2016

Who Will Be the First to Buy Autonomous Vehicles? An Application of Everett Rogers' Diffusion of Innovations Theory

Reilly Jackson Umberger
Claremont McKenna College

Claremont McKenna College

Who Will Be the First to Buy Autonomous Vehicles? An Application of Everett Rogers' Diffusion of Innovations Theory

Submitted to

Professor Craig Bowman
And
Dean Peter Uvin
By

R. Jackson Umberger

For

Senior Thesis
Fall 2015
November 30, 2015

Who Will Be the First to Buy Autonomous Vehicles? An Application of Everett Rogers' Diffusion of Innovations Theory

R. Jackson Umberger

Claremont McKenna College

Table of Contents

Abstract

Autonomous, otherwise known as self-driving, vehicles represent the future of transportation. Vehicles that drive themselves offer far reaching benefits from increased leisure and productivity for individuals to significant improvements in congestion and infrastructure for governments. The autonomous car will radically change the way we look at transportation, and they are right around the corner. However, the question remains: are we ready? Are we, as a society, ready to hand over the steering the wheel and trust autonomous vehicles with our safety? This paper predicts how the autonomous car will spread through society by analyzing and applying the product qualities and consumer types described in Everett Rogers' Diffusion of Innovations Theory. Corporations, specifically Uber and Amazon, as opposed to individual consumers, will be the first to adapt, purchase and implement autonomous vehicles. Contrary to popular belief, these vehicles will not be successfully introduced as privately owned vehicles, and therefore, must be marketed towards corporations and organizations.

Keywords: autonomous, self-driving, diffusion of innovations, innovation, product qualities, consumer types, transportation

Introduction

In the first section of this analysis we will examine Everett Rogers' Diffusion of Innovations theory, its relevance and applications. Despite being written in 1962, Rogers' book, *Diffusion of Innovations,* is still the backbone of marketing and advertising strategies today. His analysis of both consumer and product types laid the foundation for predicting an innovation's ability to go from a new product to a widespread phenomenon. To understand why Rogers' principles still hold true, we must first understand his theory.

The Diffusions of Innovations theory was developed to answer one essential question: how do new technologies spread across cultures and gain popularity? Rogers identified this gain in popularity as the adoption of the specific innovation by society. What Rogers was particularly interested in was discovering what factors influenced the rate of adoption. In other words, what qualities of both the innovation and the potential adopters determine a product's ability to penetrate major markets?

The second section of this analysis will apply Rogers' theory to autonomous cars. The diffusion of innovations theory will be used to predict how quickly autonomous cars will spread through the market, as well as attempt to predict which types of consumers will be the first to purchase autonomous vehicles. An autonomous vehicle is self-driving, meaning it is capable of all operations conducted by a manually driven car without any human input. Autonomous vehicles are predicted to represent a $42 billion market by 2025 and will initiate major transformations that extend to industries beyond automotive (BCG, 2015). The applications and benefits are boundless, yet safety concerns and psychological fears of giving up control may hamper the autonomous vehicle's ability to infiltrate the market. This section addresses these concerns and provides a prediction of who will buy and how quickly autonomous vehicles will diffuse throughout the market, if at all.

Part I: Analyzing Rogers' Diffusion of Innovations Theory

What qualities of an innovation affect the rate at which it is adopted?

Through Rogers' research and experimentation done by others, five essential product qualities have been found to directly affect an innovation's rate of adoption; relative advantage, compatibility, complexity, trialability, and observability.

The relative advantage of an innovation is "the degree to which an innovation is perceived as being better than the idea that it supersedes" (Rogers, 1983). While this idea of "being better" than a previous innovation seems vague, Rogers clarified by dividing relative advantage into two main subsections; economic profitability and social status giving.

Economic profitability relates to the innovation's ability to generate returns that exceed its cost. This obviously is a major factor in predicting the adoption of innovation, particularly if the returns are high and the price is low. The level of economic profitability of an innovation can change drastically over time. Rogers offers the example of the pocket calculator. In 1972 the calculator was priced around $250. For many, this onetime cost outweighed the economic benefits of this calculator, such as saved time and increased efficiency, and therefore, the calculator faced a slow adoption rate. However, in 1976, due to increased manufacturing efficiency and new technology, the price of the calculator was reduced to $10. The calculator was then seen as more economically profitable, leading to a much faster rate of adoption (Rogers, 1983). In recent years, economic profitability has become a major focus in the automotive industry. Since electric cars were reintroduced to the world in the late 1990's and early 2000's consumers have been calculating the number of years required before the electric vehicle actually saves them money. One researcher compared the Ford Focus Electric and the Ford Focus ST, and found that after the 4th year of ownership the Focus Electric's total costs (initial price, fuel, maintenance, etc.) become $800 cheaper than those of the Focus ST (Shrink That Footprint, 2015). While the sales of the Focus ST dominate those of the Focus Electric, Focus Electric sales are increasing and so is the popularity of electric vehicles. Overall, as technology allows electric cars to be more efficient, we can expect to see an increase in their economic profitability and, therefore, their rate of adoption.

Although economic profitability is an important aspect of an innovation's relative advantage, the potential social status increase is equally relevant. The social status increase of an innovation refers to the motivation of an individual to adopt an innovation based on the social prestige associated with owning it. Automobiles perfectly demonstrate this phenomenon. Luxury brands such as Porsche and BMW are hardly ever the most economically profitable option, however, to many people they have a relative advantage over other brands due to the status associated with them. People who drive these cars are seen as wealthy, respected individuals, and because of the social status increase that comes with ownership, these brands have been adopted across the world. This is also true of electric cars, which create an eco-friendly status for the owner. People who want to be seen as environmentally friendly will purchase an electric vehicle and obtain that social status. Innovations that directly or indirectly increase the social status of the adopter will have a higher relative advantage and faster adoption rate than innovations that do not.

It is clear that the perceived relative advantage of an innovation is positively related to its rate of adoption, and the same is true for Rogers' second characteristic; compatibility.

The compatibility of an innovation is "the degree to which [it] is perceived as consistent with the existing values, past experiences, and needs of potential adopters" (Rogers, 1983). Rogers divides the compatibility of innovation into its compatibility with sociocultural beliefs, with previous innovations, and with the needs of the adopters.

The compatibility, or more importantly the incompatibility, of an innovation with the sociocultural values of the adopters can have a major impact on its rate of adoption. If an innovation violates the values and beliefs of its intended adopters, its rate of adoption will be significantly slowed and may even be stopped.

The compatibility of an innovation with previous products has certainly become increasingly tied to the rate of adoption, even more so than Rogers might have expected. Innovations that continually build on each other have become more prevalent in the app age we currently live in. One of the most important past innovations that new innovations these days must be compatible with is the internet. 'Connected' devices, as they are now called, dominate all markets. Revenues from these devices exceed $200 billion and are expected to increase to $1.2 trillion by 2020 (Let's Talk Connected Devices Infographic, 2013). Around 50% of all cars sold this year worldwide have some kind of connectivity to the internet, and by 2025 cars will not be sold without it (Connected Car Infographic, 2015). Many different types of devices, from cars to phones to thermostats, interact with each other via internet, and any innovation that does not will have a significantly slower adoption rate.

