Technology Takes the Wheel: Analyzing Distracted Mindsets While Driving

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June 4, 2014

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Introduction

Since the advent of the mobile phone, cellular devices have gradually become a necessity in nearly all aspects of life. With elementary school children, senior citizens, and everyone else in between owning mobile phones, a recent cultural shift has taken place, causing people to be more dependent on their phones. The addiction is a serious problem, as people tend to grow emotionally attached to their phones. The heavy involvement and obsession with mobile phones should be sufficient to produce pause and wariness amongst the digital generation.

As innately social creatures, humans thrive on social interactions. Consequently, it only makes sense for humans to satiate their desire for socialization by constantly staying in touch with their circle of family, friends, and acquaintances. The yearning to be connected to others, however, can be disruptive in other circumstances that are more or less inappropriate. All too often, mobile phone users push the boundaries on what is socially acceptable behavior and as a result, establish a norm that calls for more distractions and less respect for those within their physical setting. The relationships developed and maintained through mobile and smartphones appear to be the priority, but what is sacrificed and ignored turns out to be quite costly. Besides neglecting those around them and having disregard for situations that normally would benefit from the absence of distracting technologies, the price people pay for a “quick fix” of social interaction can amount to fatality while behind the wheel.

Driving, like mobile telephony, allows humans to connect to people, places, objects, and events. Automobiles permit people to travel long distances, to get from
point A to point B, and they also afford them with freedom to “get away” from the haste or monotony of life. But automobile makers probably did not intend for “getting away” to occur through a screen of a mobile phone. What ends up escaping in this case is the human mind. As it becomes absorbed in the handheld mobile device, the mind wanders into a very dangerous realm that does something quite different than a joyride that sets the mind free of life’s stresses. Whereas a peaceful drive enables the driver to take in the scenic surroundings while also remaining in control of the car, a mobile phone defeats the purpose of driving. Instead, it sucks the driver's senses into the phone, disappearing for moments at a time, then intermittently returning to the road. The fluctuations in attentiveness have the very real potential to remove the driver from the car. Obviously, the consequences of this behavior can lead to disastrous outcomes, for both the driver and anyone in his or her path.

Despite the fast-paced, on-the-go, and distracted nature of human interactions nowadays, human brains are not designed to handle such a large overflow of information in an efficient manner. The reason drivers are more prone to getting in accidents while using their phones may strike most as glaring and obvious. The continuous influx of information, no matter how important or unimportant, has the power to overwhelm the brain to the point that information does not get effectively processed, if at all. Even one minor distraction can be enough to interfere. So, when drivers decide to
get caught up in information irrelevant to the main task at hand, of course their ability to drive diminishes.

The questions surrounding this expansive topic are endless. Should drivers eliminate mobile phones from the driving scene altogether, or should they learn to optimally control their cognitive abilities so that they can continue to operate their phones while simultaneously driving? The goal of this review is more than to simply restate that texting while driving is dangerous. Likewise, the purpose is not to admonish those who participate in this risky behavior. Instead, the vast literature review has been compiled in order to bring the issue of multitasking while driving to the forefront and to really understand the underlying factors that have caused this problem to manifest itself at the height of the digital era. It is important to examine what exacerbates this problem and figure out why preventative measures have failed. From there, combatting the issue will be more manageable. If humans cannot attain the awareness and foresight to grasp the implications of this societal issue, the roads will continue to represent avenues threatening our very existence.

In the following pages, I argue that the consequences of multitasking while driving can be reversed with cognitive interventions, the proper use of technological devices and interfaces, and the implementation of technical features specifically geared towards preventing the use of mobile devices or making telematics safer. I also explore the very valid potential of autonomous cars that might eliminate the risk of distracted driving altogether. In addition, I intend to evaluate the roles of law enforcement, public service announcements, and other organized initiatives to better understand how they might help combat the multitasking predisposition.
Overall, my aim is to raise awareness, offer plausible solutions, and promote safer practices amongst the mobile phone user and automobile driver population, as well as the general population.

**Background**

*Mobile Phone Expansion*

The concept of mobile telephony originally developed with the intention of connecting wirelessly to the public telephone network. Starting in the 1940s, mobile phones for automobiles became available (Farley, 2005). But it was not until 1973 that John F. Mitchell and Dr. Martin Cooper of Motorola demonstrated the first handheld cell phone (*Encyclopedia*, 2008). Although this technology was groundbreaking at the time, the advances in the mobile phone industry have continued to progress and flourish, evolving from bulky, brick-like phones to lighter, more compact phones.

Modern mobile phones serve as the centerpiece through which most people manage their communication networks. In addition, users have access to functionalities like audio solutions, e-mail, games, photography, and other applications with endless capabilities (Markley, 2008). As the prevalence of mobile phones and most recently, smartphones, continues to increase, people’s reliance on the devices as a means of constant communication and connection continues to rise, as well. In the recent past, users were able to place and take calls or send and receive text messages, but now their phones are equipped with numerous applications that enable them to complete several unrelated tasks through one technological medium. This revolutionary technology has shaken the roots of our
being, and most recently, has shifted from a luxury to an absolute necessity. It simply is not viable to opt out of owning a mobile phone (Weiner, 2007).

Cell phones have pervaded a large majority of the world’s population with the intention of connecting more people, making their lives arguably easier, and allowing for more tasks to be completed, whether for personal or for professional reasons. According to the Pew Research Center, as of January 2014, approximately 90% of all American adults own a cell phone, while 58% own a smartphone (Mobile Technology Fact Sheet, 2014). In the table below, the Pew Research Center shows the growth of cell phone ownership between 2004 and 2013 (Rainie, 2013).

**Cellphone Ownership, 2004-2013**

*Percentage of American adults who own a cell phone*

![Cellphone Ownership Graph](chart.png)

Source: Pew Research Center’s Internet & American Life Project, April 17-May 19, 2013 Tracking Survey. Interviews were conducted in English and Spanish and on landline and cell phones. Margin of error is ±2.3 percentage points based on all adults (n=2,252).
Worldwide, 63.5% of the population uses mobile phones, while 38.5% of mobile phone users account for smartphone users (Smartphone users, 2014). In research conducted by BI Intelligence, Business Insider’s subscription research service, their findings showed that by the end of 2013, global smartphone penetration had exploded from 5% of the global population in 2009, to 22% (Heggestuen, 2013). Clearly, mobile phones have penetrated the globe with a rapid trajectory and will likely continue to do so.

In a very tangible sense, mobile phones have been woven into the social fabric of daily life. For instance, the Internet and mobile technology have also evolved to become a part of everyday life in developing nations (Pew Research Global Attitudes Project, 2014). The ubiquity of this technology in developed nations and the growing presence in emerging nations has molded a societal norm. In a survey about phone use, Shari Walsh and her colleagues found that many individuals consider their cell phones to be a component of their self-concept (Walsh, White and Young, 2007). Put differently, mobile phones constitute a type of technology that many would describe as being a possession they cannot live without. A majority of teenagers in America are almost inseparable from their cell phones, mostly so they can connect with their friends through text messaging (Porath, 2011). For some, a cell phone is a privilege. But for many, a cell phone is a given. A right.

**Cell Phone Addiction**

The idea that mobile phone users have developed an addiction is not far-fetched. Any individual who has grown dependent on these devices understands the
profound impact on one’s sense of being after the device is suddenly ripped from his or her hands. In extreme cases, individuals report a feeling of separation anxiety and literally cannot seem to function without knowing exactly where the phone is. For example, in a survey conducted by Lookout (2012), 94% report being concerned about losing their phone and 74% say they panicked when they lost their phone. Another striking finding from the study is that nearly 60% said they do not go an hour without checking their phone. The Lookout infographic to the right demonstrates the spectrum of emotions experienced after losing one’s phone. Evidently, individuals have little patience or emotional composure when their handheld device is not in the palm of their hand. The statistics from this survey might not strike many as surprising. It is probably safe to assume that a majority of respondents would admit that their ability to continue on with their day is greatly compromised if they do not have constant access to their phone.

In an article about the severity of cell phone addiction in Forbes Magazine, David Greenfield, PhD, a psychologist and author of Virtual Addiction: Help for Netheads, Cyber Freaks, and Those Who Love Them, describes how “constant and continual use of untethered devices produces chemical responses in the body similar to gambling” (Tanaka and Terry-Cobo, 2008). In addition, he explains how
smart phones have a serious potential for becoming addictive in the way that checking email gives people satisfaction due to “variable ratio reinforcement,” meaning individuals do not know when they will receive a satisfying email, so they continue checking compulsively (Davis, 2012).

The youth population seems to be the most common perpetrator, as it is highly commonplace for college students, teens and kids to become absorbed in their mobile phone screens to get a fix of seamless communication and media content. Paul Atchley, professor of psychology at the University of Kansas notes, “They’re digital natives, meaning they’re really used to using technology first and foremost for communication—not as a second option” (Lynch, 2012). In one of his studies, he sought to determine if habitual use of cell phones had the potential to interfere with college students’ ability to make rational decisions, like refraining from text messaging while driving (Atchley and Warden, 2012). The premise of the study was to assess whether or not somebody would be willing to engage in “delayed discounting” for a reward. Atchley and Warden also proposed standard definitions of addictions to cell phone usage, including: tolerance (decreased value requiring more use to get the same effect), withdrawal (symptom is that individual does not have access to addiction), increased use, inability to cut back on use, reduction of competing behaviors, and engaging in the behaviors despite risks and negative consequences (Hyman, 2013). The basic finding of the study was that texting immediately was more important than extra money.

The compulsive behavior associated with cell phone use is not only unique to teens and college kids. Leslie Perlow, PhD, the Konosuke Matsushita professor of
leadership at the Harvard Business School, conducted a study on 1,600 managers and professionals (Segev, 2014). The most notable findings included:

- 70% check their smartphone within an hour of waking up
- 56% check their phone within an hour of going to sleep
- 48% check over the weekend, including on Friday and Saturday nights
- 51% check continuously during vacation
- 44% said they would experience “a great deal of anxiety” if they lost their phone and could not replace it for a week

Based on her research efforts, we begin to see that being raised in a digital environment is not the sole requirement for becoming addicted. Instead, adults are learning this behavior and quickly adopting it so as to remain in the loop at all times. But the consequences of such dependence can lead to unnatural perceptions of the environment around us.

For instance, in a *New York Times* article by Brenda Goodman (2006), she explains “Some sound experts believe that because cell phones have become a fifth limb for many, people now live in a constant state of phone vigilance, and hearing sounds that seem like a telephone’s ring can send an expectant brain into action.” She interviewed Rob Nokes, president of a sound effects company in California called Sound Dogs, who says “‘Phantom rings are a ‘psycho-acoustic phenomenon’ related to the way the human brain interprets sound. Your brain is conditioned to respond to a phone ring just as it is to a baby crying.’” Apparently, the concept of phantom vibration syndrome—perceived vibrations from a device that actually is not vibrating (Drouin, Kaiser, and Miller, 2012)—resonates with many. So much so,
that it has prompted researchers to study it. In their study among undergraduates, Drouin et al. discovered that 89% of the sample experienced the phantom sensations, and on average, they experienced them about once every two weeks. Apparently, the excessive amount of time spent with our mobile phones has caused us to fill in the voids of our lives with imaginary stimuli from our phone. It almost seems as though our senses are heightened and acutely devoted to filtering and identifying any information coming from the mobile source.

Yet another symptom of cell phone addiction is referred to as “no mobile phone phobia,” or nomophobia—the fear of being without a mobile phone (Dixit, Shukla, Bhagwat, Bindal, Goyal, Zaidi, and Shrivastava, 2010). This condition leads to anxiety levels and has the ability to recruit all of an individual’s attention to the fact that the mobile phone is missing, broken, malfunctioning, or that the battery has died. An online survey conducted in 2008 through the Post Office in the United Kingdom found that approximately 53% of mobile phone users in Britain had a tendency to experience anxiety when any of the aforementioned events occurred (Nomophobia, 2008). To demonstrate the intensity of the stress elicited, the researchers compared nomophobia to other stressful events, such as dentist visits and wedding days (D’Agata, 2008). In Lizette Borrelli’s Medical Daily article (2013), she draws on James Roberts, Ph.D., author of a study conducted at Baylor and Seton Hall Universities, who believes that cell phones have become a part of our consumer culture. As consumers, our attachment to our phones is enormous and solidifying at a high rate. This phobia even extends to times when an individual is alone in public settings and is unable to sit without reaching for his or her phone, according to Dr.
Fran Walfish, a family psychotherapist and author in Beverly Hills, California (Borrelli, 2013).

