

# **Trust in Autonomous Vehicles: A Study on Tesla and its Community**

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In the markets of our society there exists a level of trust between every consumer and producer. The products people use every day are assumed to be safe so long as their use instructions are followed reasonably. This bond between people and companies is particularly interesting, as there are many items used that are potentially life threatening if constructed carelessly. Products like cars, motorcycles, bikes, lawn mowers, can all produce dangerous outcomes if they are designed poorly. This fact is intriguing when considering the rapid advancement in the autonomous vehicle field. There are deadly consequences for poor design decisions, so those creating these cutting-edge devices are forced to assure the general user of their safety. The question that comes to mind is “How do companies and users co-produce trust in the radical new innovation space of autonomous vehicles?” The paper will focus on the rise of the Tesla group that has created a community around using their Autopilot feature. These topics will be examined through the framework of Users and Nonusers.

### **Users and Nonusers**

Understanding that the user is in control of testing out this new technology is key to observing how the Tesla community has propelled this prototypical technology forward. In her chapter *Placing Uses and Nonusers at the Heart of Technology*, Nelly Oudshoorn says that “Users can contribute to stabilizing – or destabilizing – new technologies” (Oudshoorn, 2019). This idea is relevant to the case of Tesla’s autonomous driving features, as the community of users are propelling the technology forward and shedding light on the benefits of its use. The technology being at a level of autonomy where the user can choose to use it or not has placed the user in control of how the technology is used and how others will perceive it. Additionally, Oudshoorn states that “nonusers” can also play a large role in the adoption of a new technology (Oudshoorn, 2019). In the case of Tesla these nonusers are significant and often vocal about their

choice and opinions about the product. The nonusers in this situation are interacting directly with the users, as all cars share the same infrastructure. Thus, it is important to analyze the users and community members driving this technology forward, as well as the nonusers critiquing the emerging relatively unregulated technology.

In the case of the nonusers interacting with the autonomous vehicle technology, the idea of test beds is useful to explore the different user and nonuser dynamics at play. Testing technologies in isolation only provides one level of assurance about its functionality, but test beds provide “benchmarks functionality and reliability that confirm (or refute) certain predictions” (Engels et al., 2019). A test bed in relation to autonomous vehicles brings to light all the nonusers that need to be considered. An autonomous vehicle test bed requires adapting to “existing relationships between drivers, bikers, pedestrians, police officers, insurers, local residents, passers-through, roads, street signs, digital infrastructures, etc.” (Engels et al., 2019). Many of these nonuser relationships are “legally codified” through various laws and regulations, and testing these relationships with a new user should follow in this way in order to increase chances of adoption (Engels et al., 2019). Thus, the scenario surrounding the Tesla test bed is unique, as they have bypassed the use of a small test bed and advanced towards a large-scale experiment with users and nonusers. Bypassing the small-scale testing stage is an intriguing decision, and the reaction of users and nonusers to this advancing technology will help reveal how it is being received.

### **Levels of Autonomy and Tesla’s Implementation**

To understand more about what level of risk is involved with autonomous vehicles, one must understand the five levels of autonomy within autonomous cars. Levels zero and one involve very little autonomy, but as the number increases so does the driver control decrease

(Garcia et al., 2015). Level two includes systems like assisted braking, and at level three the car can perform most tasks but still needs human intervention (Garcia et al., 2015). Level three assumes that the car can perform all critical functions under some conditions (Garcia et al., 2015). Finally, the holy grail of autonomous cars is level four, as there is zero human interaction needed with the vehicle (Garcia et al., 2015). From these five levels, it can be reasoned that as the level of autonomy increases so must the level of trust in the autonomous vehicle increase.