Most importantly, innovations that are compatible with the needs of the consumer will be adopted much faster than innovations that do not. While most innovations are tailored and marketed to meet the needs of their potential clients, the fastest spreading innovations meet the most important and basic of needs. One of the most important needs we have as humans is safety. The modern seat belt was invented in 1959 while air conditioning has existed in cars since 1953. However, seat belts exist in all types of vehicles today while air conditioning is still considered somewhat of a luxury (Waters, Macnabb, Brown, 1998). Innovations that meet the immediate needs of a widespread market will be adopted faster than innovations that solve less pressing issues.

Rogers' third characteristic that influences the rate of adoption of an innovation is its complexity. The complexity of the innovation is "the degree to which an innovation is perceived as relatively difficult to understand and use" (Rogers, 1983). Rogers' results were mixed when it came to the relationship between complexity and rate of adoption. He found that nine research studies supported his hypothesis that complexity and rate of adoption are negatively related, and seven that did not (Rogers, 1983). While his explanation for these ambivalent findings was that upper class adopters enjoy the challenge and sophistication that comes with complexity and lower class adopters prefers the opposite, it seems that currently simpler is better. Innovations today are more complex than ever, yet design and marketing efforts including logos, slogans and user interface are simpler than ever. Whether it is Nike's 'Just do it.' slogan, Facebook's lowercase 'f' logo, or Amazon's '1-Click Ordering', simple is effective. It seems that consumers want complex, high performance products such as Nike DriFit and Amazon Prime, but prefer to perceive and use these innovations in a simple manner. For these reasons, it becomes clear that the perceived complexity of an innovation has a negative relationship with the adoption rate.

Rogers' fourth innovation characteristic that determines the rate of adoption is its trialability. The trialability of an innovation is defined as "the degree to which [it] may be experimented with on a limited basis" (Rogers, 1983). Rogers found that innovations that went through a testing process prior to their release experienced faster adoption cycles than those that did not. An experimentation phase gives an innovation two distinct benefits. First, by testing the product the innovator can continue to make changes to ensure that the product will function for the consumer. Testing periods often times reveal unforeseen issues that are crucial to fix prior to a release. Releasing a defective product halts the adoption process and gives potential adopters a negative first opinion, which can be hard to overcome. Second, testing an innovation and achieving positive results can increase the adopter's confidence in the product. Proving that a product is effective provides comfort and inspires the first wave of consumers to adopt, and in doing so, triggers the diffusion process. Of course, the necessity of an experimentation phase is completely dependent on the type of innovation. For innovations concerning the immediate needs, such as safety, an extensive testing process is required. For example, before a new drug can be sold in the U.S. it must be extensively tested on animals and eventually humans, then those tests are evaluated by the FDA's Center for Drug Evaluation and Research, and finally, if the drug's benefit is seen to outweigh all potential costs, it is approved (FDA, 2015). A similar yet less extensive process is involved for automobiles. On the other hand, innovations that do not directly affect the adopter's health and safety, such as mobile apps and video games, require a much shorter testing process and are often harder to test. Overall, there is a positive relationship between the trialability of an innovation and its adoption rate.

Rogers' fifth and final product quality that plays a role in determining an innovation's rate of adoption is its observability. The observability of an innovation is defined as "the degree to which the results of an innovation are visible to others" (Rogers, 1983). The observability of an innovation does not necessarily include the consumer's ability to view the inner workings, as discussed earlier. These inner workings have become significantly more complex in recent years resulting in a change in consumer focus from understanding how a product works to how easily a product is to use. Instead, observability refers to the visibility of the results and benefits obtained by adopting an innovation. For example, the average consumer does not completely understand how their car can turn on and preheat itself at the touch of a button, but that same person can physically observe the benefits of this innovation as he opens the door and feels the warmth overcome the winter afternoon. This person can then easily describe these advantages to others, thereby continuing the diffusion process. On the other hand, if a consumer cannot observe the direct results of adopting an innovation, he will be unable to articulate a reason for others to adopt, thus slowing the adoption rate. The observability of an innovation also encompasses the visibility of results to others. An innovation with a high level of observability not only allows you to physically experience its benefits, but also displays these benefits for others. The adopter's co-workers pass his car hearing it idle and seeing the windows defrost on the way to their frozen vehicles. The adopter does not even have to explain the benefits necessarily; instead the innovation displays its benefits, thus inspiring further adoption itself. Overall, the more observable the results of an innovation are, the faster the adoption rate.

In summary, Rogers' research indicates that the five product characteristics that most influence the product's rate of adoption are relative advantage, compatibility, complexity, trialability and observability. It is important to remember that there are often times no empirical measures to rank innovations on each characteristic. When a product is released to the world it is not released along with metrics of its complexity or observability, for example. Instead, it is most likely released with statements explaining that 'experts have determined this product to be easy to use' etc... These statements do not determine the product's rate of adoption, rather, it is the consumers' perceptions of the statements' validity that determines whether or not they adopt. Therefore, it is the consumer's' perception of these five characteristics that determine an innovation's ability to diffuse, not the characteristics themselves. Rogers explains this concept by relating innovations to beauty. Beauty, although it is continually desired in society, cannot be generically measured and ranked. Just like beauty, the power of innovation lies in the eyes of the consumer (Rogers, 1983). When attempting to predict the rate of adoption of an innovation, it is more important to analyze the perceived values of these determining characteristics than their actual values. This does not mean that metrics and expert evaluations do not play a role in determining the rate of adoption. These 'actual' values do affect the adoption process, but only to the degree that they are viewed as valid by the consumer.

Further research has been done to test Rogers' five innovation characteristics as they relate to adoption rate. Louis Tornatzky and Katherine Klein ran a meta-analysis of seventy-five articles pertaining to innovation qualities and found significant evidence supporting the influence of relative advantage, compatibility, and complexity on rate of adoption. They did find that trialability and observability affected rate of adoption, however, these characteristics did not appear in enough of the seventy-five studies to be statistically significant (Tornatzky & Klein, 1982).

How and when do different types of consumers adopt to new innovations?

Rogers was not only interested in the characteristics of the innovations that affect its adoption rate, he also sought to understand and discover the different types of consumers who evidently determine the success and adoption of a product. Before distinguishing adopter categories, Rogers first estimated that the adoption of an innovation follows a bell-shaped, normally distributed curve. While this seems like a massive generalization, Rogers defended his assumption by relating adoption to an infectious disease (Rogers, 1983). One person gets two people sick, then they each infect others and on and on. Since the majority of the population is healthy at this time, the disease spreads with increasing returns. Once the majority has become infected, each newly infected person has fewer people to pass the disease to, causing decreasing returns until eventually everyone is infected. This phenomenon, much like the human learning process and several other human behaviors, follows a normal curve. While there certainly are limitations to this model, Rogers believed it appropriately estimated the diffusion effect of an innovation. After developing a model, Rogers described five main adopter categories that fall under this normal distribution.

