The Advent of Autonomous Vehicles: A Transportation Revolution

By

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Abstract

This article focuses on the advent of both semi- and truly-autonomous vehicles, their effect on culture(s) globally, and the perceptions of different generations of people. Automobile manufacturers in Europe, the U.S., and China are in a race to change cars, trucks, buses and, by extension, new and different modes of transportation. Unfortunately, to varying degrees, people and societies are lagging behind in accepting these innovations. In part, resisting change can be a rational response. For example, semi- and truly-autonomous vehicles can have both positive and negatives consequences. On the positive side are simplicity and, ultimately, less stress for passengers. On the darker side are issues in hacking of the computer systems in vehicles and the potential for such vehicles to be weaponized. Stressing the positive, by re-learning, adapting and accepting autonomous vehicles, societies will make these vehicles a part of their cultures and their life styles.

Keywords: semi-autonomous vehicles; truly-autonomous vehicles; positive and negative consequences; generational differences in people's responses to innovations; cultural lag

INTRODUCTION

Along with trucks and buses, the automobile has been one of the most useful inventions of the twentieth century. These vehicles have contributed to the economic growth of the U.S. (and every other country in the world) and have affected the lifestyles of people globally, including our geographic mobility and independence. Without them, our lives would be only local or regional. This article focuses on the revolution in vehicles that has been going with increasing frequency in the second decade of the 21st century. This article also focuses on people's responses to the dramatic changes in today's vehicles and in the projected changes in vehicles in the coming years. Finally, it explores the gap between the speed at which the transportation revolution is taking place and the ability of drivers of various ages to adapt to these changes.

To place this article in context: I have been a volunteer driver safety instructor for AARP for the past thirteen years. I have seen many changes in the curriculum of the course along with the advent of semi-autonomous vehicles and the start of autonomous vehicles. When I first started leading the course (one talks about the students as participants; instructors do not teach, we lead the discussions with senior drivers over 55 years of age), our course consisted of one small VCR tape of 20 minutes in length and a small manual. The course was two days; four hours each day. The instructors were not assisted by computers back then (circa 2004). Each instructor had to upgrade to new computer skills and read articles on the newest innovations in vehicles.

Over the years, the course morphed into one four and one half hour program, which includes an hour-long DVD presentation on selected topics. The content of the course now includes many topics not presented 13 years previously-- for example, technological advances, such as park and first lane assist; backup cameras for rear vision; blind spot detection; advanced cruise control; sensors for crash avoidance and automatic high/low beams and smart headlights (lights that turn with the direction of the vehicle). Vehicles now offer mood lighting, heated and vibrating seats, an entire dashboard information panel for temperature control, satellite radio, weather reports to assist drivers in any weather condition, GPS systems (including maps), and

sensors for drowsy drivers, which warn the driver that he/she is falling asleep, and lane changing sensors along with warnings for drifting from lanes (*AARP Smart Driver Course Guidebook* 2014: 27-29).

Every year cars and trucks change. The latest changes include different types of engines and fuel requirements for operation (e.g., biodiesel, natural gas, electric, ethanol, waste oil, and even fuel cell). In 2018, United Parcel Service is planning to put Class 6 delivery trucks with fuel cells on the road. (Jost 2017). According to Bloomberg Press, electric cars (EV) may make up more than a third of new-car sales by the end of this decade (Randall 2017). In a recent *Forbes Magazine* article, Newcomb (2017) describes a Mercedes Benz model with onboard controls; when one takes her/his hands off the steering wheel for five seconds, the car beeps to warn the driver and the automobile shuts off after five more seconds. Teal (2017) also describes innovations in auto emergency braking systems (AEB) already available in many European models along with adaptive cruise control, parking assist systems, steering assist, and camera-based road sign recognition.

The United States government's National Highway and Transportation Safety Board (NHTSB) has defined Autonomous Driving (AD) as having four levels of autonomy:

Level One: You drive the vehicle. Various onboard systems back you up.

Level Two: The vehicle can drive some of the time. Driver must be ready to take over when necessary.

Level Three: The vehicle can drive autonomously much of the time. Driver must be ready to take over with advance warning from the vehicle.