To understand more about the technology, the features of Autopilot should be discussed. Autopilot, as defined by Tesla, is “an advanced driver assistance system that enhances safety and convenience behind the wheel” (*Autopilot and Full Self-Driving Capability*, 2020). Basic Autopilot allows for Traffic-Aware Cruise Control and Autosteer. Additionally, directly following this information Tesla writes “the currently enabled Autopilot and Full Self-Driving features require active driver supervision and do not make the vehicle autonomous” (*Autopilot and Full Self-Driving Capability*, 2020). This information is noteworthy as it places all of Tesla’s technology at Level 2 autonomy, requiring constant human intervention to operate. Anyone who has purchased a Tesla with this software pack can use these features, and the site also provides warnings against driver complacency while operating in these modes (*Autopilot and Full Self-Driving Capability*, 2020).

### **Riskiness of Tesla’s Autonomous Vehicles**

The level of risk of the technology being discussed must be determined, as more influence is necessary to motivate use of technologies with higher risks. Tesla is a unique operator in the autonomous driving space, as it is one of the few companies that places control of the technology in the hands of the user. Other companies such as Waymo and Cruise control all the enabling of the technology, while Tesla users can turn on or off the technology with the press

of a button. Thus, the user assumes the risk of the vehicle control, and many have criticized Tesla for creating such a system. The primary cause of the risk is the need for the user to observe the road constantly while the autonomous system is engaged. While the system is engaged, users are tempted to glance away from the road and perform other tasks (Lin et al., 2018). A study showed that even a two second glance away from the road while the system was engaged increased the likelihood of a crash (Lin et al., 2018). The primary risk with these systems is that humans tend to be poor system monitors, especially for extended periods of time (Lin et al., 2018). In fact, a study found that while using Autopilot, ninety percent of users reported that they performed activities outside of monitoring the road while driving (Lin et al., 2018). Among those, several activities would not allow for the driver to take over in the case of an emergency, as tasks like putting on make-up and playing phone games require heavy attention (Lin et al., 2018).

Use of partially autonomous systems like Tesla's Autopilot differs for each user. A study was done to analyze the use of both manual driving systems as well as partially automated systems using a questionnaire ranking from 1 (never) to 6 (at least five times a week) (Nordhoff et al., 2021). This study found that respondents reported a mean of 2.17 when asked if they do other activities while the car is operating partially autonomously (Nordhoff et al., 2021). Additionally, respondents indicated that they always monitored the road 62% of the time when operating partially autonomously, compared to 79% when operating manually (Nordhoff et al., 2021). Another study particularly centered on users engaging with the Tesla Autopilot system found that "a driver may not monitor the system as closely as is warranted due to the perception of high system reliability" (Banks et al., 2018). Users of Autopilot were quoted as saying "it is so easy to get used to this" highlighting the problem of human monitoring, as attention will decay the longer the human has to engage with the system (Banks et al., 2018).

## **Consequences**

While the need to pay attention may seem pointless if the system is robust, a lapse in focus can have severe consequences. The technology is risky, imperfect and there have been fatal crashes as a result. In one instance in August 2019, a Tesla Model 3 slammed into the back of a Ford Explorer, killing a fifteen year old boy (*Tesla Says Autopilot Makes Its Cars Safer. Crash Victims Say It Kills. - The New York Times*, n.d.). This situation occurred while the Tesla driver had Autopilot engaged, and the system failed to detect the truck in front (*Tesla Says Autopilot Makes Its Cars Safer. Crash Victims Say It Kills. - The New York Times*, n.d.). Similarly, there have been three fatalities of Tesla drivers using Autopilot since 2016 (*Tesla Says Autopilot Makes Its Cars Safer. Crash Victims Say It Kills. - The New York Times*, n.d.). Thus, the dangers of such a technology come from both the human aspect and the unforgiving nature of high-speed automobiles.

## **User's Motivation for Assuming Risk**

The motivation for taking on risk should also be discussed, as the merits of the technology are important to its proliferation. Several users of the Autopilot system were interviewed, and their responses regarding what they did while Autopilot system was engaged were recorded. The majority of responses regarding their motivation to use Autopilot involved their mobile phones with one user stating, "Autopilot gives me more time to talk via Wechat on my phone" (Lin et al., 2018). Similarly another user admitted, "As soon as I use Autopilot, I play on my phone" (Lin et al., 2018). The evidence shows that users take the time given by Autopilot to do things like using their phones to chat. Again, the fact that human users are in control of the technology allows for them to circumvent the safety systems in place for the Autopilot system.

