Driving Confidence and In-Vehicle Telematics: A Study of Technology Adoption Patterns of the 50+ Driving Population

by

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Abstract

In-vehicle telematics is a term that encompasses a wide range of technologies, which aid the driving function through features assisting in safety and service tasks. These technologies are designed to give the operator and passengers added safety control and convenient service amenities- both of which contribute to an overall increase in piece of mind and satisfaction in the driving experience. Much effort has been exercised in the rapid development of technologies that comprise in-vehicle telematics systems. But, as is the case with many emerging technologies, these systems appeared on the market before thorough study of their impact on end users had even begun.

In recent years, several studies have shown the effects of various technologies on driver distraction, and many insightful results have emerged from that work. However, little has been done to understand consumer perception of these in-vehicle technologies. This thesis provides understanding of the role of in-vehicle telematics in today's automobiles and an analysis of survey data on driving confidence. Particular attention is given to the 50+ driving population, the nature of self-regulation among drivers in this age cohort, and the role that in-vehicle telematics can play in increasing confidence of older drivers. The objective of this thesis is to present the findings of a consumer perception survey in the context of the evolving dialogue on in-vehicle technologies and lay the groundwork for future studies on related topics. Findings in this work show that telematics can positively affect driving confidence, especially in the oldest women drivers. The results also show that telematics providers can greatly improve their delivery of these systems to appeal to a wider consumer base.

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Chapter 1: Introduction and Objectives

The following chapter will begin by defining the two main ideas introduced in the title of this work: in-vehicle telematics and the 50+ driving population. Then these two terms will be related by driving confidence, the variable under consideration in the following analysis. Finally, this chapter will outline the overall goals and specific chapter content contained in this thesis.

1.1 In-Vehicle Telematics

Telematics has often been defined as a "wireless communications system designed for the collection and dissemination of data"[1,2,3]. This definition is helpful for understanding the full measure of telematics capability. Not only can such systems read and store data, but they also have the capacity to write data as information is processed. And telematics have the added ability to operate wirelessly, without the burden of being tied down to landline connections. Obviously these characteristics open up a tremendous realm of possibility for innovation and application.

One such application is in the automobile- hence the term *in-vehicle* telematics. Here the capabilities of these systems are exploited to provide the driver with valuable safety and service features that enhance the driving experience. Many of these features employ global positioning systems (GPS), which enable the vehicle's position to be recognized by a remote third party. Such knowledge can be useful for obtaining directions when lost, for receiving advice on the closest outlet for a specific purchase, or for retrieving a lost or stolen vehicle.

But GPS tracking is hardly the only interesting feature of existing telematics systems. Technology is also in place that can interpret and project images from the roadway to enhance nighttime vision for the driver. Collision warning systems have also gained in popularity recently. This telematics device delivers an audible warning when onboard sensors detect a

[1] http://www.webofficials.com/glossary.htm
[2] http://www.mobilecomms-technology.com/contractors/handset/mobileglossarytz.html
[3] http://www.gsmworld.com/technology/glossary.shtml

nearing object that threatens collision. These and other in-vehicle features have the potential to positively impact the driving public. In the future, new and better systems are likely to come to market, creating even more opportunity for increased safety and convenience.

1.2 50+ Driving Population

The 50+ driving population is simply the group of people over the age of 50 who are licensed to drive and do so regularly. This cohort is of interest because physical and mental abilities have begun to decline in many people by this stage in life. These abilities, including visual acuity, flexibility, and reaction time, are crucial for safe automobile operation. Without these and other related skills, the driver and those with whom the driver interacts on the road, are put at increased risk for crash.

Cognizant of this fact, many older drivers have chosen to restrict their driving habits to correct for age-related skill deficiencies. Such practices are called self-regulation and can include the avoidance of night driving, avoidance of unfamiliar areas, or avoidance of such conditions as poor weather or heavy traffic. If problem drivers stay off the roads to avoid potentially high-stress conditions, road safety can be improved. But this has less than ideal impacts on those self-regulating their behavior. Self-regulation is essentially self-imposed, denied mobility. And denying oneself access to automobile transportation under certain conditions can eventually lead to feelings of isolation and loneliness. Therefore, new solutions must be tailored to the 50+ driving population in order to maintain high quality of life and ensure safety for the rest of the driving public.

1.3 Bringing It All Together: Driving Confidence

Having defined both in-vehicle telematics and the 50+ driving population, one may wonder if there is a helpful connection between them. This work argues that there is indeed a very helpful connection. Telematics systems presently have the ability to provide valuable safety benefits, and these benefits are likely to multiply in future iterations. Safety gains from in-vehicle telematics could help the 50+ driving population address core performance concerns related to vision, flexibility, and cognitive capacity.

The potential of these systems to increase safety is encouraging but would be meaningless if older drivers failed to adopt these technologies. After all, it is more likely that drivers in this cohort are not as comfortable with advanced technology either because they feel unqualified to manipulate it due to their own degraded physical and mental skills, or because they have little past experience with technology at all. One way to gauge the adoption patterns of the 50+ driving cohort is to examine the impact that telematics have on driving confidence. If telematics could lead to driving confidence gains, these drivers may achieve the safety benefits of a technique like self-regulation without the detrimental consequence of isolation. Of course, if these drivers were wary of adopting such new technology for any of the reasons just described, they would indicate that these systems do not increase driving confidence. But for those who do see confidence gains from telematics, adoption is more likely, and the telematics industry must seize the opportunity to market to these consumers.

1.4 Thesis Objectives

This work examines the self-regulatory behavior of older drivers and explores the feasibility of in-vehicle telematics. Using a nationwide survey, advanced vehicle technologies are held to the flame of consumer opinion. This paper analyzes the relationship between older drivers perceptions of in-vehicle telematics and the confidence to drive in light of self-regulatory behavior and strives to answer the question: Do in-vehicle systems and services affect the confidence of older drivers to drive?

In addition, this thesis aims to relate these findings on driving confidence to the current practices of the players in the telematics field. Brief case studies of telematics providers are presented to illustrate the present state of the industry. Then alternatives are described and recommendations are made to reconcile the 50+ driver survey responses with what telematics companies could be providing the driving public. This body of work will attempt to improve the state of the art in telematics provision by arguing for changes in business models and marketing strategies based on the results from the in-depth survey analysis.

1.5 Thesis Outline

This discussion is organized into six chapters and an appendix as described below.

Chapter 2: Background and Motivation

This chapter builds the case for implementation of in-vehicle telematics systems as a strategy worthy of consideration for assisting the 50+ driving population. The problem is framed through a description of the changing demographics of the U.S. population and the consequences that result from these changing demographics. One well-documented solution, self-regulation, is discussed and its faults are brought to light. Finally, telematics is presented as a potential solution to the problems described earlier in the chapter.

Chapter 3: Research Methodology

Beginning with a description of common research techniques, this chapter outlines the course of action taken in this thesis in analyzing technology adoption patterns of the 50+ driving population. Popular methods for data collection and analysis are discussed and the particular method employed in the chapters that follow is presented as well.

Chapter 4: Survey Results

The survey data are thoroughly explored in this chapter. It begins with summary statistics of interesting trends in different demographic groups. Then the chapter presents the results of the regression analysis as each telematics technology is regressed on a set of independent variables. It concludes with a cross-tabulation summary that was motivated by some of the interesting results from the regressions.

Chapter 5: Implications of Results

Results from Chapter 4 were not meant to stand alone. Rather, they were to be mapped to current initiatives in the telematics field. This is done so that empirical findings can be compared to real-world implementation, resulting in recommendations for alternative development and delivery methods. This chapter takes the empirical findings of the previous chapter and discusses the implications on the telematics marketplace.

Chapter 6: Conclusions and Recommendations

The last chapter of this thesis provides a wrap-up of all the important ideas presented. It also discusses potential pitfalls in the telematics industry and provides recommendations for future research in the field that would add to the body of work in this thesis and expand the knowledge base in the industry.

Appendix A: Survey Questionnaire

The survey is attached, in its entirety, as a helpful tool for the reader in understanding the sequence and delivery of the questions that were explored in the data analysis.

Appendix B: Chapter 4 Tables

Tables appear in this appendix and are referenced in the Chapter 4 text.

Chapter 2: Background and Motivation

In-vehicle telematics have received increased attention from consumers, manufacturers, and the media in recent years. The following chapter will describe some of the more popular telematics offerings on the market today and their potential impacts on the driving public. Before this, however, it is critical to understand the motivation for discussing the relationship between these technologies and older drivers. Therefore, the first part of this chapter will provide background information, clarify the problem, and build a case for new, creative solutions- one of which is in–vehicle telematics.

2.1 Changing Demographics

In the year 2025, persons aged 60 and older will make up one-quarter of the U.S. population. Census figures indicated less than one-fifth had reached this level of maturity by the year 2000. The number of persons aged 65+ in the year 2000 (35 million) is expected to double to 70 million by the year 2030[4]. In addition American Baby Boomers (those born between 1946-1964) are turning 50 at the rate of one every seven seconds. These Boomers have had a tremendous impact on society throughout their lives, and there is no reason to think they will not continue this trend in their winter years.

Indeed, society is graying at an unprecedented pace. And this is not just true in the U.S. In fact, older adults comprise an even larger proportion of the populace in Japan and throughout Europe. The United Nations forecasts that by 2050, one out of three persons in developed countries will be over 60 years old[5]. Undoubtedly, this shift of numbers among age groups will have tremendous impacts on society at large.

Interestingly, there is a twist on the significance of the growing numbers of elderly. Rather than living the older lifestyles that their parents lived, the new older population is more closely mimicking certain attributes of the younger population. That is, they are more active and

[4] U.S. Department of Commerce 2001
[5] United Nations 1999

engaged in their communities than generations of elderly before them. People in the new older population do not live sedentary lives, content to sit back and watch their remaining time slip away. Simply put, the 50+ age cohort has evolved dramatically in recent years and dismissing this age group as chronically ill or marginally disabled is more outlandish today than ever before.

Martin Wachs[6] argues that personal health, education level, and income are the critical determinants of active lifestyles. Interestingly, these are three areas where the older population has seen tremendous advance in recent years. Therefore, reason suggests that these older adults will demand and be capable of pursuing more "youthful" lifestyles than their parents and grandparents[7].

The same is true not only in the United States, but also in other parts of the world. Older adults in developed countries are in far better health than previous generations at the same age. In fact, some studies indicate that as many as 40% of those over 65 report good or excellent health. Even controlling for income effects, there appears to be a decline in disabled elderly. However, diagnosis of chronic disease has continued at historical levels. This apparent contradiction is explained by advances in medical care that have allowed older adults to manage illness rather than live at the mercy of otherwise debilitating sickness.

This increased level of health is one of the main factors influencing forecasts for older adult travel demand. Bush states, that due in part to better health, the emerging elderly population can be expected to travel more than the current group[8]. She specifically notes differences between American Baby Boomers and generations before them. Burkhardt et al. have concluded that vehicle miles traveled (VMT) by older Americans will increase by 35% in the 30-year period from 1990 to 2020[9], but even these results seem conservative. That research fails to include many of the changing demographics that so drastically influence travel demand. This leads to an underestimate of VMT and begs further analysis.

[6] Wachs 1979
[7] Coughlin 2003
[8] Bush 2003
[9] Burkhardt et al. 1998

Austin and Faigin measured travel exposure across age groups using data from the 1995 Nationwide Personal Travel Survey and the 2001 National Household Transportation Survey[10]. The results show a tremendous percent change in number of trips among the oldest group.

Changes in total person miles traveled in privately owned vehicles by age (1995 NPTS and 2001 NHTS day trips)

Age	1995	2001	Percent change (1995-2001)
Total person miles (billions)			
25-44	1352	1360	1
45-64	764	931	22
65-74	191	211	10
75+	66	100	**51**
Person miles per person			
25-44	15780	15856	<1
45-64	14854	15312	3
65-74	9796	11312	15
75+	5659	6772	**20**

Table 2-1: Percent Change in Number of Trips
Source: Austin and Faigin 2003

The changes above provide evidence that mobility for the oldest segment of the population continues to evolve, ensuring that travel patterns will be significantly different than for previous generations. The first bold value (51%) shows the impact of the growth in absolute numbers of the older population. The second value (20%) shows the effect of changing demographics (better health, and higher socioeconomic status) on the travel behavior of the older population.

Other factors that are positively correlated with increased demand for travel are educational attainment and household income. In the United States, the number of 50+ adults with a college degree has doubled in the last 20 years. And this same age group, which makes up just 20% of the total U.S. population, maintains control over 40% of all disposable income. This combination of brains and dollars suggests the current 50+ cohort has significant buying power combined with a propensity to shop "smart". It follows that these older adults will likely behave similarly when faced with decisions relating to the consumption of transportation.

[10] Austin and Faigin 2003

2.2 Causes for Concern

This increased mobility among the older population raises concerns for several reasons. The first is the fact that older adults will achieve this high level of mobility in their cars. Personal mobility, for most, is synonymous with individual freedom and independence. Without it, a person is unable to participate in all the daily events that, in aggregate, are life. In the United States, the mechanism for personal mobility is most often the automobile. A statewide survey of Michigan drivers aged 65 and over provides perspective on the mode choices of this older cohort[11].

Transportation mode relied on most often

What transportation do you rely on most often?	Drivers (n=986) (%)	Former Drivers (n=67) (%)
Drive own car	89.7	0
Passenger in car	9.4	94.8
Dial-a-ride	0	5.2
Public transit bus	0.3	0
Walk	0.3	0

Table 2-2: Mode Choices of 65+ Population
Source: Kostyniuk and Shope 2003

The table above illustrates the heavy dependence that these respondents place on the automobile for their transportation needs. It is notable that transit accounts for less than 1% of trips. What is more striking is that of those surveyed, over 33% stated that bus stops were in place within 2 miles of their homes. While much has been done to close this mode split gap through various incentive-rich carrots and regulatory sticks, the fact remains: the automobile is, and for the foreseeable future will be, the dominant choice for the older adult population.

America's level of auto dependence is truly remarkable. In the year 2000, only 3.8% of commuters used transit for their journey to work[12]. Transit usage for non-work trips was not much higher. But even more startling was that less than 10% of Americans lived near a transit alternative. The elderly population, along with the rest of the country, is inescapably tied to their cars for mobility. Without viable options in place, either traditional transit services or alternative

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[11] Kostyniuk and Shope 2003
[12] Orski 2002

accessibility mechanisms, potentially dangerous drivers are forced to continue driving in order to live life. Even in parts of Michigan, as the example above illustrates, those who do consider their areas transit accessible still do not frequent those alternatives.

Consequently, it is imperative to address the concerns that a growing elderly driving population poses to the general public. It is well documented that as people age, vision, cognitive capacity, perceptual acuity, and physical dexterity all begin to decline[13]. Past research supports the theory that these age-related declines are associated with increased accident risk[14]. (This risk constitutes the second area of concern regarding the growing older adult population.) And while all of these abilities are necessary for safe operation of the automobile, there are a myriad of obstacles to assuring that seniors behind the wheel still have the minimum capacity necessary to drive safely.

Driver testing and re-licensing are controlled at the state level in the U.S. And there is tremendous variability in requirements from one state to the next in obtaining or renewing one's license[15]. Since this area of public policy is so politically charged, yet so inconsistently regulated, it is doubtful that one comprehensive program for older driver re-licensing could ever be universally adopted. However, serious thought must be given to this issue, because allowing inept drivers to remain behind the wheel can prove devastating.

Accidents where older drivers are blamed for continuing to drive past their competence can be very public and very tragic. In July of 2003, an 86-year-old driver in Santa Monica, California crashed into a farmer's market killing 10 and injuring dozens others. The event captured the public's attention and temporarily fueled discussion on elderly travel. Many other similar, though less newsworthy, crash events have devastated families and upended lives. These kinds of headlines could appear with greater frequency in future years due to the ever-growing, increasingly mobile older population.

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[13] Skinner and Stearns 1999
[14] Brayne et al. 2000
[15] Coley 2002

At least two mechanisms exist for testing older drivers in an attempt to minimize costly accidents. The first of these is driving simulation. While all details of the driving environment cannot be fully captured through these artificial scenarios, this testing strategy is ideal from a cost-effectiveness standpoint. Recent work by Lee et al. suggests that regardless of obvious shortfalls, a driving simulator can be used to identify drivers at inflated risk of motor vehicle crashes[16]. And this early identification could help these drivers take steps to improve their driving behavior before they experience trouble on the roads.

Another driver testing mechanism is on-road evaluation. Stutts and Wilkins argue that such evaluations are a potential tool for helping older adults drive safely longer[17]. But in their study, the researchers found that apart from driver education classes like AARP's 55 Alive Mature Driver class, only 2% of respondents said they themselves had participated in an open-road driving evaluation.

Though more costly than driving simulation, on-road testing can better assess the skills and abilities of the driver. The comparison between these two testing strategies is akin to stated preference and revealed preference survey implementation. In stated preference surveys, as in driving simulation, any imaginable scenario can be tested and nearly unlimited data can be collected. However, the results must be viewed with caution because there are no tangible consequences for responses the subjects give. Likewise, if a subject crashes or speeds in a simulator, it is not going to harm the subject or their driving record.

On the other hand, on-road testing allows the evaluator to test real reactions to real events in a consequence-rich environment. Just as revealed preference surveys show what actually takes place, so road testing provides genuine information about driver behavior. Of course, liability and safety concerns prevent the evaluator from introducing complex mechanisms to test the limit of the driver's ability. Thus both driver-testing protocols have significant flaws, which limit the power of the evaluator to effectively judge driving competence.

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[16] Lee et al. 2003
[17] Stutts and Wilkins 2003

So far, this chapter has discussed five reasons for concern for the future of older adult travel. They are, in the order of appearance:

- Increased absolute numbers of older people, including the aging Baby Boomers
- Increased mobility of the older cohort due in part to better health, higher income, and higher levels of formal education
- Sustained levels of dependence on the automobile
- Declining physical and cognitive capacities as people age
- The failure of, and inherent difficulty in implementing, testing strategies to catch all driving problems before an accident

A final reason for concern stems from the evolving female lifestyle. In general, women of earlier generations made fewer trips than their male counterparts[18]. But emerging generations of women, including the Baby Boomers, made more trips than males during the last decade of the 20th century[19]. This is due in large part to increased labor participation rates[20]. More often, women are responsible for duties both in the workplace and in the home. This leads not only to more frequent work commutes, but also patterns of trip chaining following the workday as these women attend to the tasks of running their home. All of this implies increased VMT from a gender that was once grossly underrepresented on the roadways.

Recent research results suggest that older women are over represented in crashes that occur under the "safest" conditions, in daylight, when traffic is low (not at rush hour), when the weather is good, and when the roads are dry[21]. And even though this study failed to control for exposure to risk, the results bring to light an important idea. That is, when addressing the concerns of the ailing female driver, one needs to seek solutions that have impact before the driver even gets behind the wheel. Frailty in older adult women constrains the solution set to the realm of prevention, because it seems that once an accident has occurred, the probability of serious injury among this cohort is very high.

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[18] Spain 1997
[19] See 1995 Nationwide Personal Transportation Survey
[20] Fullerton 1999
[21] Baker et al. 2003

2.3 Self-Regulation

Clearly the automobile is, and will continue to be, at the center of the older adult lifestyle- a lifestyle that is expected to be much more active than older adults before them in terms of both VMT and absolute number of trips. So the question arises: What action can be taken to ensure road safety for this ever-present, yet potentially impaired driving cohort? Luckily there are ways to mitigate these effects, thus ensuring safe automobile operation in later years.