Level Four: The vehicle drives itself all the time. Passengers can read a newspaper or nap. This level describes the ultimate autonomous vehicle (Roy 2016).

In 2016, Uber, the ride-hailing service, began using semi-autonomous vehicles within a grid of downtown Pittsburgh, PA. That grid is expected to expand in the next couple of years (Cava 2017). Imagine an Uber vehicle, without a driver, coming to your workplace or residence to pick you up and delivering you to a particular destination. No cash: just **Mastercard** @, **Visa** @, **Paypal** @, or **ApplePay** @.

Waymo, previously called Google Cars, is Google's autonomous vehicle project. By 2016, Waymo already had a fleet of semi-autonomous vehicles that have driven over 3 million miles with only two accidents, neither of which was the fault of the semi-autonomous car (Waymo 2016).

Other prototypes have also been tested. For example, in cooperation with a Chinese company, Volkswagen has developed an experimental air car in China.[1] This car drives itself at level 3. At this writing, BMW is testing a driverless car that parks itself in a parking garage.[2]

China has introduced an innovative bus-train hybrid, which is electric-powered and has no rails (operates on sensors picking up white lines on the road surface). These vehicles will operate in the Chinese city of Zhuzhou by 2018 (Thompson 2017).

Along with the autonomous vehicle revolution comes the prospect of underground shuttles to relieve the congestion of major cities. Innovator and entrepreneur, Elon Musk, aims to wipe out traffic by designing 120 mile per hour underground shuttles in Los Angeles (Sadler 2017). Uber will also be test flying cars in Dallas and Dubai by 2020 (Huet 2017). The latest news is Toyota is planning on using a flying car to light the torch for the 2020 Summer Olympics in Tokyo. The initiative, code named, SkyDrive, has a long way to go. (AP & Kageyama 2017). Eventually, the trucking industry will also get involved. Autonomous trucks and hybrids, without drivers, can transport containers of goods cross-country on-time and with no overtime. With new innovations coming out each month, other forms of transportation may surface in the future. Hypo-speed planes, trains, and automobiles may also be there, too.

To date, some problems still linger with Mercedes-Benz (MB) Drive Pilot E-class program cars. According to Adams (2016), these cars still have problems with merging and arching of the road (taking corners). On the plus-side, the MB S-class vehicles for 2017, according to Edelstein (2017), have even more autonomous capabilities including vehicle-to-vehicle

[1] See the video at http://www.flixxy.com/volkswagen-levitating-car.html

[2] See the video at http: //www.youtube.com/watch?feature=playerembedded&v=rgM8MOrss40

communication, remote parking (similar to the BMW parking itself), autonomous braking, following other cars in stop-and-go traffic, lane-keep assist, steering assist during evasive maneuvers. Moreover, Edelstein (2017) also reports that the MB S5500 plug hybrid for 2018 will have wireless charging capability.

DRIVERS' PERCEPTIONS and CONCERNS

The question in most drivers' minds is: Can we "trust" these semi-autonomous and autonomous vehicles? Their concerns: Semi-autonomous vehicles are controlled by sensors, cameras and computers. So, safety and performance are only as good as the controlling programs involved.

When I ask participants in my driver safety courses about these vehicles, more than two-thirds of the participants say they are leery, do not trust the technology, or are just plain baffled by the idea of a vehicle driving itself. Since they started driving, these seniors have experienced cars with a manual transmission (now: dual transmission), no seat belts (now: lap and seat belts), no air bags, no cruise control, and even no radios.

To change drivers' perceptions, Durbin (2017) reports that Fiat-Chrysler and Waymo will be offering free rides to the public in these semi-autonomous vehicles in the Phoenix area. Their objectives are to gain feedback from the public and to gain the public's confidence in these vehicles. All of these vehicles will have backup drivers in case of emergencies.