Thus far, mobile and smartphone technologies have shown signs of being quite addictive. There appears to be no end in sight, as mobile phones continue to widen their expanse and advance in ways that allow individuals to customize and grow more attached to their devices. Ronald J. Burke and Cary L. Cooper, authors of *The Long Work Hours Culture: Causes, Consequences and Choices* (2008), note “Not all drivers that text or talk on their cell phones while driving are addicted, but those who are addicted will be far more inclined to discount the risk to maintain that technology interaction or their contact with their job” (p. 265). It seems that the more mobile phones progress and become technologically advanced, the more our society regresses by developing arguably unhealthy habits of mobile phone craving and dependence.

**Automobile Evolution**

In much the same way that mobile phones have swept over nations of people, driving is a practice that represents a main method of transportation in many countries. Although humans have not grown “addicted” to automobiles with as much angst as they have with mobile phones, many rely on automobiles for reasons of both work and play. With the birth of the modern automobile in 1886, cars have become more of a standard commodity in most developed nations and are on their way to achieving the same status in developing countries (Urry, 2004). Ownership levels in the United States, specifically, have steadily risen since the automobile industry was launched in the 19th century. In the 21st century in the U.S.,
the ratio of cars to people was approximately 1:1 (Mittelstaedt, 2010). Today in the U.S. alone, vehicle ownership per capita is 769 vehicles in operation per 1000 people (Sousanis, 2011).

On a global scale, car ownership had quadrupled between 1950 and 1991, from 48 people for every car, to only 12 people per car (Lomborg, 2001). As of 2010, the amount of motor vehicles in use exceeded one billion worldwide (Sperling and Gordon, 2009). In other words, global vehicle ownership per capita was 148 vehicles in operation per 1000 people, or a ratio of 1:6.75 vehicles to people (Sousanis, 2011).

Over time, cars have evolved to cater to the various needs and desires of society, like tourism, travel, and more connectivity between rural and urban neighborhoods, to name a few (Foner and Garraty, 1991). The changes that have occurred have implications on a societal scale, but also on an individual level. David Blanke (2010), a professor of History at Texas A&M University-Corpus Christi, claims that automobiles symbolize individual freedom, mobility, and independence as a representation of modernity. He also notes “Like complex cell phones and high-speed Internet today, consumer technologies such as the automobile [free] those able to afford the gas, hotel bills, ticket prices, and especially the time needed for leisure.” This trend has since led to automobile-dependence. In many ways, a car is one of the only viable means to get anywhere in life.

**Collision Course**

The introduction of the automobile and its various benefits has also introduced an additional and rather unfortunate route to death. The freedom
associated with driving comes at quite a hefty cost. And it does not only come down to the irresponsible drivers paying the cost. Innocent motorists, passengers, pedestrians, and bystanders all become susceptible and constitute part of the fatal equation. When automobiles hit the pavement, the potentially deadly effects of collisions have no discretion.

Based on the 2012 Fatality Analysis Reporting System released by the U.S. Department of Transportation’s National Highway Traffic Safety Administration, highway deaths increased to 33,561 in 2012, which was an increase of 1,082 from 2011 (Naylor, 2013). The U.S. Transportation Secretary Anthony Fox commented on the release, asserting “‘Highway deaths claim more than 30,000 lives each year and while we’ve made substantial progress over the past 50 years, it’s clear that we have much more work to do. As we look to the future, we must focus on our efforts to tackle persistent and emerging issues that threaten the safety of motorists, cyclists and pedestrians across the nation’” (Naylor, 2013).

A separate report from the United States Census Bureau indicates that between 1990 and 2009, the rate of motor vehicle accidents decreased from 11.5 million to 10.8 million (Motor Vehicle Accidents, 2012). The amount of motor vehicle deaths between the same time interval marks a decrease from 46.8 thousand in 1990 to 35.9 thousand in 2009. Although these show decreases in vehicular accident and death rates, they also provide evidence that the rate is still considerably high in both categories. Either way, the need for continual reduction in these areas remains great. The U.S. may very well be on the right track to
substantially lessening the sheer amount of loss experienced on American roads, but the expectations will always be high.

With the evolution of the automobile, there has been a growing demand for infrastructure to accommodate the increasing amount of motor vehicles, along with higher speeds achieved by cars. As the technological advancements allow mankind to pursue faster speeds and reduce the travel time between distant locations, more roads and highway systems have been implemented. More lanes have been added and more complex traffic control devices exist to ensure safer driving conditions. But with higher speed limits, drivers are willing to push the boundaries more and more.

The U.S. Department of Transportation’s *Federal Highway Administration* conducted research on traffic speed in 1998 and concluded that the risk of having a crash increases both for vehicles traveling below the average speed, as well as for those traveling above the average speed (Stuster and Coffman, 1998). According to the 2007 Annual Report (2008) put out by the Department of Transport in Great Britain, traveling above the speed limit contributed to 5% of all casualty crashes and 14% of all fatal crashes, while speeding too fast for conditions contributed to 11% of all casualty crashes and 18% of all fatal crashes. Even though cars feature more appropriate safety affordances to help prevent and reduce the fatality rate from automobile accidents, it is evident that speeding and reckless driving continues to pose a huge threat on the roads.

Despite the efforts to minimize traffic accidents and the damage from collisions, the reality is that driving delegates freedom to drivers who too often fail
to exercise responsible behavior on the public roads and highway systems.

According to the *AlertDriving Magazine* (2011), human error accounts for 90% of road accidents. In the *National Motor Vehicle Crash Causation Survey*, researchers found that in a large proportion of the crashes under study, the reasons for the critical pre-crash events were attributed to the driver, most of which were recognition, decision, or performance errors (NHTSA, 2008). Jose Miguel, chairman of the Portuguese Society for Road Accidents Prevention, claims that a road accident is a consequence of the quality of the road transport system or a break in the balance between the environmental demand and the driver's ability to act (*AlertDriving*, 2011).

Apparently, man-made crises are not the sole root of the problem on the road. America might have distracted, aggressive, and unaware drivers, but it also has poor transportation quality. According to a report in *The Economist* (2011), America’s transportation infrastructure ranks only 23rd compared to other countries. The quality of the roads combined with more time spent on the roads due to traffic congestion calls for a deadlier transportation network (*Life in the slow lane*, 2011). Furthermore, the distractions and deficiencies on the road are exceedingly plentiful. Consider how many billboards, company logos on the side of corporate buildings, vehicles on the side of the road, accidents, road signs, and other scenic and peripheral distractions that are within plain sight while driving along most mainstream and urban roads and highway systems.

In a study released by the National Highway Traffic Safety Administration and the Virginia Tech Transportation Institute, 80% of crashes and 65% near-
crashes involved some form of driver distraction and the distraction usually occurred within three seconds before the vehicle collision (NHTSA, 2006). The study's findings also indicate that the principal actions that cause distracted driving and lead to vehicular crashes include: cell phone use, reaching for a moving object inside the vehicle, looking at an object or event outside of the vehicle, reading, and applying makeup. Since driving is a skill that requires the individual's undivided attention to safely operate the vehicle and respond to surrounding events, it involves constant and complex coordination between the individual's mind and body (Driver Distractions, 2011).

The California Department of Motor Vehicles (2011) refers to three different types of distractions that may factor into the prevention of safe driving habits: visual (eyes of the road), cognitive (mind off the road), and manual (hands off the steering wheel). Also, according to the DMV (2011), cell phone use while driving has increased so significantly within the last few years that at any typical daytime moment, as many as 10% of drivers are using either a hand-held or hands-free phone. And knowing how cell phones most often require visual, cognitive, and manual operation, it is no wonder that cell phone usage while driving is one of the most prominent distractions today.

Granted, the automotive industry has created many lasting benefits for society. But as Bob Joop Goos, chairman of the International Organization for Road Accident Prevention, points out, 1.3 million road deaths occur worldwide every year and more than 50 million people are seriously injured (AlertDriving, 2011). Thus, if
vehicular drivers do not take necessary precautions while operating mobile phones, the chance of harmful and deadly events occurring rockets dramatically.

**Driven to Distraction**

Although the underlying purpose of mobile and smartphones might be to connect people and make it simpler to manage one’s life, they also have the very serious potential to wreak havoc in some seemingly monotonous areas of life. In particular, driving appears to be on the frontline of this problem. Consider, for instance, that cell owners use their phone to send or receive text messages 81% of the time they are using them (Cell phone ownership, 2013). In addition, 74% of adult smartphone users, ages 18 and older, say they use their phone to get directions (Mobile Technology Fact Sheet, 2014). These statistics might not seem that alarming, but when one considers how frequently driving is interfered by text messages and digital directions, it becomes easier to grasp the hysteria regarding distracted driving caused by electronic and mobile devices. If a majority of phone use is dedicated to producing and responding to text messages and three quarters of smartphone users admit to utilizing their phones’ GPS capabilities, there is no doubt that driving is being intercepted by these distractions periodically and probably too frequently.

Besides distracting cell phone operation while driving, drivers are vulnerable to engaging in other activities, such as applying makeup, reading, eating, changing radio stations, reaching for objects on the floor below or behind them, tending to whining children, looking up written directions or trying to read a map, and a myriad of other distractions. All of these disturbances can be just as dangerous as
texting while driving, as it only takes a split second for a wreck to occur. But texting while driving is especially unsafe since it combines all three types of distractions—visual, manual, and cognitive (Centers for Disease Control and Prevention, 2013).

The CDC conducted a study (2013) to analyze 2011 data on distracted driving in the United States and seven European countries, including Belgium, France, Germany, the Netherlands, Portugal, Spain, and the United Kingdom. About 69% of U.S. drivers age 18-64 admit that they talked on their phone while driving within the 30 days before the survey was administered, while the percentage in Europe ranged from 21% in the United Kingdom to 59% in Portugal. For texting or emailing while driving, 31% of U.S. drivers reported that they had read or sent texts or emails while driving at least once within the 30 days before the survey took place. In Europe, this statistic varied between 15% in Spain to 31% in Portugal.

Furthermore, the CDC website dedicates a webpage to informing the public on injury prevention and control in the context of motor vehicle safety. According to the site, one of the common risk factors is that texting diverts the driver’s attention more frequently and for longer time periods than other distractions. The younger and more inexperienced drivers tend to be at increased risk because they have the highest proportion of distraction-related fatal collisions. Another interesting finding from the CDC study shows that texting while driving is linked with drinking and driving or riding with someone who has been drinking among high school students in the United States.

Texting Vs. Drunk Driving
In order to demonstrate the similarities of using a cell phone and driving under the influence of alcohol, researchers at the University of Utah sought to determine the relative impairment associated with these actions (Strayer, Drews, and Crouch, 2006). Using a driving simulator in a controlled laboratory setting, Strayer and his colleagues assigned participants to either the intoxication or cell phone conversation condition. They found that drivers who talked on a handheld or hands-free cell phone exhibited a delay in braking responses to events in the driving scenario and were more likely to get into a traffic accident. On the other hand, intoxicated drivers were more aggressive, following more closely to the vehicle in front of them and they applied more force while hitting the brakes. The key takeaway from their findings suggest that when driving conditions and the time on task were controlled for, cell phone driver impairments can be as profound as those associated with driving while intoxicated. To put the concept more into perspective, the NHTSA (2012) reports that sending and receiving a text removes the driver’s eyes from the road for an average of 4.6 seconds, which is the equivalent to driving the length of an entire football field at 55 miles per hour while blindfolded. No wonder driving has surpassed drunk driving for teenage accidents and fatalities (Texting While Driving, 2012).

Quite naturally, people have and most likely will continue to use their cell phones in inappropriate settings. For instance, students might type out a few texts during class, athletes might make a call during the middle of practice, families might play video games or check various email accounts while at the dinner table, and drivers might do any combination of these activities while on the road. There may
be fewer obvious and inherent dangers with some of these tasks, but it is behind the
wheel that media multitasking poses the greatest threat to mankind. Talking on the
phone or texting while driving has the power to remove the driver from the road in
a psychological sense. The human brain loses efficiency and drivers become more
prone to erroneous judgments when attempting to process information coming
through their mobile phones. As drivers become displaced from reality, they lose
focus and become more concerned with where their hands are, not where their
minds are. Not only are people endangering their own lives and the lives of others
by risking the chance of getting into a fatal accident, but they are also hardwiring
their brains to develop a more fixed multitasking and distracted mode of operation.
What is even more worrisome is the fact that drivers are already susceptible to the
danger of busy roads and intricate highway systems where accidents appear to be
waiting to happen.