Self-regulation has been touted as an effective mitigation strategy for older adults. Self-regulation is a series of "self-generated thoughts, feelings, and actions that are planned and cyclically adapted to the attainment of personal goals"[22]. With respect to driving, this term denotes choices that limit specific tasks that may no longer be second nature, such as night driving, freeway use, or left-hand turns. Drivers usually take these precautions when their confidence dips to a level where they no longer feel comfortable performing such tasks. Some researchers have lauded self-regulation as a safety-enhancing strategy, but such praise may not be warranted.

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[22] Zimmerman 2000

The following list is exemplary of the motivation behind personal self-regulation decisions:

Responses of 171 former drivers to the following open-ended question:
"Please tell me the most important reason why you stopped driving"

Primary reason for stopping driving	%
Health related	
Problems with vision	23.5
Health problems other than vision	13.5
Problems with use of arms or legs, turning head or neck	9.4
Doctor advised not to drive	5.3
	51.7
Driving comfort related	
Didn't enjoy or feel comfortable driving	5.9
Didn't like driving environment	4.1
Didn't need to drive, someone else could drive	4.1
Didn't feel a safe driver	4.1
Nervous	4.1
Poor reflexes, didn't feel could react quickly enough	1.8
Afraid of crime	1.2
Family encouraged	1.2
	26.5
Other	
Cost to own a car	4.7
No longer own car	4.7
In an accident	4.1
License not renewed	2.4
	15.9
Unspecified	5.9
TOTAL	100

Table 2-3: Example Causes of Self-Regulation
Source: Stutts and Wilkins 2003

Stutts and Wilkins note from this table "over a fourth [of respondents] offered reasons that were not tied to any specific medical condition or event, but which were more related to a *lack of confidence* [emphasis added] in their driving ability and a *lack of comfort* [emphasis added] driving under current roadway and traffic conditions"[23].

[23] Stutts and Wilkins 2003

While these self-regulatory practices may bring marginal increases in safety for older drivers and those whom with they interact on the roads, driving restrictions can have detrimental effects on those implementing them. Self-regulation alters the lifestyle of the driver, in effect denying them a level of mobility they once enjoyed. This in turn leads to decreased quality of life as driving freedom and independence are curtailed. Certainly, self-regulation can achieve safety gains, but the negative effects on one's freedom to go where one wants, when one wants, can strip an individual of dignity and cause physical and mental declines due to isolation.

Adjustments to drivers can help achieve increased road safety. But as discussed above, it is very difficult to take something away as critical as the driving privilege because of what the car means to so many Americans. Therefore, clever strategies need to be developed to keep older drivers behind the wheel for as long as possible. These strategies must address both the mechanics of safer driving and help increase the confidence of these drivers. The strategy described in this work involves altering the automobile and could potentially achieve significant safety benefits while maintaining quality of life for older adults. Following is the introduction to this safety enhancing strategy, in-vehicle telematics.

2.4 Telematics

Often defined as the blending of telecommunications and computing technology, telematics serve the pursuit of conveying information to users and improving operating functions. One prevalent application of telematics is in the automotive industry. Here, telematics is manifest in systems designed to improve safety and convenience for the automobile occupants. The bulk of these systems are realized as features lumped into one of the following two groups: safety or service. In the following sections, these two distinct telematics offerings will be discussed.

Telematics Safety Features

A wealth of telematics safety features has hit the market in recent years. These options are designed to increase driver confidence and help prevent costly accidents. In fact, these systems may actually improve driving for older drivers by compensating for declining physical and mental abilities. In the early stages of development, engineers have attempted to advance these technologies without adding significantly to driver distraction. For the most part, these efforts have proven successful. After initial familiarization, users are generally pleased with the features and agree that most do not significantly contribute to distraction. However, any new addition to the automobile requires some learning period, and that corresponding disruption can increase probability for driver error. But relative to their telematics counterparts – service features – safety enhancements provide positive benefits with minimal disturbance.

Safety-related technologies have been developed for a wide variety of applications. Some are designed to aid in accident prevention, and some are meant to speed response after accidents. But regardless of purpose, telematics providers have found a wellspring of potential in the provision of safety benefits that may have particular applications for the older population. Some popular safety features are presented in the matrix below.

Safety Feature	**Primary Benefit to Driver**
Advanced Braking Technology	Maximum steering control in emergency braking conditions- especially on loose surfaces (e.g. gravel)
Larger Sized Auto	Potential for increased protection in a wreck
Night Vision Technology	Brings clarity and illumination to objects in the driver's line of sight
Intelligent Mirrors	Glare reduction through automated dimming
Collision Warning Systems	Increased time to react before contact with unperceived objects
Emergency Communications Systems	Sends for help even when occupants are unable to initiate communication
"Smart" Steering/Braking Systems	Automated control of operating systems to aid collision avoidance
Remote Diagnostics	Alerts operator of mechanical failures that could lead to compromised safety in the near or long term

Table 2-4: Telematics Safety Features

Sustained demand for these services has spurred continued research into safety technology. It appears that consumers are willing to pay for the added piece of mind that these products provide. But of concern to some stakeholders, including NHTSA, is the increased tax on cognitive capacity that such systems demand[24]. Ironically, if designed poorly, telematics safety features could actually *increase* - instead of decrease - the operator's risk of crash. Based on somewhat condemning data provided by NHTSA and other automotive databases, regulators may soon be forced to respond to safety technologies in the car to ensure automakers are not, in fact, hindering driver safety.

One of the primary benefits to the older driver that safety-related telematics hold is the potential to curb self-regulation. As noted previously, self-regulation can have detrimental effects on those practicing it. The reasoning behind these decisions is based on intelligent facts: in some cases older drivers should not continue driving in challenging environments. Making the automobile smarter in more dangerous situations could meet the needs of specific deficiencies in a driver's competence and free that driver from having to take self-regulatory action.

For example, those drivers who have decided to avoid nighttime driving could exploit night vision technology and return to the roads after dark with increased confidence. Those with restricted head and neck movement could employ intelligent mirrors that provide better views, and less glare, than traditional car mirrors. And others who have limited their driving because of decreased reaction times, increased frailty, or concern over vehicle maintenance needs they can no longer detect can be comforted knowing their car will help them in these areas and eliminate these arguments for staying off the roads. Safety-related telematics has the potential to free older drivers of the prison that is self-regulation by shouldering the burden of tasks the driver can no longer perform.

Telematics Service Features

On the opposite end of the telematics spectrum lie service features. Meant to enhance the driving experience, not necessarily to make it safer, these features have attracted the attention of the connected public. The theme of information services where you want them when you want them has not been left out of the automobile. In fact today, the technology is already in place for

[24] L. Tijerina et al 2000

a moving information console providing real time assistance and allowing the driver to carry on much of the business of life while behind the wheel.

Of course, these features are plagued with controversy. Safety advocates argue that some service telematics require a level of driver attention that significantly increases the probability of accidents[25]. Harbluk and Noy describe the need for "a better understanding of the ways in which drivers interact with these devices," so that developments can be made toward the minimization of distraction level[26]. As noted earlier, driver distraction is documented as the catalyst for many auto accidents. And booking airline tickets or making dinner reservations, two actions that could become more common in the automobile, requires some degree of concentration diverted from the task of driving. Those concerned about vehicle safety have a strong stake in the presence of service telematics and any regulatory response that may follow.

The following table provides information on several of the more common service features and their benefits to the driver:

Service Feature	Primary Benefit to Driver
Remote Door Unlock	Assurance that assistance is available when keys are lost or locked in the car
Voice-activated Cell Phone	Hands-free communication so the driver can maintain two-handed control of the wheel
Route Support	Helpful guidance in unfamiliar areas or in situations where road/traffic conditions have deviated from the norm
Personal Concierge	A personal assistant available to make arrangements for the driver while on the road
Ride Assist	Guarantee of alternative transport when driver is rendered incapable of vehicle operation
Stolen Vehicle Tracking	Assurance that authorities will know the where and when of the owner's car location in case of theft

Table 2-5: Telematics Service Features

To date, market demand for such services is still unclear. Proponents and sales personnel cite consumer awareness as the major inhibitor to a telematics revolution. With smart advertising

[25] Sovocool and Ventrelle 2000
[26] Harbluk and Noy 2002

campaigns, they argue, sales would begin to escalate[27]. Critics of such service providers as OnStar and ATX technologies counter with data that show subscription rates falling off drastically after a period of free use expires[28]. That data is very convincing and has lead to a race among providers and original equipment manufacturers to develop the best combination of technologies and price to meet consumer demand. In the absence of these efforts, service telematics would experience continued stunted growth.

Telematics technologies have reached a point where even the most technologically savvy critic would be impressed. Safety and service features satisfy many consumers' previously unmet desires for technology in the automobile to increase safety and make the driving experience more enjoyable and productive. In recent years some car owners have responded to the advent of telematics packages by paying extra for in-vehicle hardware and signing up for monthly service. But this activity has not lead to profitability for the most recognized provider, OnStar[29].

In 1998, Coughlin and Tallon[30] proposed a research agenda for older drivers and ITS. ITS, or intelligent transportation systems, is a term that includes in-vehicle telematics and other transportation enhancing technologies. Below is the table they used to summarize their ideas.

	Technology	**Markets**	**Public Policy**
NEAR-TERM	Human Factors, e.g., driver workload.	Product Marketing, e.g., application bundling or vehicle customization?	Deployment, e.g., which technologies offer near-term public benefit vs. which are readily available.
LONG-TERM	System Integration, e.g., interface with other systems and services.	User Adoption, e.g., speed of technological advance and user acceptance.	Driver Testing and Licensing, e.g., integration of new technologies into testing protocols.

Table 2-6: Research Agenda for Older Drivers and ITS (Source: Coughlin and Tallon, 1998)

27 Piszczalski 2003
28 Lienert sites unofficial values of around 20-50%
29 Gregor and Serroels state that OnStar must achieve a re-subscription rate of 80% to be profitable.
30 Coughlin and Tallon 1998

Clearly these issues beg further research. Telematics safety and service features have the ability to improve driving for older adults leading to increased safety not only for them, but also for others on the roads. However, the full implications of these systems on consumers, and the consequences for public policy are not yet fully understood. As Table 2-6 implies, user adoption and the resulting impacts on driver testing and licensing were significant issues in 1998. Today they are just as important, and must be analyzed further.

2.5 Technology Adoption and Value Perception

Technological innovation is not new to the automobile industry. Even during the tough economic times in the first years of the 21st century, the industry has answered the call to challenge the existing paradigms. One such call was issued by the publication Automotive Industries following September 11, 2001:

> "To be a leader, an auto company needs to excel in all value disciplines simultaneously -- product innovation, process excellence, and customer intimacy. It is now time for innovation in product and service design, business process execution, and demand-chain planning and execution."[31]

Engineers are always quick to respond with the next "killer app". But these efforts fall short when consumers fail to pay for them.

The first example of this, which has been stated previously, is that of OnStar. Despite aggressive publicity campaigns, consumers have not responded in ways that General Motors had originally hoped. Another example of unsuccessful telematics offerings is BMW's iDrive system. Early response to this system has been predominantly negative with consumers complaining the system is too complicated, dealers citing considerable buyer resistance, and engineers arguing the design is ergonomically flawed[32]. And who can forget the infamous "talking car" manufactured by Nissan in the 1980's. Users were quick to disable the system after they became unsure of its real assistive value.

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[31] Automotive Industries 2001
[32] The Sunday Business Post 2003

As these examples illustrate, adoption of new technology is often harder to come by than the technology itself. In the case of in-vehicle telematics, companies must appeal to core consumer values such as safety and freedom. Only then will heads be turned and pockets opened.

At the heart of consumer demand is the idea of value perception (i.e. to what extent does a product add value to one's experience). Confidence is one consumer value that directly relates to the core values of safety and freedom. If driving confidence could be improved, perhaps self-regulatory behavior could be curbed. And this would provide adequate value for widespread telematics offerings. The analysis that follows directly addresses the idea of driver confidence.

Chapter 3: Methodology

The following chapter will review common methodologies for survey analysis and will introduce the specific methodology employed in the following chapters.

3.1 Data Collection and Analysis

Various techniques exist for market research and analysis. There are different mechanisms available for both collecting and processing information. Essentially there are two sources of information for market research: primary and secondary sources. The former are usually obtained with a specific analysis in mind and can include personal interviews, focus groups, mail/online/other surveys, or experiments. The latter group of sources is preexisting. Usually this data is collected by a public agency, such as the U.S. Census Bureau, and the databanks are available for widespread use.

Data from market research can be analyzed in several ways. Qualitative information can be gained from responses to questions giving color to issues of interest. For example, a focus group respondent may give some personal insight into a product under study. That insight could be helpful in determining future direction of product development. In this way, analysis of qualitative responses can prove influential with regard to industry advancement.

Quantitative information in the field of social science is gained most commonly through surveys administered to groups of people. When collected and analyzed as a whole, survey data can prove quite useful. In fact, information from just a small sample can often be generalized to the population as a whole. Of course, the researcher must ensure that the respondents represent the entire population and not just a limited group. For example, a survey administered only to high-schoolers in a predominantly Hispanic neighborhood in Texas would serve as a poor predictor of behavior for the entire U.S. population, or even for the state of Texas. Instead, the survey must be completed by respondents of all ages, incomes, geographic regions, etc. to truly have significance on a large scale.

This quantitative data can be examined in a number of ways. One of the more common methods includes basic summary statistics. Such statistics provide insight into general trends within the sample under consideration. For example, survey results may show that 80% of respondents choose to drive alone in their daily commute. Or, more specifically, results may show that 70% of men and 90% of women drive alone in their daily commutes. These are examples of simple summary statistics. Obviously, a large survey can lead to a tremendous amount of summary statistics. But in addition to these statistics, survey results can also be used in forecasting. This is done most commonly by building regression models.

Using 'a priori' assumptions, or truths knowable based on reflection alone, a general strategy for model construction is formed. Then different model structures, as well as different variable combinations, are tested for goodness of fit and individual variable significance. The process of choosing the best model from the batch of those produced is as much an art as a science. Of course, the model statistics are important, but so are the a priori assumptions. Once a final model is deemed acceptable, it can then be used as a forecasting tool for policy and planning decisions.

3.2 Survey Method

For this analysis, the population of interest was automobile drivers aged 50 and older. Drivers were defined as people who were licensed to drive and had driven an automobile at least once in the previous 12 months. The primary mechanism for obtaining information on this driving cohort was a nationwide (i.e. United States) survey. The survey was sent to a pool of respondents that had previously participated in a consumer marketing panel and had agreed to participate in periodic surveys.

In total, 7200 questionnaires were sent to drivers aged 50+ and 3859 were returned for an effective individual response rate of 53.6%. This sample of participants did not sufficiently represent the U.S. population as a whole, so the data were weighted to 2001 Current Population Study quotas on demographic characteristics. Furthermore, 35 of the respondents did not meet the 50+ age criteria and were thrown out of the analysis. These two adjustments left an effective weighted individual sample size of 3819. As a result of these corrections, the survey results were estimated to be applicable to the U.S. population with accuracy of $^{+}/- 3\%$.

The fundamental question of this work (i.e. driving confidence) was posed in the following manner:

> "There are a number of modern safety features and services available in automobiles today. Please think about whether your confidence in driving would change if you had the following available in your car."

The survey then went on to list 11 safety and service features next to a scale from 1 to 7 with a check-box associated with each number. A response of 1 indicated that the individual would be much *less* confident with that technology, and a response of 7 indicated the driver would be much *more* confident with it. The respondent could rate according to this scale or choose an 8th box, which indicated they already had this feature in their car[33].

A summary graph is provided in Figure 3. Note that although this image is quite busy, it does the best job illustrating the overall picture of driving confidence for the 50+ population when faced with 11 common telematics technologies.

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33 In the directions for this question it was requested that each respondent check just one box for each of the eleven in-vehicle technologies. However, some who already had the feature checked that box along with a box on the confidence scale. It should be noted that, in this analysis, those respondents who checked two boxes were *not* thrown out of the data set. Rather, they were incorporated in the response set of both (just as if two separate individuals had checked those boxes). The effects of this decision are minimal, however, as the following analysis focuses primarily on the change, if any, in confidence level- not on the number of people who already have any particular technology. In the few cases where technology ownership is considered, the confidence responses are not. Therefore, no double counting of respondents took place.

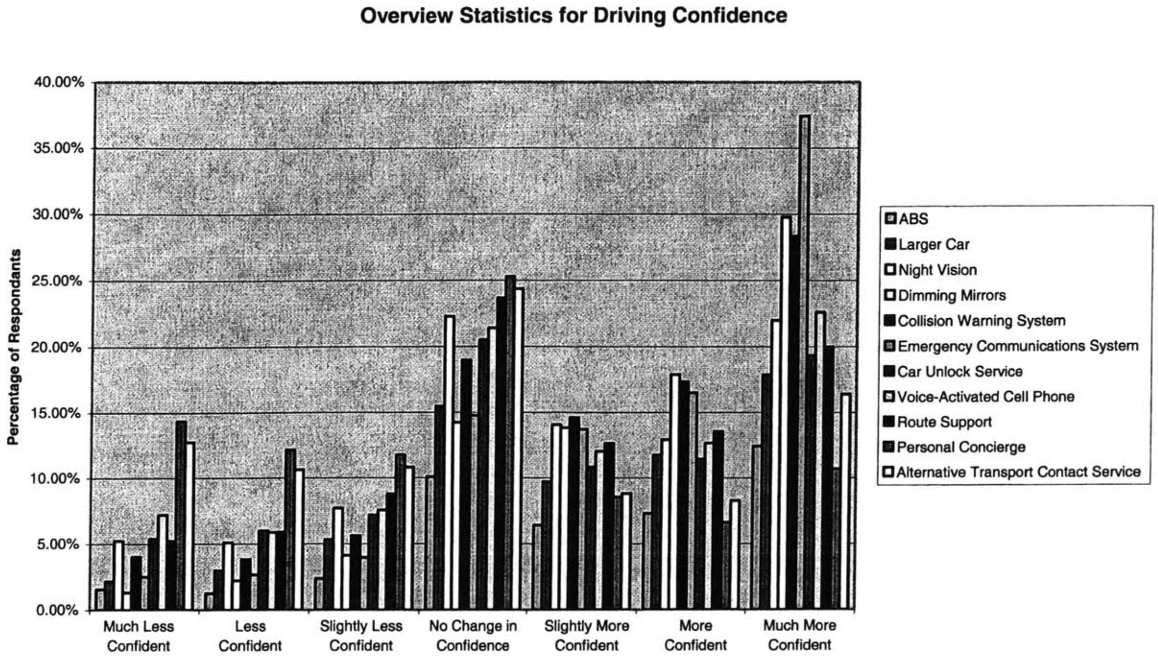

Figure 3: Responses to Driving Confidence for Each of 11 Technologies

From this figure, one can see the individual results for each technology with respect to the absolute scale at the left and in relation to one another. Of particular interest are the responses received for "Personal Concierge" and "Alternative Transport Contact Service". Many respondents felt that presence of these technologies would actually *decrease* confidence in a significant way. This likely indicates a public cognizance of the driver distraction phenomenon which many believe leads to decreased safety. The knowledge that safety could be compromised led many participants to respond in this way. This is but one example of information that can be gleamed from this summary chart. In fact, the discussion of these results will continue in depth in the chapters that follow.

Figure 3 sparks more questions than answers. The purpose of the following chapter is to use personal demographic information in tandem with other survey question responses in order to explain why people react to in-vehicle telematics as they did in this exercise. It is clear from the data that differences in personal demographics as well as differences in driving behavior affected their responses to the posed question. Through a series of summary statistics, cross tabulations, and regression models, Chapter 4 sheds some interesting light onto the issue of driving confidence in relation to in-vehicle telematics. In the end, a "typical" 50+ driver who finds telematics to be significantly confidence enhancing is described.

