blurring the vehicle and older driver/passenger. While improvements in the infrastructure are critical, e.g., signage and lighting, and future connectivity between the road and the car are forthcoming, this matrix and discussion focuses specifically on a variety of older driver safety issues that are directly related to the vehicle and therefore should be of particular interest to the automobile industry over the next three platform cycles.

Figure 1. Older Adults & Automobile Safety Evolving Challenges & Opportunities

Pre-Crash	• Learning and extreme usability of new in-vehicle technologies. • Active safety technology, self-regulation and driver confidence • Driver flexibility and visibility
Crash	• Passive safety and older occupant fragility. • Personalized advanced collision notification systems.
Post-Crash	• Older drivers and new safety responsibilities for the automobile industry • Emerging standards of negligence & liability.

PRE-CRASH

While there has been some focus on the safety of older drivers, it has been largely from the vantage of passive safety, e.g., improvements in safety restraint systems, crash cage, etc. Recent developments in active safety, where the automobile is able to detect, warn and potentially intervene to avoid or reduce the severity of a crash, are providing new and promising ways to improve safety. While an improvement, the current approach is incomplete.

Older driver experience and age-related changes highlight multiple challenges for systems safety design and engineering in the pre-crash domain. These include learning and using new in-vehicle systems and the role of technology in older driver behavior, and the design implications of reduced strength and flexibility.

Learning and Usability of Novel In-Vehicle Systems

Older consumers present an innovation paradox to the automobile industry. The majority of new in-vehicle systems find their way into the product packaging of higher-end premium vehicles – cars most often purchased by people 50+. However, while these older consumers are the first buyers of the new technologies, they may be the least likely to rapidly learn and use these systems. Consequently, the industry is now introducing novelty at a speed where the OEM's may be at risk of inventing a new future of driving that leaves their premium customers behind.

Many of these systems are developed by suppliers in the electronics industry where change and speed are the hallmark of progress and continuous innovation. New devices, interfaces, warnings, navigation, entertainment and related systems are introduced with their own user assumptions and metaphors – most often based upon 'what's hot' in consumer electronics, e.g., games, music, personal and mobile computing, generally the tech-savvy or youth-oriented markets.

The 50+ year old driver is likely to have well over 30 years of driving experience – experience that makes them among the safest drivers on the road. The same experience that makes them safe drivers often makes their learning and use of novel systems a challenge. Both research and market experience provide insight.

Research suggests that younger and older drivers learn to use new systems differently. For example, older drivers have been shown to be distracted from the driving task when the cause of a warning system was not clearly evident. Trust in their own experience and judgment 'second-guessed' their trust in the validity of the warning system causing them to look for clear reasons why an auditable alarm was triggered. In contrast, younger operators, by definition with fewer years of driving experience, were shown to have more trust in warning systems often choosing to rely on the system alone rather than using it as a driver assist (Yick, 2003; Cottè, Meyer & Coughlin 2001).

Market experience has examples of where new technology has challenged the older consumer. For example, BMW courageously introduced a new metaphor in driving – the iDrive. The iDrive interface removed an estimated 200 buttons and knobs from the dash, e.g., radio, navigation, climate control, etc., and on to a display manipulated by a hand interface on the center console. The initial introduction of the iDrive system met with criticism from customers and industry analysts alike. Over time, modifications have been made to the iDrive to make it more user-friendly for the predominantly 45+ buyers. Since BMW's first move, however, other manufacturers have followed introducing their own iDrive-like interfaces, e.g., Audi MMI.

The industry has been remarkably successful for decades in introducing innovation while maintaining a common language with the driver throughout their lifespan. Today, that common language is at risk, and efforts to identify the ideal strategy to integrate new technologies safely into the older driver's car is both a business and safety imperative. Successful deployment of active safety strategies, where the car takes a more 'active' role in anticipating and averting an accident, may meet their greatest challenge from the capacity of older drivers to learn, use, value and trust these new systems.