A 2017 J.D. Power Report entitled, US Tech Choice Study, revealed that all generational groups, with the exception of Gen Y (those born 1977-1994), are become skeptical of self-driving technology. Specifically, 40% of Boomers (those born 1946-1964) do not see any benefit to self-driving vehicles. Only 7 % of Baby Boomers say they would purchase a full self-driving vehicle. However, younger consumers, such as Gen Z (those born 1995-2004), are far more comfortable with autonomous technologies than are older generations. Moreover, Gen Z consumers also say they have a higher interest in a digital key (versus a physical key or a fob) and 50% of age cohort indicated that they are definitely/probably interested in mobility sharing or co-ownership of a future vehicle. Unmanned mobility (level 4) is favored by 56% of this age grouping.

Kristin Kolodge, Executive Director of Driver Interaction and HMI research, concludes "in most cases, as technology concepts get closer to becoming reality, consumer curiosity and acceptance increases. With autonomous vehicles, we see a pattern which trust drives interest in the technology and right now, the level of trust is declining." Kolodge also indicates while automated driving is a new and complex concept, many consumers must experience it firsthand to fully understand it (Dobrian 2017).

DISCUSSION

When fully-autonomous vehicles come on the road in the future, questions may arise about the liability of an accident. First, who will be at fault-- the manufacturer of the vehicle or the owner of the vehicle? Second, what is known about the condition of the passenger? Is she or he legally "under the influence?" Can the occupant instruct the vehicle to deliver him/her to a particular place? Third, can disabled persons take these vehicles without problems? Can children, without adult guidance, operate these vehicles? Fourth, will passengers even need a driver's license anymore? Fifth, because these vehicles will have multi-lingual capabilities, can a foreign traveler with little driving experience operate these vehicles?

On the darker side, just like drones, can these vehicles be equipped with weapons by dangerous individuals? Also, with more people riding in these vehicles, there is a question of whether governmental controls (i.e., controlling the numbers) should be put on the vehicles. Another big problem is the issue of hacking the computer of these vehicles by unlawful individuals. Regarding the potential for hacking, car manufacturers and developers need to design a series of firewalls and gateways/passwords to prevent unlawful access to the vehicle's computer systems.

Along with changes in driving environments, traffic laws must change. Enforcement also may have to change. According to National Conference of State Legislatures (NCSL), as of early 2017, 13 states --Alabama, Arkansas, California, Florida, Louisiana, Michigan, New York, Nevada, North Dakota, Pennsylvania, Tennessee, Utah, Virginia-- and District of Columbia have passed legislation to allow autonomous vehicles to operate on those states' roads (www.ncsl.com).

Possible positive consequences may come about: There would be little road rage or any emotional dispute over some slight that may happen on the road. Drowsy and drunk people can be easily transported to their destination without incident. Persons with handicaps will be able to use these vehicles with some modifications in seating to travel anywhere. Also, passengers do not need to spend long hours navigating traffic on long trips.

CONCLUSION

On a more sociological note, because of the increasing cost of such vehicles, more people may opt to car-share, or co-own, or to choose other forms of transportation. We may have a return to mass transportation--- high speed trains or inter-city trolley systems. Or take either Lyft or Uber, both ride-hailing entities somewhere. Autonomous vehicles may provide a moving office or just be people movers. Moreover, with the increasing cost of buying and even leasing these new vehicles, car-sharing, such as Zipcar, may be more economically feasible for the general public.

All these vehicle innovations will require re-learning, adjustment, and adaptation. Just as we have learned to adjust to other technologies in our daily lives, we need to adapt to changes in the area of transportation technology. One final question: How easy is it for "old dogs" to learn new tricks? The author's answer: That depends on certain variables and how they operate. Which variables are most influential in getting older drivers to accept new technological changes? An extensive cross-disciplinary literature exists on what is involved in the adoption of innovations and, more recently, in resistance to innovations (Ram 1987).

Decades ago, Rogers (1962) identified five important characteristics of an innovation: Relative Advantage, Compatibility, Perceived Risk, Opportunity to Try the innovation before committing to it (Trialability), and Communicability. Relative advantages of self-driving vehicles, for example, are cost and conveniences for passengers (no one has to drive). Opportunity to try the innovation, too, is an on-going process, from semi-autonomous to fully unmanned, autonomous vehicles.