The tools employed to run this analysis include the following software packages: SPSS Graduate Pack 11.5 for Windows and Microsoft Excel. These packages allowed for data manipulation, regression model construction, and chart/table development.

The other piece to this analysis is contained in Chapter 5 and includes qualitative discussion of issues pertinent to the telematics industry. Brief case studies are presented on the experiences of two telematics providers including tried business models. The case studies were developed from published articles in magazines, newspapers, and journals. The case study method of research provides historical perspective to an issue. Case studies illustrate what's been done before and elucidate successes and failures. The value of this research method lies in the objective discussion of past experience. Obviously, lessons can be learned from such studies and improvements can then be made in future iterations.

Chapter 4: Survey Results

4.1 Summary Statistics

Following is a brief review of several independent variables and their relation to the telematics variables of interest. These are simply summary statistics derived from cross-tabulations performed to explore interactions among these variables. Results seen below provided motivation for the regression analysis that follows in section 4.2.

4.1.1 Age

Population segmentation by age revealed interesting trends. For some of the technologies, there was an obvious pattern in the level of indifference across the age spectrum. This trend was true for both safety and service features. The following table outlines these differences:

Percentage of Respondents Citing No Change in Confidence

	Indifferent to Technology			
	50-59	60-69	70-79	80+
Night Vision	25%	22%	18%	15%
Collision Warning System	21%	18%	16%	14%
Emergency Communications System	17%	16%	12%	10%
Car Unlock Service	22%	20%	17%	16%
Voice-Activated Cell Phone	23%	20%	18%	15%
Route Support	26%	23%	20%	18%
Alternative Transport Contact Service	29%	23%	20%	18%

Table 4-1: Confidence Comparison Among Age Brackets for Select Technologies

The table highlights the increase in indifference level in younger age cohorts. In short, younger respondents expressed "No Change in Confidence" with much higher frequency than older respondents. And those in the older age brackets who did think that these technologies would change their confidence level were much more likely to indicate some level of *increase* rather than a decrease in confidence.

Also of interest in this analysis was the response to Alternative Transport Contact Service. While only 10% of baby boomers (aged 50-59 at time of survey) indicated that the technology would cause much more confidence in driving, more than twice as many in the 80+ age cohort felt the same way. Obviously, the oldest of drivers would be much more comfortable with an available alternative than younger drivers who less often have trouble in difficult driving situations.

For both "Automatically Dimming Mirrors" and "Larger Car for Increased Collision Safety", there were no striking patterns among age groups. The absence of differences among age cohorts is significant from a marketing and development perspective. Both safety features solicit similar responses for confidence level regardless of age.

4.1.2 Education

The results of the education-segmented analysis proved less intriguing. No striking differences among respondents with varying levels of formal education were evident. In fact, only the "Alternative Transport Contact Service" showed any significant result. Table 4-2 below provides these results:

Percentage of Respondents Citing No Change in Confidence

Formal Education Does Not Include a College Degree	21%
College Degree Obtained	28%

Table 4-2: Indifference Levels of Two Education Cohorts

The above values indicate the levels of indifference to this service feature. The more highly educated group indicated with higher frequency that their driving confidence would not change with this feature. And the difference between these values for the less educated was skewed toward the "Much More Confident" end of the response spectrum. This implies the respondents with less education feel that, indeed, alternative mobility service would change their driving confidence level.

A discussion of the reasons for this result would be purely speculative. One may theorize that the highly educated are more experienced with technology and therefore less likely to be impressed by the novelty of new systems. Some may argue that the "gee whiz!" factor may affect the technological neophyte more easily than those of the techno-savvy population. In addition, one could hypothesize that the more highly educated cohort has more access to cellular telephone technology and could easily contact friends or alternative transportation services. However, in this survey only ownership of such items was examined. The data do not provide insight into the usage or confidence one has in those technologies. Therefore, no conclusive causality for this response can be formulated.

4.1.3 Household Income

Attitudes toward these safety and security features did not vary significantly across income. Individuals in every financial state seemed to agree on the ways in which each technology would affect confidence. The interesting results seen from this analysis, however, are that perceived increases in driving confidence do not directly correlate to willingness-to-pay. It was clear from this analysis that as income increased, technology ownership increased. While many in the lower income brackets felt that a certain technology would greatly increase their driving confidence, fewer in those brackets reported they already had that feature. The following graphic shows how ownership increased with increased income.

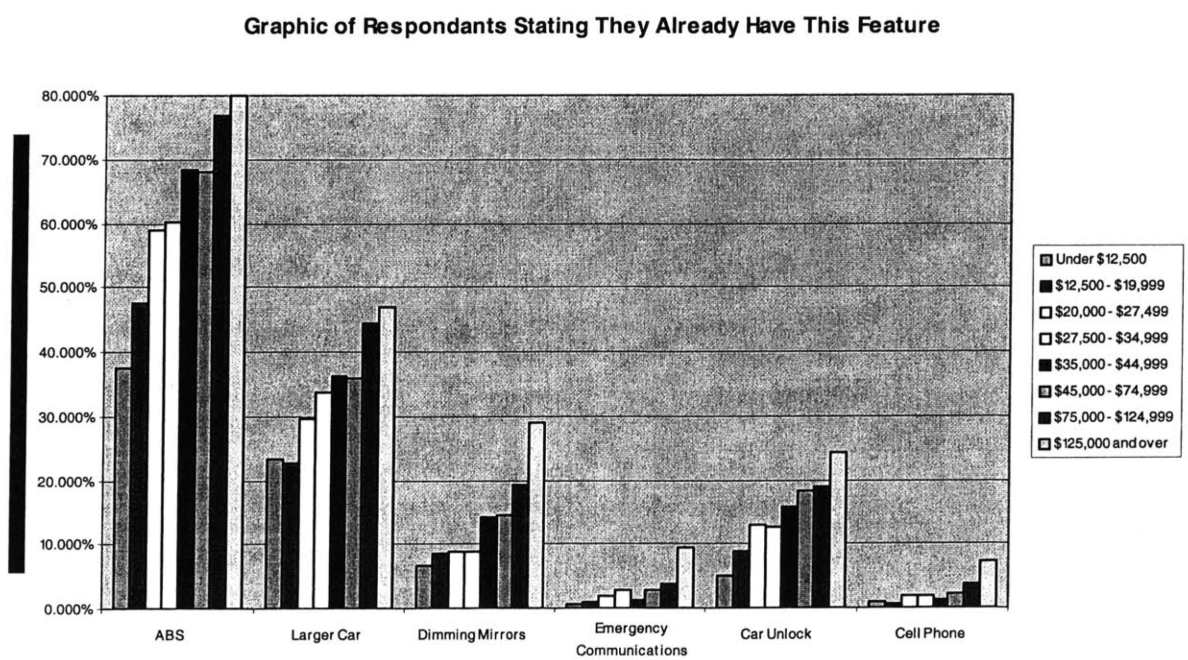

Figure 4-1: Technology Ownership by Income Bracket

While much of the population feels that modern auto safety and service features would increase confidence, those with the highest levels of buying power are more likely to have those features in their automobiles. In fact, those automobiles most likely to be equipped with these technologies are high-end, and consequently people with lower incomes are less likely to own them. This shows the existence of suppressed demand among those with lower incomes. If the market price for these features was more in line with the ability to pay for lower income groups, the data would likely show higher uniformity across income brackets in response to this question.

4.1.4 Self-reported Health

Perceived personal health is an often-studied demographic variable and is commonly linked to the level of dependency one has for mechanisms of assistance. This follows simply from the idea that as one's health declines, the ability to operate in one's world under one's own power becomes more difficult. This fundamental principle comes to light in the data set under consideration in this analysis.

Figure 4-2 clearly shows a difference in attitudes toward in-vehicle technologies between those with good self-reported health and those with poor self-reported health.

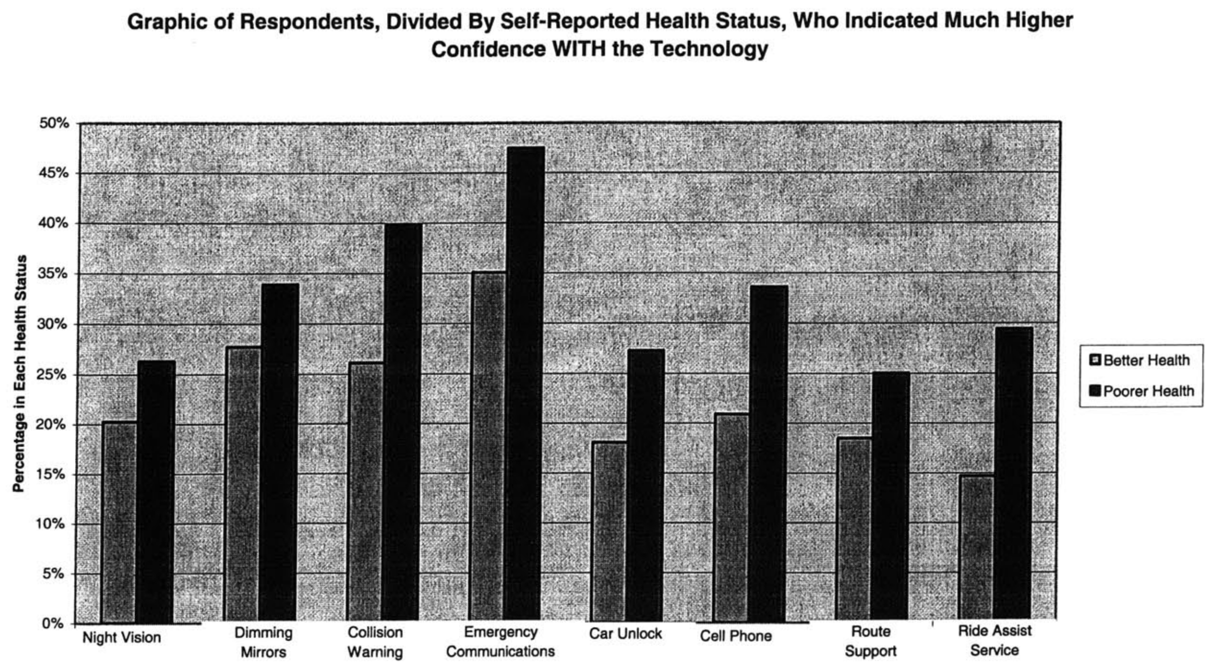

Figure 4-2: Response of Much Higher Confidence (Segmented by Self-Reported Health)

For example, about 40% of respondents with poorer health indicated they would be much more confident with a collision warning system in their car (third grouping from the left in the previous figure). Conversely, just over 25% of those respondents in better health indicated the same level of increased confidence. These differences show not only higher affinity for assisting technologies among poorer health respondents, but more generally indicates that those in poorer health have reason to feel that their confidence could be significantly influenced with assistive devices. This statement is further confirmed in the following graphic of those who indicated "no change" in overall confidence:

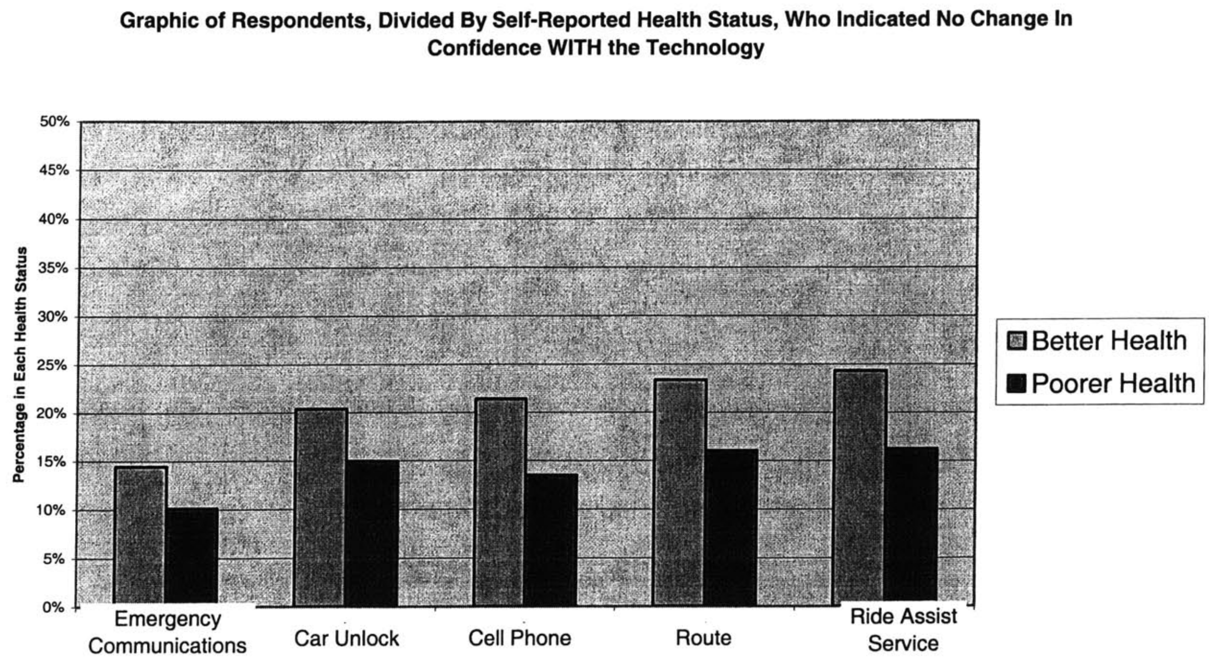

Figure 4-3: Response of No Change in Confidence (Segmented by Self-Reported Health)

Those in better health were more likely to exhibit indifference with regard to confidence and in-vehicle technologies than those in poorer health. Also of interest in this analysis is the nature of the technologies where significant differences were seen. With the exception of Emergency Communications, each of the above technologies is a *service* feature. It would seem plausible for those in poorer health to indicate confidence gains for safety-related features. The fact that they indicate such gains for service features shows that convenience is of high value for the population in poorer health.

4.1.5 Gender

For two of the safety features studied, ABS and larger car, males indicated a higher likelihood of increased confidence (28% and 41%, respectively) than females (22% and 34%, respectively). However, this trend did not hold for the other telematics technologies. In fact, women were more likely than men to indicate a rating of "Much More Confident" for nearly all of the other technologies studied in the survey. In addition, men were more likely than women to indicate no change in confidence (a check in box 4) for many of these same technologies.

	Indifferent to Technology		Much More Confident	
	Men	Women	Men	Women
Dimming Mirrors	15%	11%	26%	31%
Collision Warning System	20%	18%	25%	30%
Emergency Communications System	18%	11%	31%	41%
Car Unlock Service	23%	17%	17%	21%
Voice-Activated Cell Phone	22%	18%	18%	26%
Route Support	24%	21%	16%	22%
Alternative Transport Contact Service	26%	21%	12%	18%

Table 4-3: Confidence Comparison Between Genders for Select Technologies

The result indicating women have more confidence in safety features than men is well documented. Market research has shown this difference to be widespread in American culture[34]. This research, however, sheds light on another interesting fact related to gender. Not only do women gain more confidence from safety features, but according to these results they gain more confidence than men from service features as well. Women indicated higher confidence levels for the car unlock service, voice-activated cell phone, route support service, and alternative transport contact service- all features designed to aid the driver but not necessarily make driving safer.

4.2 Regression Analysis

This analysis presents factors influencing the confidence levels that drivers experience with the presence of advanced technology in the automobile. A listing of sociodemographic variables was systematically regressed on a scale of driving confidence variables produced through a stated preference survey. This analysis was guided both by the summary statistics presented previously and by preconceived notions of such relationships as described below. It is understood that there are many more factors influencing stated confidence levels other than the variables used in this analysis. But the goal here is not to explain a tremendous portion of the variance (as seen in a high adjusted r-squared (R^2) value), rather the goal is to discover variables that are useful in describing the dependent variable (i.e. overall driving confidence).

[34] OnStar 2003

Following is the regression analysis of driving confidence change. The reader will find final models coupled with brief analysis of the results. In some cases, the models have been sent to Appendix B in order to avoid confusion in the flow of ideas. In these cases, the model's location is notd in the text.

4.2.2 Hypotheses

It is most helpful in any econometric analysis to outline one's intuition concerning the variables of interest. This was undertaken here and is presented below.

Age

Older adults are more likely than younger people to regulate their driving behavior[35]. These self-regulating practices may include such tactics as avoiding night driving, freeway driving, or driving in unfamiliar areas. The motivation behind such self-regulation is often increased safety. In many cases, the driver – or someone very familiar with the driver – has lost confidence in their ability to operate in any of an array of challenging driving environments. These people have the most to gain from telematics devices that can increase driving safety. Therefore, even in this sample with a limited group comprised completely of 50+ drivers, it is likely that as age increases, respondents will more frequently indicate that confidence level increases with access to these technologies.

Self-reported health

An individual's health is positively correlated with lifestyle behavior. Simply put, healthier people are more active, and vise versa. The consequence for driving is that healthier people are more likely to drive longer and more often. It is those people in poorer health that will restrict driving because of their decreased cognitive and physical capacities. And therefore, it is this group that will more likely note an increase in confidence with new assistive technology.

[35] Please see Tables 4-13 and 4-14 on pages 64 and 65, respectively

Following this thinking and considering the structure of the health variable, it is expected that these coefficients should be negative.

Gender

The impact of gender is not intuitive in this analysis. One could predict that since men are more prone to be attracted to new technologies they would therefore have more confidence in driving because of them. Alternatively, one could argue that women would find security in the assistive properties of these technologies and therefore be more confident in their driving just having them. Either case could be supported, and no prejudgment is made here.

Education

Higher levels of educational attainment can indicate increased propensity to consume goods and services. However, it is unclear how education level will influence the confidence level one attains from the presence of in-vehicle telematics in the car.

Household income

A person's income level also has an unclear influence on change in driving confidence level. It is hoped that this analysis will shed light on this issue.

Overall driving confidence

Since these technologies are designed to aid the driving task, it is predicted that as one's overall driving confidence declines, the probability that that person indicates increased confidence with technological aid will go up. That is, those with less confidence in their own ability to drive will experience a greater confidence increase with assistive devices. Based on these assumptions and the particular structure of this variable, these coefficients should have negative signs.

Overall mobility satisfaction

Using similar logic as for overall driving confidence, it is likely that those persons less satisfied with their ability to go where they want, when they want will more likely indicate increased confidence with advanced technology.

Self-regulating behavior

Those individuals who are regulating their driving due to physical or cognitive decline will likely indicate an increase in confidence if they had access to some of the telematics technologies in their own automobile. Therefore, negative coefficients are expected for these variables. Specifically, self-regulation strategies designed to mitigate unease in the following situations were examined for their impact on stated confidence change: night, dusk/dawn, highway, traffic, weather, distance, and unfamiliar areas.

The preceding hypotheses, in addition to the results of the survey cross tabulations, serve as a guide for the analysis that follows. One can find a comparison of a priori hypotheses with model results in Table 4-12.