Introduction of active safety systems to the car is occurring at a greater frequency and velocity than can be easily absorbed by drives of any age – but may be particularly problematic for experienced drivers. Features such as brake assist, audible and haptic collision warning systems, fatigue and lane deviation detection, visual warning displays on the dash and eventual Heads-Up-Display (HUD) systems will require the older experienced driver to learn how to drive in a new way – three to four decades after their last 'drivers ed' class. The very effectiveness of these innovations to save lives, as well as their market success, may depend on how good a teacher the industry can become to its older premium consumer and student.

Lifelong driver education and training may be one approach. Taking delivery on a new car may require more than the traditional dealer prep and briefing before handing over the keys. The automobile industry may wish develop a fun, but thorough, delivery process with related materials to teach drivers of all ages how best to use new in-vehicle systems. Technology training partnerships with driver education programs, such as the AARP Driver Safety Program, which touches nearly a million people 50+ annually, may be one approach to improving adoption and safe use.

Technology, Self-regulation and Driver Confidence

Although new technology may provide a learning challenge to the older operator, it may also be a valuable strategy in improving driver longevity. Older drivers self-regulate their driving behavior, that is, they choose when they drive based upon their level of confidence under certain conditions. Drivers 50 and older report that they are most likely to avoid poor weather, night driving, periods of peak traffic and major highways. This strategy of self-regulation is seen as a major reason why older drivers are most often safe drivers.

New technologies may offer a way to extend safe driving and confidence. While many see self-regulation as a success in promoting safety, it results in lost mobility. Hutchinson (2004) found that selected technologies and systems improved older driver confidence and extended their willingness to drive. For example, navigation and location systems were found to enhance the confidence of older people to travel to unfamiliar locations. Night vision increased the likelihood that drivers might drive past sun down. Consequently, as long as the industry is able to make systems easy to learn, understand and usable, new technologies may extend the confidence and mobility of older people while ensuring public safety.

Older Driver Flexibility and Visibility

Considerable attention has been placed upon the older occupant's physical capacity to comfortably enter and exit the vehicle. However, the natural physical changes associated with aging affect more than ingress and egress. Older drivers, particularly older women, are more likely to suffer from arthritis and other muscular-skeletal conditions that reduce their overall flexibility. Diminished and comfortable movement of the neck and torso result in larger 'blind spots' making design, mirror use and other systems a larger safety imperative for older drivers.

Ostrow et al. (1992) demonstrated the importance of range of motion on operator vision and that improvements to rear, side and rear quarter vision could be improved with range of motion training. Another study examined how much flexibility was used by younger and older operators to perform selected driving tasks. These included backing up, parking, etc. The research showed that older drivers used a far higher percentage of their flexibility to operate to perform routine tasks than younger operators and in many cases used over 100 percent of their capacity by leveraging their body weight to turn off the steering wheel. Moreover, the same study found that those who reported pain, due to arthritis or a similar chronic condition, showed reduced flexibility necessary for optimal visibility (Reimer, et al., in press)

Production plans for future vehicles are addressing visibility issues associated with the 'A' pillar. However, the industry should place additional emphasis on understanding how mirror use and size, reversing assistance, side warnings and other driver-assist systems may improve the safety and comfort of older drivers suffering with reduced flexibility and chronic pain. Eventual introduction of clear composite materials may eliminate the visual obstruction altogether benefiting both older and younger operators.

CRASH

Considerable effort has been placed on the actual crash. Next generation passive safety systems such as multi-point belt systems, airbags, crash cages, seat sensors indicating the location and weight of the driver or passenger have all improved survivability and injury severity. Introduction of advanced collision notification systems also promise to improve the likelihood of people of all ages to survive a crash. Similar to the pre-crash domain, older users present unique challenges and opportunities to the industry in developing and integrating these strategies into the car.