**Distracted Driving Statistics**

Specifically within the United States, where nearly all those who drive a vehicle
also own and operate a mobile phone, there is an unprecedented amount of
automobile accidents that occur on a yearly basis that involve cellular devices.
According to the California Department of Motor Vehicles (2011), driving
performance is greatly lowered and the level of distraction increases when drivers
become heavily engaged in cell phone conversations. In addition, the use of hands-
free devices does not, in fact, lower distraction levels. Instead, the percentage of
vehicle crashes and near-crashes as a result of dialing is just about identical to the
percentage attributed to talking or listening. The Colorado family-run organization
dedicated to spreading driving safety, called Don’t Text and Drive, accumulated statistics to generate an extensive report on distracted driving. Based on the most recent trends, we begin to see how “Texting while driving is a growing trend, and a national epidemic, quickly becoming one of the world’s top killers” (Texting and Distracted, 2012). Below is a list of some of the most striking statistics that indicate how prevalent and deadly texting while driving can be.

- In 2011, at least 23% of automobile collisions involved cell phones, which roughly equates to 1.3 million crashes
- The minimal amount of time one’s attention is taken away from the road when texting while driving is 5 seconds
- Texting makes a crash up to 23 times more likely to occur
  - Dialing increases the risk of crash 2.8X
  - Talking or listening increases the risk of crash 1.3X
  - Reaching for a device increases the risk of crash 1.4X

Regarding teenaged drivers, statistics show that texting is a huge temptation:

- 13% of 18-20 year old drivers involved in car wrecks admitted to texting or talking on their mobile devices at the time of the crash
- 82% of Americans age 16-17 own cell phones
- 34% say they have texted while driving
- 52% say they have talked on a cell phone while driving

Most teenagers seem to think their behaviors are not a problem:

- 77% of young adults report being somewhat or very confident that they can text safely while driving
55% of young drivers claim it’s easy to text while they drive

But there is evidence to the contrary:

- Teens who text while driving spend about 10% of their time outside of their lane

Apparently, teens pick up these habits from adults:

- 48% of young drivers have witnessed their parents talk on a cell phone while driving
- 48% of children age 12-17 have reportedly been in a car while the driver was texting
- 15% of teen drivers have seen their parents text while driving
- 27% of adults have sent or received texts while driving

Across all age groups, distracted driving is a constant threat:

- 1 in 5 drivers of all ages admit to surfing the web while driving

Their justifications for doing so:

- Reading a text is safer than composing and sending one
- Holding the phone near the windshield creates “better visibility”
- They increase following distance
- They text only at a stop sign or red light

Another compilation of distracted driving statistics can be found on a law firm’s website, called Edgar Snyder & Associates®, where people seek legal representation after being injured in an accident caused by a driver using a cell phone. According to this law firm, “At any given time during daylight hours, 660,000 drivers in the United States use cell phones. Whether it’s texting, taking a phone call,
or sending emails, cell phone use is associated with higher rates of dangerous or fatal crashes.” Below are additional statistics that seem to further compound the thick set of data above:

- In 2012 alone, 3,328 people were killed in distraction-related crashes, while 421,000 people suffered injuries in accidents involving a distracted driver
- One-fourth of teenagers respond to at least one text message every time they drive
- Nearly half of drivers admit to answering their cell phone while driving
- Of those who answer their phones while driving, 58% continue to drive while talking on the phone
- Most respondents support laws that ban talking on cell phones, or emailing while driving

Taken at face value, these statistics call for an intervention. There is little doubt that these numbers will evoke fear as the public becomes more exposed to the facts, but is this evidence enough to incite a movement towards abstinence? Considering how addictive mobile and smart phones have become, the heavy dependence can certainly lead to very destructive outcomes while behind the wheel, where unexpected danger is already lurking in the first place. Factor in distracted drivers using their smartphones for any number of reasons, and the odds of causing or getting into an accident escalate substantially.

**Contemporary Relevance**

Multitasking while driving is highly relevant today in more ways than one. And although most people might automatically assume this topic refers to “texting
while driving” or “hands-free devices,” it actually encompasses more than just that.

Across populations of several nations, the danger of driving distractions caused by multitasking is ever-present and has a growing influence on social interactions, legal matters, technological innovation, and biological exploration. As social creatures, humans have learned to interact with others on the basis of juggling a multitude of ongoing activities and stimuli. Due to this enhanced ability to take on many tasks at once, technology is constantly shaped and invented to suit our multitasking capabilities and demands. And because these two reinforce each other, it has become necessary to implement laws to reduce and/or prevent the potentially damaging consequences associated with some multitasking actions, as well as to further explore the neurological foundation for such behavior.

Overall, the spread of cellular and smartphone technology coupled with a generation’s predisposition for distraction makes for undeniably hazardous driving conditions on the roads. More and more, the reliance on cell phones in general has grown and has seeped into the cracks of our everyday lives. Even with the recognition of this particularly worrisome issue, the government’s efforts to thwart distracted driving are seemingly futile. The costs of putting away one’s cell phone while driving far outweigh the benefits (at least immediately) and people appear to have little intention of becoming “disconnected” from their mobile devices and social circles, even if it means saving his or her own life, or someone else’s.

Haphazard driving might not be completely avoidable, but there are some measures that are worth taking, which can greatly minimize the negative effects of multitasking while driving. Thus, it is imperative for society as a whole to better
understand multitasking and its symptoms, in addition to its benefits. From there, people can begin to grasp why it is so critical to drive with few or no distractions and to closely monitor the amount of attention devoted to multimedia sources while on the road.

**What is Multitasking?**

Multitasking, or the practice of engaging in more than one activity at a time (Willingham, 2010), is a habit that many people might consider a necessary skill to survive in today’s fast-paced lifestyle. But it is a concept that is relatively novel. The term was first coined in the computer engineering industry, referring to the ability of microprocessors to take on multiple tasks at once (Rosen, 2008). The nature of computer multitasking eventually spawned the idea of human multitasking, and today, it is an apparent “talent” in which many people revel. “In modern times, hurry, bustle, and agitation have become a regular way of life for many people—so much so that we have embraced a word to describe our efforts to respond to the pressing demands on our time: multitasking” (Rosen, 2008). All too often, individuals are quick to exclaim with pride how “good” they are at multitasking. For instance, it might be one’s handy ability to write a paper while talking on the phone. It could also be someone’s uncanny ability to play Words With Friends while, at the same exact time, learn the lyrics to a new, catchy song.

The first example might be more manageable since the act of talking on the phone can be classified as an automatic action (Wallis, 2006). A person becomes habituated to talking on the phone, or to another person, to the extent that her replies are robotic and do not require much thinking. The paper, on the other hand,
demands more attention and therefore receives more thoughtful input. In the second example, playing a word game while simultaneously listening to a new song and trying to learn the words is fundamentally impossible. If the song had been one she recognized and knew by heart, the act of singing along would have been automatic, therefore allowing her to effectively play the game. But since the song is unknown, it throws off her habit of being able to sing along and forces her to actively understand the lyrics and learn them at the expense of the other task.

The theory that both of these examples support is that humans are not actually capable of performing two tasks that require deep thinking, or information processing, at the same time. As psychiatrist Edward M. Hallowell states clearly, “‘You cannot divide your attention like that. It’s a big illusion. You can shift back and forth’” (Tugend, 2008). The first example can be classified as dual-tasking, in which tasks are performed concurrently (Kim and Rieh, 2005), as in talking on the phone while driving. The dual-task interference paradigm assumes that if a task selectively interferes with a particular type of processing but not another, then the two types must be reliant on different aspects of cognition (Baddeley, 2011). Here, only one of the tasks (probably the paper) requires effortful attention since the mind can only consciously process information associated with one activity at a time. Performance of the other task (talking on the phone) simply operates in a more programmed manner, relying on mindless processing that does not detract from the more demanding task. The phone conversation just might lack any depth and be chock-full of non-substantive matter. Put differently, the performance of two tasks at once
that require the same perceptual domain causes performance to be less efficient
than when performing the tasks separately (Baddeley and Hitch, 1974).

The second aforementioned example demonstrates task-switching, in which the
individual switches back and forth between two or more tasks, “…alternating
attention and effort between tasks in a serial fashion” (Yeykelis, Cummings, and
Reeves, 2014). In order to learn the lyrics to the song, the person must pause his
game and devote all his attention to the foreign lyrics to interpret and commit them
to memory. “It takes a moment or two to mentally recalibrate to these different
circumstances” (Willingham, 2010). In general, humans are accustomed to
switching back and forth between two tasks rapidly (Wallis, 2006). However, they
are not exactly adept at doing this effectively or efficiently. With each succession or
“switch,” individuals have to pay the cost of losing their train of thought
(Multitasking: Switching costs, 2006). Even those who are able to remain on task are
plagued by the necessity to refocus and reinstate to where they were before
switching. The abrupt switching between two tasks incurs a temporal cost.

Ultimately, more time is lost with multitasking than with performing the tasks
sequentially (Raskin, 2010). To better understand this concept, the image (Samet,
2007) below shows how switching between tasks takes more time than doing one
task first, followed by the next.
Unfortunately, this usually is not a viable option for multitaskers in today’s day and age. The rings, beeps, notifications, alerts and other digital signals appear to have too strong of a magnetic pull. Even just the anticipation of a distraction can perturb a given task.

On the other hand, when individuals attempt to perform two tasks at the same exact time, evidence suggests that such a feat is psychologically impossible. Earl Miller, the Picower professor of neuroscience at the Massachusetts Institute of Technology explains that humans can do a couple of things simultaneously, as long as they are routine, but once those tasks demand more cognitive processing, the brain experiences ‘a severe bottleneck,’ causing us to really only focus on one or two items at a time (Tugend, 2008). Alternatives might be to habituate one’s brain for completing one task so that the other tasks that require thoughtful processing can be the center of attention. This is perhaps the only strategy that ensures concurrent execution of tasks without sacrificing too much brainpower. But it works only if the passive processing of one of the tasks does not become deficient. Walking while
talking on the phone exemplifies this notion, as the act of walking is so engrained and automatic that it does not distract the brain from contributing to the conversation on the phone. The figure (Salvucci, Taatgen, Borst, 2009) below further demonstrates the types of multitasking behavior that span a time scale at several orders of magnitude.

![Multitasking Continuum Diagram]

**Figure 1: The Multitasking Continuum.**

To better understand multitasking with other representative examples, imagine a busy mother today who can often be tasked with feeding a newborn baby, preparing dinner for her family, and performing other household chores, while also tending to her personal needs by gossiping on the phone with a close friend. The father, on the other hand, may find himself trying to manicure the front lawn, talking to a neighbor, checking the mail, and watching his kids play in the yard, all at the same time. In both cases, the mother and the father may attempt to process two or more types of information simultaneously. Assuming the parents are experienced and able to devote attention to the more demanding tasks, none of the kids will be harmfully neglected. Minor details might go unnoticed or be left unattended, but overall, the cost of juggling all of these activities should not be too high. That is
unless they allow one task to completely distract him or her to the point that the children’s wellbeing and care are sacrificed for the gratification derived from a less demanding task.

On the other hand, suppose a teenaged girl tries to complete a homework assignment while also watching the newest episode of her favorite show. The assignment requires a much different psychological capacity than passively watching her entertainment show, as each task follows a different logical progression (Willingham, 2010). The noise of the TV in the background will likely diminish the quality of her homework assignment since it poses as a distraction. Because television in general has many formal features meant to capture attention, the girl will be attracted to the material that is more likely to cause arousal and pique her interest.

In all the above scenarios, it is highly improbable that the multitaskers will be very successful in carrying out any of their tasks proficiently, unless they are very well trained (Stoet, O'Connor, Conner, and Laws, 2013). However, a majority of the human race experiences troubleshooting even when trying to perform the most basic of functions at the same time, if both tasks require selecting and producing action (Pashler, 1994). People are vulnerable to severe interference when attempting to perform two or more tasks simultaneously as effectively as one (Gladstones, Regan and Lee, 1989). Although neither parent can carry out all the tasks simultaneously, there is a decent chance that at least a couple can be performed concurrently. For the most part, however, they both switch between two or more tasks. This mode makes successful completion of tasks difficult because
each of the tasks follows a different set of rules and calls for different kinds of responses (Willingham, 2010). In other words, it takes time for people to mentally adjust to the circumstantial differences of each task. Perhaps the parents are capable of switching between these tasks, but the cost to speed, accuracy, and precision will likely suffer. The example of the girl probably demonstrates dual-tasking, as she attempts to engage in one task actively (homework) while processing other information passively. This method is also highly inefficient as one of the tasks takes attention away from the other, thus leading to cognitive dysfunction. The only way to successfully carry out multiple tasks at once is if the task demands can be performed without the need to simultaneously perform involved tasks (Stoet et al., 2013).