Which variables are important for the implementation and acceptance of these vehicles? Sociologist Stephen Vago (1999) organizes potentially influential variables into four categories. As Vago (1999) points out, some of the variables in these categories tend to stimulate change whereas others tend to generate resistance to change. The first category focuses on *social variables*. The stimulants for change in this category include the desire for prestige, contact with people in other societies who are accepting of an innovation, and participating in the decision making. In the second category, *psychological variables*, the motivation to change and perceived needs can operate as stimulants to change. Seniors are, generally, more reluctant to try something new. Younger people tend to be less reluctant. That suggest that most people would eventually accept the stress-less aspect of self-driving vehicles. In the category of *economic variables*, cost and economic advantage are major factors affecting change. Is the innovation affordable? Will the innovation be a major improvement over previously-existing options with which a consumer are familiar? Like variables in the social and psychological categories, economic factors can either aid or hinder the acceptance of autonomous vehicles. The cost of these vehicles relative to the benefits they offer will figure into the decision to purchase one in the future. Vago's (1999) fourth category, *cultural variables*, includes the type of culture and the degree of cultural integration. For example, a low cultural context and/or low cultural integration would be the biggest hindrance to accepting autonomous vehicles. Since autonomous vehicles are still completely untested, they are not yet part of the fabric of national or global culture(s). Therefore, the potential impact of cultural variables is presently unknown.

Baby boomers (born between 1946 and 1964), especially, love their cars and trucks as they presently are. Using Rogers (1962) innovation adoption lifecycle terminology, this age cohort would fall into the *Laggards* category: the 16% of the bell-shaped curve who resist the adoption of an innovation. Interestingly, Generation X, generally those born between 1965 and 1976, would be considered part of the *Late Majority*, the 34% of the curve who adopt just *after* the "average" consumer; Generation Y, generally those born between 1977 and 1994, and would likely fall into the *Early Majority*, the 34% who adopt the innovation just *before* the average consumer; and Generation Z, generally, those born between 1995 and 2012, would fall into the small category (2.5%) of *Early Adopters*, consumers who would adopt an innovation relatively quickly. A lot of research conducted in the 1960's and 1970s attempted

to identify the characteristics of the individuals that fell into these categories. The evidence reporting the characteristics of the individuals falling into each category was inconsistent (Harper and Leicht 2011:244-245).

In sum, to maintain their mobility, older drivers must adapt to changing transportation conditions and do so soon. Automobiles, trucks and other hybrid vehicles, will become more complex, more efficient, and more innovative than any vehicle previously built. The rate of innovation in these vehicles has also increased dramatically. All car manufacturers have a target date range of between 2020 to 2030 for autonomous vehicles to be available for purchase (Kagayama 2017; Randall 2017). Whether that target date range is achievable remains to be seen. However, European automakers, including Mercedes, Volkswagen, and Volvo, are already at the forefront of the race to produce the first truly-autonomous vehicle. Therefore, this author speculates that the Europeans will likely win this race. However, the Chinese may surprise everyone by being the first nation to produce a fully-autonomous vehicle.

The *actions of powerful individuals* and *communication sources* also matter. For safety reasons, governments may either phase out or pull older vehicles off the highways to accommodate newer vehicles. One important concern is that newer, autonomous vehicles cannot communicate with older, semi-autonomous vehicles. Various popular media, especially social media and movies, will also influence people's views on autonomous vehicles. It is likely that more consumers will look at these new vehicles as convenient modes of transportation and not as troublesome, expensive vehicles which will replace their "beloved" vintage "toys." Will the new vehicles have the soul and personality attributed to much-loved, older vehicles?

From Model A to flying cars, driver-less trucks, and bus-train hybrids, our lives will be forever changed by these new vehicles. People will travel more; people will spend their time during travel quite differently--e.g., some will read a book, some will sleep, some will socialize with the other passengers, and others will work. With a huge drop in fatalities on roads, our lives will be far safer than in the past. Eventually, people's perspectives on autonomous vehicles will change and will accept them. Younger generations are already comfortable with these vehicles and, as these generations age, autonomous vehicles will be a way of life. Until manufacturers eliminate the glitches and problems in these vehicles (as of June 2017), we will have to wait until these manufacturers make the decision to release them for public and private use. In that world of the near future, once autonomous vehicles are standard on the road, Driver Safety courses will no longer be necessary.

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