BETTER TECH FOR TOMORROW

RESPONSIBLY USHERING IN AUTONOMOUS VEHICLES IN TEXAS

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KEY POINTS

- **While technological hurdles** have stalled the development of fully self-driving vehicles, tremendous progress has transpired in the last decade.
- **While the federal government** plays a pronounced role in traditional transportation policy, without federal laws on self-driving vehicles, Texas has led in codifying its own laws.
- **Despite the opportunities** that self-driving vehicles present for humanity, there are significant threats that policymakers ought to consider when crafting legislation.
- **Texas should advance** legislation that promotes driver autonomy and privacy, and should bolster collaboration among companies testing the technology, relevant state agencies, and emergency responders.

EXECUTIVE SUMMARY

Autonomous vehicle technology has existed for decades, but the path to mass adoption has quickened dramatically over the last decade. Like any other technology, self-driving vehicles are a tool that can be a force multiplier for good, while also introducing consequential challenges to human liberty, dignity, and individual autonomy. This paper explores the animating facets of this technology—namely, the technological, business, policy, and consumer-protection aspects associated with self-driving vehicles.

Of particular importance to lawmakers and regulators is the fragmented nature of the public policy framework currently in place. While this paper does not explore legislative solutions at the federal level, it is worth noting that a federal framework will be a necessity soon to ensure the seamless flow of autonomously shipped goods and persons across state and international boundaries. However, this research does unpack the existing rulemaking authority of federal agencies tasked with overseeing transportation, the various state policies currently governing this technology in Texas, and novel policy recommendations lawmakers should consider. Moreover, this analysis is provided through the lens of balancing Texas' pursuit of being the preeminent innovator in this sector while prioritizing human safety, dignity, and autonomy.

Finally, this paper takes an objective look at the broader opportunities and threats of self-driving vehicles. This includes opportunities for enhanced safety and mobility, efficiency, and public planning, while analyzing threats for safety, cybersecurity, liability, and vehicular autonomy over human autonomy. In addition to the fundamental economics and safety of autonomous vehicles, this paper contends with the sociocultural considerations of an unfettered policy regime surrounding this technology. In conclusion, this analysis guides concrete policy recommendations the Texas Legislature should consider during the 89th Legislature.

OVERVIEW OF SELF-DRIVING VEHICLE TECHNOLOGY

A Brief History of Self-Driving Vehicle Technology

The prospect of self-driving vehicles has captivated the imagination of inventors, engineers, researchers, and the lay public for centuries. Conjuring images of futuristic, hyper-efficient societies, we are now at a point in the innovation cycle where average Texans are interacting with self-driving vehicle technology, even if they do not realize it.

Before examining what it means when companies boast of "self-driving capabilities," a brief history of the technology is warranted. The idea of a self-driving vehicle traces as far back as the 15th century, with polymath Leonardo da Vinci designing a spring-propelled cart that could steer itself down a predetermined path (Da Vinci Inventions, n.d.). This invention inspired centuries of tinkerers, and by the 20th century, committed engineers began creating software for crude self-driving vehicles. This includes General Motor's foray into designing a radio-controlled electric vehicle for the 1939 World's Fair to later efforts by Stanford researchers to create self-driving carts at the zenith of the space race (Baker, 2017). While many of these projects were associated with the broader pursuit of innovation, researchers and engineers also explored this technology in hopes of engendering safer roads, increased productivity, enhanced mobility, and more.