**Primal Roots in Distracted Mindset**

Even when society was not so concerned about accomplishing tasks more efficiently to gain headway in the workforce or in a social setting, humans have had a tendency to multitask. When humans roamed the Earth as cavemen, the brain was wired to be distracted. “Mothers have done it since the hunter-gatherer era—picking berries while suckling an infant, stirring the pot with one eye on the toddler” (Wallis, 2006). This neurological framework enabled people to attend to different bits of stimuli as a sort of survival mechanism. The ability to detect motion, sound, scent, and touch within one’s immediate vicinity functions like an alert system that can suddenly send someone into a state of urgency. According to Nicholas Carr, “Neuroscientists have discovered primitive ‘bottom-up mechanisms’ in our brains...” (p. 63) and that “Our fast-paced, reflexive shifts in focus were once crucial to
survival. They reduced the odds that a predator would take us by surprise or that we’d overlook a nearby source of food. For most of history, the normal path of human thought was anything but linear” (p. 64). This physiological adaptation appears to be quite simply, human nature.

Although it may have been commonplace to encounter and process distractions back then, the human brain has continued to mold itself to fit the ever-increasing digital landscape. The Internet, specifically, is perhaps the most powerful (and distracting) tool when thinking about digital media. Delving further into Carr’s stance on the distracted mindset, he elaborates on how the Internet throws out many distractions: “The distractions in our lives have been proliferating for a long time, but never has there been a medium that, like the Net, has been programmed to so widely scatter our attention and do it so insistently” (p. 113). Despite the human predisposition for fragmented attention, the overflowing load of information coming from the Internet can be overwhelming. Carr explains how sometimes our “cognitive load,” which is the flow of information into our working memory, can exceed the mind’s capacity to store and process the information (p. 125).

So, although humans have been historically apt for taking in several informational cues at once, receiving digital stimuli in such excessive amounts that overload the human brain is a process that was not previously possible or natural in a more bland, or technology-lacking, environment.

**Rewiring Circuitry**

One of the primary reasons that humans have been able to adapt to a digitally mediated world is due to the brain’s ability to make new connections and reshape
its chemical structure. This attribute is also known as plasticity. According to Nicholas Carr (2010), because of the brain’s plastic nature, neurons and synapses change as circumstances change, causing us to exercise neural circuits devoted to skimming and multitasking while neglecting those used for more mindful thinking, like reading and pensiveness. Carr also draws on UCLA professor of psychiatry, Gary Small, and his study testing the neuroplasticity of the human brain. In 2007, Small recruited participants to represent novice and experienced web surfers. Their brains were scanned while performing assigned Internet searches to indicate particular brain activity. The preliminary results showed that experienced surfers’ brain activity was more extensive than the newbies’. But part of the condition was for the novices to spend an hour a day surfing the Net. Remarkably, the new brain scans six days later revealed that the inexperienced and veteran surfers had brain activity patterns that closely resembled each other. In his book, *The Shallows* (2010), Carr inquires “If our brains are so sensitive to just an hour a day of computer exposure, what happens when we spend more time [online]?” (p. 121).

From this finding, it became evident that digital technology has an altering effect on our brain’s wiring. Overall, in Carr’s book, he notes that our use of influential technologies has strengthened some neural circuits and weakened others (p. 48), altered chemical flows in our synapses, and ultimately modified the structure of our brains (p. 49). This explains why adults are capable of picking up new technical skills after playing around with them repeatedly. In other words, generations that do not get the luxury of deep digital immersion are still able to train their brains to interact with the technology effectively. Our grandparents
might be “stuck in their ways,” but those who are patient long enough will witness improvements in their aptitude for navigating the vastly complex highways of the Internet system. With patience and practice, anyone can become a “media multitasker.”

**Media Multitasking**

Since the dawn of digital technology, it has not been uncommon for humans to attempt to use several technologies at once in order to accomplish more within a given time frame. Media multitasking refers to “…a person’s consumption of more than one item or stream of content at the same time…” (Ophir, Nass and Wagner, 2009). Anecdotal evidence suggests that “media multitasking” is a common occurrence (Foehr, 2006). In fact, many people boast about how well they can do it (Skerret, 2012). According to a Kaiser Family Foundation report (2006), 16% of the time spent using media was spent on multiple media at once in 1999, as opposed to 26% in 2005 (Rosen, 2008; Foehr, 2006).

Those who are raised or immersed in the Digital Age are notorious for engaging in such behavior, as they commonly conduct more than one activity at a time to keep up with social demands. A person’s consumption of more than one item or stream of content at the same time is undoubtedly becoming more prevalent at an accelerated rate, especially among the young (Ophir et al., 2009). And due to the early and continual exposure to computers, today’s youth is perhaps more prone to media multitasking (Foehr, 2006). “I multitask every single second I am online. At this very moment, I am watching TV, checking my email every two minutes, reading a newsgroups about who shot JFK, burning some music to a CD and writing this
message,’- 17 year old boy” (Lenhart, Rainie, and Lewis, 2001). The youth market strongly and proudly embraces their “expertise” in multitasking. “These children live and exist in a digital realm which they find as natural as the air they breathe” (Affleck, 2002). But the proclivity for multitasking is not only limited to the Net Generation-older adults have also begun to practice this skill rather religiously, as evidenced by the brain plasticity studies.

Looking specifically at concurrent multitasking, or dual-tasking, across multiple media devices, three Stanford researchers (Ophir et al., 2009) based their study on the premise that chronic media multitasking is quickly becoming ubiquitous despite posing as a substantial challenge for human cognition. They set out to answer whether or not there exist systematic differences in information processing styles between chronically heavy media multitaskers and light media multitaskers. Crucial to understanding this concept, they recognized that media multitasking is a trait, depending on the brain’s wiring. Therefore, each person’s brain map differs in accordance with the level of media multitasking—low or heavy.

To test this relationship, participants completed a self-report questionnaire about their personal media use to determine if they belonged in the low media multitasker (LMM) or heavy media multitasker (HMM) category. They then compared the subjects’ performances on measures of cognitive control. In the case of filtering tasks, participants had to indicate whether or not a red rectangle had changed orientation between its first and second exposure, while simultaneously ignoring blue rectangles referred to as “distractors.” This tested the breadth of orientation in allowing the stimuli into subjects’ working memory. The results
showed that HMM’s performance was negatively affected by distractors, while the LMM’s was not. The heavy multitaskers performed worse on a test of task-switching ability, likely due to reduced ability to filter out interference from the irrelevant task set. Based on this finding, it suggests that LMMs have the ability to successfully filter out irrelevant stimuli and that HMMs are less selective when faced with different stimuli.

In the task-switching portion, participants were presented with a number and a letter combination and were asked to classify depending on the cue presented before the stimulus (i.e. Letter: B3, Number: D7). The findings demonstrated that HMMs’ switch cost was 167 milliseconds greater than that of LMMs and that HMMs were 426 milliseconds slower to respond to switch trials. This implies that HMMs are less likely to filter external or internal information when reconfiguring tasks. In conclusion, the study found that LMMs have a greater tendency for top-down attentional control. By contrast, HMMs are more likely to respond to stimuli outside the realm of their task. Basically, the controversial finding was that chronic media multitaskers, who are traditionally thought to be better at multitasking, are actually worse.

Commenting on the studies findings, Clifford Nass explained how high-tech jugglers are "suckers for irrelevancy" (Gorlick, 2009). As a result, heavy multitaskers are more prone to making costly mistakes and missing important information. Building on that notion, associate professor of psychology, Anthony Wagner, described the heavy media multitaskers dilemma: “When they’re in situations where there are multiple sources of information coming from the external world or
emerging out of memory, they’re not able to filter out what’s not relevant to their current goal. That failure to filter means they’re slowed down by that irrelevant information’” (Gorlick, 2009). The findings here suggest that perhaps doing less and focusing more can accomplish more efficiently.

In general, people today have a tendency to overestimate their ability to multitask. This falsehood, as put forth by a group of authors of *The Multitasking Myth*, often times causes people to seriously misjudge their ability and substantially increases their vulnerability to errors (Loukopoulos, Dismukes, and Barshi, 2009). The authors are also careful to note that in reality, a person’s ability to multitask is a function of the degree to which tasks are practiced together, the degree to which each individual task requires conscious effort and attention, and the cues available to prompt recall of intended actions. If everyone seems to share this misconception in common, then society plays a pivotal role in reinforcing this belief.

*Societal Expectations*

With the diffusion of larger computing screens supporting multiple windows and browsers, chat, and SMS, and portable media coupled with social and work expectations of immediate responsiveness, media multitasking is quickly becoming ubiquitous (Ophir et al., p. 3) In the work environment, the ability to juggle multiple tasks simultaneously is a mark of distinction and often rewarded. In many respects, “…multitasking has become a workplace badge of honor that many proudly wear” (Green, 2011). In fact, the word “multitasking” has begun to appear on résumés (Rosen, 2008) in order for applicants to market their multitasking “expertise.” As multitasking capabilities become more desirable in the workplace, employees
develop a sense of urgency to try to get more work done in less time. And since all employers assume that workers have multiple email accounts, a mobile device, and other communication modalities, employees are expected to maintain an active and constant dialogue with their boss or co-workers. Physical location is no longer a boundary within companies because the digital cabling transcends it. Now, people are accessible and reachable at the touch of a button. If speedy responses or immediate follow-ups to phone calls and emails are lacking, then employers have the grounds to humiliate, demote, or fire the slackers. Nicolas Carr voiced his opinion during a talk on his book, *The Shallows*, and thinks that as we become more dependent on intellectual technology, it gets woven into the social expectation (Forum Network, 2012). But he also acknowledges the fact that if people change these habits, it could threaten their job standing or social status. On the whole, a social norm has taken root, reinforcing our dependence on technology—especially smart phones.

This problem has become magnified due to the variety of communication channels available, including the phone, email, instant messaging, and social networking sites (Bruzzese, 2011). In day-to-day activities, those unable to keep up with the various tasks of managing one’s life are generally labeled as inept or slow. Multitasking, in light of our conceptions about it, is a mandatory skill. But the building research indicates clearly how hazardous multitasking truly is. The downsides include an increased chance of making mistakes, as well as being unable to tease apart important information. In addition, multitaskers are less likely to
retain information in working memory, which can thwart problem solving and creativity (Skerret, 2012).

As technology continues to transform and advance in ways that are not quite conceivable yet, will the norm be further cemented? Currently, it seems as though the growing expanse and capabilities of technology are leading users to try to fulfill the very expectations that are rarely met. We may know how unhealthy juggling several responsibilities at once can be, but the technology available to us supports that behavior and propels a vicious cycle. Is there hope for our brains to somehow channel our focus and rewire the circuitry so as to effectively multitask? It seems like this evolutionary prospect is highly unlikely in the immediate future, but if our minds can manage the transformation, we will probably have a very large bill to pay. The key is to not allow the reliance on technology to be exacerbated with the improvements in technological capabilities, but instead control it and use it to our advantage.

**Consequences of Multitasking**

Over the course of evolution, we have learned, the human brain has transformed on the neurological circuitry level. Despite consisting of the same primitive makeup, the human brain has had a knack for taking on more than it can handle, which in turn has rewired it. Nicholas Carr commented on some recent findings regarding neuroplasticity, saying that "They tell us that the tools man has used to support or extend his nervous system—all those technologies that through history have influenced how we find, store, and interpret information, how we direct our attention and engage our sense, how we remember and how we forget—
have shaped the physical structure and workings of the human mind” (p 48). He also
notes “Every technology is an expression of human will. Through our tools, we seek
to expand our power and control over our circumstances--over nature, over time
and distance, over one another” (p. 44). Essentially, the technical tools available to
humans have had a massive influence on how the brain functions. At the root of the
multitasking inclination, it becomes apparent that the human race has evolved to
adapt to the ever-changing mediated environment. Our actions “...alter the chemical
flows in our synapses and change our brains” (p. 49) and these structures get
passed down to following generations. The neurological prowess in response to
technologies, in other words, has altered man’s habits.

