Transportation Research Part F 35 (2015) 139–151

Contents lists available at ScienceDirect

Transportation Research Part F

journal homepage: www.elsevier.com/locate/trf

Cross-generational acceptance of and interest in advanced vehicle technologies: A nationwide survey

Justin M. Owens [a,*], Jonathan F. Antin [a], Zachary Doerzaph [b], Susan Willis [c]

[a] Center for Vulnerable Road User Safety, Virginia Tech Transportation Institute, Blacksburg, VA 24060, USA
[b] Center for Advanced Automotive Research, Virginia Tech Transportation Institute, Blacksburg, VA 24060, USA
[c] Center for Survey Research, Virginia Tech, Blacksburg, VA 24060, USA

ARTICLE INFO

Article history:
Received 8 January 2015
Received in revised form 9 June 2015
Accepted 13 October 2015
Available online 2 November 2015

Keywords:
Driving
Seniors
Generations
Advanced technology
Connected vehicle systems
Intelligent transportation systems

ABSTRACT

The number of older drivers on the roadways is increasing; at the same time, technology in the automotive environment is rapidly evolving. To investigate the potential impact of these converging changes, this study used a cross-generational approach to compare driver attitudes toward advanced automotive technologies. Approximately 1000 drivers between the ages of 18 and 85 located across the United States responded to a survey about their opinions regarding general technology, advanced in-vehicle technology, and near-horizon connected vehicle systems. Participant responses were categorized using a generational construct, sorting responses not only by age but by shared life experiences (e.g. economic circumstances, involvement in wartime activities, cultural movements, etc.). The oldest generation (the "Silent" generation) exhibited the least interest in and comfort with advanced technology, although they owned and used advanced in-vehicle technology at approximately the same rates as the two middle generations. The youngest generation (the "Millennial" generation) was most likely to be interested in and comfortable with technology, but was least likely to own vehicles with advanced technology. All participants expressed interest in safety-related connected vehicle systems, but less so in infotainment applications. Reservations regarding data security and system cost were shared across generations. These findings are framed in the context of an aging population with unique driving and vehicle needs, and provide information that may assist both with vehicle technology design aspects and the proposed large-scale implementation of connected vehicle systems, including considerations for seniors and emphasis on safety systems and data security.

1. Introduction

The landscape of vehicle-related technology is in a state of rapid change, brought about by advances in wireless connectivity, rapidly increasing integrated computing power, and the ubiquity of advanced mobile devices such as smartphones, music players, and navigation systems. Vehicle technology advances are being developed and integrated from multiple directions. Vehicle and device manufacturers are competing to provide drivers with the newest technological options, while the government has recently begun moving forward to incorporate advanced wireless communication technology to allow vehicles to

* Corresponding author at: 3500 Transportation Research Plaza, Blacksburg, VA 24061, USA. Tel.: +1 (540) 231 1010; fax: +1 (540) 231 1555.
E-mail addresses: jowens@vtti.vt.edu (J.M. Owens), jantin@vtti.vt.edu (J.F. Antin), zdoerzaph@vtti.vt.edu (Z. Doerzaph), suwillis@vt.edu (S. Willis).

http://dx.doi.org/10.1016/j.trf.2015.10.020
1369-8478/

communicate with each other and with infrastructure using "connected vehicle" systems (CVS). These changes are enabling new opportunities to advance driver safety, in-vehicle entertainment, vehicle control, and how drivers interact with the roadways and the surrounding environment. However, these advances also have the potential to add complexity and variability to the driving experience, which may disproportionately affect those who are least able or willing to deal with such changes. Older drivers, who often are already facing a variety of physical, perceptual, cognitive, and social challenges typically associated with aging, may find interacting with these novel technologies particularly daunting, particularly if they increase the cognitive load of the driver beyond what he or she is comfortable with. In addition, the current generation of older drivers is one of the last generations to have come of age before microcomputers became ubiquitous, and these individuals may be less familiar with and accepting of the general computing technology that underlies vehicle system interfaces.

