

How Promoters of Autonomous Vehicles Sustain Confidence in Their Potential

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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Tesla has grown due to the popularity of its electric cars and the novelty of its machine-learning-based driver assistance algorithm. However, their assistance algorithm is widely misrepresented as “self-driving” technology and has led to crashes (McFarland, 2023) and fatalities (Lee, 2020). Similarly, high profile crashes from GM’s autonomous vehicle unit, Cruise (Wayland, 2022), and Uber’s Arizona fatality (Shepardson, 2020) are only some instances of AV’s failures to fulfill promises made by these tech companies and automakers. Despite the poor performance of vehicle automation, automakers and tech companies have sustained credibility in their systems through inventive marketing campaigns, misleading vocabulary, and invocation of the astonishing capacities of state-of-the-art technology.

Since 2018, when a defect in Tesla’s so-called “Autopilot” driver-assist system caused the fatal crash of Walter Huang’s Tesla Model X (Lee, 2020), experts, lawmakers, and safety advocates blame Tesla for exaggerating their self-driving features. Tesla has been sued for such claims, including “indicating that a fully self-driving, fully autonomous Tesla vehicle was just around the corner, often expressly stating that would occur by the end of that calendar year or ‘within the next year’” (qtd. in Mayorquin, 2022). In 2017, the Union of Concerned Scientists warned that “While self-driving vehicles have the potential to reduce vehicle-related fatalities, this is not a guaranteed outcome” (UCS, 2017).

Review of Research

Stilgoe (2018) suggests that “autonomous vehicles are not as heroically independent as their enthusiasts would have us believe, nor are they as autodidactic.” Machine learning’s quick growth and its black-box nature poses challenges for

governance as people are beginning to be shaped by its influences. With the growth of large but young Silicon Valley companies, self-driving cars must be a process of democratized social learning (Stilgoe, 2018). Nordhoff et al. (2023) published a study that conducted 103 in-depth interviews with users of Tesla's Full Self-Driving Beta (FSD) program that showed heavily reduced user behavior and perception. With Autopilot engaged, "drivers became complacent over time ... failing to monitor the system, and engaging in safety-critical behaviors" (Nordhoff et al., 2023). To prevent such misuse of technology, companies must have "extraordinary transparency regarding self-driving cars due to technical complexities and inevitable tradeoffs occasioned by this new technology" (Borenstein, Herkert, and Miller, 2017).

Li, Seth, and Cummings (2019) evaluated the safety of the Normal, Cautious, and All- Knowing versions of CoEXist, a self-driving algorithm. Each version corresponds to a degree of programmed risk aversion in driving performance. They found that "Fleets of AVs did not demonstrate large improvements for traffic efficiency and safety." Even the more cautious version took risks, such as accepting long passing times and slower acceleration, causing more traffic conflicts (Li, Seth, & Cummings, 2019). Brown and Laurier (2017) performed a study of Tesla and Google autonomous vehicle recordings show that autonomous vehicles do not provide enough transparency in driving scenarios and are often 'rude'. The cars moved into lanes too late (after offering cars begin to accelerate) and hesitated at intersections and did not 'creep' to reserve the turn (Brown and Laurier, 2017).

Philip Koopman, a researcher at Carnegie Mellon University, condemns the "drive-fail-fix" method typical of automated vehicle development (Koopman 2018).

Automated vehicles are susceptible to cyberattacks. Petit and Schladover (2014) identified cyberthreats to connected vehicles. Petit and Schladover (2014) found that GPS jamming, an inexpensive attack (about \$20), can prevent an antitheft system from locating a stolen vehicle. An EMP attack can damage onboard sensors and processors; maps can be poisoned to take control of navigation systems (Petit & Schladover, 2011). An article from Yaqoob et. al (2019) highlights the indispensable requirements for the successful deployment of autonomous vehicles. They divide potential attacks into physical access and man-in-the-middle attacks and require novel and effective authentication algorithms to ensure secure autonomous driving (Yaqoob et. al, 2019).