Whether these changes are benevolent or downright malignant is up to the
individual evaluating this phenomenon. Of course, the multitasking mode of
operation has reaped some cognitive benefits, including visual acuity, hand-eye
coordination, and expansion of short-term memory (Forum Network, 2012). But
when one steps back and takes a look at the downfalls, it becomes evident that
society as a whole is shifting from truly social creatures in person, to socialites with
an attention deficit, inability to process on a deep level, and a lack of introspection
and contemplation. Is the tradeoff really worth it?

The building knowledge that multitasking is a learned skill begs the question
then, can multitasking in a driving environment be changed? We have already
learned how multitasking while behind the wheel is a deadly combination, but we
need to dig deeper and determine what other types of multitasking take place while
driving. Texting or talking on the phone while operating a vehicle strike many as the
most obvious examples, but seemingly mundane activities are just as costly and perilous. Any type of multitasking that detracts mental effort from all tasks is essentially grooming the brain to become more accustomed to a flurried state.

**Multitasking While Driving**

Thus far, it has been established how hazardous multitasking can be when driving large, heavy metal boxes on wheels that can achieve high speeds, are furnished with high-tech gadgets and interfaces, and are controlled by humans whom are notorious for making errors. The mixture of all these features is a recipe for disaster, and it is no wonder so many deaths result from reckless and distracted driving.

Moreover, it is not an uncommon site to see a fellow driver engaging in risky behaviors while simultaneously steering a car, changing lanes, turning into a busy intersection, stopping at a stoplight, speeding, or battling the “stop-and-go’s” of traffic jams. The Response Insurance National Driving Habits Survey showed that 76% of all drivers engaged in distracting activities while driving (James, 2000). Cranky commuters might be more interested in finding a decent radio station that will boost their mood. Perhaps a woman is late for an interview and needs to apply mascara while also weaving in and out of traffic. Maybe there is a friend in the passenger seat who keeps pointing to billboards and other sights that fascinate her. What if a parent has a screaming child in the backseat whom has just thrown his bowl of cereal to the floor? What if the driver accidentally spills his coffee mug between his feet and at the same time inadvertently turns on the windshield wipers? According to a telephone survey of 1,026 drivers conducted by the Network
of Employers for Traffic Safety (NETS), 70% of drivers routinely talk to passengers, 47% adjust controls, 29% eat or read, 26% pick something up that fell, and 19% talk on the phone (James, 2000). All of these actions are arguably distracting to the more demanding task at hand, which is driving in this case.

Though these activities are all undoubtedly distracting, the objective here is not only to determine how individuals should or can abstain from engaging in these “frivolous” activities. Rather, the purpose is to better understand how the very technologies that bestow us so much power are also endangering our life and well being, as well as those of others. As discussed thoroughly before, the technological advancements available to us are encroaching on our lives in ways that divert our attention from arguably more important tasks. If we cannot eliminate the technology that fosters these distractions, we can certainly make a concerted effort to get to the bottom of how and why various types of multitasking take place while on the road and determine a strategy to decrease their adverse impact on driving performance. Once we figure out how multitasking operates and affects cognitive performance, we can mold technology to better handle this mindset and hopefully mitigate its symptoms. First, it is necessary to analyze the similarities and differences between the kinds of multitasking and evaluate how each one influences a driver’s capabilities.

Turning now to experimental studies, there exists ample data on how multitasking, or otherwise distracting activities, affect drivers’ reactions. Even though it is not exactly ethical or realistic to put drivers on the road and ask them to text or engage in a phone conversation, there are opportunities to study this within
high-tech car simulator labs. For instance, a team of researchers from the University of Utah, Salt Lake City (Watson and Strayer, 2010) investigated the differences in performance for both single- and dual-task conditions in their study regarding extraordinary multitasking ability. After familiarizing the participants with the driving simulator, they were tasked with the driving portion of the test in which they followed an intermittently braking pace car. The experimenters measured brake reaction time and following distance from the pace car. For the cell phone condition, subjects had to perform an auditory version of the operation span (OSPAR) task, which asked them to remember a series of a few words that were scattered with math-verification problems. The driving and OSPAR task were performed as single tasks, while the dual-task condition included a concurrent performance of both tasks. On the whole, the dual-task performance was substandard to single-task performance for brake reaction time, following distance, memory OSPAR memory performance, and OSPAR math performance. However, a small portion of subjects showed no performance deficit from single to dual task, meaning the dual-task cost for these “supertaskers” was zero. Their findings suggest that an overwhelming majority of drivers suffer cognitive impairment when using a cell phone while driving, but that supertaskers—those with extraordinary multitasking abilities—do exist. Perhaps then, this issue should be looked at from more of an individual-differences perspective in order to better understand the theory of attention and performance.

Furthermore, a British nonprofit organization called the RAC Foundation conducted a study (Reed and Robbins, 2008) using a driving simulator to
understand how texting affects driving. The participants, age 17 to 24, demonstrated impaired behavior when performing concurrent text message tasks. Typing out messages posed a larger impairment than reading, and overall reaction times had a tendency to be higher when doing both of these tasks. When texting, participants were not able to maintain a constant distance behind a lead vehicle and demonstrated higher variability in lateral lane position when following it. Despite having a less detrimental impact on driver performance, reading text messages decreased reaction times and induced more variable lane positioning. In addition, drivers tended to reduce their speed when reading text messages, indicating that they recognized the impairment associated with attempting to read the text and drive at the same time. The participants realized that while engaged in a text messaging task, they demonstrated poor lane positioning, chose to decrease their speed, and maintained larger safety margins. Overall, the study found “...that the combination of increased mental workload required to write a text message, the control impairment caused by the physical act of holding the phone, and the visual impairment caused by continually shifting visual orientation between the phone display and the road ahead resulted in significantly impaired ability to maintain safe road position...” (p. 47). To no surprise, this study corroborates any previous findings or conceptions that texting while driving is detrimental to the driver’s performance in different ways.

Now, considering how common it is for cars to be equipped with GPS capabilities and a fancy digital screen that allows the driver to control several functions with one interface, it is interesting to understand how navigating the
hierarchical design of these car features can be more dangerous than simply pushing one button to turn on the radio, flicking a switch to signal a blinker, or turning a knob to start the windshield wipers. Because the hierarchical menu system requires the user to navigate through the different options, there are more steps to ultimately complete the desired task. In effect, more cognitive power gets devoted to the task of searching through the various menu options and can often times require more looking time from the driver. Without direct tactile or auditory feedback, drivers are forced to watch the screen to ensure that their actions are aligned with the desired outcome.

However, as Richard Swette (2013) and his colleagues at the Georgia Institute of Technology point out in their study, some car interfaces offer multimodal feedback and gestural input to allow drivers to perform menu navigation while also minimizing the impact on the driving task. Swette et al. suggest that driving performance increases with feedback across multiple modalities. In order to analyze the distraction level caused by four different device prototypes while performing a driving task, their study used a car simulator and simulated in-vehicle technologies (IVTs) and measured mean lane navigation performance, eye-tracking, subjective cognitive workload, and subjective preferences. The participants engaged in a driving task and concurrently used these prototypes to navigate and select within the menu. The three multimodal prototypes had an external touchpad that was separate from the infotainment display so that gesturing could be eyes-free. The serial swipe multimodal condition, in which the driver swiped the touchpad to move through menu items one at a time,
allowed for better driving performance than the direct touch system. Additionally, the other multimodal conditions enabled users to feel around a list menu to find touchpad zones that corresponded to menu items, allowing shortcuts and exploratory browsing. This approach, known as GRUV, was not as effective as the serial swipe mode and direct touch, probably due its uninterruptable and novel nature. The takeaway from this study was that minimal interaction time and visual demand lead to safer driving conditions.

Next, in a University of Michigan Transportation Research Institute study led by Paul Green (2004) regarding potential solutions to driver distractions, he explains the fundamental difference between telematics and other in-vehicle tasks. The task completion duration for devices, like headlights, windshield wipers, air conditioning, and radio, is relatively short compared to telematics devices. In other words, telematics require more involvement and attention due to having more steps than simply pushing a button. And even now, the functionality of climate control and entertainment systems requires multiple steps rather than a single button press. These secondary tasks captivate drivers until the task is completed which inevitably diminishes driving safety. Therefore, navigational menu hierarchies, despite their benefits, have serious pitfalls. Instead of having simply equipped cars, it is almost as though cars are transforming into cockpits, with an abundance of electronic controls and devices.

That brings us to the complexity of cockpit design and how it relates to driver distractions. Any seasoned traveler has probably seen the inside of a cockpit to know how incredibly wired, digital, and mechanical it is. Pilots are forced to perform
a multitude of demanding tasks in order to ensure a smooth flight, meaning they are
subject to high workload levels. In turn, pilots have no choice but to succumb to the
time-sharing of cognitive resources necessary to operate all flight controls and
effectively coordinate with air traffic control. There is no denying that despite the
disadvantages of juggling multiple tasks and the advantage of having electronic
deVICES meant to aid pilots in assessing flight information, cockpits require efficient
multitasking nonetheless. In addition to the various tasks related to operating the
plane, other external factors and distractions are constantly entering the flight deck,
causing pilots to become more vulnerable to committing errors. In order to assist
pilots with the increasing demand of flight tasks, flows and checklists serve to guide
the sequence of events and enable pilots to draw connections between tasks.

In a study run by Dr. Loukia Loukopoulos, Dr. R. Key Dismukes, and Dr.
Immanuel Barshi (2001), they evaluated concurrent task issues in the cockpit of
scheduled revenue flights. Out of the 20 observed flights, the authors found that
numerous events interrupted pilots from their prescribed duties, forcing them to
intersperse distractions and habitual practices. As a result, pilots were more likely
to continue to engage in decision-making that required recalculation actions, thus
increasing the chance of error. This condition applied to even the most practiced
operations performed by the most experienced pilots. This analysis demonstrates
that although most aircraft failures stem from human error, the mistakes
themselves are a result of distractions that meddle with the pilot’s ability to
remember what task they were performing before the distraction. The comparison
between cockpit pilots and drivers shows that the space in which pilots and drivers
operate is usually inundated with various signals, notifications, manual controls, automatic controls, and other non-related distractions. Although multitasking is necessarily performed in some circumstances in order to guarantee complete and meticulous operation, the evidence suggests that minimizing distractions is crucial to successfully and safely operating a vehicle.

Moving away from strictly technology-related multitasking, it is worth discussing the reason that merely talking to another person while driving can impair the driver’s capacity to maneuver properly. If this is true, then the idea that hands-free devices solve all the handheld woes is faulty. Because talking on the phone can be facilitated with hands-free devices or Bluetooth capabilities today, people automatically and falsely assume that the inherent dangers of using a phone fade away. However, it must be emphasized that even partaking in a conversation with a fellow passenger in the car can distract the driver. According to FocusDriven (2014), an organization advocating for cell-free driving, the area of the brain responsible for processing moving visual information has 37% less capacity to gather and process critical driving data and instead focuses on the cell phone conversation. What is important for drivers to understand is that the conversation itself, not the device, creates the dangerous situation. And in the case of a cell phone conversation, drivers may be forced to strain to hear the voice coming through the phone, or imagine the other person on the other line to better understand the context of the conversation. This just makes it harder for the driver to give driving his or her full, undivided attention.
As recently as April 2014, a National Safety Council poll found that 80% of drivers across America incorrectly assume that hands-free devices are safer than using a handheld phone (Mohn, 2014). This most certainly has to do with the absence of laws in any state banning hands-free use. And with an increasing number of dashboard infotainment systems that permit drivers to compose emails, texts, and social media updates, along with making phone calls, it is no wonder that drivers are under the impression that hands-free equals risk-free (Mohn, 2014). A growing mass of studies demonstrate that hands-free devices are actually no safer than handheld ones, because the brain remains distracted in either condition. The CEO and president of the National Safety Council, Janet Froestscher, claims that “More than 30 research studies shows that hands-free devices provide no safety benefit as the distraction to the brain remains” (Distracted drivers on road, 2014). For example, a University of Utah study (2013) demonstrated that using hands-free devices to talk, text, or send email while driving is not only risky, but as risky as using a handheld device to carry out those activities. Furthermore, Professor David Strayer claims that speech-based technologies in the car have the potential to overload the driver’s attention and consequently impair their ability to operate the vehicle safely (University of Utah, 2013). The bottom line is that focusing on a conversation alone can overtake the brain’s ability to carry out information processing related to driving.