Because of this convergence of increased vehicle technology, the impending arrival of CVS, and an aging driving population (National Safety Council, 2008), it is of critical importance to consider the impact of advanced vehicle technology on current older generations relative to younger generations, and the potential adoption of these systems by younger generations as they age. The population of the United States is aging rapidly, and is expected to continue to do so for the next several decades. In 2013, there were more than 7.3 million licensed drivers age 65 and older in the United States (Federal Highway Administration, 2015), and Census projections predict that those aged 65 and older will increase their percent of the total population by over 40% over the next 20 years, in direct contrast to all other age groups, which show flat or slightly decreasing projected percentages over that same timeframe (U.S. Census Bureau, 2012). While several studies have been conducted or are underway on general interest in and acceptance of advanced vehicle systems (Schoettle & Sivak, 2014) and the design characteristics of these systems (Brugeman, Wallace, & Cregger, 2012; Intelligent Transportation Systems Joint Program Office, 2013a), investigations that consider the effects of driver age and generational association on driver interest in and acceptance of advanced vehicle technology are needed.

1.1. Current in-vehicle technology

Recent advancements in technology have had far-reaching implications for vehicle design and the availability of novel features. In-vehicle information and entertainment (*infotainment*) options, for example, had remained relatively constant for several decades, and were generally limited to an AM/FM radio and a physical media player controlled by a small number of buttons and/or knobs. Within the past several years, however, the complexity and variety of infotainment options in vehicles has undergone a revolution corresponding to the rapid rise of mobile computing and connectivity. Today, many vehicles include a touchscreen system that allows the driver to interact with a variety of infotainment options, including terrestrial, satellite, and internet radio, compact discs, portable music players, and smartphones via auxiliary input, Bluetooth, and/or USB audio streaming. In addition to entertainment, these systems often also offer climate controls, internet connections, navigation and destination features, as well as access to advanced vehicle settings, functions and diagnostics. Automotive infotainment interfaces are rapidly changing from traditional vehicle-based controls into interfaces similar to modern computers and tablets.

In addition to advanced infotainment technology, new types of technology are designed to help the driver avoid crashes. These crash-avoidance technologies include systems such as backup cameras that supplement rear-view mirrors (with interfaces often contained in the same screen used for infotainment purposes), collision warning systems that alert drivers to impending conflicts using radar or machine vision, adaptive cruise control that can maintain a constant distance to a vehicle ahead, and night vision systems that can allow drivers to better detect pedestrians or animals in the roadway, among others. Like the advanced infotainment technology discussed above, most of these crash avoidance technologies have been introduced only in the past half-decade or so and are increasingly available across newer vehicle platforms.

1.2. Connected vehicle systems

The National Highway Traffic Safety Administration recently announced that it will begin the process of considering a mandate for CVS including vehicle-to-vehicle (V2V) technology for light vehicles in the United States (National Highway Traffic Safety Administration, 2014). In September 2014, General Motors announced that at least one 2017 Cadillac model will be one of the first production vehicles to incorporate V2V technology (Media.Cadillac.com, 2014) This combination of regulatory and commercial milestones sets the foundation for continued development and implementation of V2V technology, which allows vehicles to communicate with other similarly equipped vehicles in close proximity using Dedicated Short Range Communication (DSRC), a variant of Wi-Fi (Intelligent Transportation Systems Joint Program Office, 2013b). V2V communications convey pertinent location, speed, direction, and other vehicle data, and can be utilized in a variety of ways to improve safety and otherwise improve the driver's roadway experience. A typical implementation is to allow equipped vehicles to "know" where similarly-equipped nearby vehicles are located and headed. For example, if a driver attempts to pass a lead vehicle on a winding road, a CVS V2V system could alert him or her to an oncoming vehicle that is predicted to pose a conflict (Fig. 1A). If a vehicle is approaching an intersection, CVS could alert it to a rapidly approaching vehicle with which the driver is predicted to collide (Fig. 1B).

Further extension of CVS technology includes vehicle-to-infrastructure (V2I) communication, which enables vehicles to rapidly exchange information with infrastructure features such as intersections, allowing smart intelligent traffic signal control, dynamic routing (e.g. to avoid traffic), and highly-localized weather/roadway information systems among many