4.2.3 A Night Vision System That Projects A Display Of The Road On My Windshield

MODEL 1

	Intercept	Age	Income	Health	Education	Gender
Coefficient	**3.494**	**0.026**	**-0.004**	**0.024**	**-0.030**	**0.184**
Standard Error	0.2716	0.0032	0.0057	0.0259	0.0215	0.0626
t-Stat	12.86	8.10	-0.71	0.94	-1.39	2.93

# of Variables	6
# of Observations	3824
Deg. of Freedom	3818
R^2	0.0243
Adjusted R^2	0.0230
F statistic	19.0

Table 4-4: 14c with Sociodemographic Variables

Table 4-4 above shows the attempt to regress all five common sociodemographic variables on confidence level change given a night vision system. The t-Stats for income, health, and education all fall below the standard 95% confidence level, which is used as a heuristic for significance cut-off points in many regression analyses. A revised model was built without income and education, because both of these variables had uncertain influence on driving confidence. Self-reported health was kept because, a priori, it is expected to play a significant role in predicting driving confidence change.

MODEL 2

	Intercept	Age	Health	Gender
Coefficient	**3.166**	**0.027**	**0.033**	**0.196**
Standard Error	0.2171	0.0031	0.0255	0.0623
t-Stat	14.58	8.71	1.30*	3.15

# of Variables	4
# of Observations	3827
Deg. of Freedom	3823
R^2	0.0232
Adjusted R^2	0.0224
F statistic	30.2

* This value not significant at 99% confidence level, but is significant at the 85% level

Table 4-5: 14c with Sociodemographic Variables (revised)

The revised model, in Table 4-5 above, is more appropriate for predicting confidence change with night vision systems. The adjusted R^2 value is very close to the one in Model 1 (just 2.7% lower), indicating that this model explains nearly the same amount of the variance. However, the t-Stats are stronger, including the one for the health variable. The signs of the coefficients are directly in line with expectations, and the magnitudes are reasonable based on the survey design. Obviously, these three variables help explain driving confidence change successfully, while income and education do not.

The final model, AB1, seen in Appendix B is a stronger fit, statistically, than Model 1 or 2. The adjusted R^2 value is just over 0.04, a 45% increase over Model 2, which considers only sociodemographic variables. The F statistic is significantly different from zero indicating that the eight variables present, as a whole, are not equal to zero. The individual t-Stats show that while all variables are not significant at the 99% confidence level, they do show significance at the 70% confidence level or higher. (Previously it was mentioned that the 95% confidence level is used as a litmus test for the significance of a model variable. While this still holds, it must be understood that model building is as much an art as a science, and strong a priori assumptions can legitimize an apparently statistically weak variable.)

All of the coefficients take signs that fit the a priori expectations, except one. The coefficient for overall driving confidence indicates that drivers who are more confident in their driving already will more likely indicate a positive change in confidence with this night vision system. Perhaps this result is an anomaly related to this particular technology. That is, those who are not confident driving at night are not going to see confidence benefits regardless of the technological assistance.

The above procedure is meant to illustrate the arduous process by which a "final" model was developed. However, in order to provide a concise discussion of this regression analysis, only the final models will be presented for each of the remaining technologies.

Finally a joint F-test was run to determine if the self-regulation questions, as a group, were significant in explaining the variance. The statistic that was used is calculated as follows:

$$F_{q,N-k} = \frac{\left(R^2_{UR} - R^2_{R}\right)/q}{\left(1 - R^2_{UR}\right)/(N-k)}$$ (Equation 5.21 in Pindyck & Rubinfeld, 1998)

where:

R^2_{UR} = the R^2 value for the *unrestricted* model

R^2_{R} = the R^2 value for the *restricted* model

q = the number of regression coefficients in the subset of the coefficients being tested

N = the number of observations

k = the total number of coefficients estimated in the unrestricted model

In this case:

$$F_{3,3824-10} = \frac{(0.0918 - 0.0761)/3}{(1 - 0.0918)/(3824 - 10)} = \mathbf{21.98}$$

This exceeds the critical value of the F distribution at the 1% level, so we reject the null hypothesis that the self-regulation variables don't help explain perceived driving confidence when offered an alternative transport service. A similar exercise was performed for each of the models to follow, and in every case the null hypothesis was rejected- indicating that indeed the self-regulation variable(s) did help explain perceived driving confidence.

4.2.4 Rearview And Side Mirrors That Dim Automatically To Reduce The Glare From Other Vehicles

FINAL MODEL

	Intercept	Age	Gender	Overall Driving Confidence	SR_NightDriving	SR_PoorWeather
Coefficient	**4.227**	**0.013**	**0.275**	**0.253**	**-0.168**	**-0.085**
Standard Error	0.3185	0.0028	0.0542	0.0303	0.0421	0.0400
t-Stat	13.27	4.65	5.07	8.33	-3.98	-2.13

# of Variables	6
# of Observations	3824
Deg. of Freedom	3818
R^2	0.0358
Adjusted R^2	0.0345
F statistic	28.33

Table 4-6: 14d Final Model

The variables that rose to the top in this analysis all had strong impacts a priori. It seems quite logical that dimming mirrors would be helpful for people driving at night and in poor weather conditions since, in both of these situations, drivers are expected to operate while using their headlights. Drivers who currently avoid these driving conditions could be persuaded to return to the road given the result that this specific technology was able to grant significant increases in confidence. Again, older drivers and women demonstrated a dominant propensity to express increased confidence in driving due to technological aid. And as before, overall driving confidence proved highly significant, but had a counterintuitive sign. This proves to be common, and this result is discussed in detail in the final summary.

All five of these variables had strong t-statistics indicating significance at the 99% confidence level. The F statistic is also significantly different from zero, showing that collectively the variable coefficients are not close to zero. Variables that did not make the cut included indicators of other self-regulatory behaviors, socioeconomic variables of income and education, and health. This specific technology is only helpful for drivers with vision deficiency, so it makes sense that a large number of people in poorer health did not indicate an increase in confidence- hence the variable's absence.

4.2.5 A Collision Warning System That Beeps When My Car Comes Too Close To Another Vehicle/Object

FINAL MODEL

	Intercept	Age	Gender	Overall Driving Confidence	SR_NightDriving	SR_PoorWeather	SR_Unfamiliar
Coefficient	**4.281**	**0.020**	**0.153**	**0.163**	**-0.142**	**-0.090**	**-0.158**
Standard Error	0.3477	0.0030	0.0594	0.0332	0.0472	0.0477	0.0450
t-Stat	12.31	6.70	2.57	4.93	-3.00	-1.88	-3.52

# of Variables	7
# of Observations	3824
Deg. of Freedom	3817
R^2	0.0433
Adjusted R^2	0.0418
F statistic	28.78

Table 4-7: 14e Final Model

The final model for collision warning technology is also quite interesting. Again, age and gender appear with high significance and the expected signs. The same peculiar sign is evident for overall driving confidence, but this variable is still highly significant. The adjusted R^2 value and F statistic are very similar to values obtained in previous models showing a comparable level of overall predictive power.

The three variables related to self-regulation that appear in this final model all seem logical based on the nature of this telematics technology. The variable for driving in unfamiliar areas is most significant based on observed t-stats. It seems that a warning system that alerts drivers to unexpected stationary and moving objects is quite valuable to drivers in unfamiliar areas. Likewise, night driving conditions and poor weather conditions beg for this technology. Additional sets of "eyes" looking out for the driver in these potentially hazardous driving situations could prove helpful- and the data in this analysis support this claim. Unfortunately, this system does little to increase the confidence of those drivers who self-regulate in other ways.

4.2.6 An Emergency Communications System That Calls For And Sends Help In The Case Of An Accident Or Medical Emergency, Even If I Am Unable To Tell Them My Exact Location

FINAL MODEL

	Intercept	Age	Health	Gender	Overall Driving Confidence	SR_NightDriving	SR_Unfamiliar
Coefficient	**4.149**	**0.017**	**0.046**	**0.347**	**0.181**	**-0.101**	**-0.186**
Standard Error	0.342	0.003	0.022	0.055	0.031	0.042	0.038
t-Stat	12.12	6.05	2.08	6.29	5.84	-2.39	-4.88

# of Variables	8
# of Observations	3824
Deg. of Freedom	3816
R^2	0.0473
Adjusted R^2	0.0458
F statistic	31.6

Table 4-8: 14f Final Model

Age, gender, and overall driving confidence again appeared in the final model. One interesting note is that gender was the most significant variable, based on relative t-stats. This shows that gender plays a more important role in predicting driving confidence change with this technology than any other sociodemographic variable. The fact that the driver is female is more significant in terms of increased confidence for this technology than any other fact. Additionally, the self-regulatory related variables that appear in the final model are quite significant and make sense considering the particular aid that this technology provides. Finally, the adjusted R^2 value shows that this is the strongest fit so far in this analysis.

Ceteris Paribus, those in poorer health are more likely to indicate increased confidence from this emergency communication system. This follows logically from the nature of the system. In an accident or emergency, those in poor health are at greater risk and would therefore find such a technology more beneficial than those in better health. The likelihood that someone in poor health would be unable to seek the help they need due to injury is also higher than for a person in better health. Thus, these systems are more likely to be considered by car buyers suffering from weaker health.

4.2.7 A Service That Unlocks My Car By Sending A Remote Signal To My Car's Computer

Model AB2 as seen in Appendix B includes the socioeconomic variables income and education for the first time in this analysis. The sign on the education variable is quite intriguing and is discussed in detail in the regression summary. Both the presence and sign of the income variable are unexpected. Indeed, the impact of income was uncertain, a priori, and this researcher is still wary of including the variable- regardless of its significance in this case. In addition, mobility satisfaction made its first appearance in a final model but comes with the same counterintuitive sign as overall driving confidence. This variable appeared in no other models and is not mentioned as a useful predictor of confidence change in the final summary.

Two variables related to self-regulation also appear, the most significant of which is the variable for driving in unfamiliar areas. Car unlock service would be seen as confidence enhancing for individuals self-regulating both in unfamiliar areas and at night. Some drivers may feel uncomfortable in an area that is not familiar to them, and the guarantee that they would be have access to their car, even if they locked their keys inside, seems quite valuable based on these results. However, all five other self-regulation related variables did not prove significant. The model as a whole proved to be the strongest fit yet with an adjusted R^2 value of 0.054. The F statistic of 28.3 indicates that the variable coefficients are not collectively equal to zero.

4.2.8 Voice-Activated Cellular Telephone In The Car

FINAL MODEL

	Intercept	Age	Education	Gender	Overall Driving Confidence	SR_Dusk/Dawn	SR_Unfamiliar
Coefficient	**3.619**	**0.020**	**-0.030**	**0.467**	**0.176**	**-0.133**	**-0.163**
Standard Error	0.4170	0.0034	0.0200	0.0673	0.0374	0.0594	0.0468
t-Stat	8.679	5.832	-1.491	6.947	4.698	-2.231	-3.483

# of Variables	7
# of Observations	3824
Deg. of Freedom	3817
R^2	0.0400
Adjusted R^2	0.0385
F statistic	26.5

Table 4-9: 14h Final Model

This technology allows for hands-free communication so that even dialing is done through voice commands. It can be seen from this final model, that this in-vehicle device enhances the confidence of women drivers who are further along in years and have low levels of formal education. It also enhances the confidence of drivers currently self-regulating during dusk or dawn and those avoiding unfamiliar areas. Surprisingly, the variable describing nighttime self-regulatory behavior is missing from this final model. It was expected that the benefits of completely hands-free communication would be apparent in those currently self-regulating at night, and subsequently no reasonable explanation can be posited concerning the variable's absence.

Gender has the highest level of predictive power with age close behind. It appears that women would find the most confidence from communication devices that allow them to keep their hands on the wheel. The education variable is significant only at the 85% confidence level, but was kept in the final model because the coefficient's magnitude and sign fell in line with models for other telematics services. The overall fit is slightly less powerful than some of the previous models as seen in the 0.0385 adjusted R^2 value.

4.2.9 Route Support To Provide Me With Step-By-Step Directions

FINAL MODEL

	Intercept	Age	Education	Gender	Overall Driving Confidence	SR_Unfamiliar
Coefficient	**3.842**	**0.020**	**-0.041**	**0.406**	**0.135**	**-0.285**
Standard Error	0.3692	0.0032	0.0190	0.0639	0.0351	0.0410
t-Stat	10.409	6.331	-2.150	6.351	3.839	-6.956

# of Variables	6
# of Observations	3824
Deg. of Freedom	3818
R^2	0.0479
Adjusted R^2	0.0466
F statistic	38.4

Table 4-10: 14i Final Model

The overall model fit for the route support system model was on par with previous models as demonstrated by the adjusted R^2 value of 0.0479. Age and gender variables are again present as is the variable for driving confidence. Collectively, these variables are statistically significantly different from zero based on the high value for the F statistic: 38.4.

The presence and high level of significance of the self-regulation variable aligns perfectly with a priori expectations. The evidence that route support telematics systems can increase the confidence of those who avoid driving in unfamiliar areas is clear. In fact, this variable has the highest associated t-stat of any variable tested for this technology. Other self-regulation variables did not appear in the final model. However, while route support may seem to enhance confidence for those self-regulating at night or those avoiding long distances, the benefits for these folks are not as clear as for those avoiding unfamiliar areas.

These results, coupled with earlier models that included the variable for those self-regulating at night, generated enough curiosity that two sets of cross-tabulations were produced. These can be seen, along with corresponding discussion, in section 4.3.

4.2.10 Personal Service To Help Me Plan Trips, Make Reservations And Purchase Tickets To Events While I Drive

While this service can prove helpful to drivers hoping to make plans while in the automobile, it is uncertain how such a feature could change a person's driving confidence. However, many respondents were convinced that such a device would indeed provide such aid. Persons who expressed this fact were most likely to be much older females who avoided driving in unfamiliar areas. Other variables seen in Model AB3 in Appendix B had much weaker significance. Even gender, which has been highly significant in all previous models, is barely significant at the 99% confidence level. These results show that respondents were not as convinced of confidence gains with this technology as they have been with many of the previous technologies.

These results are further confirmed by the lowest adjusted R^2 value and the lowest F statistic yet. Still the model is not baseless, because many variables do appear with reasonable significance levels and the overall statistics are not so weak as to warrant throwing the entire model out.

Major confidence gains for this service could come from perhaps two cohorts. The first cohort would include those who allow wandering thoughts of tasks yet undone hamper their driving performance. These are people who may fail to stop at a stop sign or crosswalk because they are thinking about how they must look up a phone number for a restaurant once they get home. This telematics service could help them complete tasks like these, purge the thoughts from their minds, and concentrate wholeheartedly on driving. The second cohort would include those who responded positively to the voice-activated cell phone device. For these people, the advantage of hands-free communication could help increase their confidence. But the low overall model fit and F statistic speak for themselves. And unfortunately they indicate that these variables do a relatively weak job of predicting driving confidence.

4.2.11 A Service That Contacts A Taxi Or My Nearest Relative If I Could Not Drive

The final model for this service, Model AB4 seen in Appendix B, brought together the largest number of significant variables of any of the models constructed. In addition, all but one of the variables was significant at the 99% confidence level.

The signs on each of the coefficients fit the prior expectations. The positive age coefficient shows that as age increases, people are more likely to expect the telematics technologies to increase their confidence. Also, as health declines, respondents indicate increased confidence with higher frequency than healthier individuals. Additionally, females seem to associate telematics with higher levels of confidence than males. Based on this result and the results in previous models, the argument that women attach more value to assistive devices wins out over the hypothesis that men may place more confidence in these devices since they are more likely attracted to them in the first place.

Both socioeconomic variables, income and education, have negative coefficients. This indicates that as income and education levels increase, drivers would less likely describe this technology as confidence enhancing. An explanation of this effect would be purely speculative, however, because it seems illogical that those in different socioeconomic brackets would view this technology differently. However, the variables were highly significant and therefore reluctantly left in the final model. Finally, the magnitudes of the coefficients seem reasonable considering the variables themselves. No one term becomes dominant and no one term is dominated by others in the final model.

The final model constructed for this technology includes three variables representative of the issue of self-regulation. Specifically, they address driving at dusk or dawn, driving on the highways or freeways, and driving in unfamiliar areas. The estimated coefficients were all highly significant and were preceded by the expected negative sign. In addition, the magnitudes of the coefficients fall precisely within the range of reasonability based on the survey design characteristics. But while the presence of the variable representing unfamiliar area self-regulation is simple to justify, the presence of the dusk/dawn and highway variables is not. There was little understanding, a priori, of the effects that these two variables would have on driving confidence. After the fact, it remains a mystery why these two were so significant.

Surprisingly, mobility satisfaction was not significant in this analysis. One possible explanation was that many of these drivers could count on riding as a passenger if driving ever became a true problem- they were not scared of losing the ability to move about freely. As noted in Chapter 2 of this work, the second most popular mode choice of the 50+ population is riding in a car as a passenger- second, of course, only to driving themselves.

The adjusted R^2 value is higher than that for any other model by a factor of two. Obviously there is more predictive power in the variables behind this transportation contact service than for the other technologies studied in this analysis. Even though the final value, 0.0897, still reveals that less than 10% of the variance is described, the attempt here was to further understand the systematic impacts of several common explanatory variables and not dwell on issues of taste variation among the participants.

4.2.12 Summary Regression Discussion

Tables AB5 and AB6 in Appendix B give the final results for each of the ten models built for this analysis. The models, as shown, are considered most efficacious with regard to predictive power for each of the ten technologies considered.

Information presented in tables AB5 and AB6 includes coefficient values with standard errors and t-stats for each of those values. Also, the associated values for R^2, adjusted R^2, and the F statistics for each of the models is given.

Several of the independent variables used in the analysis proved successful in the prediction of driver confidence change. The first of these was age. The coefficients for this variable ranged from 0.013 to 0.031 over the ten models built. The consistently positive signs support the a priori hypothesis that as age increases, drivers are more likely to attribute these technologies with increases in confidence on the road. Additionally, the magnitudes of these coefficients imply that this factor will have an influence on the regression equation approximately equal to one-eighth the influence of the equation intercept. This fact, combined with high t-stats ranging from 4.65 to 8.65, indicate that age is a very relevant and highly useful variable in describing the influence of in-vehicle technologies on driving confidence.

The gender dummy variable was another sociodemographic variable that proved successful in driver confidence change prediction. It was significant in nine of the ten models developed with values that ranged from 0.081 to 0.467. The 0.081 value was an outlier with relatively low significance, and all of the other coefficients had at least twice that magnitude. The positive signs on these coefficients indicate that women are more likely than men to indicate an increase in confidence with these new technologies. Again the values are highly significant- though not as significant as those for age. The t-stats range from 1.26 to 6.95 and the term has roughly one-tenth the influence of the intercept value. These facts lead to the conclusion that gender is a significant predictor of driving confidence change, but less so than age.

Surprisingly, health had a weak impact on stated change in confidence. A priori, it was assumed that health would play a significant role in explaining the variance of this dependent variable. Out of ten possible models, health was left in only three of them- and was significant at the 99% level in only two of those three. When it was significant, it did have the predicted positive sign indicating that those in poorer health were more likely to state that new technologies would increase their driving confidence. But compared to the intercept, the term had little impact on the overall regression equation. Perhaps responses to the health question itself were biased, or perhaps those in better health do reap the same confidence increases from new technology. Either way, it is safe to conclude that health has an indeterminate effect, at best, in explaining stated confidence change.

The variable for education had perhaps the most interesting effect on the regression models constructed. According to the consistently negative coefficients, it appears that those with *lower* levels of formal education are more likely to indicate that these technologies increase their driving confidence. The values for this variable ranged from -0.030 to -0.077 with t-stats ranging from 1.49 to 3.30. And while the variable appeared in only half of the 10 models constructed, its consistent magnitude and sign indicate that it is a fairly strong predictor of driving confidence change.