We can gather from these experimental studies that although multitasking in general is dangerous, it is media or “telematics” multitasking that pose a greater safety hazard on the road. This is due to the fact that telematics, like cell phones or
car interfaces with a menu hierarchy, can take an order of magnitude longer to complete than conventional tasks (Green, 2004). Either way, multitasking in a conceptual sense is not an activity that should permeate operation of detailed and demanding tasks that could put people's lives in grave danger. In the context of driving, multitasking with cell phones and other electronic devices or interfaces has become beyond troublesome. Technology has saturated our lives in a manner that extends beyond disrupting basic social interactions. Instead, we have become so engrossed in implementing and utilizing technology to facilitate daily tasks that we lack the awareness of carrying out practiced or habitual tasks such as driving. Consequently, our abilities to complete these tasks while minimizing error have been greatly diminished.

In the handful of studies presented and summarized above, we can gather that the effects of multitasking in these circumstances have serious impacts on the human capacity to perform basic and complicated tasks. Although it is impractical to expect humans to quit multitasking altogether, we can all take pause to understand how to mitigate the symptoms. We might take a gamble and decide to multitask every now and again, but overestimating our ability and testing the limits can end horribly, especially when everyone else does it on busy roads where we are already prone to road rage, visual distractions, or just all-around bad drivers. It merely increases the chances of mayhem ensuing indefinitely. The more we partake in this practice and continue to design technology that reinforces this behavior, the more we as a society learn to accept it as a necessary skill for everyday survival. This topic might have enough of a solid research base to indicate that it is a serious and
growing dilemma, but until everyone recognizes that the problem merits a concerted effort to combat, multitasking will persist and manifest itself in our standards and norms of everyday life over time. This matter cannot be taken lightly and it will require action on everyone’s behalf. First, we should evaluate the legal forces that currently govern the use of mobile phone technology and other telematics while operating a vehicle.

**Legal Battleground**

The laws that pertain to multitasking are usually associated with the ban of texting or talking on a mobile phone while driving. Within the last few years, this law has expanded to various states and has taken on different forms of enforcement. There is no universal law that prohibits all cell phone use for all drivers (Distracted Driving Laws, 2014), but states and localities have taken the matter into their own hands in order to regulate distracted driving.

According to a Governors Highway Safety Association report (2014), there are 12 states that do not permit any driver to use handheld phones while driving, in addition to D.C., Puerto Rico, Guam, and the U.S. Virgin Islands. In regards to novice drivers, 37 states and D.C. ban all cell phone use. As for school bus drivers, 20 states and D.C. prohibit them from using cell phones. Believe it or not, not all 50 states have a ban on texting, despite the vast number of fatalities and accidents caused by it and the corroborative research that has been produced recently. However, 43 states, D.C., Puerto Rico, Guam, and the U.S. Virgin Islands do ban texting for all drivers. Of those, only five do not have primary enforcement, meaning that an officer cannot ticket a driver for the offense without any other violation occurring (State
Laws). Furthermore, several localities have begun to pass their own distracted driving bans, while states like Florida, Louisiana, Mississippi, Nevada, Pennsylvania, and Oklahoma do not allow localities to enact these laws.

In an assessment of texting bans’ influence on drivers, economists Rahi Abouk and Scott Adams (2013) of the University of Wisconsin-Milwaukee found that the state level texting bans have a limited effect on fatal accidents. Unfortunately, they reduce single occupant vehicle accidents by only 8%. For multiple occupant vehicle accidents, no change was observed. They concluded that the effect of legislature is short-lived because drivers simply pick up their old habits and continue previous behaviors within months of the ban going into effect. This, among other factors, is why the use of mobile phones while driving continues to be commonplace. Drivers apparently have neither the time nor the patience to obey laws that interfere with their social lives.

As the United States continues to grapple with this contentious issue, we can analyze previous cases that have continued to pop up around the country with varying outcomes. In one New Jersey court case (Moye, 2012), a driver caused an accident while replying to a text from a friend, taking out a couple on a motorcycle. The crash left the two motorcyclists without a leg each and led to a suit against the driver. The complaint also encompassed the friend who sent the text, on the grounds that she was “electronically present.” Although she did not explicitly admit to knowing that her friend was driving, she indicated that she might have had an idea. The civil case ended up holding the sender responsible since she arguably knew that the recipient was driving.
In addition, the appeals court argued that the sender should assume that the recipient will open and read a text when it is safe to do so (i.e. not driving a car). Therefore, the friend takes a foreseeable risk in sending a text during a time that the recipient is mostly likely operating a vehicle (Peters, 2013). The logic here is that the sender knowingly engages in distracting conduct and therefore, it is not unjust to hold her liable for causing the distraction. Overall, this case proved to be highly controversial. How are we expected to not only deter drivers from texting, but non-drivers from sending texts to someone he/she knows or thinks is driving? The rationale behind this decision is justifiable in some ways, but it seems that these types of cases would just be appealed to a state Supreme Court. In the meantime, perhaps it is not such a bad idea to threaten people with a possible lawsuit if they engage or initiate a texting conversation with someone who’s behind the wheel.

Can we expect the same type of law to be enforced with callers who know the person on the other end is driving? Associate Professor of Law at William & Mary Law School, Jeffrey Bellin (2013), points out that it will likely be easier to establish that the remote caller was aware that the driver was driving, and that the driver was responding to the call while on the road. Bellin also brings up a good point in regards to using texts and phone records as a way to determine the content of the conversation. Obviously, we have yet to reach the point where law enforcement can have unlimited access to people’s private conversations through texts or phone calls. But is it so unreasonable to gather this information when drivers are so careless on the road and as a result, jeopardizing the lives of others? If law enforcement personnel seize the driver’s phone, should they use the messages or
phone call record as evidence? As more cases similar to the New Jersey one emerge, it might be worth it for all mobile phone users to be wary of potentially courting a lawsuit if they willingly or knowingly text or call someone who’s driving.

As for a federal ban on the use of cell phones altogether, perhaps that action is a bit too extreme. The National Transportation Safety Board has recommended a complete ban on the use of portable electronic devices at all while driving (No call, no text, 2011). On the other hand, perhaps it would make more sense to enact a federal law that bans texting while driving. At least this brings to light that texting is a definite hazard. For example, Insurance Institute for Highway Safety spokesman Russ Rader claims, “‘When laws are strongly enforced, drivers, change their behavior…’” (Copeland, 2011). The reality is that right now, we cannot ban all cell phone use. If that were the case, we would have to ban drivers from talking to passengers in the car. Technology that prevents the use of cell phones in designated areas does not seem practical either because it poses a safety hazard, as people would not be able to make or receive emergency calls. Maybe passing legislature is not the solution. There is such a wide array of distracting activities that we would have to pass a law for each type. Clearly, that is not in the playbook. And as we have already learned from Abouk and Adams (2013), the influence of laws only lasts for a limited time span. Like Michael Masnick, president of a technology Web site called techdirt.com, points out; “‘Making the activity illegal won’t alleviate the problems [drivers’] stupidity will cause’” (Zeller, Lohr, and Smith, 2007). Humans are creatures of habit. And like Carr has expressed repeatedly, humans survive and thrive by multitasking. Because of this, people are only temporarily going to
respond and adhere to laws, but once they muster up the confidence and ignorance to strike up old habits, they are going to return to their distracted frame of mind in the car. That is not to say that laws cannot help combat the problem, but perhaps other approaches in combination with legal constraints will yield more successful results.

**New Angle**

The reason we seem to be fighting a losing battle stems from multiple sources, not just one. Even with all of the positive forces working in conjunction to thwart distracted driving, there exist some barriers to prevention and progress, not least of which is a generally unmotivated society. How, then, can we effectively motivate people to take action?

Quite frankly, the only way people are going to start taking this matter seriously and actually disengage from the dangerous behavior is if the technology morphs subtly to encourage less multitasking-prone behaviors. In other words, it will be up to car and mobile phone manufacturers to gradually introduce technology that will mold society to accept and eventually *expect* smarter technology—smarter in the sense that the technology will not reinforce multitasking mindsets, and will actively assist people in refraining from distracting activities and more properly operating cars and mobile phones. As John D. Lee (2007) notes in his research article on technology and teenage drivers, “Although technology could distract drivers and undermine safety, it also has the substantial potential to improve driving safety” (p. 209). The objective, then, is to harness the power of technology and use it to our advantage instead of allowing it degrade our driving and mental
capacities. If we can remove the technological temptations and distractions before something goes terribly awry on the road, then the possibility of telematics distractions will fade away. More specifically, the inclusion of driver support systems that tailor to the driver’s needs could have a positive impact (Lee, 2007, p. 211). This concept is grounded in research that shows how people tend to respond to technology in much the same way they would respond to a person, since technology frequently engages social and emotional responses (Nass and Brave, 2005). As long as the adjustments are not blatantly forced upon users, people will still feel as though they have freedom to make choices based on their prerogative. At the same time, the avoidance of multitasking will become secondhand nature.

We cannot sit back and expect all drivers to recognize the perils of multitasking while driving and then take the initiative to abstain from the behavior. It usually either requires people experiencing a horrific outcome of multitasking at the wheel, or knowing a family member or close friend affected by the same type of incident. For these reasons, it would be wise to gradually introduce technology that would not be wildly transformative, but rather used to grease the wheels of society. As Michael Petricone, senior vice president of government and regulatory affairs at the Consumer Electronics Association (CEA), comments, “‘It has to be done in a way that makes sense to consumers’” (Tolve, 2012). So, the optimal way to address safety threats and still meet consumer demands is to embed technical features that would facilitate safer driving and disable types of devices except in cases of emergency. For those who are well aware and proactive about putting a stop to distracted driving, this approach would certainly foster their efforts. For those who
fail to recognize this issue and the severity of it, this strategy would probably help them to change their habits and become more inclined to act in a less harmful and distracted manner, whether consciously or not. Essentially, the technique can be viewed as a counter-cultural movement of sorts, encouraging people to be more conscientious and considerate, as well as grooming the less mindful to simply accept the new movement as yet another social norm.

Briefly touched on in an aforementioned topic, it is not reasonable to stick drivers on real roads and ask them to text for the purposes of a scientific study. Not only is it unethical and illegal, it is also pointless. We already know enough about the dangers and detriments of multitasking while driving to know that we should not engage in it. Sure, experiments with high-tech car simulators in laboratory settings have the potential to generate more specific statistics, but they also have limitations since we cannot assume that participants behave the same way in a simulator as they do when actually driving. And no matter how realistic the virtual driving conditions are there are obvious disadvantages when compared to field studies. On the whole, academic research might produce research that substantiates the perspective on distracted driving, but is that really going to help the matter at this point? It might suffice to conduct studies that test and evaluate new proposed solutions and better understand how humans interact with technology. We can continue to gather statistics, and assess past studies and run new ones, as these findings will surely play a part in supporting the fight and raising awareness. But beyond that, we need more techniques in our repertoire.
Currently, many corporations and nonprofit organizations are campaigning to fight distracted driving. The more that these campaigns spread and gain more advocates, the more the general public will become aware and hopefully averse to distracted driving. But those campaigns can only take us so far. As mentioned before, automobile and mobile phone engineers carry a significant load in this quest for the elimination of distracted driving. Lawmakers play a role in this battle as well, as does every person who decides to buy a mobile phone and drive a car. But the car and phone manufacturers stand on the frontline. We have already witnessed some very advanced and clever technological developments to try to curb distracted driving, but it is evident that some very large strides still need to be made. Knowing how ineffective laws can be in changing people’s behavior, we are going to need to look further and dig deeper. The obstacles that stand in the way of winning this fight run aplenty, but the first step in solving the problem is recognizing that there is one. Since we can now confidently explain how and why multitasking has entered the driving scene, it is time to come up with a strategic plan for fighting this problem in the present and in the near future. The techniques and suggestions that follow are not exhaustive, but they deserve consideration and might serve well to implement in the future.

**Purpose:**

Before we delve into an in-depth proposal on how to resolve this large-scale issue, let us revisit the objective of this review. The case has already been made that multitasking is performed by every person and that a majority of people overrate their ability to do so. The consequences of multitasking are not limited to the driving
scene, but extend into our daily lives, engendering long-lasting and more permanent roadblocks to overcoming the distracted circuitry. Considering what we know and understand about multitasking behavior and how the mindset persists without active reversal, a protocol needs to be established in order to undo the mental degradation and prevent further damage. More specifically, it is critical to develop a plan and harness the dynamic power of multiple forces.