Passive Safety and Older Occupant Fragility

The aging of the baby boomer generation is more than simply more older people – it is the largest generation of women to be buyers and drivers in their own right. Studies suggest that boomer women will lead more active lives than their mothers as caregivers, volunteers and workers. Consequently, it is likely that they will rely on the car and drive more than previous generations of women (Spain, 1998).

Older women present their own challenges to automobile safety. Generally smaller, older women sit closer to the steering wheel. Although new seat and pedal extension systems available in selected cars adjust to manage some of this risk, many older women choose to sit closer to the wheel to optimize their sense of control. Sitting closer to the wheel may subject older women to greater injury from an accident and from airbag deployment. In extreme situations, airbags deployed with sufficient force combined with older female occupant placement and fragility may cause injury and have negligible safety benefits (Kahane, 1996).

Moreover, older women are more likely to suffer from muscular-skeletal disease making them more susceptible to severe injury than men. The incidence of osteoporosis among older women increases their fragility risking multiple fractures and internal injury. Likewise, rheumatoid arthritis and similar diseases are experienced in higher rates by women increasing their risk of spinal dislocation and brain stem injury after a crash.

The industry has been increasingly sensitive to women as a growing, and in certain categories, dominant, market force. Volvo, for example, worked with a design team of women to address comfort, convenience and other ergonomic elements. In addition to design considerations, the introduction of smart materials, advanced composites and related polymers may be useful in sensing older operator location, weight, appropriate restraint and enhancing overall crashworthiness. Greater attention must now be given to the unique crash safety needs of older people with special attention given to older women in an accident.

Personalized Advanced Collision Notification Systems

Traffic safety professionals are well aware of the criticality of responding to accident victims as quickly as possible. The often referred to "golden hour," the time between roadway injury and treatment, is often the difference between life and death. Older adults suffering from co-morbidities, complicating medications and other

age related frailty may increase both consumer and government demands for innovations that speed the delivery of emergency services to the scene of an accident and enable rapid movement of victims from the roadside to the hospital.

While there have been substantial developments in the integration of Advanced Collision Notification Systems or ACNS into newer cars, this is only a beginning. Current applications use an array of sensors and GPS to detect an accident and notify emergency services. More recently, an extended view of ACNS includes detection of driver/occupant weight, distance from wheel and other features that seek to enable the vehicle to take active role in adjusting the force of airbag deployment and the engagement of other passive safety systems. Nearly everywhere else in their lives, the baby boomers have become accustom to personalization and connectivity.

The auto manufacturers in collaboration with emergency medical professionals and information communication technology integrators should seek to develop personalized systems that notify emergency services of an accident, the severity of the accident, and leverage the rich array of current and future sensors to collect and transmit personal information regarding the driver and occupants.

For example, in addition to rapid deployment of emergency services to the scene, the car could become a platform to help organize the emergency room and trauma resources before the patient(s) arrive. Important data that would help organize the chaos of the emergency room would be information related to the type of accident, estimation as to the extent of injury, blood types, co-morbidities, likelihood of complications due to medications, allergies, etc. Uploading personal information to the car combined with the real time detection and reporting from on-board systems would take ACN to the next level – enabling rapid notification, informed emergency response and optimal readiness of hospital emergency and trauma team resources.

POST-CRASH

While the first two domains focus on risk management – reducing the chances of an accident and increasing the survivability of an actual crash – our framework defines post-crash issues as the evolving assignment of responsibility and blame impacting the industry, insurers and policymakers.

Older drivers and New Safety Responsibilities for the Automobile Industry

While it has been noted that the safety of older drivers is a frequent question on the media and government agendas, the issue has not been well defined or resolved. Often trapped between humor and horror, pinpointing the exact risk of older drivers to others and to themselves eludes scientific consensus. Because of that ambiguity, older driver safety remains a political discussion. If, as suggested earlier, an increase in the number of older driver deaths is realized – who will be blamed for those crashes? Although individual determinations may be made one trial at a time, a more general public policy consensus is likely to emerge.