The users are driving the technology forward, revealing that the primary motivation for their use is to do tasks they could not normally while driving.

Some users do things that completely take their attention away from the road with one user saying, “I have to admit I take selfies” and another saying, “You know as girls, sometimes there’s a need to edit photos. Autopilot can help me and then I can do it while driving” (Lin et al., 2018). In this instance, the driver would be completely distracted and unable to perform any monitoring on the vehicle. In regards to why all these users trust the software, many of their responses appear to show a great trust in the Tesla brand and CEO Elon Musk (Lin et al., 2018). Another source of trust is the consistency with which it operates with one user saying, “Nothing serious has happened yet. Everything it does never surprises me. It is trustworthy” (Lin et al., 2018). Thus, the desire to do these other activities and the trust in the system has propelled the technology forward in a way that these users are taking advantage of the system in a dangerous fashion. However, there was a notable nonuser in the group that is “afraid to trust it” as they are “more reliable” when driving (Lin et al., 2018). This group of users also demonstrates how their community pushes them towards use as “There is a lot of information on the Internet. I just read it and learned about the Autopilot,” showing how the internet presence of Tesla users informed this person’s usage (Lin et al., 2018). A smaller community was also revealed as one user has a local “Wechat group” to “discuss the Autopilot,” saying that “if someone comes across a dangerous situation, all of us will try to avoid that situation” (Lin et al., 2018). In this situation, a micro-community of users of this system has formed, galvanizing this groups use of the system. There are several reasons that people are motivated to use this feature, and the trust in the company and the system has allowed for its use.

**Who is pushing this technology forward?**

The identity of the group of users that are propelling these innovations forward must be considered. The largest conglomeration of Tesla users exists on the forum *Tesla Motors Club*. On this site Tesla users and nonusers engage in discussions about a wide range of topics related to the ecosystem of Tesla cars. A study was conducted to determine the make-up of this forum and it indicated a “large participant diversity” and a “strong sense of community” (Meelen et al., 2019). Additionally, the average user was found to be white and male, with an average age of forty years (Meelen et al., 2019). The study found that the socio-economic diversity of such users was found to be relatively small, as many identified as entrepreneurs or business owners in the IT sector (Meelen et al., 2019). However, the diversity of the professionalism of the users was found to be high. While there are a sizeable amount of “pure” users that are Tesla users and owners, another group was found to be those who had some ownership of Tesla accessories and charging points for sale (Meelen et al., 2019). These members have a larger investment in the success of the company than those who are simply fanatics about the technology. The forum also provides for real-world actions, as people are connected enough to the community to attend meet-ups in-person as well as providing help to users who have troubles with the technology (Meelen et al., 2019). Finally, animosity exists in the forum to those who are not committed to the same cause as many of the users are, as degradation of doubters and people who use regular cars, “dino-juice burners,” exists in the forum as well (Meelen et al., 2019).

### **Tesla Community Push**

A discussion of how the Tesla community pushes the technology forward through responses to accidents involving the Autopilot system should be had. On the *Tesla Motors Club* site, there have been multiple instances of accidents involving the system reported by users. On one occasion a user posted complaining that his car did not stop in time to avoid hitting the car in



front, resulting in a crash (Koskinen et al., 2019). A lengthy discussion occurred in the forum following this post with many users emphasizing “The car doesn't drive itself, it's driver assistance, not self-driving” (Koskinen et al., 2019). In this situation users experimenting with the technology are being criticized by other users of the technology. Concerns raised about the riskiness of the technology are dismissed as the user complaining is expected to take more ownership of the technology they trusted. In these threads users acknowledge the problem of human control and complacency with one user writing “Yeah, the fact that it works really well for long stretches of freeway, and then suddenly fails for a variety of reasons, is the real problem. It really does lull you into complacency” and that it is “human nature to get sloppy” (Koskinen et al., 2019). This writer acknowledges that the technology is good for a reason as well as bad for another, emphasizing that the human element is what is dangerous about the technology. Yet, other users identify the human element as the reason the technology is not at fault. Nonetheless users create deep connections with this technology and pride themselves on discovering how it reacts to certain situations, as some users have “been able to develop preconceptions on how the technology may behave in different situations and then prepare their own actions as a strategy for those situations, thus growing more confident that they are in control of the situations and can cope with using the automation” (Koskinen et al., 2019).