Electric vehicles are becoming increasingly adopted across the world. Alexander Wentland, the head of the Innovation Research Group in the Technical University of Munich, conducted ethnographic fieldwork over the course of 3 years (2012 to 2015) including over 30 recorded interviews and extensive document analysis regarding electric vehicle stakeholders in Germany. He found that the removal of barriers and incentives for these vehicles have allowed companies to begin focusing on smart grid infrastructures. These stakeholders imagine a future where EVs were integrated into smart electrical grids along with other sources such as wind and solar. The EV users will be compensated financially in exchange for making their vehicles available to grid operators and utilities, which would also lower their costs of ownership (Wentland, 2016). In Norway, one of the leading EV countries in the world, interviews with a diverse group of stakeholders explored the different concerns and expectations of technology developments and their influences on policy as of 2016. Approximately one half of the stakeholders had extensive experience as EV users and eight of the twenty interviewees participated in efforts to electrify Norway's transport sector. A clear common factor they found between these

stakeholders was price. They saw electrification as a strategy where the public need to be lured into electric mobility through economic incentives. Another aspect was safety, which was more than just meeting standard requirements in that it also included user perspective and feeling (Ryghaug & Toftaker, 2016).

Acceptance of self-driving also reliant on transparency. Graf and Sonnberger (2020) performed a qualitative analysis of text related to the stakeholders of self-driving vehicles in Germany where they found that “trust and acceptance” and “transparency and acceptance” were often used interchangeably, showing that stakeholders and the government must also have a shared understanding of their basic values. They found that “The Federal Ministry of Transport and Digital Infrastructure (BMVI), the Federation of German Consumer Organizations (vzbv), and the Association of German Transport Companies (VDV) claim that establishing a regulatory framework for autonomous driving will likely increase acceptance.” They also delve into the stakeholder perspective that citizens are holding irrational fears that “can and should be quelled by receiving adequate information.” However, there exists a large amount of competing research in this field that leads to a lack of undisputed knowledge that can be communicated to the public to quell these fears (Graf and Sonnberger, 2020).

Allegations against Tesla’s Self Driving

Despite the deficiencies in its automated driving systems, Tesla has denied responsibility for Huang’s death and for other fatal crashes, blaming driver error instead. According to Tesla, “the only way for this accident to have occurred is if Mr. Huang was not paying attention to the road.” However, the crash report shows that the vehicle

accelerated to 72.8 mph before the crash, likely giving him little time to react and redirect the steering wheel (Korosec, 2019).

Since October 2018, 5 months after Huang's crash, Tesla has released vehicle safety report information; such disclosures often assert that drivers are safer with Tesla's Autopilot. For example, in the 4th quarter of 2021, Tesla stated that "we recorded one crash for every 4.31 million miles driven in which drivers were using Autopilot technology For drivers who were not using Autopilot technology ... we recorded one crash for every 1.59 million miles driven" (Tesla, 2022). In fall 2018 Musk was under fire for stating falsely that Tesla would go private.

In 2016, Tesla CEO Elon Musk oversaw the creation of a promotional video that exaggerated Tesla's Autopilot abilities where Musk tweeted "Tesla drives itself (no human input at all) thru urban streets to highway to streets, then finds a parking spot" (Musk, 2016). At the same time, Tesla also released a statement falsely advertising their self-driving as full self-driving with the video in it stating, "Full autonomy will enable a Tesla to be substantially safer than a human driver, lower the financial cost of transportation for those who own a car and provide low-cost on-demand mobility for those who do not... We are excited to announce that, as of today, all Tesla vehicles produced in our factory – including Model 3 – will have the hardware needed for full self-driving capability at a safety level substantially greater than that of a human driver" (Tesla, 2016). In October of 2022, a Bloomberg report stated that Tesla is now being prosecuted for these claims, "prosecutors in the US Justice Department's Washington and San Francisco offices and investigators at the Securities and Exchange Commission were probing whether the company made misleading statements about its vehicles' automated-driving capabilities". The report also stated that Musk emailed his team before filming the demo

telling them that, “Since this is a demo, it is fine to hardcode some of it, since we will backfill with production code later in an OTA [Over-The-Air] update”. However, these capabilities were yet to materialize until more than six years later. This email also provides insight to Musk’s mindset at the time in that he himself was not fully confident in the car’s self-driving potential (Hull & O’Kane, 2023).