While driving is the primary mobility choice for all age groups, it is particularly important to older adults. Since transit is rarely a feasible option for the majority of older Americans living in the suburbs and rural areas, the car is the lifeline to all those big and little things that together make up life. Tougher standards for re-licensing of older drivers frequently fail because of uncertainty around what is old, which testing method is most appropriate, and the lack of clear transportation alternatives to the car. Consequently, most states have found that restricting the ‘automobility’ of older adults without clear objective assessment methods or viable transportation alternatives is neither equitable nor politically viable.

Policymakers have shown the willingness to place regulatory burden upon industry when individual behavior can not be easily changed to meet national goals. For example, with respect to clean air or fuel use, policymakers met with mixed results attempting to limit single occupant vehicle use. Instead, demands for a cleaner car became more acceptable than pushing individual drivers to car pool or make greater use of public transportation options. Assuming that there is not a major breakthrough in scientific knowledge clearly defining what is an older driver, development of an affordable and widely acceptable testing method, or a radical shift away from the car as the primary choice of

transportation, political action to rigorously regulate individual older adult behavior will remain elusive. Instead, a political consensus may emerge to place greater responsibility on the auto industry to develop a safer car that ensures the safe operation of older drivers and safety of older drivers and occupants.

Emerging Standards of Negligence & Liability

> There would not be any product liability suits if there were not any people involved with engineered systems. Unfortunately, people are everywhere, and they sometimes make mistakes…They misunderstand instructions, overlook labels, employ equipment for inappropriate purposes (Baruch & Merz, 1994 p.159).

As Baruch & Merz (1994), liability remains a significant concern for all engineered systems and the organizations that develop and commercialize them. The aging of the population potentially pose at least two related liability concerns.

First, the range of new in-vehicle systems being introduced to the car may (emphasis added) contribute to more accidents stemming from inadequate usability, operator misunderstanding or misuse. Historically, these innovations have been introduced first in those premium and luxury cars that bought most often by older consumers. Consequently, older adult usability and the capacity of older operators to learn novel systems will become far more than a design consideration, it is likely to become a very important liability risk management strategy.

Second, standards of legal negligence are based, in part, on the reasonable man standard. That is, a community-wide standard that provides an "objective" notion of what is reasonable to expect, in contrast, to the subjective opinion of litigants. The dramatic aging of the population may place new meaning on what is deemed reasonable. While the baby boomers were young the nation's expectations were designed to accommodate what a 'young' reasonable man might expect. Will the reasonable expectations for design, engineering and overall safety standards that the automobile industry has become accustom to during the baby boomer's youth now be forced to change to meet the new expectations of a much older population? And will this new 'older reasonable man standard' be used in future litigation by an almost certainly older jury pool determining what is reasonable, what is negligent, and who is to blame?

CONCLUSION

The nation's aging population poses a number of new safety challenges to the automobile industry as well as related stakeholders in government, insurance and health. The integrated approach toward vehicle and older driver safety presented here identifies a number of safety challenges and opportunities facing the automobile industry before a crash, at the time of an accident and after a crash. While the velocity of innovation in the car has accelerated at a record rate, the industry must now take an active role to address a large number of interrelated social, commercial, technical and legal factors impacting the safety of an aging baby boomer population.

ACKNOWLEDGMENTS

The authors wish to acknowledge the United States Department of Transportation-sponsored New England University Transportation Center and the AARP Driver Safety Program for their generous support of older driver safety research at the Massachusetts Institute of Technology Center for Transportation & Logistics and MIT AgeLab.

REFERENCES

Burkhardt, J., Berger, A.M. Creedon, M.A. & McGavock, A.T., *Mobility and Independence Changes and Challenges for Older Drivers.*Econsometrics, Inc. for the US Department of Health and Human Services and the National Highway Traffic Safety Administration. 1998.