However, the implications of this predictive strength are quite intriguing. The variable did not appear with the expected sign, and the reasoning behind this fact is unclear. Perhaps those with more education are skeptical of the technologies' abilities to impact their driving. Or perhaps those with less formal education put more trust in new technologies, because they are less likely to seek detailed information on technology-related capabilities and limitations. Regardless of the reasoning, the negative coefficients have significant implications for the telematics industry as a whole. It appears that those with higher education levels (and likely higher incomes) are less impressed with telematics systems.

This presents a challenge for the telematics industry because these systems often appear in high-end automobiles- those likely to be purchased by highly educated, wealthy consumers. It is quite possible that these systems are bundled and sold in the wrong class of automobile. Sales of telematics systems in high-end autos could be driven by materialistic, consumptive tendencies of this cohort. Alternatively, those typically buying lower-end cars would reap measurably enhanced confidence from such systems. This, in turn would constitute a more sustainable consumer base for both the automaker and telematics provider based on real value rather than on fickle tendencies or trendy fads.

The income variable was left in just four of the ten models built in this analysis. As predicted, a priori, income has an inconclusive effect on driving confidence. The variable coefficient is positive for both "larger car" and "car-unlock service", but it is negative for "personal concierge" and "alternative transport contact service". This leads to conclusions that for the first two technologies, higher income levels are associated with confidence *increases*. The opposite is true for the last two technologies. One possibility is that income does have different, significant effects on confidence depending on the specific technology and therefore should be considered when analyzing driving confidence.

However, since income and education level are closely related, it may be necessary to create a hybrid variable to account for the underlying impact behind socioeconomic status. If this correction is not made, the resulting model may not meet the Gauss-Markov assumption for independence, and the coefficients will not have all of the characteristics of best linear unbiased estimators (for a further discussion of the implications of the Gauss-Markov theorem in regression analysis, see Pindyck and Rubinfeld 1998 pgs. 61-65). This should certainly be explored in future research on this topic. In this discussion, the issue of independence was not pursued, but the models constructed ignite little concern as they seem to be only marginally affected by this property.

One variable that came out completely contrary to a priori expectations was overall driving confidence. It was predicted that those with lower levels of confidence in their driving abilities would state with high frequency that new technologies would increase their driving confidence. But the consistently positive sign implies that those with higher confidence levels would actually reap the greatest confidence increase from in-vehicle telematics. These results also lead one to believe that those who have little confidence in their driving abilities do not see substantial confidence gains with telematics.

Different explanations could be posited for this phenomenon. Perhaps the most plausible is that these different questions of confidence are measuring completely different things. The first – that of overall driving confidence – strikes at personal inadequacies and limitations. In effect, this question is challenging the respondents to admit cognizance of their own failings as drivers.

Obviously, this particular question's phrasing is more likely to generate biased responses since it seems probing and possibly even offensive.

Indeed, response statistics show a dearth of respondents indicating they are not confident in their driving abilities. In fact, less than 1.8% of the 3,824-person sample checked boxes one, two, and three on the 7-point scale of increasing confidence level. 3,757 people checked boxes in the four to seven range (with 3,226 checking six or seven), showing that strong confidence levels in driving abilities are widespread. The average of responses was 6.3 with a median response of 6. This overwhelming skewness is strong evidence that these responses were based primarily on personal pride rather than on objective analysis of driving ability (also possible, but less likely, is that the question was phrased in such a way that it appeared confusing to the respondents).

The question pertaining to in-vehicle telematics, on the other hand, addresses issues of potential rather than limitation. It is phrased in such a way that allows respondents to imagine the impact of new devices and infer the resulting change to confidence level. Therefore, it is understandable that the overall driving confidence variable does not give the "expected" negative sign. And this leads one to believe that while there is significant positive correlation between the independent variable and the 10 dependent variables (10 technologies), there is little causality. So a stated preference survey asking questions about driving confidence, in the current form, cannot help predict change in confidence due to new technologies (to view the actual survey used, the reader is encouraged to see Appendix A).

Mobility satisfaction was predicted to have the same effect as overall driving confidence. However, the variable appeared in only one final model and had the same counterintuitive sign as the variable discussed above. Thus, it can reasonably be concluded that mobility satisfaction has little effect on determining change in driving confidence in the presence of advanced technology.

Five of the seven self-regulation variables were helpful in explaining the dependent variable in this analysis. Those who self regulate in the following ways indicated that significant confidence gains could be achieved from many of these technologies:

- Those who avoid night driving
- Those who avoid dusk or dawn driving
- Those who avoid highways or freeways
- Those who avoid driving in poor weather
- Those who avoid driving in unfamiliar areas

The resulting variables were all negative, as expected, with values ranging from –0.061 to –0.285. Some variables were more influential than others. Specifically, the "unfamiliar areas" and "night driving" variables had the highest t-stats and the highest magnitude coefficients, overall. The other three variables named in the bulleted list above appear in less than half of the final models. Interestingly, self-regulation with regard to distance and traffic did not provide any insight into driving confidence change.

This realized hierarchy of variable significance seems logical. Simply put, some self-regulating tactics are simply more feasible than others. It would be quite difficult for even the weakest of drivers to avoid driving distances of over one hour or to avoid driving in traffic congestion. These are essentially prerequisites to driving at all. Summary statistics below point out that fewer people who choose to self regulate in some way choose to self regulate specifically in these two ways. That is, people are more likely to avoid unfamiliar areas and poor weather than they are to avoid distances or congestion simply because the latter two are nearly unavoidable.

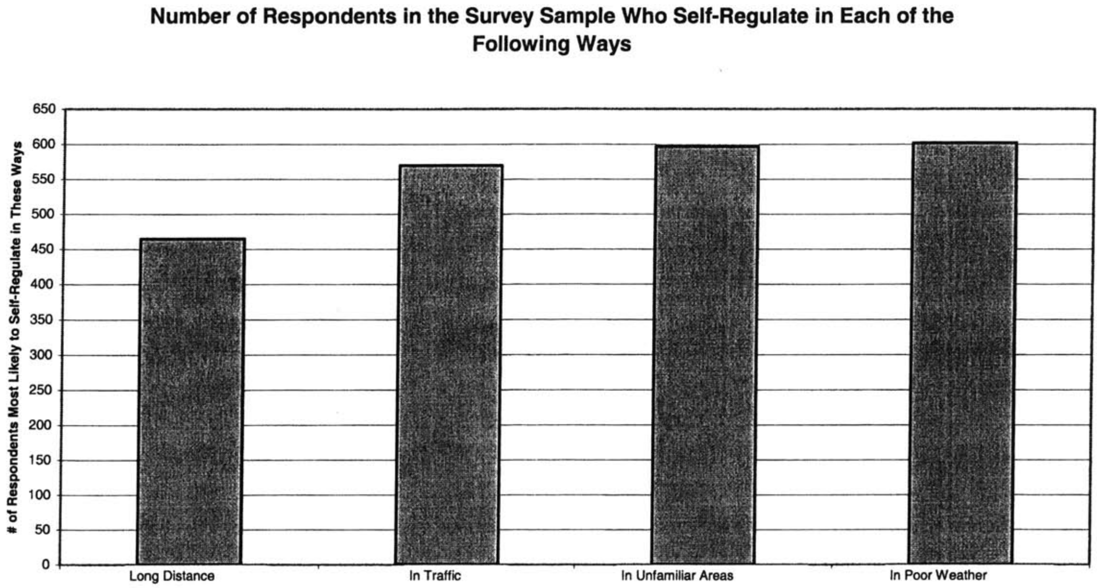

Figure 4-4: Comparison of Numbers of People Choosing to Self-Regulate

Even so, telematics devices have yet to be conceived that can bring two points closer together or decrease traffic congestion. So the core issues underlying these two self-regulating strategies cannot even be addressed with telematics.

From the results of the analysis, it is apparent that in-vehicle devices best serve those choosing to avoid night driving and driving in unfamiliar areas. Those avoiding dusk or dawn driving, highway driving, and driving in poor weather are served to some extent. These results provide developers of telematics systems with guidance for future development, as well as affirmation regarding positive impacts to date. The most striking of these impacts is, of course, the success of these systems in adding confidence to those drivers self-regulating at night and in unfamiliar areas. Targeting these two populations would be most financially beneficial to telematics providers and developers alike.

However, the core values behind dusk/dawn, highway, and weather restricted driving can be met more effectively than they are now. Advances to mirrors and windshields can help cut down on glare that can be a problem at dusk or dawn. Automatic acceleration/deceleration systems based on smart sensors could help timid drivers confidently navigate difficult highways. And advanced braking and headlight abilities could provide drivers added piece of mind during poor weather conditions. Advances such as these could do more to free the self-regulating population- leading to increased quality of life by providing freedom and independence as described earlier in this work.

The final topic to be addressed in review of the regression analysis performed is that of overall fit. The common metric for this is the adjusted R^2 value, which can be seen for each model in Tables AB5 and AB6 in Appendix B. The values ranged from 0.0212 for the "larger car" to 0.0897 for "alternative transport contact service". Thus, these models explain between 2.1% and 9.0% of the total variance. While these may seem somewhat low, (typically econometricians obtain values reaching to 40% or even 50% in some analyses) this is expected due to the nature of the dependent variable under consideration. Good strides were made in selecting independent variables that were very significant, but obviously there are other considerations in one's stated preference as to how technology can impact confidence. But predicting one's change in confidence, while difficult, should prove immensely valuable. It has already been argued that increasing one's confidence can lead not only to buying decisions beneficial to the telematics industry, but also to an increased sense of well-being among the aging, driving public. And while the regression that was performed fails to explain the majority of the variance behind these confidence changes, the results show some very significant independent variables.

The following qualitative summary chart shows the makeup of the "typical" person that regards telematics systems as confidence enhancing versus persons who do not.

Stated Preference Results for Change in Confidence	
Most likely to indicate increased confidence	*Least likely to indicate increased confidence*
·Oldest of the "old"	·Younger "old" (i.e. those closer to 50 years)
·Those in poorer health	·Those in better health
·Those with lower levels of formal education	·Those with higher levels of formal education
·Women	·Men
·Those with high confidence in their driving now	·Those with low confidence in their driving now
·Those who self-regulate at night	·Those who do not
·Those who self-regulate at dusk or dawn	·Those who do not
·Those who self-regulate on highways	·Those who do not
·Those who self-regulate in bad weather	·Those who do not
·Those who self-regulate in unfamiliar areas	·Those who do not

Table 4-11: Typical Characteristics Table

This table is interesting considering the original hypotheses outlined at the beginning of Chapter 4. In fact, some of these hypotheses were rejected after the analysis. Table 4-18 below shows a comparison of the a priori thoughts to the analysis results.

	Hypothesized Direction of Correlation	Actual Model Results
Age	+	+
Health	-	-
Gender (0=male, 1=female)	?	1
Education	?	-
Income	?	?
Driving Confidence	-	+
Mobility Satisfaction	-	+
Self-Regulating Behavior	-	-

Table 4-12: Hypotheses vs. Actual Results for Expected Coefficient Signs

In fact, only half of the original hypotheses stood up to the statistical tests that were run. It seems that the impact of these telematics technologies on driving confidence was more difficult to gauge than thought at first.

4.3 Regression Post Mortem Cross-Tabulations

Interest in the findings regarding the two most significant self-regulation related variables lead to the following cross-tabs. Through this analysis, more information was gained concerning correlation among age, gender and self-regulatory behavior. Below is Table 4-18, the first of these tables.

Q.15 Willing to drive at night			0 'male' 1 'female' 0.00	1.00	Total
Absolutely Never	R age from survey data	50-59	2	6	8
		60-69	2	12	14
		70-79	6	24	30
		80 and up	13	26	39
	Total		23	68	91
Never, Unless I Can't Avoid it	R age from survey data	50-59	11	41	52
		60-69	23	60	83
		70-79	29	73	102
		80 and up	33	54	87
	Total		96	228	324
Will Sometimes	R age from survey data	50-59	63	163	226
		60-69	77	156	233
		70-79	102	172	274
		80 and up	64	54	118
	Total		306	545	851
It Does Not Usually Affect My Willingness To Drive	R age from survey data	50-59	534	484	1,018
		60-69	426	332	758
		70-79	291	189	480
		80 and up	72	31	103
	Total		1,323	1,036	2,359
No Answer	R age from survey data	50-59	6	3	9
		60-69	3	4	7
		70-79	4	10	14
		80 and up	9	4	13
	Total		22	21	43

Table 4-13: Driving at Night Self-Regulation Cross-tabulation

Several interesting findings were generated from study of this table on night driving self-regulation. These results are discussed in the cross-tabulation summary. Table 4-19, which follows, is the other table of interest: cross-tabulations of age, gender, and the "unfamiliar areas" self-regulation variable.

Q.15 Willing to drive in unfamiliar areas			0 'male' 1 'female'		Total
			0.00	1.00	
Absolutely Never	R age from survey data	50-59	2	19	21
		60-69	7	22	29
		70-79	6	36	42
		80 and up	12	29	41
	Total		27	106	133
Never, unless I can't avoid it	R age from survey data	50-59	23	73	96
		60-69	28	82	110
		70-79	35	99	134
		80 and up	33	57	90
	Total		119	311	430
Will sometimes	R age from survey data	50-59	103	221	324
		60-69	98	188	286
		70-79	113	182	295
		80 and up	57	46	103
	Total		371	637	1,008
It does not usually affect my willingness to drive	R age from survey data	50-59	477	380	857
		60-69	393	267	660
		70-79	272	141	413
		80 and up	83	32	115
	Total		1,225	820	2,045
No Answer	R age from survey data	50-59	11	4	15
		60-69	5	5	10
		70-79	6	10	16
		80 and up	6	5	11
	Total		28	24	52

Table 4-14: Driving in Unfamiliar Areas Self-Regulation Cross-tabulation

Cross-Tabulation Summary

A wealth of information can be gleamed from the above tables. Several of the more interesting results are presented here. The first of these results is one that is confirmed by the previous regression analysis. It is the fact that women of all age groups are more likely than men in the same age group to indicate 'Never' or 'Never, unless unavoidable'. The statistics here are startling, with only 25% of men over 80 years old replying in this manner versus just fewer than 49% of women over 80. Likewise, 21% percent of women between the ages of 70 and 79 stated 'Never' or "Never, unless unavoidable', while only 8% of men in this age group did.

On the other side of this spectrum, 40% of men aged 80+ stated that night driving is usually not an issue while only 19% of women of the same age indicated likewise. Similarly, for those aged 70-79, a full 68% of male respondents and only 41% of female respondents said night driving was not an issue. Differences can be seen in younger age cohorts as well, but the most striking divergence is between the 70+ populations.

The trends among the age groups are also interesting to note. While just 0.6% of the 50-59 year-old bracket states that they 'Never' drive at night, over 11% of the total 80+ population states the same. Likewise, just 4% of the 50-59 group states 'Never, unless unavoidable', contrasted by 25% of the 80+ population that feels the same way. And while over 78% of 50-59 year-old respondents says driving at night is no issue, less than 30% of the 80+ group feels the same way.

The same patterns can be seen from an analysis of the cross-tabulation table for 'Unfamiliar area' self-regulation. Indeed, for females, almost the same number of 80+ year-old respondents stated 'Never' (18%) as those who indicated driving in unfamiliar areas is not an issue (19%). This is contrasted by the response from 80+ year-old men, of which only 6.5% stated 'Never' and 45% said unfamiliar areas were no issue for them.

Of course, the oldest of the 50+ population shows increased self-regulatory behavior with regard to driving in unfamiliar areas- as they did for night driving. Statistics for those responding 'Never' begin at just below 2% for the 50-59 group and explode to 12% for the 80+ group. Similarly, those who state that unfamiliar areas are not an issue include 66% of all 50-59 year-old respondents and just 33% of 80+ year-old respondents.

There are two main conclusions that are overwhelmingly supported by the data in this analysis. The first is that women, more so than men, are prone to self-regulatory behavior (or at least prone to admit it). The second is that regardless of gender, the oldest drivers are more likely to self-regulate. These results were implied from the final regression model coefficients, but the statistics derived from these tables clearly show the extent to which these facts are true.

Chapter 5: Survey Implications

The preceding work describes the existing demographic of 50+ drivers that would see increased confidence gains with in-vehicle telematics. And as argued previously, these perceived confidence gains could lead to increased consumer demand for these offerings. These conclusions spark interest in the current landscape of the telematics industry. The following chapter outlines the operations of two key players in the telematics field: GM's OnStar and BMW's iDrive. The chapter also summarizes telematics provider's business models and suggests enhancements to existing ones. The objective of this discussion is to map the results of the 50+ driver survey to today's telematics industry. Obviously, the results in Chapter 4 have implications for this industry that could help guide future development to better address consumer desire.

5.1 OnStar

OnStar began as a joint effort of General Motors, Inc., and its two subsidiaries, Hughes Electronics (bringing satellite communications technology) and Electronic Data Systems (bringing data processing expertise). Today, Hughes is no longer involved with OnStar, but EDS is, providing information technology and call center assistance[36]. OnStar's concept involves the convergence of global positioning systems (GPS), cellular communications, and automotive electronics. It employs a simple 3-button system mounted on the rearview mirror or, in some cases, on the dashboard. Chet Huber, OnStar Corp.'s president in 2003, sees this simple user interface as one of the attractive qualities of OnStar. In a July 2003 interview, Mr. Huber recalls a comment from a participant on an expert panel of scientists who reviewed OnStar's operation: "Don't ever let them talk you into a fourth button"[37].

There are several technologies offered to OnStar customers bundled in one of two available packages. These technologies include automatic airbag deployment notification, stolen-vehicle tracking, emergency services, roadside assistance, remote door unlock, remote diagnostics, and

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[36] Allan 2003
[37] McCormick 2003

even personal concierge services. The more expensive package includes additional directions and information services. Monthly subscription prices range from $16.95 for the bare bones plan to well over $40 for the enhanced plan with optional add-ons. The monthly fee is one characteristic of OnStar's business model that has been questioned by some in the telematics industry. This and other issues regarding OnStar's business model are discussed later.

Since first appearing in 1996 in three Cadillac models, OnStar's presence has since expanded with standard installation in several different automobiles[38]. In most cases service comes free for the first year, with service contracts required after that period. Of course, this re-subscription rate (how many customers actually decide to pay for OnStar after the free first year) is of great interest to those in the business of telematics, and is a key indicator in gauging real consumer demand. While industry estimates usually put this rate in the 40% range[39], OnStar's president recently boasted rates higher than 50%[40]. However, many suspect that even higher rates of re-subscription are necessary for OnStar to become profitable.

GM rolled out their OnStar initiative with several goals in mind. Obviously, they hoped to cover their costs and quickly become profitable. But the incremental goals of the initiative, like establishing relationships with their customers, have enabled OnStar to move toward the ultimate prize of profitability. In the beginning, OnStar was delivered with the goal of limiting the amount of driver distraction for safe driving[41]. This was to be accomplished while incorporating a set of safety and service features in the automobile. OnStar's simple 3-button system and use of voice commands – which do not require the driver to take their eyes from the road – effectively serve both purposes: incorporation of advanced technology in the car while maintaining a high level of safety. In fact, a 2001 GM study concluded that of the 8.1 million calls from OnStar customers between 1996 and 2000, only two drivers had accidents while using the service[42]. Clearly, the design has proven safe with regard to driver distraction.