Rogers conducted and analyzed several hundred research studies comparing individuals’ willingness to adopt new technology with their socioeconomic characteristics, personality variables, and communication behavior. He then created his adopter categories using standard deviations from the mean to separate categories and fit them into his bell-shaped model. The categories are as follows; innovators, early adopters, early majority, late majority, and laggards (Rogers, 1983).

Innovators represent the first 2.5% (mean minus two standard deviations) to adopt the innovation. Innovators are the youngest in terms of age across the five categories. They are upper class individuals who use their wealth to finance their search for the ‘latest and greatest’ innovation. Their wealth allows them to be extremely risky and adopt innovations without significant consideration of the innovation itself. They are also relatively well educated, especially when it comes to the latest technology. Venturesomeness is described by Rogers as the defining trait of an innovator. They venture out of their social circles in search of anything new, so they are constantly interacting with different people. Innovators play the role of gatekeeper in the diffusion process. They open the door and allow the innovation to reach new audiences outside its initial social circle.

Rogers describes the 13.5% (mean minus one standard deviation) who adopt just after the innovators as early adopters. While innovators adopt because a product is new and exciting, early adopters adopt when they see potential value in and application of the innovation. Early adopters also differ from innovators in their basic knowledge of new technology. They are not far from the average citizen when it comes to their innovativeness, which is important because it makes them relatable to the population. Rogers' key characteristic for early adopters is respectable. This category of adopters, more than any other, represents leadership. Early adopters are looked up to, and therefore, by adopting, they add credibility to the innovation. Rogers classifies early adopters as opinion leaders.

To Rogers, opinion leaders are "individuals who lead in influencing others' opinions about innovations" (Rogers, 1983). These individuals have several attributes that attract followers. Opinion leaders have a higher socioeconomic status, more exposure to mass media, and are more socially adept than the average citizen (Rogers, 1983). These attributes make opinion leaders respectable to their followers and give them influence over the opinions and behaviors of others. Because of their ability to impact others, opinion leaders are often sought out by the innovation creators, named "change agents" by Rogers. Modern examples of opinion leaders include actors, professional athletes, and many other celebrities. Celebrities fit all the characteristics of opinion leaders. Their fame has provided them with substantial financial resources, they are constantly in front of the camera, making them increasingly recognizable and, through the nature of their profession, they have larger social networks than the average individual. Change agents, in this case advertising and marketing executives, seek out celebrities to promote their products in commercials and on social media. Studies have shown that between 19% and 25% of all advertisements feature celebrities (Shrimp, 1997). Celebrity endorsements increase adoption rates as they increase the level of attention given to an innovation, add a level of credibility and produce a "glamor aspect" to the innovation (Spielman, 1981). While celebrities are certainly examples of opinion leaders, the term more broadly applies to anyone in a leadership or respectable position. School teachers, coaches, friends, anyone who is looked up to and has the ability to influence others is seen as an opinion leader. These lower level leaders may not generate the same level of adoption rate increase as celebrities due to their much smaller follower base, but they exist in every community and are a crucial part of the diffusion process. Opinion leaders have been shown to directly affect the diffusion process across several innovation types from education to agriculture to health, yet it is important to note that most opinion leaders only influence others within their areas of expertise (Valente & Davis, 1999). An opinion leader does not necessarily influence others' opinions concerning a broad range of topics. For example, your opinion on which sporting innovations to adopt may be critically influenced by your coach, but your coach's opinion on the latest automotive technology may have little to no influence. This makes a change agent's ability to recognize which opinion leaders add credibility to the innovation extremely important.

Early adopters represent the most crucial point in the diffusion process. The level of opinion leadership that these adopters display is a major deciding factor that triggers the majority of adopters. Geoffrey Moore refers to this gap between early adopters and the remaining population as the "chasm" (Moore, 2002). It is the turning point in the diffusion process and differentiates successful innovations from failed ideas. Opinion leadership initiates mass diffusion, so the level at which early adopters can influence others determines the fate of the innovation.

The leadership of the early adopters triggers the next 34% that Rogers labels as the early majority. The early majority adopts just before the average person and, while they tend to be social, hardly ever displays leadership (Rogers, 1983). Instead, they are deliberate with their decision to adopt, which makes their “innovation-decision” period significantly longer than that of the innovators and early adopters (Rogers, 1983). The early majority represents interconnectedness and its main purpose in the diffusion process is to spread the innovation throughout their specific social groups. The early majority represent the last of what Rogers classifies as “earlier adopters”, which he found to have distinct differences across socioeconomic status, personality characteristics and communication behavior from “later adopters” (Rogers, 1983). These differences will be discussed after a brief description of Rogers’ remaining two adopter types.

These “later adopters” include the next 34% which represent Rogers’ late majority. The late majority chooses to adopt an innovation after the average person, and tends to adopt either due to necessity or peer pressure from previous adopters. Their lower socioeconomic status forces their decision to adopt to be delayed until all uncertainty about the innovation has been removed. Rogers deemed their defining characteristic to be skepticism. They are skeptical of anything new, and wait for the majority to adopt before adopting themselves (Rogers, 1983).

Finally, the fifth and final of Rogers’ adopter types is the laggards. The laggards represent the final 16% of adopters. Rogers describes them as traditional in nature and values. Laggards are often isolated in smaller social systems and reference the decision making of the past to determine their actions (Rogers, 1983). In other words, they look back at the actions and behaviors of previous generations and act according to these traditional values. The combination of their isolation, past-focused philosophy, and limited resources make them extremely cautious to adopt. An innovation must be a necessity before they choose to finally adopt. An example today is the stereotypical grandparents. They have lived their whole lives without cell phones and email and, while they do not see the advantages at first, are forced to adopt after years of continuous pressure from family members.

As mentioned previously, Rogers found significant differences in economic status, personality variables and communication behavior between the “earlier” 50% of adopters and the “later” half. Rogers analyzed approximately 900 empirical studies in order to determine these trends. While these studies were conducted prior to 1968 and the number of related studies has nearly doubled since then, the current “investigation has followed the same direction...and...the present conclusions would not be changed much if they were more up to date” (Rogers, 1983).

Socioeconomically, Rogers found that earlier adopters are more educated (74% of studies supported this finding), have higher social status (68%), are more accepting of credit (76%) and do not differ in age compared to later adopters (Rogers, 1983). These results indicate wealth to be a key factor in determining a person’s innovativeness and adoption rate. Earlier adopters are willing to take on more uncertainty because of their economic status, not because they are younger and inherently more risky.

In an analysis of personality characteristics, Rogers discovered earlier adopters were more intelligent (100%), had a more positive outlook on change (75%), higher aspirations (74%) and a better ability to cope with uncertainty (73%) than later adopters (Rogers, 1983). Rogers’ findings indicate that wealth and education are not the sole factors that separate earlier from later adopters. Instead, people who adopt innovations earlier in the diffusion process tend to differ in personality. They have higher aspirations, which push them to constantly search for better innovations and products to enhance themselves and their quality of life. Earlier adopters also seek out change and are able to handle the uncertainty that comes with the new. On the other hand, later adopters shy away from the new and untraditional causing them to need extensive proof that the innovation is successful before they decide to adopt.