The user's relationship with a growing technology has also seemingly created a bond between the software and the driver. User's also are more interested in advancing technology when they are included on the details of its creation (*CHI EA '19: Extended Abstracts of the 2019 CHI Conference on Human Factors in Computing Systems*, 2019). A community of online users that are “particularly interested in Autopilot features” was found to be more enthusiastic as they learned about the follow-at-a-distance feature within the technology (*CHI EA '19: Extended*

*Abstracts of the 2019 CHI Conference on Human Factors in Computing Systems*, 2019). These users are “in a good position” to “do some of the work of making the technology more socially competent and accessible” (*CHI EA '19: Extended Abstracts of the 2019 CHI Conference on Human Factors in Computing Systems*, 2019). The community sharing how they believe the technology will react further pushes the technology forward as the sense of ownership of the users grow.

Additionally, reactions to accidents show that even in the face of tragedy and controversy, this group of users continues to push the technology. A study was done on Twitter posts following an accident involving Autopilot (Jefferson & McDonald, 2019). In the accident a driver was confused when their Tesla misinterpreted a lane and crashed into multiple road signs (Jefferson & McDonald, 2019). The study involved a sentiment analysis on the tweets related to the event, and it was found that even with the large negative news for the technology, there were equally as many positive tweets as negative tweets about the crash (Jefferson & McDonald, 2019). There was a notable drop, however, in the number of positive tweets compared to the days prior to the crash (Jefferson & McDonald, 2019).

In contrast to the user group, there exist nonusers that are skeptical of this technology as well. One user made it clear that their previous trust in the technology had diminished saying, “But these highly reported accidents, together with many unreported others, and my own experience have lead me to now be more cautious and wary of the features, as there definitely are a few cases in which it just doesn’t respond adequately” (Koskinen et al., 2019). These types of posts also contribute to the advancement of the technology. Oftentimes posts like these in the community are met with pushback, with users claiming the human is in control and must take ownership. This form of pushbacks locks in the most dedicated users, while it can make those

not confident more unsure about the technology. The interaction of these users is key to how the technology develops and to how it is perceived. For all of these different cases, the community is dictating the response to this risky technology, pushing and pulling at the level of trust in the community.

## **Discussion**

Several different aspects of the system and its use with regards to users and nonusers have been discussed. The framing of testing a system such as Autopilot revolves around users and nonusers of the technology. In releasing Autopilot to the community at large, Tesla have created a test bed of users and nonusers that is larger than a small experiment. Without consent many nonusers have been placed into the grand experiment of Tesla's autonomous driving ecosystem. Risk was also discussed, as the human factor in Tesla's is what differentiates it from other AV brands. Placing the control of the technology in the user's hands has had consequences that have not seriously hindered the pushing forward of the technology yet. Research shows that humans are bad at monitoring semi-autonomous systems, but these technologies are active, nonetheless.

The primary motivation to take on the risk was discussed with many of the users claiming that performing common mobile phone actions was the reason people were interested in using Autopilot. Another fact that was revealed was the community and brand around Tesla were the primary reasons these drivers trusted their lives with the system. These drivers were willing to give up the wheel because of their faith in the system. Perhaps what is most vigorously advancing the technology besides Tesla is the community surrounding its products. The broader online community of Autopilot users was discussed and discovered to be homogenous in makeup. The online forums the community acts in serve to be a place for primarily glorifying the

system and discrediting those who go against the grain. The community's response to accidents was also discussed, and oftentimes the drivers of these vehicles are blamed with little mention of the technology. The users of the technology are giving it a free pass in failure, but only if the driver of the vehicles is not being attentive. The technology is clearly being pushed forward by these groups of users who trust in the system and are much quicker to blame individual users than the technology or the company.