Bush, S., *Forecasting 65+ Travel : An Integration of Cohort Analysis and Travel Demand Modeling*, Massachusetts Institute of Technology, PhD Thesis, Center for Transportation & Logistics AgeLab, Department of Civil & Environmental Engineering, 2003.

Cobb, R. and J. Coughlin, Regulating Older Drivers: How are the States Coping," in *Journal of Aging & Social Policy*, Volume 9(4) 1997.

Cobb, R. and J.. Coughlin, Transportation Policy for an Aging Society: Keeping Older Americans on the Move, in *Transportation for an Aging Society*, Conference Proceedings 27, Transportation Research Board, National Academies Press, Washington, DC 2004

Cottè, N., Meyer, J., & Coughlin, J. Older and younger drivers' response to collision warning systems. *Proceedings of the Human Factors and Ergonomics Society 45th Annual Meeting*, Human Factors and Ergonomics Society: Santa Monica, CA., pp. 277-280. 2001.

Coughlin, J., Not Your Father's Auto Industry? Aging, the Automobile and the Drive for Product Innovation. *Generations*, 28(4), 38-44. 2005.

Fischhoff, Baruch and Jon F. Merz, "The Inconvenient Public: Behavior Research Approaches to Reducing Product Liability Cases," in *Product Liability and Innovation: Managing Risk in an Uncertain Environment*. National Academy of Engineering, Washington, DC: 1994

Haddon, William. Jr., "A Logical Framework for Categorizing Highway Safety Phenomena and Activity," in Journal of Trauma. Volume 12, pages 193-207. 1972.

Hutchinson, T. Driving Confidence and In-Vehicle Telematics: A Study of Technology Adoption Patters of the 50+. Massachusetts Institute of Technology Center for Transportation & Logistics AgeLab, MST Thesis. 2004.

Kahane, C. *Fatality Reduction by Air Bags: Analyses of Accident Data Through Early 1996*. National Highway Traffic Safety Administration Report Number DOT HS 808 470. Washington, DC. 1996.

Ostrow, A., P. Shaffron, et al. ''The Effects of Joint Range-of-Motion Physical Fitness Training Program on the Automobile Driving Skills of Older Adults.'' Journal of Safety Research, 23(4): 207-219. 1992.

Reimer, B., R. Puleo, L. D'Ambrosio, J. Coughlin, J. Cichon, D. Griffith, Driver Flexibility: The Impact of Age on Rotation. Currently under review, MIT AgeLab 2006.

Rosenbloom, S., *The Mobility Needs of Older Americans: Implications for Transportation Reauthorization*. Brookings Institution, Washington, DC. 2003.

Spain, D., "Societal Trends: The Aging Baby Boom and Women's Increased Independence" Nationwide Personal Transportation Survey Symposium. *Searching for Solutions: A Policy Discussion Series*. U.S. Department of Transportation, Federal Highway Administration, 1999.

US Department of Transportation, National Highway Traffic Safety Administration, *Traffic Safety Facts Older Population, 2004*. http://www-nrd.nhtsa.dot.gov/pdf/nrd-30/ncsa/TSF2004/809910.pdf

Yick, K., Design and Test of Intersection Collision Avoidance Systems for Automobiles. SM Thesis, Massachusetts Institute of Technology AgeLab and Department of Aeronautical and Astronautical Engineering. 2003.

CONTACT

Joseph F. Coughlin, PhD is founder of the Massachusetts Institute of Technology AgeLab (http://web.mit.edu/agelab) and Directs the USDOT Region I New England University Transportation Center and may be contacted at coughlin@mit.edu where he chairs the AARP-sponsored National Older Driver Safety Advisory Council.

Bryan Reimer, PhD is Associate Director of the New England University Transportation Center and Research Scientist at the MIT AgeLab. Dr. Reimer sits on the National Older Driver Safety Advisory Council and conducts research on the safe operation of in-vehicle systems and older drivers.