In terms of communicative behavior, Rogers found earlier adopters have higher social participation (83%), information seeking (86%), interconnectedness within the social system (100%), and opinion leadership (76%) than later adopters (Rogers, 1983). These findings illustrate a core conclusion; earlier adopters are more social both within and outside of their social circles. Their social circles are more interconnected, helping the diffusion of an idea move from leader to followers much faster than is possible with the more isolated later adopters. Earlier adopters also engage outside of their social circles, seeking new ideas, which they then spread to their specific group. On the other hand, later adopters are less social, limiting their exposure to innovations and dramatically slowing their adoption decision.

In Rogers analysis of adopter categories he not only determined there to be five main types of adopters, but also found specific socioeconomic, personality and communication differences between earlier and later adopters. This analysis will be crucial as we attempt to predict the diffusion process of autonomous cars.

PART II: Applying Rogers’ Theory to the Autonomous Car

How do Rogers' five product qualities apply to autonomous vehicles?

Earlier in this analysis we learned that Rogers described five main innovation characteristics that directly affected the adoption rate of the innovation. These qualities were: relative advantage, compatibility, complexity, trialability and observability. We will now analyze the autonomous car in respect to these qualities.

First, autonomous vehicles will provide significant relative advantages in economic profitability and social status giving. Economically, autonomous vehicles provide productivity benefits for consumers and the economy, cost depletion for companies and infrastructure benefits for governments. In the U.S. alone, people spend around 75 billion hours driving annually (Morgan Stanley, 2015). This time is spent almost entirely unproductively. The driver must focus on the road, other cars, directions to their location and many other variables. The autonomous car will take care of all these distractions, allowing the 'driver' to spend their travel time productively. This provides obvious benefits to the consumer, as they will be able to read, write, work, relax, or do whatever they please while commuting. This personal productivity increase adds up to significant benefits to the economy when accounting for drivers nation-wide. Ravi Shanker, Morgan Stanley's lead North American auto analyst, suggests that this economic increase could surpass "$1.3 trillion in annual savings to the U.S. economy...with global savings estimated at over $5.6 trillion" (Morgan Stanley, 2015). These are substantial benefits that extend beyond the individual consumer and directly improve the nation's and the world's economy. Transportation and ridesharing services, such as Uber, will benefit tremendously from the release of autonomous cars.

Autonomous cars will eliminate the need for drivers to pick up and transport riders to their destinations. Instead, the car will be notified by the app on the rider's cell phone and will drive itself to meet the rider. In the last three months of 2014 alone, Uber paid $656.8 million to its driver-partners (Hall & Krueger, 2015). Assuming no growth, this will result in $2.63 billion in annual payments to drivers. This is an easy $2.63 billion that Uber can save solely by replacing drivers with autonomous vehicles. This same concept applies to any transportation based firms that employ drivers, including public transportation and delivery services.

Finally, autonomous vehicles will create immense savings in infrastructure due to accident and traffic reduction. The National Highway Traffic Safety Administration (NHTSA) found that public revenues from the government pay for 7% of all vehicle crash costs in the U.S. (Blincoe, Miller, Zaloshnja & Lawrence, 2014). Autonomous vehicles have been proven to be remarkably safer than human-operated vehicles, (discussed in depth later) and upon implementation can nearly eliminate this $10 billion in annual expenditures (Autonomous vehicles will have…, 2015). This elimination of accident related costs represents merely a portion of the governmental spending that will no longer be necessary because of autonomous cars. First, autonomous cars will be able to increase highway capacity by an estimated 273% (Tientrakool & Maxemchuk, 2011). This is because the sensors in autonomous vehicles allow them to react faster to changes in speed than human drivers, allowing them drive much closer to other vehicles. This incredible increase in capacity will dramatically decrease the necessary spending on building additional roadways, which has been estimated at $21.6 billion (Smart Growth America, 2014). The Eno Center for Transportation estimates that a 50% adoption of autonomous cars can save the government $211 billion in unnecessary infrastructure and transportation related spending, with this number increasing to $447 billion with 90% adoption (Transportation Research, 2015). These tremendous economic benefits display the vast relative advantage of autonomous cars for individual consumers, private companies and government.

Autonomous vehicles also present social status implications for these three consumer groups. Individual consumers will experience status increases immediately upon purchasing an autonomous vehicle. Autonomous vehicles are a popular topic in society today, meaning those who adopt early will be looked up to by others, allowing them to experience a sort of fame. The same applies for the other two consumer types. Companies who implement autonomous cars into their operations will likely see an initial rise is business. For example, people may choose to take an Uber as opposed to a taxi or a Lyft solely for the chance to ride in an autonomous vehicle. Cities, states and countries will be able to display their dominance over others by being the first area to implement autonomous vehicles. Because of their tremendous economic benefits, these vehicles can positively transform the image of the consumer and provide them with a competitive advantage.

Overall, the economic and status relative advantages of autonomous vehicles will inspire a rapid rate of adoption once they come to market.

Second, autonomous vehicles will be bolstered by their compatibility with consumer needs, but hampered by their compatibility with existing infrastructure. Autonomous cars are extremely compatible with the needs of many different types of consumers. As mentioned previously, the most important needs of an individual revolve around their safety. Safety is a huge concern that has been discussed in depth regarding autonomous vehicles and, contrary to popular belief, they are significantly safer than manually operated vehicles. Experts have estimated that over 90% of the world's 1.2 million traffic accident related deaths are caused by human error (Detroit Free Press, 2015). Google's autonomous cars alone have logged over 1 million miles, around 75 years of driving for an average adult, in just over 6 years, and only experienced twelve accidents (Venture Beat, 2015). All twelve of these accidents were minor with "light damage, no injuries", and all of them were caused by humans. Google's autonomous cars' only incidents were all caused by other drivers on the road. Autonomous cars will not drive drunk, will not drive recklessly, will not take their 'eyes' off the road, and will not create additional accidents. Autonomous cars are significantly safer than human drivers and research indicates that traffic related fatalities and injuries will experience "a 95-99.99% percent reduction" with 100% adoption (The Driverless Car Debate, 2015). In addition to safety, autonomous cars are compatible with an individual's needs for convenience. Owners will save time by being able to do whatever they please on their way to their destination. The autonomous car drives, navigates and parks with no necessary input from the 'driver', eliminating the stress of traffic, missing turns and finding parking. Autonomous cars are also compatible with the immediate needs of efficiency and revenue generation. The main purpose, despite what they may claim, of any private business is to make money. Autonomous cars will allow companies to cut their costs of hiring drivers and paying for accidents, and generate additional revenue through media exposure. The first companies equipped with autonomous vehicles will be immediately thrown into the spotlight. Media exposure will increase awareness for their company and customer curiosity will inspire an immediate spike in revenue. As mentioned with relative advantage, consumers are excited by the new, and given the popularity of autonomous cars, the first companies to feature these cars will gain a competitive advantage. Finally, the autonomous car is compatible with the government's immediate needs to address infrastructure issues, ensure the population's safety and reduce spending. Autonomous cars can travel much closer to other vehicles, making existing infrastructure 273% more effective (Tornatzky & Klein, 1982). In addition to maximizing existing roadways, autonomous cars will reduce the growing traffic congestion concerns by decreasing the number of vehicles on the road by 99% (245 million vehicles to 2.4 million) (Detroit Chamber, 2015). As mentioned before, the safety and infrastructure implications of autonomous vehicles will allow the government to save $21.6 billion (Smart Growth America, 2014).