The ecosystem of users and nonusers involved with Tesla Autopilot is undeniably intriguing, but it demonstrates a haphazard approach that can be troubling. While engineers and developers at Tesla may have confidence in their product, nonusers of this technology are nonconsenting members in a large study. One cannot help but question the ethics of testing new technologies on parties not actively involved. Additionally, the online community groupthink parallels toxic, cultish culture and does not lend itself to accept more users that will eventually need to join this ecosystem. Thus, from my analysis additional regulation is needed surrounding programs such as Tesla's. The grand experiment they are conducting has had victims and will continue to cause harm if nothing in their system changes.

## References

- Autopilot and Full Self-Driving Capability*. (2020, May 15).  
[https://www.tesla.com/en\\_AE/support/autopilot-and-full-self-driving-capability](https://www.tesla.com/en_AE/support/autopilot-and-full-self-driving-capability)
- Banks, V. A., Eriksson, A., O'Donoghue, J., & Stanton, N. A. (2018). Is partially automated driving a bad idea? Observations from an on-road study. *Applied Ergonomics*, *68*, 138–145. <https://doi.org/10.1016/j.apergo.2017.11.010>
- CHI EA '19: Extended Abstracts of the 2019 CHI Conference on Human Factors in Computing Systems*. (2019). Association for Computing Machinery.
- Engels, F., Wentland, A., & Pfothenauer, S. M. (2019). Testing future societies? Developing a framework for test beds and living labs as instruments of innovation governance. *Research Policy*, *48*(9), 103826. <https://doi.org/10.1016/j.respol.2019.103826>
- Garcia, D., Kreutzer, C., Badillo-Urquiola, K., & Mouloua, M. (2015). Measuring Trust of Autonomous Vehicles: A Development and Validation Study. In C. Stephanidis (Ed.), *HCI International 2015—Posters' Extended Abstracts* (pp. 610–615). Springer International Publishing.
- Jefferson, J., & McDonald, A. D. (2019). The autonomous vehicle social network: Analyzing tweets after a recent Tesla autopilot crash. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, *63*(1), 2071–2075. <https://doi.org/10.1177/1071181319631510>
- Koskinen, K. M., Lyyra, A., Mallat, N., & Tuunainen, V. (2019, January 8). *Trust and risky technologies: Aligning and coping with Tesla Autopilot*. <https://doi.org/10.24251/HICSS.2019.697>
- Lin, R., Ma, L., & Zhang, W. (2018). An interview study exploring Tesla drivers' behavioural adaptation. *Applied Ergonomics*, *72*, 37–47. <https://doi.org/10.1016/j.apergo.2018.04.006>
- Meelen, T., Truffer, B., & Schwanen, T. (2019). Virtual user communities contributing to upscaling innovations in transitions: The case of electric vehicles. *Environmental Innovation and Societal Transitions*, *31*, 96–109. <https://doi.org/10.1016/j.eist.2019.01.002>
- Nordhoff, S., Stapel, J., He, X., Gentner, A., & Happee, R. (2021). Perceived safety and trust in SAE Level 2 partially automated cars: Results from an online questionnaire. *PloS One*, *16*(12), e0260953. <https://doi.org/10.1371/journal.pone.0260953>
- Oudshoorn, N. (2019). Placing Users and Nonusers at the Heart of Technology. In T. L. E. Pittinsky (Ed.), *Science, Technology, and Society: New Perspectives and Directions* (pp. 163–175). Cambridge University Press. <https://doi.org/10.1017/9781316691489.007>

*Tesla Says Autopilot Makes Its Cars Safer. Crash Victims Say It Kills. - The New York Times.*  
(n.d.). Retrieved March 4, 2022, from <https://www.nytimes.com/2021/07/05/business/tesla-autopilot-lawsuits-safety.html>