While continuing to inform the public and calling on car and mobile phone designers to craft technology that decelerates multitasking tendencies, we can also educate the general public to implement mental training strategies and to properly and appropriately use technology. The ultimate goal is to raise awareness and figure out how to encourage people to adopt these techniques. Creating solutions is only part of the equation. We need to ensure that people are driven to put these techniques into practice to the point where it becomes instinctual and standardized. The following proposal might pertain strictly to multitasking while driving, but it is safe to assume that the techniques offered here could be employed by anyone who struggles to bypass the overwhelming mental activity known as multitasking. For now, the focus will be on how to curb multitasking behind the wheel and what this feat entails. Ultimately, the consequences of multitasking while driving can be reversed with cognitive interventions, the proper training and use of technology, and the innovation of technical features for both automobiles and mobile phones specifically geared towards preventing driving distractions via technology. In addition, law and educational campaigns will provide supplemental aid in the fight against multitasking while driving.
**Proposed Solutions:**

**Situational Awareness Training:**

On behalf of all drivers, applying situational awareness while taking on the busy roads where distractions fly left and right should be in high demand. Situational awareness represents the complete opposite of multitasking, which we already know is the practice of performing several unrelated tasks at once. Instead, situational awareness sits on the other side of the spectrum, referring to how we operate in a complex environment. It contains three main components: the perception of environmental elements, the comprehension of their meaning, and the projection of their status after an intervention” (Schulz, Endsley, Kochs, Gelb, and Wagner, 2013). Knowing how crucial attention is during driving, especially when drivers attempt to multitask, these components can be used to measure a driver’s situational awareness and ultimately gauge how fit they are for particular driving conditions.

In an extensive article written by Leo Gugerty (in press) from the Clemson University Department of Psychology, he defines situational awareness in great detail and explains how it pertains to driving. According to Gugerty, situational awareness is the “…meaningful knowledge of an unpredictably-changing, multifaceted situation that operators use to guide choice and action when performing a real-time, multitasking task” (p. 2). He further explains that maintaining this awareness is contingent upon an individual’s processes of focal vision, including attention allocation within tasks, event comprehension, and task management across concurrent tasks, as well as ambient vision processes, including
attention capture by sudden peripheral events (p. 2). To better encapsulate the concept of multitasking while driving, Gugerty notes that driving, aside from unrelated tasks, involves multitasking at a base level since it requires simultaneous performance of at least three distinct subtasks: vehicle control, monitoring and hazard avoidance, and navigation (p. 9). In the event of a multiple-task situation, it is also worth noting that tasks have varying degrees of priority that are subject to change over time. Regarding event comprehension, Gugerty found that driver’s comprehension capacity improves with experience, training, and the accumulation of driving knowledge, and that it degrades by multitasking (p. 15-16). Despite the drawbacks that multitasking bring to the table, there is hope that the detrimental impact can be reversed with practice. Gugerty concedes that past studies show how people can actually improve their multitasking performance after training in task management (p. 16). While this finding seems valid, we should consider what we learned from Professor Clifford Nass—that those who multitask more often are actually worse at doing it.

Turning to another study, Gugerty et al. (2004) demonstrated that drivers could recognize when one task was more difficult than another and would thus allocate less attention to the more difficult task so as to minimize the negative impact on the more important driving task. Maybe it is not wildly unreasonable to expect that drivers have the ability to become more accustomed to managing several tasks. Nonetheless, the findings do acknowledge that task management during driving is very limited due to the degrading effects it still has on safe driving. More or less, Gugerty’s research suggests that situational awareness can be trained and improved
with driving experience. Although some previous research supports the idea that multitasking can be improved, it might be safer to focus on improving situational awareness. After all, the facets of situational awareness appear to correlate positively with safe driving.

To support the idea that mental training strategies can be employed to retrain people’s minds, let us turn to a review of training for situation awareness (SA) within the aviation domain. Mica R. Endsley of SA Technologies and Michelle M. Robertson of the Liberty Mutual Research Center (2000) paired up to analyze training techniques to improve SA for aviators, but the findings are also applicable to individuals of various backgrounds and professions. By evaluating their discoveries, it seems rational to transfer what they know about SA while in flight to everyday drivers on the ground. Their evidence shows that through extensive and thorough training, pilots are capable of improving levels of SA and in turn, reducing the amount of accidents. Even though they recognize that trial and error are part of the learning process, it is highly plausible that training programs can enhance fundamental cognitive skills necessary for safe driving.

Furthermore, in an analysis of multitasking behavior it was stated that “Driving a car is extremely complex and unpredictable; the higher level cognitive components maintain situation awareness, determine strategies for navigation, decide when to initiate and terminate maneuvers, and manage lower level cognitive components such as changing radio stations, conversations, and eating and drinking” (Spink, Cole, and Waller, 2009). This claim alludes to the need for drivers to prioritize tasks and manage attention according to the nature of the driving conditions. The
realization that safe driving can be attained only when drivers are fully aware of their surroundings rests on some rather fundamental theories of situation awareness. For instance, a group of authors from Chemnitz University of Technology, Institute of Psychology, describe how safe driving is achieved when “drivers perceive the relevant objects of a situation, comprehend the meaning of these objects to form a holistic understanding of the current situation, and predict the future development of the situation” (Baumann, Rosler, and Krems, 2007). But when a mobile phone or some other type of secondary task emerges on the scene, the driver's situation awareness quickly becomes impaired, because they impose significant load on visual attention and working memory. In order to study this relationship, they conducted two experimental studies to test the effects of in-vehicle tasks on situation awareness—the first evaluated the visual and cognitive demands of in-car tasks, while the second evaluated the effect of the same tasks on drivers’ situation awareness in a driving simulator. The results of their study indicate that both cognitively and visually demanding tasks prevent people from maintaining accurate situation awareness.

As we have learned, situation awareness is critical to the maintenance of safety and control on the road. While it may be a long shot to persuade every driver to practice their situational awareness on a regular basis, it is worth encouraging people to practice it in other domains of life. The more that people train in a variety of circumstances, the more instinctive and intuitive it becomes while driving. We cannot expect drivers to take it upon themselves to enroll in training course for situational awareness, and we certainly cannot expect everyone to actively practice
this habit every time they put their foot to the pedal. Just as equally, we cannot force every driver to honestly hone his or her situational awareness skills. The reason pilots have to go through extensive training courses is because aviation has higher standards and the stakes are higher if something goes wrong. Drivers, however, have more individual freedom and do not have as many responsibilities or controls to monitor. Nevertheless, we can still put a greater emphasis on preparing our drivers for the roads through situational awareness training. If our brains are plastic and constantly molding to become more distracted, there is no reason we cannot reverse that wiring to support more alert cognition.

**Proper Use of Technology**

In addition to improving our abilities to assess situations and heighten awareness, we can also encourage drivers to do something that might seem so obvious and straightforward that it probably would not be taken seriously. Being totally immersed in the digital era, there is a common delusion that digital natives all know how technology works. On the surface, this assumption holds true for the most part, as most probably know how to sign onto a computer and surf the Net, or call someone on a mobile telephone, or play a video game, or input an address into a GPS. A fair amount of people also “knows” how to drive a car. But being able to engage in any of these activities does not necessarily mean that we all are properly or appropriately operating the technology that we have at our disposal. Not to mention, who takes the time to read through an entire manual to ensure safe and proper operation?
Dr. Leon James (2000), psychology professor at the University of Hawai‘i, has compiled various reports and has generated articles and analyses on his own website dedicated to educating people on distracted driving. While most of what we have learned in regards to multitasking points to driver inattention, Dr. James believes that multitasking is the result of a lack of proper training with new car gadgets. He proposes a system that updates information electronically on either drivers’ permits or licenses, indicating their level of skill with certain technological devices. The idea behind this is that drivers will be able to use smartphones and GPS devices competently. He also argues that any form of multitasking, especially with communication devices, is a form of aggressive driving since drivers are willfully imposing their own level of risk upon others. Therefore, the need for drivers to train themselves is his main point of emphasis, claiming that drivers should practice operating the equipment until they have mastered it. Of course, his opinion on the matter seems to bestow too much trust in the hands of drivers, as he expresses how dire it is for drivers to voluntarily train themselves. His reasoning is valid, but can we really trust all drivers to willingly go the lengths to practice using all technologies before using them in a driving scene? It is probably safe to assume that most humans do not possess this level of patience and will not agree to train religiously for the sake of better driving. But if we want to circumvent government regulations and restrictions that seem to infringe upon our everyday freedoms, then Dr. James hits the nail on the head—drivers have to acknowledge that personal and voluntary training is the only option.
After analyzing some of the ways that drivers can attain higher levels of situation awareness and engage in proper use of technology, it begs the question: Can we separate driving mode from everyday life mode? Are drivers able to turn on the switch to pay more attention to their surroundings while in the car but then revert to the distracted mindset that prevails in the workplace? Realistically, it appears that our proclivity for multitasking will win over since we cannot afford to sacrifice this “extraordinary” ability in other areas of life. But just as we can groom our brains to become more hardwired for multitasking, we should be able to groom our brains to become more focused and attentive. The transition from a brain with haywire circuitry to a state of concentration will not and cannot change over night. As Nicholas Carr explains, the most profound shifts happen slowly (Forum Network, 2012). The more we allow ourselves to become dependent on intellectual technology, the more it weaves itself into the social expectation. Carr realizes that changing these habits could threaten our job or social reputations, but if we truly value the more attentive modes of thought, we really have no other choice than to put that thinking into practice. Maybe sheer disposal of multitasking skills is not necessary, but seeking a healthy balance is undoubtedly in order.

**Friendly Reminders and Incentive:**

On top of self-training activities to change the mental approach to driving, drivers can join social media or online movements, like the “Red Thumb Reminder,” which encourage people to do seemingly small tasks that help them and others to remember not to engage in dangerous multitasking activities while driving. The “Red Thumb Reminder” was introduced on a YouTube video by Steve Babcock who
Rich 68

claims that he got his idea from his daughter who would tie yarn to her finger to remember something for school (The Story). So, he took it upon himself to start painting his thumbnails with red nail polish so that any time he reached for his phone to start texting, he would immediately notice the “red thumbs” and be reminded to put the phone down. Other similar ideas have caught on with a portion of the driving population, including “Thumb Wars,” which is also a campaign meant to remind friends not to text while driving (Thumb Wars). Much like “Red Thumb Reminder,” this movement uses “Thumb Socks” that drivers can wear on their thumbs to deter them from texting. The accessories even have a clever phrase on the socks: “Thumb Wars.”

Perhaps having everyone paint their thumbnails red or wearing thumb socks is a bit of a stretch, but for those who are willing to actually do so, they are contributing to a greater cause that at least spreads awareness. So, even if every single driver does not jump on this bandwagon, the strong online presence of the movement can ignite social change and work towards making distracted driving a much less-practiced activity than multitasking. The mass following and organization of these movements carry a great deal of weight and can play pivotal roles in raising more awareness, as well as unweaving multitasking from the social expectation. The more that people are exposed, the more clear the message becomes. Distracted driving will soon go out of fashion and people will begin to have high expectations not only for others, but for themselves. Or so that is the ideal scenario.

Both of these movements have spurred thousands of people to take part in powerful and meaningful ways. The campaigns contain other online elements that
allow drivers of all ages to get involved and come up with new ideas to discourage distracted driving. There is a multitude of organizations dedicated to promoting safer driving, and most of these websites offer the opportunity for people to become advocates, become more informed, take pledges, and even submit project or video ideas to help spread the word. The various methods of contribution supply incentive for individuals to join the force and motivate others as well.

Although it is difficult to measure the direct outcome of these initiatives and determine whether supporters are actually practicing safe driving habits, the cause should leave a large mark on society and have the potential to reinforce the idea that texting, or multitasking, is dangerous and unacceptable while driving. For instance, the NHTSA found that handheld cellphone use and texting while driving dropped in Syracuse, New York, and Hartford, Connecticut during four periods of heightened enforcement combined with media campaigns (Copeland, 2011). Their findings suggest that the high-visibility enforcement model coupled with education campaigns lead to significant decreases in handheld cellphone use. Keeping in mind that even though strong laws’ influence fades out, we still see signs of success from these crackdowns and educational campaigns. Even if drivers have temporary lapses in judgment at the wheel, the message that has been ingrained in their memory has the potential to overtake a mental slip and at least reduce the frequency of multitasking occurrences.

Overall, movements such as these play a crucial role in entwining new expectations into the social fabric that so often govern our daily behaviors. As Petricone puts it, social conventions change with education and take time to catch
up with the new technologies (Tolve, 2012). In order to sustain this transformation, it will also be necessary to implement “smarter” technology. That is, technology that helps people to avoid the multitasking dimension of the mind. At the same time, technology that hurts and exacerbates the problem will need to be filtered out and modified.