While autonomous cars support consumer needs for individuals, companies and governments, their incompatibility with current conditions may dramatically reduce their consumer base. One of the most substantial benefits of owning a car is the freedom to go where you want, whenever you want. For autonomous cars to be able to provide this freedom for consumers, above average road conditions and an extensive mapping system are required. Autonomous cars rely on complex algorithms that allow them to recognize lane dividers and differentiate them from branches or snow or any kind of debris. Debris can cover up massive portions of road and, while it can usually be identified by a human driver, autonomous cars currently do not have a perfect attentiveness to unexpected objects. The ability to perceive obstacles and respond in a safe and effective manner "represents the single biggest hurdle for self-driving cars" (Gizmodo, 2015). Another related issue is the mapping system for the autonomous car. Conventional street maps generated by HERE, Google, Apple and TomTom use GPS, which has some major limitations that restrict its ability to support autonomous movement on all roadways. First, because GPS uses satellites, an unobstructed view of the sky is required. This means GPS would not be able to guide the autonomous cars through tunnels, forests, and indoor parking lots (Gizmodo, 2015). Secondly, GPS resolution is accurate up to one meter, which is nowhere near precise enough to navigate a vehicle safely without human interference. Before autonomous vehicles can be sold to individual consumers, their recognition and mapping must be able to navigate all types of roadways in any condition. TomTom aims to provide mapping that supports autonomous vehicles on all freeway type roads in Germany by the end of 2015, before expanding to Europe and North America (The Verge, 2015). It will likely be long after autonomous cars have been released that they will be able to navigate all areas, which brings us to our first prediction: the first consumers of fully autonomous vehicles will not be individuals. Transportation companies such as delivery and ride-sharing services can operate in specific areas where mapping is available, allowing them to be unaffected by this dilemma. These taxi related services maintain fleets in specific areas, and can therefore have autonomous fleets in cities and areas where autonomous support mapping is available. This makes them immune to these predicted restrictions for individual consumers, and allows them to adopt autonomous vehicles earlier. The initial autonomous cars will not be compatible with the expectations that come with owning a car, and therefore individuals will be pushed back and potentially removed from the diffusion process.

Third, despite the complexity that comes with a car being able to navigate itself, the perceived simplicity of the solution that autonomous cars provide will support a quick adoption rate. Rogers stresses the importance of perception when describing these five innovation characteristics. The complex algorithms and machinery required to operate an autonomous vehicle are not seen by the consumer. Instead, the consumer views a comfortable chair in a car that will take them where they want to go without any assistance. This solution could not be any simpler. They merely tell the vehicle their desired location and then without any further action they are transported to that spot. Autonomous cars remove the complexity of navigating and avoiding traffic and add the simplicity of sitting in peace. Rogers findings support a negative relationship between complexity and rate of adoption, therefore, the perceived simplicity of autonomous vehicles will support a fast adoption rate.

Fourth, the public spotlight on autonomous prototypes and trials provides autonomous vehicles with a high level of trialability. Rogers theory suggests that experimenting and testing an innovation prior to releasing it to the public both enhances the innovation by fixing unforeseen issues, and decreases the uncertainty of potential adopters. For obvious safety reasons, automobiles, especially autonomous ones, must go through years of extensive testing before they are approved for public sale. Due to the popularity of autonomous vehicles, manufacturers are making their experimentation public and using it to generate exposure. A simple Google search of autonomous vehicles delivers hundreds of articles announcing the current results of test vehicles or new prototypes or the start of trials in a new country. Whether it's Google advertising the number of miles their vehicles have accumulated in the U.S. or Volvo announcing the beginning of its trials in the U.K., manufacturers are presenting their testing to the world. The progress of autonomous vehicles is on display for the world to see, which dramatically decreases potential adopters' uncertainty and increases the rate of adoption.

Finally, the results of autonomous vehicles will be easily observable, allowing them to promote themselves and increase the adoption rate. First, for individual consumers, the ownership of an autonomous vehicle will be immediately observable to others, as will its benefits. Autonomous cars will not require a steering wheel, gearbox, brake and gas pedals and other traditional elements of current cars. This will make their appearance significantly different, clearly separating owners from others. Early individual adopters will receive a status increase that, due to the unique appearance, is visually observable to others. The benefits of adopting are also easily observable. The autonomous car can drop you off in front of your office building and then park itself, immediately displaying its superiority. Adopters can also easily describe its benefits to others by simply stating what they accomplished during the ride. Whether its sleep or work, it is certainly better than the driving that everyone else did. Second, companies who adopt autonomous vehicles will immediately separate themselves in an observable manner. Mass media exposure will increase, leading to business development and increased sales, which may even eliminate competitors. Autonomous fleets will be seen driving the streets displaying their owner's logo and in doing so speak to the innovativeness of the company. Similar results will come for early governmental adopters. Cities that adopt will experience increased tourism, decreased congestion, and minimal required infrastructure spending, all of which can be economically quantified. Local governments that first adopt autonomous public transportation will set the precedent for the upcoming national adoption. Their policy will be easily observed globally, giving them a status increase and an innovative, forward thinking reputation. Rogers discovered a positive relationship between observability and rate of adoption therefore the easily observable benefits of autonomous cars across all consumer types will result in quick diffusion.

With the exception of individual consumer compatibility, autonomous vehicles exhibit all five of Rogers' innovation characteristics that support fast adoption rates. This analysis brings us to our second prediction: upon their release, autonomous cars will rapidly diffuse through all adopter categories. Now that we know that autonomous vehicles will be rapidly adopted and individual consumers will not be the initial buyers, we can attempt to predict what kinds of consumers will be the first to adopt.

How do Rogers' five adopter categories apply to the autonomous car market?