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[38] These models include Acura, Audi, Buick, Cadillac, Chevrolet, GMC, Hummer, Isuzu, Lexus, Oldsmobile, Pontiac, Saab, Saturn, Subaru, and Volkwagen.
[39] Homsen 2002
[40] McCormick 2003
[41] Allan 2003
[42] Klein 2002

OnStar has achieved other successes in addition to maintaining a safe driving environment. Year on year growth, in terms of subscription volume, has ranged from 16% to 19% in the past three years. And on a monthly basis, OnStar call centers are answering 250,000 routing requests, 25,000 remote door unlock requests, 8,000 emergency calls, 800 stolen car claims, and 800 air bag deployment dispatches[43]. Perhaps the greatest success of OnStar is overall brand marketing. In the market that is automotive telematics, OnStar has emerged as the most familiar entrant. In mid-2002, OnStar accounted for 80% of the United States telematics market[44]. And this overwhelming market share is coupled with nearly ubiquitous name recognition. There is no doubt that this will help carry the company into the future as they continue to differentiate their product line and compete in the ever-growing telematics market.

Despite several successes, OnStar has not been immune to criticism. The most skeptical observers see OnStar's business model[45] as less than desirable.

> "GM subsidizes the first year subscription with what is essentially a forced trial. To get the first year "free" subscribers to choose a car model with OnStar and have it activated, OnStar must not only pay to support each subscriber, it must also sink millions of dollars into advertising and promotion to make customers believe that OnStar is for them[46]."

And while the aforementioned re-subscription rate is 40-50%, this is still insufficient to cover costs, pay back investments, and leave a profit. The monthly service charge is also much maligned. As OnStar expands into lower-priced cars, drivers are even more unlikely to accept the fee.

> "A number of telematics companies have decided that the OnStar business model is a mistake. Rather than investing hundreds of millions of dollars in telematics infrastructure, as GM has done on behalf of OnStar, telematics service providers are scaling back investment plans...some see telematics as a cost center for services that come standard with the vehicle, features that distinguish it from other models (such as remote diagnostics capability)[47]."

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[43] Ryan 2004
[44] Lienert 2002
[45] For a visual schematic of OnStar's business model, please see Figure 5 on page 74
[46] Homsen 2002
[47] Homsen 2002

Mobile privacy is another concern that OnStar has failed to manage wisely. Some consumers are likely wary of a service that can track their every move in their car. This group will obviously think twice before signing up for even the first free year of service. On the other hand, car tracking can provide great benefits to those drivers who are interested. They could be informed of nearby buying opportunities such as fuel or entertainment without even asking for such advice. OnStar could profit from this information by selling to third-party advertisers who would then promote their products at opportune times.

So what might OnStar's future look like? Subscription-based, monthly-fee service may soon prove to be the delivery mechanism of the past. As more and more entrants to the telematics market blaze their own paths in the industry, it is likely that something more appealing will emerge. OnStar must keep its eyes on the future and develop flexibility into their service offerings in order to protect itself from up-and-coming telematics providers.

Additionally, OnStar could do a better job of marketing itself to the customers who would see the greatest return from telematics. In 2003, OnStar's president said the following regarding OnStar's appeal: "People thought it would only have a high income, luxury market appeal, but that's not the case. Our experience has shown the safety, security and peace of mind elements have very broad demographic appeal[48]." But Roger Allen writes "All that's missing [from OnStar's implementation] is a way to instill the extra confidence in consumers that the returns from telematics are worth the few extra dollars[49]." The research presented in Chapter 4 of this work shows that, indeed, certain people see stronger confidence gains from in-vehicle telematics. OnStar needs to not only market to those people, but also sell the confidence-enhancing characteristics of their product.

5.2 iDrive

BMW's iDrive system was first introduced in 1999 at the Frankfurt Auto Show and began to appear in high-end BMWs in 2001. The system is intended to clear up valuable dashboard real

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[48] McCormick 2003
[49] Allan 2003

estate by reducing the need for gauges and manual controls. By the mid-1990s a BMW 7 Series dashboard had 35 different gauges and indicator lights and 66 manual controls[50]. It is understandable that BMW would attempt to address this overcrowding, and iDrive was designed to do just that.

The iDrive interface includes a large, multifunction knob located between the front seats and a monitor positioned near the driver's line of vision. Through a combination of pushes, turns, and shoves, the user can navigate through a set of 700 individual functions. The most common driving functions, including headlights, air conditioning and others, are also controllable by traditional switches on the instrument panel. So for basic operation, the driver can get by without the use of the iDrive's controller[51].

Unlike OnStar, iDrive does not provide personalized service. There is no feature that enables the driver to communicate with a representative if they are lost or just need directions to a place of interest. iDrive's navigation, mapping, and other features are built into the system and must be accessed by the controller (though they can be customized to meet the user's priority demands or mental map, thus giving the feel of personalization). However, since iDrive has low variable costs (e.g. they do not need to staff a control center for agents to communicate with customers) they can easily avoid the monthly subscription-based business model. The fact that this telematics system is built into the purchase price of the car makes it more appealing than its GM-owned counterpart.

However, many in the industry have criticized iDrive's user interface. The device requires the driver to take one hand off the wheel to operate the controller and to periodically take their eyes from the road to confirm proper menu navigation. Granted, after a period of time, a user should be able to perform many operations instinctively. But with 700 available features, it is unlikely that anyone will be able to do everything by memory. As a result, some see iDrive as a facilitator of driver distraction, and therefore a detriment to driving safety.

[50] Wilkinson 2003 [Stephan Wilkinson, 2003, Popular Science]
[51] Fargo 2002 [Robert Fargo, February 25, 2002, PistonHeads.com]

A recent review in an online automotive journal gives some interesting insight into one iDrive neophyte's experience with the system. "The company that builds 'The Ultimate Driving Machine' is the one company that should know an over-complicated and dangerous distraction when it sees one. The iDrive is not, as BMW claims, 'A New Way to Drive'. It is, in fact, a new way to die[52]." Of course this testimony is overdramatic, but it rightly draws attention to the plight of the new iDrive user. Wilkinson notes that a large part of the market for luxury sedans consists of middle-aged people who have never even bothered to develop computer literacy. iDrive president Kuenzner advises these people to "put a lid over the screen and enjoy driving"[53].

5.3 Alternative Strategies and Business Models for the Telematics Industry

Having examined the operations of two key players in the in-vehicle telematics industry, it would be helpful to discuss possible improvements to business models and competitive strategies.

Figure 5 shows a schematic of OnStar's current business model.

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[52] Fargo 2002
[53] Wilkinson 2003

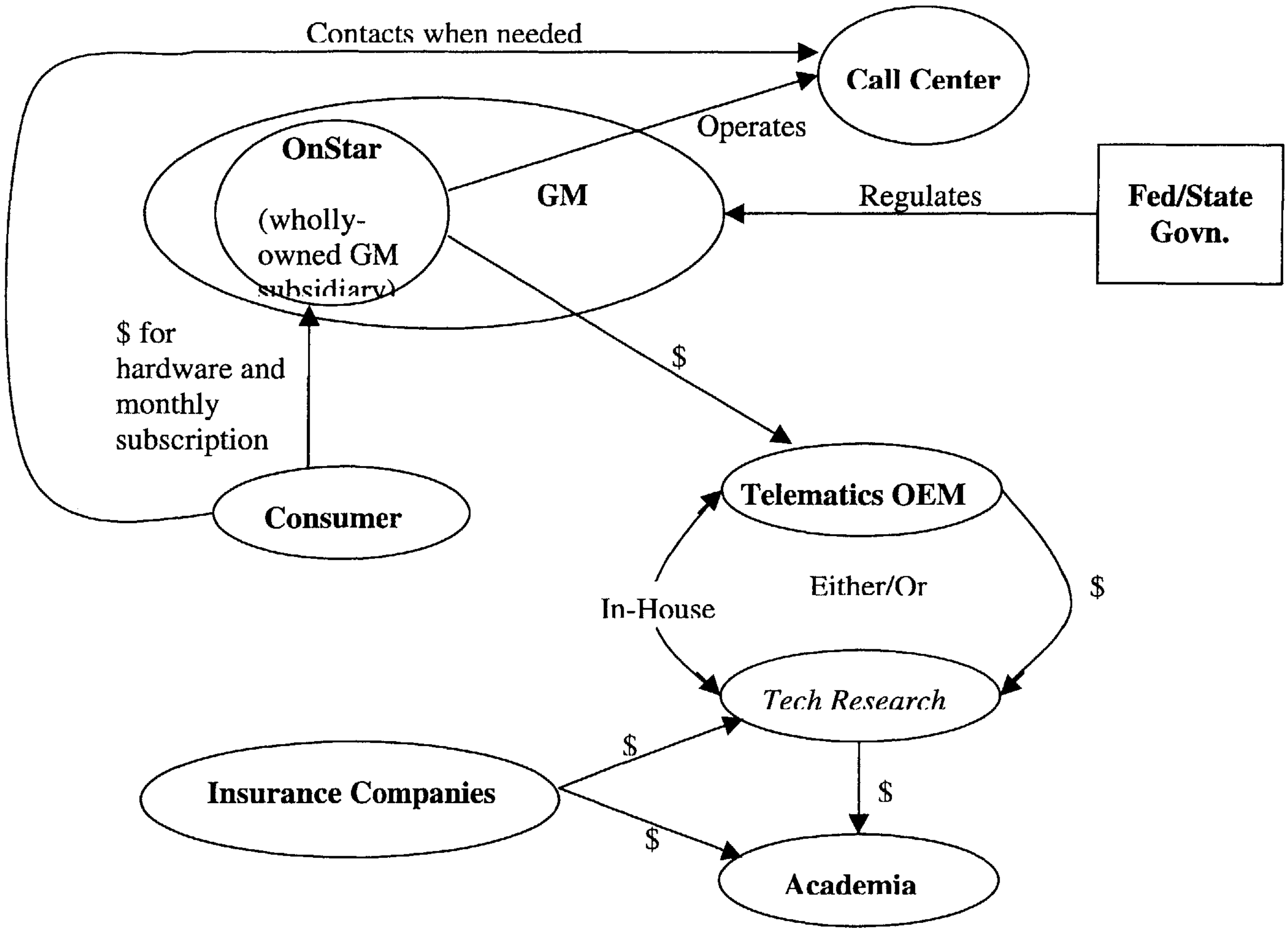

Figure 5: OnStar Business Model

The above figure shows many of the relationships that OnStar has with other organizations from equipment manufacturers to the academic researchers funded to improve the state of the art in telematics offerings. Of most importance in this figure is the consumer relationship with OnStar- since that is the sole revenue stream for this endeavor. Customer monthly subscription fees must cover OnStar's cost to operate the call center, OnStar's payments to original equipment manufacturers (OEM's), as well as OnStar's administrative operating and overhead costs. Clearly, this is a considerable sum to pass on to customers in the form of user fees.

Alternative strategies for making telematics profitable have been proposed. Kermit Whitfield suggests that automakers should foot the bill for telematics hardware[54]. This business model could help build brand loyalty as the car company delivers a valuable service to the customer at a cost that is "hidden" in the initial purchase price. But for this to seem palatable to many automakers, telematics installation rates would need to be very high. This would exploit economies of scale and drive down unit costs, making telematics hardware worth the automaker's time and effort.

Another option for operating a telematics enterprise would include soliciting data-hungry companies as contributors to the provision of telematics services. Advertising firms and even ratings services companies would be interested in having access to the data on travel patterns that telematics providers can collect. Subsequently, these firms may be willing to pay the service provider in exchange for this information.

This approach does create privacy concerns, however. Drivers may be unwilling to allow information on their driving habits and destinations to be given to a third party. On the other hand, some drivers may be very interested in giving this information away if they would receive helpful information in return. Such information could include updates on nearby sales and promotions on items of interest. Today, OnStar can tell the driver where the nearest gas station is. But enhanced information from a third party could tell the driver where the closest gas station is with the lowest price on windshield washer fluid. As with other technologies, some consumers would hop on board and some would refrain. But if implemented intelligently, third party involvement in the delivery of telematics systems could provide the 'killer app' that the industry has been seeking for so long.

One final telematics implementation strategy would involve the federal government. A considerable body of empirical research is needed on the benefits of telematics to the safety of the driving population. Today this body of knowledge does not exist because telematics is not yet ubiquitous in the automotive fleet. But in the future, it is likely that empirical research will

[54] Whitfield 2003

laud the safety benefits of such in-vehicle technologies. These results would provide the foundation for helpful government intervention.

As automobile safety increases, the cost to insurance companies of providing car and health coverage decreases. This in turn should drive down the price for insurance premiums for consumers- creating what economists call a positive externality. Additionally, in-vehicle telematics are significantly confidence enhancing for some drivers. This increase in overall well-being for many in the driving public is another so called positive externality. Economic theory suggests that the source of such positive spillover effects, telematics in this case, should be subsidized. Thus the government would be justified in stepping in to contribute funds to telematics research, development, and implementation.

Of course, a mixture of the above strategies might prove to be the dominant telematics business model. Customers could pay a very small fee up front or on a monthly basis (perhaps even a fee incorporated as a nominal surcharge to an existing monthly bill). Automakers could finance the installation of in-vehicle telematics systems, and third-party advertisers and others could be responsible for operation of all real-time call center assistance. Finally, the federal government could sponsor research and development initiatives in academic or private sector settings. However, this is but one possible combination of responsibilities. Other arrangements should be explored to ensure that the costs and benefits of a telematics strategy are distributed appropriately among the invested partners.

Apart from the business models, however, is the issue of technology adoption. Even if consumers were given free access to the telematics systems of OnStar or iDrive, would they really use them? And would automakers be able to build valuable brand loyalty as a result? It is likely - among the 50+ driving population - that if the consumer felt that the system was increasing their driving confidence, they would be more prone to use the technology and would, perhaps, be more likely to develop loyalty the particular brand they were using. Certainly, these telematics providers would want to target their technological development and marketing to the most responsive older consumers described in chapter 4 of this thesis.

Chapter 6: Conclusions and Recommendations

Driving confidence is an interesting consumer metric. It is, perhaps, as significant as the core consumer values of safety and freedom, and therefore should be considered with regard to technological development and marketing plans. Many consumers would be willing to purchase a product that increased their driving confidence, just as customers often buy safety-enhancing products or products that simplify a difficult task. The evidence in Chapters 4 and 5 of this thesis shows the significance of driving confidence for specific people groups with regard to in-vehicle technologies. The above analysis shows that stated preference for these technologies varies markedly across different sociodemographic groups. Ideally, marketing and design of such technologies would target those who would reap from them the highest levels of increased confidence.

6.1 Conclusions

While many would agree that the safety and service features of in-vehicle telematics have the potential to enhance life behind the wheel, little research has shown consumer interpretation of such devices. If one expected homogenous response from each population segment, the results of such a survey would still be beneficial to gauge overall consumer opinion. But these results have provided detailed insight into the perceptions of various consumer cohorts. This is but one small step toward understanding the potential for in-vehicle telematics, and much more needs to be done to determine the best mix of technologies for the car.

The results in this body of work show that the greatest confidence gains are seen in older women drivers with lower levels of education, etc. (see Table 4-11). This knowledge should act as a guiding light for those designing telematics systems and for those marketing such systems. Efforts should target other consumer cohorts while striving to strengthen the interest among the most receptive group. More nationwide surveys should be conducted and more focus groups should be convened on this topic of driving confidence and in-vehicle devices. The data do show marked differences in perceptions of telematics but are unable to assign causality to these perceptions. The above analysis purports to shed light on some of these reasons, but unfortunately without data to back it up, such discussion is purely speculative. However, the findings in this work are quite thought provoking and could serve as a springboard for further research.

The relationship between in-vehicle telematics and those who self-regulate their driving behavior was also explored in this thesis. It was hypothesized that those who currently altered their driving due to perceived weaknesses would state with higher frequency that telematics systems would increase their confidence. The models that were constructed confirmed this hypothesis- but not in every case. That is, only some self-regulating strategies were associated with higher frequency of increased confidence. Some regulatory tactics said nothing about how telematics were perceived. But it was found that core issues on which some of the self-regulatory practices were based were just not addressed by the telematics systems under consideration. For this reason the results, which at first appeared surprising, seem logical.

The case studies and business model discussion that followed outlined some of the important implications of the survey results. The reviews of OnStar and iDrive showed how telematics providers were not effectively meeting the needs of the 50+ driving population that was studied in Chapter 4. These systems were priced poorly (OnStar) and difficult to use (BMW). Additional business models were then discussed, with attention given to alternative financing methods and operational agreements. All of these considerations were motivated by and based on results from the survey analysis. Clearly improvements need to be made in the telematics industry to more effectively deliver such high-potential technology to the 50+ consumer.

6.2 Speed Bumps for Telematics

Advances in telecommunications, global positioning systems, voice and gesture recognition technology, and mechanical systems have provided the platform for rapid telematics development. But to date, the industry has had difficulty bundling these new features in ways that provide both net gains in auto safety and service and capture consumer attention. Early telematics offerings have been met with tentative market response. At present, developers and stakeholders seem to be seeking the appropriate business models and marketing strategies to best appeal to consumers. Companies have a wealth of technologies to offer, but have yet to conclude which are reasonable, and perhaps more importantly, what car-buyers are willing to pay for. The telematics industry is bustling with potential. These technologies could change lives, but so far there has been a failure to mate potential with consumer demand. Much work needs to be done to bring telematics to the mainstream where the strongest advantages can be seen.

Other unanswered questions relating to telematics include the following:

1) Will loading the automobile with such advanced technology really aid the driving public?
2) Are there ways to mitigate potential distractions to drivers so that those behind the wheel, especially older drivers, can quickly adapt?

Driver distraction is already cited as the root cause for more than a quarter of all automobile accidents[55]. If these trends continue and advanced telematics systems further compound this issue, regulators could one day be forced to step in and put limits on what is allowed inside the car. To ensure a positive future for in-vehicle telematics, work must be done to further understand the implications of technological deployment in light of both government and consumer response.

6.3 Recommendations For Future Research

In addition to these questions, an interesting direction for further research using this data set would include construction of choice models using many of the demographic variables studied here. One method of discrete choice modeling that would capture the unique information available in an ordinal scale, such as the one in this survey, is ordered probit. Other popular choice models, including multinomial logit and probit neglect the data's ordinality and are associated with undesirable properties such as independence of irrelevant alternatives (logit) and

[55] Mark Edwards, the Managing Director of Traffic Safety at the American Automobile Association, stated in a June 27, 2000 interview that aired on CNN "...somewhere between 25-50 percent of all motor vehicle crashes in this country really have driver distraction as their root cause."

lack of a closed-form likelihood (probit). Therefore, ordered probit would be the ideal choice model for this analysis and may provide more robust parameter estimates than the ones obtained from the multivariate regression seen in Chapter 4.

In addition to more analysis on the existing dataset, it would be useful to develop more exploratory surveys that target telematics industry professionals. These people should also be engaged in focus group settings to discuss business model enhancements and innovative financing options. It has been noted that subscription-based service alone is less than ideal, and that some combination of government subsidy, third party investment, and automaker contribution could be more palatable to consumers. The experts in the field need to be in dialogue on these, and other issues, in order to establish a robust strategy for telematics providers.

Telemedicine, which involves the application of telecommunications technology to facilitate remote diagnosis and treatment of patients, could be one interesting addition to the offerings of telematics providers in the future. The inclusion of telemedicine would not mean a new business model, but rather an entirely new genre of in-vehicle technology. And these technologies would most certainly be popular with the crowd that already sees the most significant confidence gains from telematics as described in Chapter 4. As retail health becomes ever more pervasive in society, in-vehicle telemedicine may prove to be the new hot thing in the automobile.

Finally, more case studies need to be developed, documenting the experiences of not only telematics providers, but also technology manufacturers. Cases on Ford's failed telematics offering, Wingcast, would help outline some of the pitfalls of introducing in-vehicle telematics to the driving public. But other case studies on technology development firms would also be insightful. It is imperative to understand both the technology and its relationship with the overall telematics package in order to design these systems more effectively.