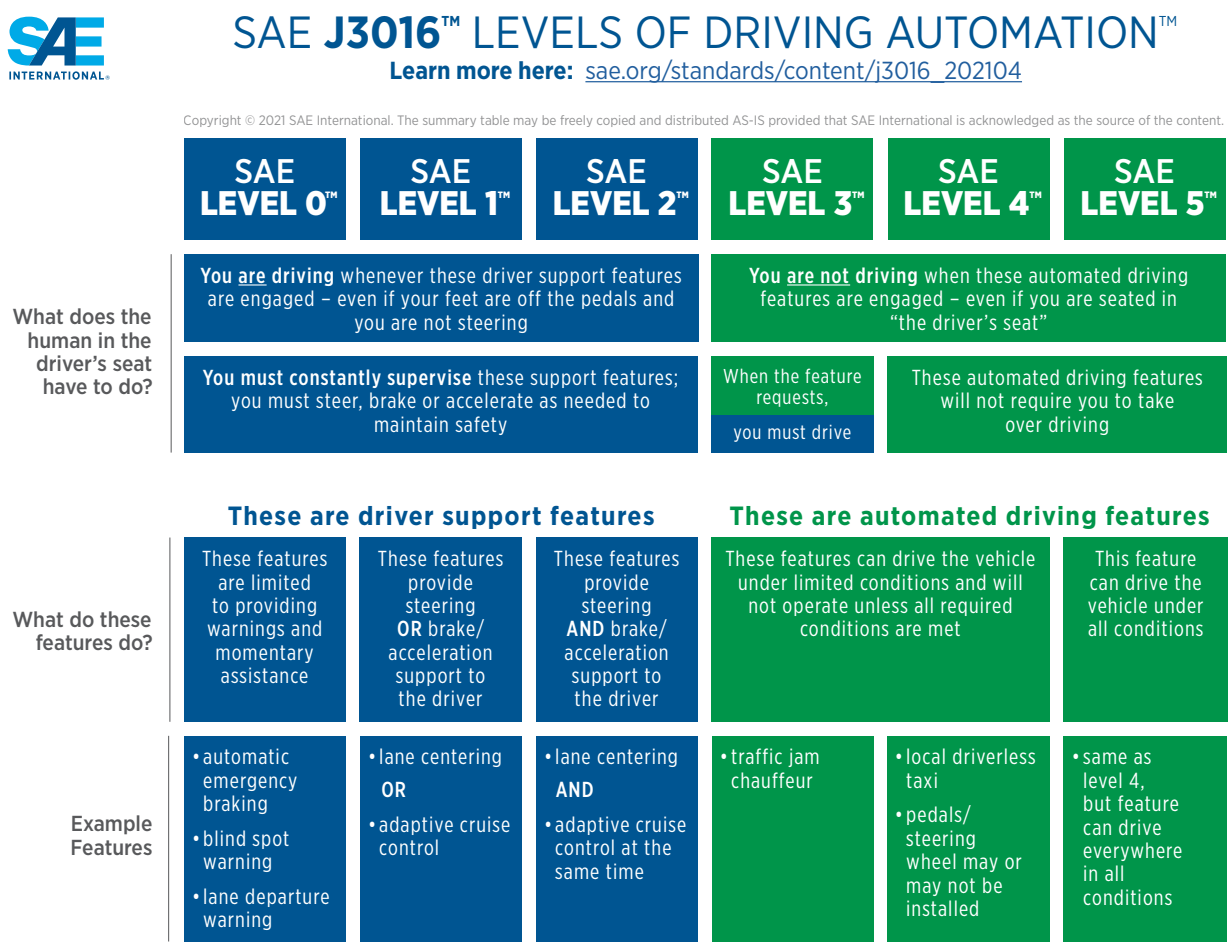
The U.S. Defense Advanced Research Project Agency (DARPA) recognized this same potential, initiating a self-driving vehicle competition in the early 2000s (called "The Grand Challenge") with the aim of fast-tracking innovation in America (DARPA, n.d.). By the mid-2010s, research and development evolved from what was originally a purely Department of Defense-driven objective, with major automobile manufacturers like Ford and Mercedes and ride-sharing companies investing in self-driving technology of their own (Glon & Edelstein, 2020). And while safety and broader economic benefits remain a strong motivating factor for ushering in this technology, there is great private sector interest in developing self-driving cars for pecuniary interest as well. For ride sharing companies, virtually all driver costs could be reduced by transitioning to autonomous cars; for automobile manufacturers, many are racing to be the first to capitalize on the growing demand for advanced driver assistance systems in consumer and commercial vehicles (Cheng, 2022).

Defining Autonomous Driving

While autonomous driving is colloquially understood to mean a car that can drive on its own sans driver intervention, the technical definition offers more nuance that is crucial to policy discussions. SAE International, a globally-active professional association of automotive engineers founded by Henry Ford to develop standards for the industry, created the de facto taxonomy and definitions for driving automation systems (SAE International, 2021). The standards, commonly referred to as the SAE Levels of Driving Automation, provide a yardstick to industry and regulators for determining how advanced the technology in question is. There are six levels, illustrated below and in **Figure 1:**

- **Level 0** is no driving automation. The driver is fully responsible for controlling all aspects of driving.
- **Level 1** is basic driver assistance, such as adaptive cruise control and lane centering. The driver must constantly supervise these support features, maintaining control over steering, braking, or accelerating to maintain appropriate safety.
- **Level 2** is partial driving automation, which includes features like lane centering and adaptive cruise control at the same time. These features are intended to support the driver with braking and acceleration functions, while still demanding full supervision of the driver.
- **Level 3** is conditional driving automation, known as the "eyes-off" system, where the car can make situational decisions and operate independently of the driver, though he must be alert and ready to take over. One such feature is traffic jam

Figure 1



Note. Data from https://www.sae.org/blog/sae-j3016-update

chauffeur, which allows the vehicle to drive itself under constrained conditions and requires the human to take over when prompted.