Rogers' innovators, the first to adopt, will be companies in the ridesharing industry. Innovators take on the uncertainty of the innovation and adopt, displaying it to society and initiating the diffusion process. The ridesharing industry sits currently as an ideal hot bed for introducing and showing off autonomous cars to the public. They are perfect candidates for the innovator role for several reasons. First, these companies are proven innovators that specialize in transportation. Carsharing services, such as Zipcar, allowing individuals to rent cars for certain periods of time, initiated a change in mobility. Zipcar has nearly doubled its users in the past six years, displaying a shift from privately owned vehicles to shared vehicles (Shaheen & Cohen, 2013). Zipcar then opened the door for ridesharing companies such as Uber that disrupted the taxi industry by introducing innovative driver concepts and app based hailing and payment. Craig Giffi and Joe Vitale discovered that young adults and urbanites are beginning to prefer a pay-per-use method of transportation over purchasing a vehicle of their own (Giffi & Vitale, 2014). Each day Uber performs around 1 million trips worldwide and that number is increasing rapidly (Cardenas, 2014). Second, the autonomous mapping issues mentioned previously mean that autonomous vehicles will need to operate in smaller geographical locations where mapping currently exists. Ridesharing services can easily sidestep these initial limitations. Uber can place a fleet of autonomous vehicles in an area like Austin, Texas, where mapping is available today. Third, the ridesharing industry makes the most sense economically. Since these autonomous taxis will have high utilization rates, meaning they are consistently in use, ridesharing companies will be less sensitive towards likely high initial purchasing costs. Additionally, a study conducted at the University of Columbia predicted that Uber could replace all of New York City's taxis with an autonomous fleet of 9,000 cars. This fleet could pick up customers in approximately 36 seconds and would decrease the cost of a ride from $4 per mile to $0.50 (Zhang, 2014). If this is the case, Uber would take over the taxi market and consumers would save $3.50 per mile causing an even greater shift away from personally owned vehicles. A Deloitte analysis of the shared vehicle economy provided additional evidence, concluding that self-driving taxi fleets would reduce costs to around $0.31 per mile (Deloitte, 2015). As mentioned previously, implementing autonomous cars nationwide would also save Uber $2.63 billion in driver payments (Hall & Krueger, 2015). These economic benefits clearly indicate the potential of the ridesharing industry. Finally, autonomous taxi rides serve as the perfect introduction to ease humans into letting go of the steering wheel. A major concern for the success of autonomous cars is the population's psychological fear of not being in control. Short, controlled rides in autonomous vehicles on slower city streets are an ideal way to limit this psychological fear and increase the population's comfortability with the idea of surrendering control to a 'robot'. These four reasons suggest that ridesharing companies will be the first to adopt autonomous vehicles, but which firm will actually be first?

Uber recently announced that if Tesla can come through on their promise to build 500,000 autonomous vehicles per year by 2020, the company will purchase them all. Uber, much like Rogers' innovators, thrives on the new, and has the financial backing to support the risk taking that comes with being the first adopter. For these reasons, Uber will be the first adopter of autonomous vehicles. Uber will gain a significant advantage by being in the market first and will either absorb or eliminate other ridesharing companies like Lyft. Google represents a threat as they have set aside substantial resources for autonomous car development: however, Uber's ridesharing experience and expertise will give them an edge in the end.

Following Uber and other ridesharing firms, Rogers' early adopters of the autonomous vehicle will be delivery based firms. The delivery industry presents a natural progression from ridesharing. Delivery services such as UPS, FedEx and Amazon operate mainly on highways, which can be more easily mapped. As we saw with TomTom, autonomous mapping companies are targeting highways, initially allowing autonomous implementation of delivery services to occur rapidly after ridesharing. Autonomous vehicles would allow delivery companies to eradicate driver costs that account for 26% of their operational costs (Trucker's Report, 2015). They would also address the industry's growing labor shortages, which now have 30,000 unoccupied driver positions (Badkar, 2014). Given that the industry generates $700 billion per year, delivery services have significant economic incentives to cut costs and differentiate themselves from competitors (American Trucking Ass., 2015). In this adoption phase, there comes the implementation of distinct autonomous vehicles including semi-trucks, boats and even cargo planes. The visibility of these fleets on the roadways and in the air will be immediate, thus decreasing consumer doubt and speeding up the adoption rate. Rogers' early adopters are not necessarily any more innovative than the average person, just as UPS, USPS, and FedEx are not seen as necessarily innovative companies. However, these adopters exhibit the highest level of opinion leadership and, after considering this characteristic, one company emerges as the first of the delivery services to adopt autonomous cars.

Amazon has separated itself in the industry through its leadership in implementing alternate delivery methods. Opinion leaders continually push themselves to stay ahead of the curve and maintain their leadership positions and, by adopting a delivery focused membership system and developing an air drone delivery system, Amazon has cemented itself as the innovative leader in delivery. Amazon Prime and Amazon Prime Air serve as concrete examples of Amazon's willingness to adopt the latest innovations and trends, and autonomous cars will be its next step. Amazon will pave the way for autonomous delivery, allowing them to significantly expand their portion of the delivery market. UPS, FedEx, and eventually USPS will have no choice but to follow Amazon after they see their share of the market slowly diminish. This will serve as an introduction to government autonomous vehicles, which will increase in the future.

The early majority adopter category of autonomous vehicle adopters will consist of forward thinking city governments. Rogers describes the early majority as deliberate adopters, with much longer decision periods that the previous adopter categories. City governments certainly act deliberately, yet are able to innovate faster than larger governments due to the limited, and specialized nature of their civilians. At this point in the adoption process, autonomous vehicles have proven their worth, and have begun revolutionizing mobility. This presents a low risk, high reward opportunity for cities to differentiate themselves and demonstrate their innovativeness by outwardly supporting autonomous transportation. City wide adoption will come in three forms. First, cities will openly support autonomous transportation by revising roadways to support autonomous mapping, implementing autonomous public transportation and providing monetary incentives for autonomous vehicle users. This means making adjustments such as repainting roadways and investing in city specific mapping to allow autonomous vehicles to travel in all areas of the city. Next is the creation of autonomous public transportation. The Los Angeles metropolitan area spends around $347 million annually on bus driver salaries, all of which can be saved by implementing autonomous bussing (Bus Drivers, Transit and Intercity, 2015). Autonomous vehicles will reinvigorate the population’s passion for public transportation and usage will reach all-time highs. This usage increase will come from the hype and popularity of autonomous vehicles in general, as well as through governmental incentives to use autonomous transportation. As mentioned previously, autonomous transportation is far more efficient than manual driving, and has the potential to save the government billions on infrastructure costs. Forward thinking cities will provide tax benefits or other monetary incentives as a means to drive additional consumers toward autonomous vehicle transportation.

The first cities to adopt will be progressive cities that are facing dire infrastructure and traffic congestion concerns. Progressive cities with more liberal inhabitants tend to be the first to adopt innovations. Cities such as Portland, Seattle and San Francisco were among the first to take green initiative measures to save energy such as incentivizing solar panel use and developing city wide bike lanes (Top Ten Green Cities, 2014). Cities with worsening congestion issues have increased incentives to adopt. According to the INRIX Traffic Scorecard, Washington D.C., Los Angeles and San Francisco rank highest in congestion, with average annual hours in traffic of 82, 80 and 78 respectively (INRIX, 2015). Although San Francisco appears in the top of both of these characteristics, Los Angeles' early commitment to citywide autonomous mobility will allow them to adopt first. In 2014, Los Angeles mayor Eric Garcetti announced that Los Angeles will commit itself to creating more rapid bus lanes because “a bus lane today may be a bus, and an autonomous vehicle lane tomorrow” (Metcalfe, 2015). Since then, Garcetti has instituted Bus Rapid Transit (BRT) lines in 8 miles of roadway downtown, ensuring faster commutes that can save commuters 30 minutes round trip (Garcetti, 2015). Los Angeles' autonomous vehicle consideration for future transportation separates it from other similar cities, and will allow it to be the first city to support autonomous public transport. Progressive and liberal cities such as Seattle and San Francisco will likely adopt rapidly after L.A.