The cases presented on iDrive and OnStar could also be improved upon. They provide just a skeletal assessment of past history, experience, and lessons learned. Much more detail is available, and should be studied, because these are two of the most popular telematics offerings.

In-vehicle telematics are comprised of a set of technologies seething with potential. Indeed, combined in an optimal way, telematics could substantially increase driving safety and personal convenience. But for drivers to adopt these systems, at some cost to them, there needs to be a recognizable return on investment. Increased driving confidence could very well be the return that telematics providers could market to consumers. As with safety and freedom, increased confidence is a benefit that many drivers would be happy to pay for. And as seen in this thesis, some drivers are quite willing to admit that telematics can increase their confidence. Those in the telematics industry must seize this information and forge new paths toward understanding relationships between this critical consumer metric and the systems they develop. Only then will the full potential of in-vehicle telematics be realized.

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Appendix A

National Family Opinion

P.O. Box 474 Toledo, OH 43654
Toll-Free Number: **1-800-537-4097**
Mon – Fri, 8:00 AM to 11:00 PM EST
Sat & Sun, 10:00 AM to 6:00 PM EST
e-mail address: **carol@nfol.com**
http://mysurvey.com/privacy.cfm

1. Overall, how satisfied are you with your ability to go where you want to go, when you want to, in order to do the different things you want and need to do? **(X ONE Box)**

Extremely Dissatisfied	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Extremely Satisfied**
	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	

2. In your opinion, how much, if at all, does driving ability decline as people grow older? **(X ONE Box)**
   - 1 ☐ Quite a bit
   - 2 ☐ A little bit
   - 3 ☐ Not at all
   - 4 ☐ Don't know

3a. Are you, yourself, a licensed driver?
   - 1 ☐ Yes → **(Continue)**
   - 2 ☐ No → **(Skip To Qu. 55)**

3b. Have you, yourself, driven a car within the past twelve months?
   - 1 ☐ Yes → **(Continue)**
   - 2 ☐ No → **(Skip To Qu. 55)**

4. Which of the following statements best describes your opinion? **(X ONE Box)**
   - 1 ☐ I do not think there will ever come a time when I will need to severely limit or stop my driving all together.
   - 2 ☐ I expect that at some point in the future I may need to limit or stop driving, but I haven't had to make any significant changes as yet.
   - 3 ☐ I have already made adjustments to my driving in order to continue driving safely.
   - 4 ☐ I have already pretty much stopped driving.
   - 5 ☐ I don't know whether I will need to severely limit or stop driving in the future.

You and Driving

5. In a typical week, how many miles do you drive? **(X ONE Box)**
   - 1 ☐ Less than 50 miles
   - 2 ☐ 50 to 100 miles
   - 3 ☐ 101 to 200 miles
   - 4 ☐ More than 200 miles

6. For the vehicle you drive most frequently, please indicate its make (manufacturer), model and year. **(Write In)**

   Make: ____________________

   Model: ____________________

   Year: ____________________

7. Please "X" all of the restrictions placed on your license by your state's motor vehicle authority. **(X ALL That Apply)**

- 1 ☐ Eyeglasses or corrective lenses
- 2 ☐ Restrictions on time of day driving is permitted
- 3 ☐ Restrictions on distance from home you may drive
- 4 ☐ Restrictions for trip purpose
- ☐ Other (Specify):______________________________
- + ☐ There are no restrictions on my driver's license

8. Please complete the following table for all of the other members of your household. **(X ALL That Apply)**

+ ☐ ***"X" here if there are no other household members, then please skip to Qu. 10.***

Member in household's relationship to you	Does the person drive?		Gender		Age
	Yes	No	Male	Female	
Spouse	1 ☐	2 ☐	1 ☐	2 ☐	____
Son	1 ☐	2 ☐	—	—	____
Daughter	1 ☐	2 ☐	—	—	____
Brother	1 ☐	2 ☐	—	—	____
Sister	1 ☐	2 ☐	—	—	____
Son-in-law	1 ☐	2 ☐	—	—	____
Daughter-in-law	1 ☐	2 ☐	—	—	____
Roommate	1 ☐	2 ☐	1 ☐	2 ☐	____
Other (Specify): ____________	1 ☐	2 ☐	1 ☐	2 ☐	____

9. When you travel with other drivers in your household, how often are you the driver? **(X ONE Box)**

- 1 ☐ Always
- 2 ☐ Most of the time
- 3 ☐ The driving is split equally among drivers
- 4 ☐ Seldom
- 5 ☐ Never
- 6 ☐ There are no other drivers in my household

10. If you rely on others to drive you, please list the top **three** people who drive you to the places you want and need to go, ranking them from 1 to 3, where "1" is the person who drives you most frequently, "2" is the second most frequent, and "3" is the third most frequent. **(Write In Numbers For Top Three)**

- ____ Spouse
- ____ Son
- ____ Daughter
- ____ Son-in-law
- ____ Daughter-in-law
- ____ Sister or Brother
- ____ Other relative
- ____ Close friend/Neighbor
- ____ Public transportation (bus, train, taxi)
- ____ Senior van service

+ ☐ *I generally don't rely on anyone else to drive me anywhere*

11. In a typical week, how many rides do you give to other people who depend upon you for transportation? **(X ONE Box)**

- 1 ☐ None
- 2 ☐ Less than one per week
- 3 ☐ 1 or 2 rides per week
- 4 ☐ 3 to 5 rides per week
- 5 ☐ 6 or more rides per week
- 6 ☐ Don't know

Your Feelings about Driving

12. How would you rank your overall confidence in your driving abilities? **(X ONE Box)**

Not At All Confident	1	2	3	4	5	6	7	**Extremely Confident**
	☐	☐	☐	☐	☐	☐	☐	

13. Would you say that you enjoy driving these days more or less than you did ten years ago? **(X ONE Box)**

Enjoy It Much Less Than 10 Years Ago	1	2	3	4	5	6	7	**Enjoy It Much More Than 10 Years Ago**
	☐	☐	☐	☐	☐	☐	☐	

14. There are a number of modern safety features and services available in automobiles today. Please think about whether your confidence in driving would change if you had the following available in your car. **(X ONE Box For EACH Statement)**

	Much Less Confident 1	2	3	4	5	6	**Much More Confident** 7	**My Car Already Has This Feature** 8
Anti-lock (ABS) brakes	☐	☐	☐	☐	☐	☐	☐	☐
A larger car that offers more protection in case of an accident	☐	☐	☐	☐	☐	☐	☐	☐
A night vision system that projects a display of the road on my windshield	☐	☐	☐	☐	☐	☐	☐	☐
Rearview and side mirrors that dim automatically to reduce the glare from other vehicles	☐	☐	☐	☐	☐	☐	☐	☐
A collision warning system that beeps when my car comes too close to another vehicle/object	☐	☐	☐	☐	☐	☐	☐	☐
An emergency communications system that calls for and sends help in the case of an accident or medical emergency, even if I am unable tell them my exact location	☐	☐	☐	☐	☐	☐	☐	☐
A service that unlocks my car by sending a remote signal to my car's computer	☐	☐	☐	☐	☐	☐	☐	☐
Voice-activated cellular telephone in the car	☐	☐	☐	☐	☐	☐	☐	☐
Route support to provide me with step-by-step directions	☐	☐	☐	☐	☐	☐	☐	☐
Personal service to help me plan trips, make reservations and purchase tickets to events while I drive	☐	☐	☐	☐	☐	☐	☐	☐
A service that contacts a taxi or my nearest relative if I could not drive	☐	☐	☐	☐	☐	☐	☐	☐

15. In a typical week, how often would you say that you are willing to ... ? **(X ONE Box For EACH)**

	Absolutely Never	**Never, Unless I Can't Avoid It**	**Will Sometimes**	**It Does Not Usually Affect My Willingness To Drive**
Drive at night (after sunset)	1 ☐	2 ☐	3 ☐	4 ☐
Drive at dusk or dawn	1 ☐	2 ☐	3 ☐	4 ☐
Drive on the highways or freeways	1 ☐	2 ☐	3 ☐	4 ☐
Drive in heavy traffic congestion	1 ☐	2 ☐	3 ☐	4 ☐
Drive in poor weather	1 ☐	2 ☐	3 ☐	4 ☐
Drive long distances (requiring more than one hour of travel time one way)	1 ☐	2 ☐	3 ☐	4 ☐
Drive in unfamiliar areas	1 ☐	2 ☐	3 ☐	4 ☐

16. Rank the top **three** trips for which you **would be willing to drive** in less than ideal conditions because the trip purpose outweighs your concerns about the driving conditions (e.g., at night, on highways, in poor weather, etc.). Please indicate a "1" for your top trip priority, a "2" for your second priority, and a "3" for your third priority. **(Write In Numbers For Top THREE)**

- A visit to family or friends .... _____
- Shopping .... _____
- Dining out .... _____
- Attending religious services or functions .... _____
- Recreational or social activities (Specify):__________ .... _____
- Physical activities or exercise .... _____
- Volunteer work .... _____
- Doctor's appointment .... _____
- Work .... _____
- Other (Specify):__________ __________ .... _____

17. How often do you do the following while you are driving? **(X ONE Box For EACH)**

	Often	Sometimes	Occasionally	Rarely	Never
Listen to the radio, cassette or CD player...	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Talk on a telephone	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Check your e-mail or go on the Internet......	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Carry on extensive conversations with passengers in your car............................	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Eat or drink	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Check maps..	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Other (Specify):_____________________...	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐

18. When you encounter other drivers who are rude or drive aggressively, how do you usually respond to them? **(X ONE Box)**

1 ☐ Ignore them and try to stay out of their way
2 ☐ Try to let the other driver know how I am feeling (for example, yell or gesture)
☐ Other (Specify):____
+ ☐ Don't know

19. In the past ten years, have you been involved in any of the following? **(X ALL That Apply)**

1 ☐ Received a ticket for a traffic violation while driving (OTHER than a parking ticket)
2 ☐ Narrowly avoided being involved in an accident while driving
3 ☐ Involved in an automobile accident while driving
4 ☐ I have had none of these

20. People decide to stop driving for many different reasons. For each of the following, please indicate how it would affect your decision to drive. **(X ONE Box For EACH Statement)**

	Would Stop Driving 1	2	3	4	5	6	Would Not Stop Driving 7
Problems with seeing at night..	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐
Feeling that your reaction times are slower	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐
A child, spouse, close friend or relative said they thought it was time for you to stop	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐
A child or child-in-law said that your grandchild(ren) could no longer ride in a car while you are driving...........................	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐
Your doctor said he/she thought it was time for you to stop driving..	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐
Diagnosed with Alzheimer's disease..	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐
A driving evaluation indicated that you should stop driving.......	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐
Involved in a traffic accident as a driver – at fault	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐
Involved in a traffic accident as a driver – not at fault	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐
Involved in a traffic accident as a driver – injured	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐
Involved in a traffic accident as a driver – not injured	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐
Other (Specify): _______________________________	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐

21. Please describe how you may have changed or modified where, when or how you drive since you were about 40 years old. **(Please Be As Specific As Possible)**

***Changes*:** ____

____

____

+ ☐ *I have not made any changes to my driving habits whatsoever since I was 40 years old.*

The Role of Driving in Your Life

22. Indicate how much you agree with each of the following statements. **(X ONE Box For EACH)**

	Strongly Disagree						Strongly Agree
If I were no longer able to drive, it would be difficult for me to continue to reside in my current home	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐
I would be interested in joining a type of transportation service that would provide me with a ride when I needed one	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐

23. If you were interested in joining a transportation service, how much would you be willing to pay on a monthly basis to belong to such a service? **(X ONE Box)**

1 ☐ Nothing
2 ☐ Less than $15 per month
3 ☐ $15 to $29 per month
4 ☐ $30 to $49 per month
5 ☐ $50 to $100 per month
6 ☐ More than $100
7 ☐ I would never join such a service

24. If you could go wherever you wanted and transportation was not a problem, what activities would you do more often? Please rate your top **three** choices from 1 to 3, where "1" is the activity you would do the most, "2" is the second, and "3" is the third. **(Write In Number For Up To THREE)**

Visit family or friends .... ______
Take local sightseeing trips .... ______
Go on vacations that require driving .... ______
Shop .... ______
Dine out .... ______
Attend religious services or functions .... ______
Recreational or social activities (Specify): ______________ ... ______
Physical activities or exercise .... ______
Volunteer work .... ______
Work (part time or full time) .... ______
Other (Specify): ______________ ... ______

+ ☐ *Transportation does not affect my ability to do any of these activities*

Your Use of Transportation Alternatives

25. What transportation alternatives are available to you (within a quarter of a mile)? **(X ALL That Apply)**

1 ☐ Public bus service
2 ☐ Senior van service
3 ☐ Commuter trains
4 ☐ Local subway or elevated train service (light rail)
5 ☐ Streetcar or trolley
☐ Other (Specify): ______________
+ ☐ None
- ☐ Don't know

26. In the past two months, have you used any of the following means of transportation? **(X ONE Box For EACH)**

	Yes	No	Don't Know
Public bus service	1 ☐	2 ☐	3 ☐
Commuter trains	1 ☐	2 ☐	3 ☐
Subways or elevated rail	1 ☐	2 ☐	3 ☐
Trolleys/streetcars	1 ☐	2 ☐	3 ☐
Commuter ferry service	1 ☐	2 ☐	3 ☐
Taxi cabs	1 ☐	2 ☐	3 ☐
Senior van service	1 ☐	2 ☐	3 ☐
Walking	1 ☐	2 ☐	3 ☐
Getting rides with family or friends	1 ☐	2 ☐	3 ☐

27. If you had to stop driving, please rank your top 3 choices for how you would get around, where "1" is your first choice, "2" is your second choice, and "3" is your third choice. **(Write In Number For Up To THREE)**

Walk .... ______
Local/community senior van service .... ______
Public transportation (buses, subway, ferry) .... ______
Taxis .... ______
Rides with family and friends .... ______
Stay at home and have goods and services delivered .... ______
Pay a private service to provide me with door to door transportation in well-maintained cars .... ______
Other (Specify): ______________ ..... ______

28. Would you use any alternate transportation service if your family, friends or loved ones paid for you to use it?

1 ☐ Yes
2 ☐ No

Your Experiences

29. If someone were to approach you with concerns about your driving, whom would you be **most** likely to listen to? **(X ONE Box)**

01 ☐ Spouse
02 ☐ Son
03 ☐ Daughter
04 ☐ Brother
05 ☐ Sister
06 ☐ Son-in-law
07 ☐ Daughter-in-law
08 ☐ Close friend
09 ☐ Doctor
10 ☐ Other healthcare professional
11 ☐ Police officer
☐ Other (Specify): ______________________

30. What would make you trust this person? **(X ALL That Apply)**

1 ☐ The person sees me drive or rides with me regularly
2 ☐ The person is a good driver and knows what they're talking about
3 ☐ The person has my best interests at heart
4 ☐ The person knows whether I am physically capable of being a good, safe driver
5 ☐ The person is in a position of authority
☐ Other (Specify): ______________________

31. Whom would you absolutely NOT want to talk to you about your driving? **(X ALL That Apply)**

01 ☐ Spouse
02 ☐ Son
03 ☐ Daughter
04 ☐ Brother
05 ☐ Sister
06 ☐ Son-in-law
07 ☐ Daughter-in-law
08 ☐ Close friend
09 ☐ Doctor
10 ☐ Other healthcare professional
11 ☐ Police officer
☐ Other (Specify): ______________________

32. Under what conditions would you feel like someone should talk to you about your driving? **(X ALL That Apply)**

1 ☐ If they were generally concerned about my safety
2 ☐ After a significant change in my health
3 ☐ If I had some incidents of forgetfulness or getting lost while driving
4 ☐ If I narrowly avoided being involved in an accident
5 ☐ If I was involved in a minor accident
6 ☐ If I was involved in a serious accident
☐ Other (Specify):______________________

33. Has anyone ever suggested that you cut back on or stop driving all together? **(X ONE Box)**

1 ☐ Yes → **(Continue)**
2 ☐ No → **(Skip To Qu. 37)**
3 ☐ Don't recall → **(Skip To Qu. 37)**

34a. In **Column "A"**, please indicate the person(s) who spoke to you about your driving. **(X ALL That Apply In Column "A")**

34b. In **Column "B"**, please indicate if that person spoke to you more than once about your driving. **(X ONE Box In Column "B" For Each Person Indicated In Column "A")**

	"A" Person Who Spoke To You	"B" More Than Once? Yes	No
Spouse	01 ☐	1 ☐	2 ☐
Son	02 ☐	1 ☐	2 ☐
Daughter	03 ☐	1 ☐	2 ☐
Brother	04 ☐	1 ☐	2 ☐
Sister	05 ☐	1 ☐	2 ☐
Son-in-law	06 ☐	1 ☐	2 ☐
Daughter-in-law	07 ☐	1 ☐	2 ☐
Close friend	08 ☐	1 ☐	2 ☐
Doctor	09 ☐	1 ☐	2 ☐
Other healthcare professional	10 ☐	1 ☐	2 ☐
Police officer	11 ☐	1 ☐	2 ☐
Other (Specify): ______________	☐	1 ☐	2 ☐

35. What did the person(s) indicated in Qu. 34a want you to do? **(X ALL That Apply)**

1 ☐ Cut back a little bit on driving
2 ☐ Cut back on certain types of driving
3 ☐ Take a defensive drivers' or driving refresher class
4 ☐ Have a formal test or evaluation of your driving skills done
5 ☐ See a doctor
6 ☐ Get a different car to drive
7 ☐ Stop driving all together
☐ Other (Specify): ____________

36. What was your reaction to them approaching you? **(X ALL That Apply)**

1 ☐ Got angry at the person
2 ☐ Felt guilty
3 ☐ Felt sad
4 ☐ Felt depressed
5 ☐ Ignored person - they don't know what they're talking about
6 ☐ Listened to what they said, but decided they weren't right
7 ☐ Listened to what they said, did what they suggested
☐ Other (Specify): ____________

37. What is the best approach for talking to **drivers over the age of 50** about cutting back on or stopping their driving? Please take a few moments to tell us what you think should happen in these situations. For example, think about how a person should approach the driver - who should do it, where should they do it, when should they do it? What should they say, or what things should they not say? **(Please Be As Specific As Possible)**

____

____

____

Your Experiences with Defensive Driving Classes

38. Have you taken a defensive driver class or driving refresher class within the past 10 years? **(X ONE Box)**

1 ☐ Yes → **(Continue)**
2 ☐ No → **(Skip To Qu. 44)**
3 ☐ Don't recall → **(Skip To Qu. 44)**

The next series of questions refers to the <u>most recent defensive driving class you attended.</u> **(X ONE Box For EACH)**	**1** (Strongly Disagree)	**2**	**3**	**4**	**5**	**6**	**7** (Strongly Agree)
39a. The most recent defensive driving class gave me more confidence in my driving	☐	☐	☐	☐	☐	☐	☐
39b. The most recent defensive driving class helped me drive more safely	☐	☐	☐	☐	☐	☐	☐
39c. My driving habits and patterns changed as a result of what I learned in the class	☐	☐	☐	☐	☐	☐	☐

40. Rank up to **three** reasons you decided to take the class. Please use the numbers 1 to 3, where "1" is the top reason you decided to take the class, "2" is the second reason you decided to take the class, and "3" is the third reason. **(Write In Number For Up To THREE)**

I wanted a refresher on driving laws in my state ______

I wanted to evaluate my driving skills ______

I wanted to learn more about the safety and technological features available on my vehicle ______

I wanted some tips on how to improve my driving skills ______

I thought the class would help me to deal better with other drivers on the road today ______

Taking the class gave me a discount on my auto insurance ______

It was a way for me to spend time with friends or to meet new people ______

My doctor suggested I take the class ______

I was required to take the class as part of a legal proceeding ______

Other (Specify): ____________ ______

41. How would you rate the class you took on each of the following aspects? **(X ONE Box For EACH)**

	Not At All Useful Or Informative						Extremely Useful And Informative
Overall usefulness of the class for your driving	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐
Information on the state's rules of the road	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐
Information about how to drive more safely at night	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐
Information about how to drive more safely on highways or freeways	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐
Information about how to drive more safely under certain road and weather conditions	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐
Information about new in-vehicle technologies and automobile features designed to help drivers drive better	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐
Information about how to adjust and use the existing safety features on your automobile	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐
Information about physical changes due to aging that may affect driving (such as changes in night vision, slower reflexes, etc.)	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐
Information about exercises that help maintain people's physical ability to drive	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐
Other (Specify): ______	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐

42. Did the class you took offer a road test to assess your driving skills and ability? **(X ONE Box)**

1 ☐ Yes → **(Continue)**
2 ☐ No → **(Skip To Qu. 44)**
3 ☐ Don't recall → **(Skip To Qu. 44)**

43. Did you participate in this test? **(X ONE Box)**

1 ☐ Yes
2 ☐ No
3 ☐ I don't recall

The Model for an Ideal Defensive Drivers' Class

We are interested in what an ideal defensive drivers' education class would look like.