Fully Self-Driving Promises

On Musk’s Twitter, he often exaggerates Tesla’s self-driving features. In 2017, a Twitter user @tsrandall asked “At what point will ‘Full Self-Driving Capability’ features noticeably depart from ‘Enhanced Autopilot’ features?” with which Musk responded, “3 months maybe, 6 months definitely” (Musk, 2017). However, even until now in 2023, Tesla has failed to reach true full self-driving. Another failed promise was regarding Tesla’s ‘summon’ feature, where someone could call their vehicle to autonomously drive to the user’s location. Musk tweeted in 2016, “In ~2 years, summon should work anywhere connected by land & not blocked by borders, eg you're in LA and the car is in NY.” Replies to this tweet around that time were optimistic, with user @composite9 replying with “@elonmusk awesome, I’m getting a Tesla.” and @DPazdan responding with “so we’ll have 99.99% autonomous capability in 2 years then.” (Musk, 2016). However, users have gone back since that tweet with skepticism about whether the feature will ever be available at all. @brainstucki expressed his frustration with this response, “Fun fact. This tweet was one year after I leased my Tesla with full self driving. When I read it, I remember being bummed out that I would be returning the lease just as this was becoming possible.... ‘Twas much ado about nothing....” (Stucki, 2021). As of 2023, Tesla’s Model 3 Owner’s Manual gives a much smaller value for their Summon feature,

“Summon allows you to automatically park and retrieve Model 3 while you are standing outside the vehicle. Summon moves Model 3 forward and reverse up to 12 meters in, or out of, a parking space... To move Model 3 a longer distance while steering around objects, you can use Smart Summon and your mobile phone.” (Tesla, 2023a). Their Smart Summon feature, while a longer distance, is still nowhere close to Musk’s 2016 tweet, stating “Smart Summon works with the Tesla mobile app when your phone is located within approximately 65 meters of Model 3.” It also comes with many warnings and conditions for its use including, “You must maintain a clear line of sight between you and Model 3 and closely monitor the vehicle and its surroundings at all times... Smart Summon is designed and intended for use only on parking lots and driveways located on private property where the surrounding area is familiar and predictable. Do not use Smart Summon on public roads... Smart Summon may not stop for all objects and may not react to all traffic. Smart Summon does not recognize the direction of traffic, does not navigate around empty parking spaces, and may not anticipate crossing traffic.” (Tesla, 2023b). The contradictory information between Tesla’s official statements and Musk’s exaggerations leads to questions regarding the true reliability of Tesla’s self-driving features and its promises.

In 2022, Tesla began rolling out a Full Self-Driving Beta version available to all Tesla owners. Musk celebrated this in a tweet, “Tesla Full Self-Driving Beta is now available to anyone in North America who requests it from the car screen, assuming you have bought this option. Congrats to Tesla Autopilot/AI team on achieving a major milestone!” (Musk, 2022). However, this system was admitted by Tesla engineers to not exceed the capabilities of SAE Level 2, which requires constant driver attention at all times and hands on the steering wheel" (Ramey, 2022). Tesla also admits that it is not

fully autonomous, stating, “Autopilot, Enhanced Autopilot and Full Self-Driving Capability are intended for use with a fully attentive driver, who has their hands on the wheel and is prepared to take over at any moment. While these features are designed to become more capable over time, the currently enabled features do not make the vehicle autonomous” (Tesla, 2023c). In a blog post, Dutch-Canadian YouTuber Jason Slaughter tested “Tesla’s Full Self Driving (Beta)” and was terrified by this feature, “I tried the "Full Self-Driving (Beta)" on a Model Y in Toronto. It was terrifying. I turned off "aggressive" and "assertive" modes and "drive 20% higher than speed limit" (why are these even options?) It tried to drive in the bike lane to avoid traffic multiple times, it got totally confused by angled parking, it had to do an emergency stop to avoid hitting a pedestrian when turning right, plus dozens of other issues. At my destination it rammed right into a snowbank. Why is this legal?!” (Slaughter, 2022).

Another American electric vehicle manufacturer, Rivian, also provides driver assistance features and has a disclaimer on their website regarding their self-driving capabilities, “Is Rivian Driver+ a [SAE] Level 3 autonomous driving system? No, like all vehicles with driver assistance features available today, Driver+ requires your full attention on the road and you should be ready to take control of the vehicle” (Rivian, 2023a). However, when referring to their system, they are misleading in calling it hands free despite requiring full driver attention, “Driver+, delivering true hands-free driving ... capable of automatically steering and adjusting your speed on command. Driver+, like all driver assistance systems, requires your full attention on the road. You should not use a hand-held device behind the wheel” (Rivian, 2023b). Similar level 2 systems like Nissan’s ProPilot 2.0 and Ford’s BlueCruise are hands-on but are also hands-free where legally possible. Nissan states their restrictions as hands-off in a single lane but hands-on between

lane changes and Ford allows users to “operate your vehicle hands-free while being monitored... to make sure you’re keeping your eyes on the road... This feature is compatible on prequalified sections of divided highways called Hands-Free Blue Zones” (Nissan, 2023); (Ford, 2023).