Rogers' late majority adopter category will be populated by individual autonomous vehicle ownership and increased autonomous transportation in cities and states. As more and more cities commit to infrastructure and research initiatives to support autonomous transportation, the coverage of autonomous supporting mapping will vastly increase, allowing autonomous vehicles to be sold to private owners. During this time a separate individual-based diffusion process will emerge, however, it will not be nearly as successful as the initial diffusion. Initially, wealthy opinion leaders such as actors and professional athletes will adopt, purchasing private autonomous vehicles for their families, but they will no longer be a driving influence on the majority of the population. The young adults and urbanites who prefer the efficiency of ridesharing services in today's world will now constitute the majority of the population. This will be the case for two main reasons; increased economic efficiency and increased urbanization. As mentioned previously, using shared autonomous vehicles will merely cost users $0.31per mile, while private ownership costs around $1 per mile (Deloitte, 2015). Additionally, commitment to autonomous vehicles will allow for separate autonomous lanes, making autonomous transportation faster than private driving. With autonomous vehicles penetrating public transportation and increasing taxi efficiency, it will be both more expensive and slower to own a vehicle, even an autonomous one. Secondly, the United States and the world are undergoing a massive transition towards urbanization. Over 80% of the population of the U.S. lives in heavily populated urban areas, with that number expected to grow for the foreseeable future. By 2050, the United Nations projects that 86% of the entire developed world will live in these urban areas (The Economist, 2012). Since urbanites today prefer public transportation and ridesharing services to the parking and maintenance hassles of private ownership, we can expect that increasing the number of urbanites will decrease the market for individual vehicles. With changes in mentality and environment, the first adopters of private autonomous vehicles will fail to influence the next wave of early adopters, thus significantly slowing the diffusion process. Individual adoption will not gain momentum, and thus only account for a small portion of the late majority.

The bulk of late majority adopters will be city and state emergency and educational services. Rogers' definitive characteristic of his late majority adopters is their skepticism. Due to budget concerns, public school systems and emergency services are forced to be skeptical about new innovations. They cannot afford to adopt the latest technology until almost all the uncertainty pertaining to the utility of the innovation is removed. After seeing the benefits of autonomous shipping and public transportation and considering the vast safety improvements, these departments will adopt. For school systems this will come in the form of autonomous school buses for students. The safety of the students is both a parent's and a school's highest priority. Autonomous busses would eliminate the risk of bus driver human error, while at the same time saving schools from paying bus driver salaries. The safety benefits will have fully proven themselves by this point in the diffusion process and even skeptical organizations will see the potential and adopt. For emergency response groups, autonomous ambulances will be able to reach people in need faster and safer than human drivers. Adopting these vehicles will also allow for additional EMTs to respond to incidents, since drivers are not needed. With taxis, delivery vehicles, buses and ambulances now becoming autonomous in progressive cities, statewide policies supporting autonomous transportation will emerge. Forward thinking states, who tend to move slower than cities due to increased population diversity, will now take stances in favor of autonomous adoption. Just like with cities, the first states to adopt will experience status and reputation benefits that will drive innovative civilians towards them, thus boosting their productivity and economy. Statewide roadways will accommodate and incentivize autonomous transportation with separate, faster lanes and exemptions from tolls. States have already begun preparing for autonomous vehicle testing, realizing the economic benefits in the form of attracting tourism and talent. California, Michigan, Florida and Nevada have already passed legislation making it easier for manufacturers to test autonomous vehicles (Grandoni, 2015). Of these states I think Michigan will be the first to adopt statewide autonomous transportation. Michigan is on the brink of losing their stronghold on the automotive market and therefore will go to great lengths to demonstrate their automotive innovativeness. Michigan spent $6 million and raised another $4 million from private investors to build a 32-acre testing ground for autonomous vehicles in Ann Arbor (Grandoni, 2015). This testing ground consisted of a “mock suburb with asphalt and gravel roads lined by brick-and-glass building facades” (Grandoni, 2015). Michigan’s early initiative and their desperation to rebuild their reputation as the automotive center of the U.S., position it as a front runner for statewide autonomous adoption.

The laggards, Rogers’ last adopter category, will consist of conservative state and, eventually, nationwide policy. Laggards by definition are traditional. They make adoption decisions based on what has traditionally been done in the past. Conservative, mainly southern, states fit this description. Autonomous vehicles are a radical innovation that will disrupt the entire transportation industry, but they are unlike any innovation of the past. The conservative population will not have traditional judgments to fall back on which will create uncertainty and increase their decision period. Eventually, states will publish the concrete statistical benefits of their autonomous policies including the number of lives saved and all economic benefits and the remainder of the nation will have no choice but to adopt. The push to be the first country with nationwide autonomous vehicle implementation will be an important one. The first countries to adopt will separate themselves in reputation and economic output. Assuming that developed countries will be the first to adopt, autonomous vehicles will increase the economic gap between developed and developing countries. Nations with autonomous vehicles will become more efficient by the year, leaving developing countries further and further behind. The United States has positioned itself to become an early adopter with significant funding going to autonomous vehicle research from tech companies in San Francisco to auto manufacturers in Michigan. TomTom has predicted that German highways will support autonomous transportation by the end of this year and, given Germany's focus on automotive excellence, it will also be a contender for the first national adopter (The Verge, 2015). While conservative states and nations will be the last to adopt autonomous vehicles, they will not be behind by much. As was discussed previously, autonomous vehicles will disperse through markets rapidly and will sustain high rates of adoption throughout the entire diffusion process.

Conclusion

An application of Rogers' diffusion of innovations to autonomous transportation resulted in several key findings. First, autonomous vehicles score highly across all five of

Rogers' innovation characteristics that are positively correlated with adoption rate, leading us to predict that autonomous vehicles will be adopted rapidly upon availability. Second, autonomous vehicles will not support the freedom that comes with private ownership of a vehicle due to mapping limitations, thus ruling out individual consumers as the first adopters. Third, ridesharing services, namely Uber, will be the first to implement autonomous vehicles into their business. Finally, when private ownership of autonomous vehicles becomes available, it will not be rapidly adopted due to increased urbanization and shared services popularity. These conclusions are important as they identify target consumers for autonomous vehicles. Auto manufacturers should target companies as their first consumers, rather than individuals.

On the other hand, this analysis was fairly limited. Due to the recency of autonomous transportation, hardly any studies have been published and the few that have are all predictive in nature.