44. A number of different public and private organizations might sponsor such a class. Of the following, please rank your top three sponsor choices, where "1" is your most preferred class sponsor, "2" is your second preferred sponsor, and "3" is your third. **(Write In Number For Up To THREE)**

- Public library or community center ______
- Senior center ______
- Hospital or rehabilitation center ______
- Fitness center or gym ______
- Organization such as AARP ______
- Travelers' organization such as AAA ______
- Automobile dealership ______
- Department of motor vehicles ______
- Professional driving school ______
- Auto insurance company ______
- Other (Specify): ______ ______

45. What kinds of instructors do you think would be best for teaching such a class? For each of the following characteristics, please rate how your willingness to take the class would be affected if the instructor were ... **(X ONE Box For EACH)**

	Less Willing	It Doesn't Make Any Difference	More Willing
Male	1 ☐	2 ☐	3 ☐
Female	1 ☐	2 ☐	3 ☐
Under 35 years of age	1 ☐	2 ☐	3 ☐
Over 55 years of age	1 ☐	2 ☐	3 ☐
Professionally trained driving instructor	1 ☐	2 ☐	3 ☐
Knowledgeable about teaching methods	1 ☐	2 ☐	3 ☐
Other (Specify): ______	1 ☐	2 ☐	3 ☐

In most states, completing a defensive drivers' class would allow you to get a discount on your auto insurance.

46. How much would you be willing to pay to take a defensive drivers' class? **(X ONE Box)**

- 1 ☐ Nothing
- 2 ☐ Less than $15
- 3 ☐ $15 to $34
- 4 ☐ $35 to $49
- 5 ☐ $50 to $74
- 6 ☐ $75 or more

47. Please indicate how interested you would be in having each of the following topics be a part of the class. **(X ONE Box For EACH)**

	Not At All Interested 1	2	3	4	5	6	Extremely Interested 7
Updates on changes to the state's traffic laws and regulations	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐
Tips for driving more safely at night	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐
Tips for driving more safely in poor weather	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐
Strategies for making a left hand turn more safely in traffic	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐
Tips for driving more safely through intersections and merging into traffic	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐
Strategies for driving more safely on highways or freeways	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐
Tips on how to drive more safely in heavy traffic	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐
Information about safe travel speeds	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐
Ways to minimize distractions while you drive	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐
Tips on ways to drive long distances more safely	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐
Information on how to use the current safety and technological features on your car properly	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐
Information on new technologies you can purchase for your current car or on a new car	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐
Safety and convenience features to consider when choosing a new automobile	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐
The effects of physical changes due to normal aging on people's vision, reaction times and spatial perception, and what this means for driving	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐
Warning signs that you should consider limiting or stopping driving	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐
Simple exercises to do on a daily basis to maintain the physical ability to drive	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐
Information on driving skills evaluations in your area	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐
Resources for alternative transportation in your area	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐
Other (Specify): ____________	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐

Assessing Driving Skills

Please read the sheet labeled Assessing Driving Skills, located on the back of the letter, and then answer the next few questions.

48. Of the five techniques described, please rate from 1 to 3 the top three tests that you think would be the best indicator of your real driving skills. "1" is the test that is the best indicator, "2" is the next best, and "3" is the third. **(Write In Number For Up To THREE)**

- Road test ______
- Computerized driving skill test ______
- Driving simulator test ______
- Paper-pencil test ______
- Physical and cognitive fitness for driving test ______

49. Do you think that your personal driving history is more valid than any single one of these tests? **(X ONE Box)**

- 1 ☐ Yes
- 2 ☐ No
- 3 ☐ Don't know

50. Thinking about the driving assessment technique you said was the best indicator of your driving skills, what would you do if you took the test and failed it? **(X ONE Box)**

- 1 ☐ Nothing; I would keep driving as I always have
- 2 ☐ I would still drive, but I would consider making some changes to my driving habits or behaviors
- 3 ☐ Stop driving
- ☐ Other (Specify): ____________________

51. A voluntary testing program open to all drivers would have a cost. In addition to your driver's license renewal fee, how much **more** would you be willing to pay in order to make this voluntary testing available to all drivers? **(X ONE Box)**

- 1 ☐ Nothing
- 2 ☐ Less than $15
- 3 ☐ $15 to $34
- 4 ☐ $35 to $49
- 5 ☐ $50 to $74
- 6 ☐ $75 or more

52. If you could participate in a voluntary personal assessment of your individual driving skills, where all results were kept confidential, would you participate? **(X ONE Box)**

- 1 ☐ Yes → **(Continue)**
- 2 ☐ No → **(Skip To Qu. 54)**
- 3 ☐ Don't know → **(Skip To Qu. 55)**

53. Why might you want to participate in such an assessment? Please number the top three reasons from 1 to 3 you would want to participate in such a test, where "1" is your first reason, "2" is your second, and "3" is your third. **(Write In Number For Up To THREE)**

I'm curious to see where my driving skills come out .... ______

I see this as a regular checkup of my fitness to drive .... ______

I want to improve my driving skills and this might help me .... ______

I think it would be fun .... ______

I am interested in getting a second opinion on my driving .... ______

Other (Specify): ____________________ ______

If you answered Question 53 please skip to Question 55.

54. Why might you <u>not</u> want to participate in such an assessment? Please number the top three reasons you would <u>not</u> want to participate in such a test, where "1" is your first reason, "2" is your second, and "3" is your third. **(Write In Number For Up To THREE)**

My driving skills are fine .... ______

I don't think the test would be a good indicator of my real driving ability .... ______

I would worry that the results would be reported to the department of motor vehicles. ______

I don't have the time to take such a test .... ______

The idea of taking a test makes me nervous or uncomfortable .... ______

Other (Specify): ____________________ ______

Others In Your Life Whose Driving Concerns You

The next set of questions asks about other drivers in your life whose driving concerns you.

55. Do you have a spouse, parents, in-laws or other relatives over the age of 50 who are still driving themselves? **(X ONE Box)**

- 1 ☐ Yes → **(Continue)**
- 2 ☐ No
- 3 ☐ Don't know → **(Skip To Qu. 57)**

For each person, please indicate their relationship to you and complete the following table.

56a. In **Column "A"**, please indicate all of those people in your life whose driving concerns you. **(X ALL That Apply In Column "A")**

56b. In **Column "B"**, have you or other people talked to this person about their driving? **(X ONE Box For EACH In Column "B")**

56c. In **Column "C"**, please write in who approached this person about their driving. For example, you, their sister, their cousin, etc. **(Write In Person In Column "C")**

	"A"	"B"		"C"
Relationship to you:	**Your Concerns**	**Yes**	**No**	**Other Who Approached This Person**
Spouse	01 ☐	1 ☐	2 ☐	____________
Father	02 ☐	1 ☐	2 ☐	____________
Mother	03 ☐	1 ☐	2 ☐	____________
Father-in-law	04 ☐	1 ☐	2 ☐	____________
Mother-in-law	05 ☐	1 ☐	2 ☐	____________
Sister	06 ☐	1 ☐	2 ☐	____________
Brother	07 ☐	1 ☐	2 ☐	____________
Uncle	08 ☐	1 ☐	2 ☐	____________
Aunt	09 ☐	1 ☐	2 ☐	____________
Cousin	10 ☐	1 ☐	2 ☐	____________
Other (Specify): ____________	☐	1 ☐	2 ☐	____________

About You

57. What is your age and gender?

Age: ________ Gender: 1 ☐ Male 2 ☐ Female

58. Overall, how happy would you say you are these days? **(X ONE Box)**

1 ☐ Very happy
2 ☐ Pretty happy
3 ☐ Not too happy
4 ☐ Don't know

59. How would you characterize your overall health? **(X ONE Box)**

1 ☐ Excellent
2 ☐ Very good
3 ☐ Good
4 ☐ Fair
5 ☐ Poor
6 ☐ I'm not sure

60. Do you regularly perform physical exercise at least three times a week? **(X ONE Box)**

1 ☐ Yes
2 ☐ Sometimes
3 ☐ No
4 ☐ Don't know

61. How often would you say that you attend religious services in a church, synagogue, mosque or some other house of worship? **(X ONE Box)**

1 ☐ More than once a week
2 ☐ Once a week
3 ☐ Almost every week
4 ☐ Once or twice a month
5 ☐ A few times a year
6 ☐ Never
7 ☐ I don't know

62. How do you keep busy these days? **(X ALL That Apply)**

- 1 ☐ Work outside of the home full-time
- 2 ☐ Work outside of the home part-time
- 3 ☐ Volunteer time outside of the home on a regular basis
- 4 ☐ Keep busy with projects at home
- 5 ☐ None of these

63. Do you have any other family members who are licensed to drive and who live 15 miles or less from you? **(X ONE Box)**

- 1 ☐ Yes → **(Continue)**
- 2 ☐ No → **(Skip To Qu. 65)**
- 3 ☐ Don't recall → **(Skip To Qu. 65)**

64. Which family members who drive live 15 miles or less from you? **(X ALL That Apply)**

01 ☐ Son	05 ☐ Sister	09 ☐ Niece
02 ☐ Daughter	06 ☐ Brother	10 ☐ Nephew
03 ☐ Son-in-law	07 ☐ Granddaughter	11 ☐ Cousin
04 ☐ Daughter-in-law	08 ☐ Grandson	12 ☐ Other

65. Do you access e-mail or the Internet either at home, work, or some other place, such as the public library?

- 1 ☐ Yes → **(Continue)**
- 2 ☐ No → **(Skip To Comments)**

66. Have you ever used the Internet to purchase an item? **(X ONE Box)**

- 1 ☐ Yes
- 2 ☐ No
- 3 ☐ I'm not sure

COMMENTS

You may use this page to expand on any of your answers to the questions in this booklet.

We would especially encourage you to describe how any of your driving habits or patterns have changed as you have grown older, and what you see as the reasons for these changes. **(Please Be As Specific As Possible)**

Thank you for your help with this study. Please return your completed questionnaire in the enclosed postage-paid envelope as soon as possible.

Appendix B

FINAL MODEL

	Intercept	Age	Gender	Overall Driving Confidence	SR_NightDriving	SR_Dusk/Dawn	SR_Highways	SR_UnfamiliarArea
Coefficient	**4.202**	**0.022**	**0.081**	**0.191**	**-0.099**	**-0.146**	**-0.061**	**-0.176**
Standard Error	0.392	0.003	0.064	0.036	0.065	0.075	0.061	0.049
t-Stat	10.72	6.58	1.26*	5.31	-1.52**	-1.96	-1.00***	-3.62

# of Variables	8
# of Observations	3824
Deg. of Freedom	3816
R^2	0.0423
Adjusted R^2	0.0405
F statistic	24.08038

* This value is significant at the 75% confidence level

**This value is significant at the 85% confidence level

***This value is significant at the 70% confidence level

Table AB1: 14c with Sociodemographic, Confidence, and Self-Regulation Variable

FINAL MODEL

	Intercept	Age	Income	Education	Gender	Overall Driving Confidence	Mobility Satisfaction	SR_NightDriving	SR_Unfamiliar
Coefficient	**2.802**	**0.031**	**0.023**	**-0.069**	**0.458**	**0.189**	**0.055**	**-0.151**	**-0.197**
Standard Error	0.420	0.004	0.006	0.023	0.069	0.040	0.025	0.053	0.048
t-Stat	6.678	8.651	3.873	-3.000	6.636	4.699	2.176	-2.851	-4.082

# of Variables	10
# of Observations	3824
Deg. of Freedom	3814
R^2	0.0561
Adjusted R^2	0.0541
F statistic	28.3

Table AB2: 14g Final Model

FINAL MODEL

	Intercept	Age	Income	Health	Gender	Overall Driving Confidence	SR_Dusk/Dawn	SR_Highways	SR_Unfamiliar
Coefficient	**2.666**	**0.027**	**-0.009**	**0.033**	**0.152**	**0.160**	**-0.125**	**-0.095**	**-0.158**
Standard Error	0.4896	0.0038	0.0058	0.0299	0.0733	0.0411	0.0678	0.0685	0.0553
t-Stat	5.446	7.189	-1.617	1.106	2.081	3.896	-1.846	-1.383	-2.859

# of Variables	9
# of Observations	3824
Deg. of Freedom	3815
R^2	0.0376
Adjusted R^2	0.0356
F statistic	18.6

Table AB3: 14j Final Model

FINAL MODEL

	Intercept	Age	Income	Health	Education	Gender	Overall Driving Confidence	SR_Dusk/Dawn	SR_Highways	SR_UnfamiliarArea
Coefficient	**3.361**	**0.031**	**-0.023**	**0.092**	**-0.077**	**0.340**	**0.161**	**-0.177**	**-0.103**	**-0.221**
Standard Error	0.475	0.004	0.006	0.029	0.023	0.070	0.039	0.065	0.066	0.053
t-Stat	7.08	8.43	-3.72	3.20	-3.30	4.86	4.10	-2.73	-1.57*	-4.17

# of Variables	10
# of Observations	3824
Deg. of Freedom	3814
R^2	0.0918
Adjusted R^2	0.0897
F statistic	42.8

Table AB4: 14k Final Model

	Larger Car			Night Vision System			Dimming Mirrors			Collision Warning System			Emergency Communic.		
	Coeff	Standard Error	t-Stat	Coeff	Standard Error	t-Stat	Coeff	Standard Error	t-Stat	Coeff	Standard Error	t-Stat	Coeff	Standard Error	t-Stat
Intercept	3.366	0.355	9.49	4.202	0.392	10.72	4.227	0.319	13.27	4.281	0.348	12.31	4.149	0.342	12.12
Age	0.019	0.003	5.82	0.022	0.003	6.58	0.013	0.003	4.65	0.020	0.003	6.70	0.017	0.003	6.05
Income	0.028	0.006	4.91	-	-	-	-	-	-	-	-	-	-	-	-
Health	-	-	-	-	-	-	-	-	-	-	-	-	0.046	0.022	2.08
Education	-0.065	0.021	-3.01	-	-	-	-	-	-	-	-	-	-	-	-
Gender	-	-	-	0.081	0.064	1.26*	0.275	0.054	5.07	0.153	0.059	2.57	0.347	0.055	6.29
Overall Driving Confidence	0.230	0.034	6.81	0.191	0.036	5.31	0.253	0.030	8.33	0.163	0.033	4.93	0.181	0.031	5.84
Mobility Satisfaction	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SR_Night	-	-	-	-0.099	0.065	-1.52**	-0.168	0.042	-3.98	-0.142	0.047	-3.00	-0.101	0.042	-2.39
SR_Dusk/Dawn	-	-	-	-0.146	0.075	-1.96	-	-	-	-	-	-	-	-	-
SR_Highways	-	-	-	-0.061	0.061	-1.00***	-	-	-	-	-	-	-	-	-
SR_Traffic	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SR_Weather	-	-	-	-	-	-	-0.085	0.040	-2.13	-0.090	0.048	-1.88****	-	-	-
SR_Distance	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SR_UnfamiliarAreas	-	-	-	-0.176	0.049	-3.62	-	-	-	-0.158	0.045	-3.52	-0.186	0.038	-4.88
R^2	0.0222			0.0423			0.0358			0.0433			0.0473		
Adjusted R^2	**0.0212**			**0.0405**			**0.0345**			**0.0418**			**0.0458**		
F statistic	21.7			24.1			28.3			28.8			31.6		

* This value is significant at the 75% confidence level
**This value is significant at the 85% confidence level
***This value is significant at the 70% confidence level
****This value is significant at the 90% confidence level

Table AB5: Summary Table for Safety Features

	Car Unlock Service			Voice-Act. Cell Phone			Route Support			Personal Concierge			Altern. Trans. Contact		
	Coeff	Standard Error	t-Stat	Coeff	Standard Error	t-Stat	Coeff	Standard Error	t-Stat	Coeff	Standard Error	t-Stat	Coeff	Standard Error	t-Stat
Intercept	2.802	0.420	6.68	3.619	0.4170	8.68	3.842	0.369	10.41	2.666	0.490	5.45	3.361	0.475	7.08
Age	0.031	0.004	8.65	0.020	0.0034	5.83	0.020	0.003	6.33	0.027	0.004	7.19	0.031	0.004	8.43
Income	0.023	0.006	3.87	-	-	-	-	-	-	-0.009	0.006	-1.62**	-0.023	0.006	-3.72
Health	-	-	-	-	-	-	-	-	-	0.033	0.030	1.11***	0.092	0.029	3.20
Education	-0.069	0.023	-3.00	-0.030	0.0200	-1.49**	-0.041	0.019	-2.15	-	-	-	-0.077	0.023	-3.30
Gender	0.458	0.069	6.64	0.467	0.0673	6.95	0.406	0.064	6.35	0.152	0.073	2.08	0.340	0.070	4.86
Overall Driving Confidence	0.189	0.040	4.70	0.176	0.0374	4.70	0.135	0.035	3.84	0.160	0.041	3.90	0.161	0.039	4.10
Mobility Satisfaction	0.055	0.025	2.18	-	-	-	-	-	-	-	-	-	-	-	-
SR_Night	-0.151	0.053	-2.85	-	-	-	-	-	-	-	-	-	-	-	-
SR_Dusk/Dawn	-	-	-	-0.133	0.0594	-2.23	-	-	-	-0.125	0.068	-1.85****	-0.177	0.065	-2.73
SR_Highways	-	-	-	-	-	-	-	-	-	-0.095	0.069	-1.38*****	-0.103	0.066	-1.57**
SR_Traffic	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SR_Weather	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SR_Distance	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SR_UnfamiliarAreas	-0.197	0.048	-4.08	-0.163	0.0468	-3.48	-0.285	0.041	-6.96	-0.158	0.055	-2.86	-0.221	0.053	-4.17
R^2	0.0561			0.0400			0.0479			0.0376			0.0918		
Adjusted R^2	**0.0541**			**0.0385**			**0.0466**			**0.0356**			**0.0897**		
F statistic	28.3			26.5			38.4			18.6			42.8		

* This value is significant at the 75% confidence level
**This value is significant at the 85% confidence level
***This value is significant at the 70% confidence level
****This value is significant at the 90% confidence level
*****This value is significant at the 80% confidence level

Table AB6: Summary Table for Service Features