Company and Consumer Skepticism of Full-Self Driving

Some electric car companies are also skeptical of full-self driving technology, with Chinese Electric Car company BYD stating that “Fully autonomous driving is ‘basically impossible’ and the technology would be better applied to manufacturing.” In a translation from CNBC, BYD spokesperson Li Yunfei stated, “When we think about [self-driving tech] from all aspects, from human psychological safety needs, from ethics, from regulation, from technology — including application in this industry — we haven’t figured out [the logic] and we think it is probably a false proposition” (Cheng, 2023).

Argo AI was an autonomous driving company that began in 2016 focusing on developing a SAE Level-4 self-driving system for AVs, which would be capable of driving in most conditions without a driver. Four months after it was founded, Ford and Volkswagen invested a combined \$1 billion into the company to create these vehicles with the intention of competing against self-driving companies in the industry (Coren, 2019). This optimism was short-lived, however, and Argo AI shutdown in 2022 with Ford reporting a \$827 million loss due to impairments on its investment in the company. Ford CEO Jim Farley stated that they were optimistic about L4 ADAs but recognized that fully autonomous vehicles are a long way off (Korosec, 2022). In Ford’s 2022 third-quarter earnings report, they stated that “Ford made a strategic decision to shift its capital

spending from the L4 advanced driver assistance systems being developed by Argo AI to internally developed L2+/L3 technology.” (Ford, 2022).

In a Reddit post asking the r/SelfDrivingCars subreddit about the imminence of full self driving, there are many conflicting opinions about its future. Users that have driven AVs tend to have estimates much larger than that of Musk. Raj_DTO stated “I used Comma OpenPilot couple of years ago (nowhere near FSD) ... The more I saw the things I do (eg anticipate other drivers’ actions), the more I realized that FSD has a long way to go. I’m not knowledgeable enough to predict how many years but in my mind, at least 4-5 more years.” Some redditors are also hopeful that the increase in AV usage will lead to much more data being used. TeslaFan88 posted “Waymo just launched in part of core Downtown Phoenix to the public ... I have no idea what usage is, but they have to have 40 cars or so at least ready to be used to keep up with demand...if they succeed, that's an incredible amount of data to make the world's two most experienced drivers. And that's a framework for continued growth with more safety confidence...Welcome to the exponential” (RedofPaw, 2022).

Advocacy Groups and Self-Driving Organizations

The Autonomous Vehicle Industry Association and Partners for Automated Vehicle Education (PAVE) represent member companies such as Cruise, Ford, and Motional, which want to protect their business from the reputational damage that overpromising can cause (AVIA, 2021; PAVE, 2022).

Advocates for Highway & Auto Safety are opposed to the expansion of exemptions from federal motor vehicle safety standards for AVs and are skeptical about the safety of such technology (Advocates for Highway and Auto Safety, 2023).

SAE International is a United States-based professional organization for engineering professionals that has provided many technical standards to the automotive and aerospace industry, including horsepower ratings and the SAE levels of autonomy which are commonly referenced in the self-driving industry (SAE, 2023). They separate vehicular autonomy into 5 levels with level 0 being no driving automation and level 5 being full driving automation. Their hope is that “These level definitions, along with additional supporting terms and definitions provided herein, can be used to describe the full range of driving automation features equipped on [motor] vehicles in a functionally consistent and coherent manner” and considers three primary actors in driving, which are “the (human) user, the driving automation system, and other vehicle systems and components” (SAE, 2021).

Conclusion

AV companies like Tesla and GM have misrepresented their driver-assistance systems with misleading vocabulary, labeling it “full self-driving” or “hands-free” technology. These systems are a long way from fully self-driving and are combined with a history of blame-shifting and broken promises. Without transparency and accountability, such an industry climate may only lead to disastrous consequences in the future.

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