Other questions left unanswered include; who will be the first to mass produce autonomous vehicles? This question has significant implications, as we could potentially see tech companies such as Google enter and take over the automotive industry. Another question left unanswered is what will happen to employment? Autonomous cars will likely take the jobs of millions, which could significantly influence the unemployment rate.

References

2014 Global Automotive Consumer Study. (2014). *Deloitte*. Retrieved September 9, 2015.

Agarwal, R., Ahuja, M., Carter, P. E., & Gans, M. (1998). Early and late adopters of IT innovations: extensions to innovation diffusion theory. InProceedings of the DIGIT Conference (pp. 1-18).

Americans Steer Away from Autonomous Parking. (2015). *Newsroom Archive*. Retrieved November 3, 2015.

Automotive Air Conditioning - History of Automotive A/C - Automobile Magazine. (2010). Retrieved November 9, 2015.

Autonomous Cars: The Future Is Now | Morgan Stanley. (2015). Retrieved November 5, 2015.

Autonomous vehicles will have tremendous impacts on government revenue. (2015). Retrieved September 9, 2015.

Badkar, M. (2014). There’s a huge shortage of truck drivers in America—here’s why the problem is only getting worse. Retrieved November 8, 2015.

Baldridge, J. V., & Burnham, R. A. (1975). Organizational innovation: Individual, organizational, and environmental impacts. *Administrative science quarterly*, 165-176.

BCG: Autonomous car market to hit 42 billion by 2025. (2015). Retrieved September 21, 2015.

Blincoe, L., Miller, T. R., Zaloshnja, E., & Lawrence, B. A. (2014). *The economic and societal impact of motor vehicle crashes, 2010* (No. DOT HS 812 013).

Bus Drivers, Transit and Intercity. (2015). Retrieved November 9, 2015.

Cardenas, P. (2014). Our commitment to safety. Retrieved September 14, 2015.

Celebrity Endorsements Still Push Product. (2010). *Advertising Age.* Retrieved September 22, 2015.

Comparing Electric Cars To Gas Cars. (2012) *Shrinkthatfootprint.com*. Retrieved November 9, 2015.

Connected Cars Infographic. (2015). *Forbes/Business*. Retrieved November 4, 2015.

Creswell, J. (2008). Nothing Sells Like Celebrity. Retrieved November 9, 2015.

Development & Approval Process (Drugs). (2015). *FDA: U.S. Food and Drug Administration*.

Five Characteristics Of An Innovation. (2015). *Smashing Magazine*. Retrieved November 9, 2015.

Garcetti, E. (2015). Mayor Garcetti Opens Five Miles Of New Bus Lanes On Wilshire Boulevard. *LA Mayor*. Retrieved November 4, 2015.

Giffi, C., & Vitale, J. (2014). 2014 Gen Y automotive consumer study: The changing nature of mobility.

Google's self-driving cars have autonomously driven over 1 million miles. (2015). *Venture Beat*. Retrieved November 9, 2015.

Grandoni, D. (2015). Among the States, Self-Driving Cars Have Ignited a Gold Rush. Retrieved November 9, 2015.

Hall, J. V., & Krueger, A. B. (2015). An Analysis of the Labor Market for Uber's Driver-Partners in the United States.

Huet, E. (2014). Uber Says It's Doing 1 Million Rides Per Day, 140 Million In Last Year. *Forbes.* Retrieved November 9, 2015.

Kanter, Z. (2015). How Uber's Autonomous Cars Will Destroy 10 Million Jobs and Reshape the Economy by 2025. Retrieved November 9, 2015.

Let's Talk Connected Devices Infographic. (2013). *Mobile Future*. Retrieved November 9, 2015.

Look Mom, No Hands! Forging into a brave new (driverless) world. (2013). *Detroit Chamber*. Retrieved November 10, 2015.

Metcalfe, J. (2015). L.A. Mayor Eric Garcetti: We Will Be the First City to Do Autonomous Vehicles Right. Retrieved November 9, 2015.

Moore, G. A. (2002). Crossing the chasm.

Repair Priorities 2014. (2014). *Smart Growth America*. Retrieved November 9, 2015.

Rogers, E. (1983). *Diffusion of innovations* (3rd ed.). New York: Free Press.

Self-driving cars will be safer, but surprises will happen. (2015). *Detroit Free Press*. Retrieved November 9, 2015.

Shaheen, P., & Cohen, A. (2013). Innovative mobility carsharing outlook. *University of Berkeley, California*.

Shimp, T. A. (1997). Advertising, communication and supplemental aspects of integrated marketing communication.

Spielman, H. M. (1981). The celebrity sell: making it work. Marketing Times, 28, 13–14.

The Driverless Car Debate: How Safe Are Autonomous Vehicles? (2015). Retrieved November 9, 2015.

The future of mobility: How transportation technology and social trends are creating a new business ecosystem. (2015). *Deloitte*. Retrieved November 9, 2015.

The Reason We Won't Have Autonomous Cars Any Time Soon. (2015). *Gizmodo*. Retrieved November 4, 2015.

Tientrakool, P., Ho, Y. C., & Maxemchuk, N. F. (2011, September). Highway capacity benefits from using vehicle-to-vehicle communication and sensors for collision avoidance. In Vehicular Technology Conference (VTC Fall), 2011 IEEE (pp. 1-5). IEEE.

TomTom is now making maps for autonomous vehicles. (2015). *The Verge*. Retrieved November 9, 2015.

Top 10 green U.S. cities. (2014). Retrieved November 11, 2015.

Tornatzky, L. G., & Klein, K. J. (1982). Innovation characteristics and innovation adoption-implementation: A meta-analysis of findings. *Engineering Management, IEEE Transactions on*, (1), 28-45.

Transportation Research Part A: Policy and Practice. (2015). *Volume 77*, 167-181.

Trucker’s Report: The real cost of trucking—per mile operating cost of a commercial truck. (2015). *Trucker’s Report*. Retrieved September 14, 2015.

Trucking revenues top $700 billion for the first time according to new report. (2015). American Trucking Association. Retrieved September 4, 2015.

Uber CEO To Tesla: Sell Me Half A Million Autonomous Electric Cars In 2020. (2015). Retrieved November 9, 2015.

Uber Reveals How Much Its Drivers Really Earn...Sort Of. (2015). *Time*. Retrieved November 9, 2015.

Urban Life: Open Air Computers. (2012). *The Economist*. Retrieved September 15, 2015.

Urban Mobility Scorecard Annual Report - INRIX. (2015). *INRIX*. Retrieved November 9, 2015.

Valente, T. W., & Davis, R. L. (1999). Accelerating the diffusion of innovations using opinion leaders. *The Annals of the American Academy of Political and Social Science, 566*(1), 55-67.

Waters, W., Macnabb, M. J., & Brown, B. (1998). A half century of attempts to re-solve vehicle occupant safety: understanding seatbelt and airbag technology. *16th International technical conference on the enhanced safety of vehicles (ESV) proceedings*.

Zhang, B. (2014). This Study Revealed The Staggering Potential Of Self-Driving Cars. Retrieved November 9, 2015.