- **Level 4** is high driving automation, allowing a car to fully drive itself in limited conditions and jurisdictions. For example, when GM's Cruise self-driving vehicles were offering driverless taxis to residents of Austin and San Francisco in a defined geographical region, they operated at Level 4 (Hawkins, 2020). At this level, pedals and steering wheels may or may not be installed.

- **Level 5** is considered full driving automation, when a car is fully autonomous and able to drive anywhere in all conditions. At this phase, pedals and steering wheels are not necessary.

Level 2 is currently the most prominently available level of autonomy in new household vehicles. Current examples include Tesla's autopilot and Nissan's ProPILOT, but the list continues to grow every year. As of this publication, Level 3 is currently the highest level of autonomy available for purchase in new vehicles. In September 2023, Mercedes-Benz debuted its Drive Pilot, making them the world's first certified SAE Level 3 system in the American automobile market (Mercedes-Benz, 2023). Waymo's robotaxi (in addition to GM's Cruise division) operates at Level 4 autonomy. While no driver is needed for the robotaxi to navigate the cities of San Francisco and Phoenix, the car is not "fully autonomous," as it can only operate along a constrained, predetermined path, and is only available to consumers as a ride-hailing service (Waymo, n.d.). At the time of this publication, there are currently no Level 5 autonomous vehicles (Threewitt, 2023).

Projected Timeline for Level 5 Autonomy

Leading innovators competing in the race toward full self-driving vehicle deployment have spoken in terms that tend to overpromise and underdeliver. Scores of executives have hyped up this technology and made overly optimistic promises for when consumers will be able to jettison their driver's licenses (McFarland, 2022). In 2015, Elon Musk (the CEO of Tesla) declared that self-driving vehicles would be capable of driving in all environments by no later than 2018. Former Lyft CEO John Zimmer said that their push for full autonomy would result in the end of car ownership as we know it by 2025. Former Waymo CEO John Krafcik has appeared to be more realistic about this schedule, as in 2018, he told consumers that it would take quite some time before fully autonomous self-driving cars would be ready for mass deployment (Mims, 2021).

With the contrasting and ever-changing timelines given by the biggest players in self-driving technology, pinpointing the exact release date is nearly impossible. Some of the factors influencing the development of Level 5 AVs include regulatory hurdles, access to robust data, safety concerns, consumer sentiment, and technological obstacles that have yet to be surmounted. Because the externalities associated with the automobile sector are much more significant than other areas (like consumer electronics), and due to the highly dynamic nature of public roads, the complexity of regulations and computer systems required for this technology is far more advanced than that of even the aircraft sector (Litman, 2023).

Putting Pollyannaish industry hype aside, the debate on when fully self-driving vehicles will come to market can be separated into two camps: the optimists and the skeptics. The optimists are of the belief that most vehicles will operate fully autonomously by 2030, while the skeptics conclude that it will take decades before a vehicle can operate at Level 5 (Litman, 2023). Regardless of the exact release year, the reality is that there are strong economic, cultural, political, safety, and pecuniary incentives propelling the advancement of this technology. Given that it is not a matter of "if" but "when" this technology is released, lawmakers at the state and federal level have an opportunity and a duty to get ahead of this technology by developing responsible, innovative frameworks before the horse is out of the barn.

WHOSE LANE? THE FEDERAL, STATE, AND LOCAL TENSION

Across the United States, the regulatory landscape for self-driving vehicles is fraught with competing interests. This has materialized in numerous ways, perhaps none more pronounced than the divergent approach that state and local governments are taking to address this technology. Comparatively, this tension is far less salient in the traditional automobile sector, given that the delineation of power between levels of government is more clearly construed, as this sector has decades of precedent and accepted practices. Below is a breakdown of the federal government's role, the legislative framework adopted by Texas, and how local governments fit into the regulatory mix.

The Federal Government's Role in Autonomous Vehicles

Several federal agencies oversee automobile safety and activity. Congress has the constitutional, legislative, and legal authority to regulate interstate commerce, meaning that all travel and commerce between states is governed by federal laws and regulation where they exist (LawInfo, n.d.). The U.S. Department of Transportation (DOT) is the federal agency tasked with setting transportation policies and regulations, and oversees various modes of transportation, such as the highway system (DOT, n.d.). The National Highway Traffic Safety Administration (NHTSA), an agency within DOT, strives to reduce deaths, injuries, and economic losses from motor vehicle crashes "[t]hrough enforcing vehicle performance standards and partnerships with state and local governments" (National Highway Traffic Safety Administration, n.d., para 1). One of NHTSA's main roles is the testing of vehicles and equipment to ensure they are safe and ready for sale to consumers, in accordance with the Federal Motor Vehicle Safety Standards (FMVSS).