**In-Car Telematics Design**

As explained earlier, automobile manufacturers and telematics engineers need to take accountability for the technological design of in-car electronics. There is an ongoing debate whether in-car technologies are a source of distraction or a defense against it. For instance, the NHTSA proposed a set of guidelines arguing that in-car electronics pose a basic threat to driver safety but that safety threats can be mitigated or eliminated if carmakers limit or deactivate certain functions when a vehicle is in motion (Tolve, 2012). On the other hand, the NTSB made the argument that all portable electronic devices are hazardous in a car and must be disabled altogether when the vehicle is moving besides for emergency use (Tolve, 2012). This proposition would in effect prohibit all mobile phone use as well as prevent all other embedded telematics that utilize mobile or smartphones. However, this type of blanket ban would not work unless all other forms of multitasking and distractions were also banned. In the CEA’s official response to this recommendation, Petricone claimed, “‘Distracted driving is the problem, not the device’” (Tolve, 2012). Not to mention, a ban of this degree would also prohibit the technologies that actually improve safety. Instead, it would be far more beneficial to enable connectivity within the vehicle so long as they follow limitations set by automakers and
government regulators. This would ensure user satisfaction because the social and consumer demands would still be met within safe parameters.

In some cases today, technologies that attempt to make driving safer have unintended consequences. According to research generated by the University of Utah (2013), Professor David Strayer stresses the importance of reducing the reliance on and fascination with voice-activated technologies, claiming that speech-based technologies have a tendency to overload drivers' attention and compromise their driving skills. Just because cars now offer ways to stay connected and communicate without removing drivers' hands from the steering wheel and eyes from the road does not necessarily mean it is harmless to do so. In a more recent research study, the American Automobile Association (AAA) discovered that mental distractions exist even when drivers have a hold of the wheel and are watching the road (Univ. of Utah, 2013). Their findings demonstrate that as mental workload and distractions increase, reaction time decreases, cognitive function becomes impaired, and drivers scan the road less often and miss cues, sometimes causing them to completely fail to see pedestrians or traffic signs.

As in-car technologies continue to proliferate, there is a growing need to consider limiting the distractions built into cars. In response, Strayer and his colleagues conducted research and ultimately concluded that hands-free, voice-activated technical features led to tunnel vision and inattention blindness. The AAA, as a result, urges automotive and electronics industries to help thwart this problem by restricting the use of voice-activated technology to core driving-related activities like windshield wipers, cruise control, and climate control and making sure that
these features do not cause mental distractions and lead to increased safety risk. The AAA also strongly advises that certain functionalities of voice-to-text technologies be disabled, especially social media, e-mail, and text messaging options, so that drivers cannot access them while driving.

Judging by the trajectory of the automobile and telematics industries, it would be wise to tailor the design of in-car technologies to fit the needs and deficiencies of the expected user population (Green, 2004). Therefore, vehicle telematics need to suit the wide array of physical and intellectual capabilities of drivers. Paul Green (2004), from the University of Michigan, proposes a workload manager to control the use of telematics while the car is being driven. It is divided into four categories including: the driving situation, driver input, vehicle performance and response, and driver state. The combination of these measures would quantify human performance and determine how distracted or overloaded a driver is. Based on these calculations, the system would alter the availability of telematics and the operation of warning systems in order to prevent further distraction that serves little or no purpose for the driver. Examples of this kind of architecture include the 2003 Saab 9-3 and 9-5 which contain a “dialog manager” that presents non-safety critical messages to the driver depending on speed, windshield wiper movement, and other data feedback (Green, 2004). Moreover, the Volvo S40 and V40 inhibit phone calls when drivers are maneuvering their cars to merge lanes or turn since these situations are where drivers should focus on the primary task of driving (Green, 2004). The measurement of this sensory information
has the potential to generate safer conditions and reduce the chances of telematics-induced collisions.

**Autonomous Cars**

Perhaps resorting to self-driven cars is where the automobile industry is headed. A project started by Google, autonomous cars remove the task of driving from humans and use intricate technology to enable cars to essentially become driverless. In this case, drivers do not have to worry about the consequences of taking their eyes of the road, answering a phone call, inputting GPS information, navigating a menu hierarchy, or any other potentially distracting task. Now, the car exercises control over all basic and advanced performance tasks. The car utilizes lasers, radars, and cameras in order to construct a three-dimensional image of the surrounding world and then uses that data to make informed driving decisions (McCracken, 2014). Despite the gadgets located on the car’s exterior, the inside emulates most normal cars by today’s standards. During driving sessions, the Google car has at least two humans present—a driver and a co-driver. The driver has a small display positioned in front of him that shows what the car’s vision captures, indicates color-coded vehicles, pedestrians, cyclists, and other objects within its vicinity. The co-driver has access to more detailed data on a laptop and monitors the journey. Since its inception, Google self-driving cars have driven over 700,000 miles without causing an accident (McCracken, 2014). Besides a few incidents that have happened as a result of human error, these autonomous cars have a cleaner track record than most human drivers of our day and age.
The reason that Google autonomous cars are so successful and safe is partly because they are programmed to error on the side of caution (McCracken, 2014). As opposed to humans who have a strong inclination to push their boundaries and overestimate their skill, driverless cars operate under a much more logical and mechanical apparatus. In a scenario like this, drivers will have the opportunity to take control of the wheel if the situation calls for human intervention. By leaving the car to operate in a programmed manner though, drivers are now allowed to get away with performing distracting tasks that would otherwise endanger the driver and anyone in his or her path if a human drove the car. But, as we have already learned, the driver and co-driver still have to pay attention to the autonomous car’s operation. Of course, humans are still responsible for taking control of the vehicle if the self-driving application is compromised or dysfunctional. Complete neglect surely isn’t an option currently, but perhaps the future of autonomous vehicles is headed in that direction.

The reality is that multitasking behavior does not show clear signs of abating (Gritzinger, 2014). All it takes is for any driver to take notice of surrounding motorists while stuck in traffic. Most drivers have their handheld electronic devices in hand, in spite of laws and regulations. If drivers are not willing to sacrifice social connections, workplace reputation, or any of the distractions that we flood our brains with daily, why not shift to driverless cars that make the roads much safer? Driver intervention and interaction with the driverless car will still need to be part of the equation for quite some time (Gritzinger, 2014), but at least multitasking will not carry as many repercussions. The handoff of control from humans to computers
might seem ridiculous and outrageous, but we can look at it as technology that empowers and enables human drivers, while simultaneously disabling them from harmful behaviors. Conversely, humans still have the authority and freedom to override self-driving cars if necessary.

**Mobile Phone Technology**

Aside from in-car technologies, drivers can eliminate the strongest temptation to multitask by using special applications created exclusively to prohibit users from using their mobile or smart phones. Today, there are several different applications available to smart phone users including Textecution, tXtBlocker, AT&T DriveMode, Quiet Zone, Drive First, DriveSafe.ly, iZUP, CellSafety, and Otter, all of which stop drivers from texting and calling while driving. By downloading any of these, drivers’ actions through the phone are severely limited and can help to reduce the frequency of multitasking while driving. Essentially, we can fight technology with technology.

To support this technological breakthrough, Apple proposed a new technology that would detect when a user is driving while using onboard sensors and would block the use of smartphone functions from the driver (Gibbs, 2014). This iPhone automatic lock-out system would provide a huge leap in the movement to prevent media multitasking while driving and could prove to be very instrumental in changing the culture of our society. If Apple’s patent plays out, it could also be integrated with its CarPlay system, which integrates iPhones with car’s entertainment and communication features (Gibbs, 2014). This software would prevent the driver from using the smartphone except through the car’s voice-
activation system. Since a growing number of people are becoming Apple product users, it is not be out of the ordinary to expect that a majority of the population would hook up to this interface and use the disabling capabilities to avoid multitasking to some extent. This technology could gradually grow to become accessible to most drivers and iPhone users, and could eventually lead to large-scale social change. In other words, a large chunk of society would be forced to operate within the confines of this technology, which would reinforce the belief that multitasking is detrimental and dangerous.

Some applications, like Drive First and FleetSafer, go even further by notifying people who try to contact the driver that he or she is unavailable. On top of disabling the phone’s functionality when a driving situation is detected, these applications redirect calls to voice mail and automatically reply to incoming texts and emails to alert message senders that the driver is currently unavailable (Lyden, 2011). This feature helps to not only discourage the driver from mobile phone use, but also those trying to get into contact with the driver. Ideally, this would bolster the initiative to generate social change without doing so in a forceful manner. It merely works to break down the popular theory that multitasking is acceptable or a mark of distinction.

Yet another proposed invention would serve as a restriction method to prevent and limit text messaging of drivers based on the speed of the car. Put forth by Harry Benjamin Correale and Clifford Kraft (2009), this apparatus would detect the speed at which the cell phone was moving and if it surpassed a predetermined speed, it would automatically lock out the texting function. In order to ensure that
the driver does not override the code meant to lock him out, the application would require several buttons to be simultaneously depressed, meaning two hands would be necessary to perform this function. Therefore, only passengers would be able to enable the texting feature while the car is in motion. This type of invention works much like the modern application, Textecution, and employs GPS capabilities to track the speed of the car to disable the texting feature. Again, technology like this could be revolutionary if implemented across all mobile phones.

Drivers can also do something so simple, but that takes a great deal of self-restraint—turn off the mobile device completely. Just like the head of motoring policy for the Automobile Association, Paul Watters, explains “There is no greater safety system than simply turning off the phone while driving” (Gibbs, 2014). If that is not an option, then the driver can put it into silent mode, and then stow it in a place that’s out of sight and out of reach. If the driver needs to keep the phone on for directions, communication, or some other valid reason and has passengers in his car, he should designate someone to operate the phone so that he does not become distracted. These are more basic steps that drivers can take, but they represent very viable options. So, although Apple and other companies may introduce technology that further facilitates the management of people’s social lives or operation of in-vehicle tasks, it is still a safer route to avoid using telematics and mobile devices altogether. Technology that “helps” can be useful in some contexts, but there is a vast amount of technologies that “hurt” and further complicate the multitasking issue. The key, though, is to do everything within our power to mitigate the
symptoms of multitasking and promote safer practices so that non-multitasking behavior becomes the norm.

**Conclusion:**

After investigating the foundation of the multitasking mindset that so many people struggle to handle, it is clear that our brains have a natural attraction to distractions. This is particularly worrisome when people seem to lack self-control when driving and allow the cognitive resources necessary for safe operation to be depleted. Multitasking is not always a detrimental activity, but when it causes drivers to lose the ability to exercise quick and appropriate judgment while behind the wheel, it represents a very precarious obstacle. The human mind is a fragile reservoir of capabilities. By burdening it with several unrelated and non-integrative tasks, individuals suffer consequences that can lead to impaired cognition and inattention blindness. And because of society’s acceptance and expectation of the multitasking ability, technology further reinforces the norm.

In order to combat the ubiquity of this issue, the proposed solutions offered earlier should be implemented in a timely manner. It comes down to drivers, mobile phone users, automobile manufacturers, mobile phone engineers, government, and everyone else taking the matter seriously and actively working to eliminate multitasking from the driving scene. Social change cannot be achieved unless a counter-cultural movement inherits enough of a following to initiate progress. As mentioned earlier, the transformation of technology can only occur with gradual strides so that individuals do not feel as though they are being coerced against their will. So long as the improvements and modifications of technologies, such as,
telematics and mobile telephony, are subtly introduced across the global population, societal expectations will begin to morph in favor of a less distracted mindset. What people need to realize, as well, is that our mentality can change now. Perhaps multitasking cannot be circumvented at all costs, but all we have to do is make a choice. We need to attain a healthy balance; otherwise, our plastic brains will continue to solidify the distracted circuitry that plagues us constantly.

Overall, individuals need to take responsibility and make a concerted effort to abstain from multitasking while driving. Law enforcement needs to continue to patrol our roads and highway systems to deter and prevent drivers from engaging in such activities. Car manufacturers and mobile phone designers are game-changers, for they hold the tools necessary to organize a large-scale technological revolution. But with that, they will need to determine which technologies help the cause and which ones hurt. Like Albert Einstein once said “I fear the day that technology will surpass our human interaction. The world will have a generation of idiots.” In some cases, technology is not the answer. Sometimes, simply engaging the human brain will solve the problem. There is no cure-all solution, but by drawing on a variety of domains, multitasking while driving can eventually be eradicated, or at least substantially reduced.
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