Currently, there is no comprehensive federal legislative framework overseeing the development and deployment of self-driving vehicles. In recent years, members of Congress have introduced bills that would provide enhanced clarity on the licensing, testing, and deployment of such technology; however, none have been enacted (Savrin & Fanelli, 2022). While industry groups such as the Autonomous Vehicle Industry Association (AVIA) have been active in urging Congress and the DOT to "assert its jurisdiction over the design, construction, and performance of motor vehicles, including those deploying emerging technology," there has been robust disagreement on the specifics of legislative and agency action (AVIA Letter to Transportation Secretary Pete Buttigieg, n.d.). Specifically, there has been disagreement over the delineation of state versus federal authority concerning vehicle registration, the powers that ought to be granted to the federal government for vehicle safety, and what authority should be reserved for the states for licensing and registration. Additional disagreement exists over whether and what types of federal safety standard exemptions should be granted by NHTSA for autonomous vehicle testing, how to address cybersecurity risks, and how best to institute a data-sharing ecosystem for this technology (Canis, 2019).

State Policy

Absent a comprehensive federal framework, state policy has played a significant role in setting the rules of the road. As of this publication, there are 29 states (plus the District of Columbia) that have enacted laws concerning the regulation and use of self-driving vehicles. Governors in 10 of those states have issued executive orders on the subject, and out of the 11 states lacking oversight laws, nine have either introduced relevant bills or attempted to pass them (Stauffer & Larson, 2024; Autonomous Vehicles State Bill Tracking Database, 2024). The breadth of state policy governing this technology is certainly wide, with laws dealing with issues such as cybersecurity, insurance, and data sharing, but the common focal points include licensing, testing, defining key terms, and registration. Moreover, the animating philosophy behind such laws varies, with states like Arizona inclined to be more laissez-faire, and states like California tending to be more regulatorily cumbersome. Divergent policy regimes aside, the inaction at the federal level and the continued technological improvements of self-driving cars have triggered momentum in statehouses across the country.

Texas has enacted a series of laws that set the rules of engagement for this technology in the Lone Star State. Below is a list of self-driving vehicle laws codified since 2017:

- Senate Bill 2205, introduced by Sen. Kelly Hancock and signed by Governor Greg Abbott in 2017, established the regulatory framework for self-driving vehicles in Texas. Importantly, it introduced clear definitions of key terms, it precludes political subdivisions and state agencies from introducing new regulations of their own, it established the owner of an automated motor vehicle as its operator and licensee, it permitted the use of automated motor vehicles in Texas without an operator present, and it clarified a series of requirements for autonomous vehicles to operate on state highways. With the operator classification, this law holds the operator responsible in the event of an accident.

- House Bill 1791, introduced by Rep. Joseph Pickett and signed by Governor Greg Abbott in 2017, permitted the use of connected braking systems by operators following another vehicle equipped with this technology to assist vehicles in maintaining "an assured clear distance or sufficient space."

- Senate Bill 1308, introduced by Sen. César Blanco and signed by Governor Greg Abbott in 2021, authorized the Texas Department of Transportation, the Texas Department of Public Safety, and the Texas A&M Transportation Institute (in concert with federal agencies) to conduct a study on the benefits of autonomous driving technology and the overall impacts it will have on the Texas economy, workforce, and public. The report was to be submitted no later than January 1, 2023, with findings made public in December 2022.

- House Bill 3026, introduced by Rep. Terry Canales and signed by Governor Greg Abbott in 2021, clarified the regulatory differences between human-operated vehicles and automated motor vehicle. Specifically, this law creates a framework to prevent duplicative vehicle inspections and vehicle operations regulations.

Senate Bill 2205 is the law with the greatest significance, situating Texas as a state that provides regulatory consistency and clarity that is attractive to automobile companies looking to test their self-driving vehicles. Many companies innovating in the commercial vehicle and trucking sectors see Texas as the ideal location, and thus choose to invest heavily in the state because of this regulatory framework. Additionally, the available infrastructure and collaborative approach that TxDOT takes to work with (not against) the industry makes Texas all the more enticing (Bellon, 2022). Because of the lack of data available to accurately pinpoint the number of autonomous vehicles being tested in cities across the country, it is difficult to say which state boasts the greatest number of vehicles on the road at any given time (Reyes, 2023). However, Senate Bill 2205 serves as a model for the industry, as companies attempt to export similar legislation to surrounding states to provide consistency across state lines. As will be discussed later, preferential standards for industry have come with a cost of increased consumer skepticism and, in some cases, consternation.

Local Government Policy

As established above, Texas' Senate Bill 2205 explicitly preempts local governments from enacting policy contrary to state law. While other states that lack this preemptive language see cities take on a much more involved role in the regulation and permitting of self-driving vehicle testing and deployment, Texas cities involve themselves in the process as partners to autonomous vehicle companies (Paul, 2024). Namely, cities like Austin, Texas, provide information on local transportation networks, assist in the collection and dissemination of pertinent data, and interface with members of the city to solicit feedback and take inventory of public sentiment (City of Austin, n.d.). As will be discussed later, however, this regulatory hierarchy has proved troublesome for local emergency responders.

OPPORTUNITIES AND THREATS

Just as with all other technology, self-driving vehicles are a tool that can induce positive and negative outcomes. This section will unpack arguments advanced by self-driving vehicle optimists and skeptics, conveying both sides of the coin in the debate surrounding what a responsible approach to this technology truly looks like.

Safety – Opportunities

Every year, tens of thousands of auto fatalities occur in the United States. In 2022, roughly 43,000 people died in motor vehicle crashes (National Highway Traffic Safety Administration, 2023). The U.S. DOT found that 94% of all traffic accidents are attributed to human error, contributing to billions of dollars in damages and tens of thousands of automobile accident-related deaths annually (Bachmann et al., 2022). In addition to human nature making us prone to unforced errors while undertaking a task like driving for thousands of hours, the most common human error elements that contribute to car accidents include impaired driving, distracted driving (such as texting), speeding and reckless driving, and drowsy driving. As a matter of valuing individual human life, public safety, and the general welfare of the public, there is perhaps no argument more compelling than the public safety one as it relates to self-driving vehicles.

Self-driving vehicle optimists have claimed that once Level 5 autonomy is achieved, the approximately 40,000 annual automobile fatalities will drop to near zero levels (Kessler, 2019). While any prediction of the quantifiable decrease in automobile fatalities is prone to bias and error, new studies indicate that self-driving vehicles—even at their current sub-Level 5 status—will engender significant reductions in automobile injuries, deaths, and property damage. Specifically, in a research study published in 2023 by autonomous vehicle company Waymo and reinsurance company Swiss Re, researchers found that "in over

3.8 million miles driven without a human being behind the steering wheel in rider-only mode, the Waymo Driver (Waymo's fully autonomous driving technology) incurred zero bodily injury claims in comparison with the human driver baseline of 1.11 claims per million miles" (Swiss Re, 2023, para. 3). Furthermore, they found property damage claims were reduced to 0.78 claims per million miles driven, compared with the 3.26 claims baseline for human drivers.

In another example, we can analyze the autonomous vehicle regulatory environment of California, which requires self-driving vehicle companies to make data on crashes available to the public. Between Waymo and GM's Cruise, the two automobile companies completed approximately eight million miles of driving, with 102 crashes reported (Lee, 2023). This equates to one accident every 60,000 miles, with that mileage being equivalent to five years of driving for the average human driver. Looking at this data, there are two important things to note. First, the data reveals that there have been a significant number of self-driving vehicle accidents, with some proving fatal. Second, these vehicles are still operating in testing mode at Level 4 autonomy, falling well short of full Level 5 autonomy. Therefore, given the incremental progress made in automobile safety associated with Level 2 features (like lane assist and car detection) and Level 3 partial autonomy, self-driving vehicle optimists note that as the technology progresses, so too will its safety.

Safety – Threats

While road safety is expected to increase with the broad adoption of Level 5 self-driving vehicle technology, the testing phase has posed public safety threats, thus souring community receptivity. San Francisco originally served as a testing hub for Cruise and Waymo. While the above statistics suggest a decrease in driver safety risks compared to the average human driver, a testing accident that occurred in late 2023 in which a Cruise vehicle rolled over a woman and dragged her for nearly 20 feet underscores the potentially fatal limitations of this technology (Howland, et al., 2023). Even though severe injuries and deaths are lower on a per-mile basis for self-driving vehicles being tested, there is a higher expectation placed on companies experimenting with new technologies that invariably involve passersby and human drivers into this experiment without their explicit consent. This incident ultimately triggered California to suspend Cruise's operations in the state, setting off a ripple effect that culminated in Cruise suspending its operations nationwide due to cited safety concerns (Shepardson, 2023).

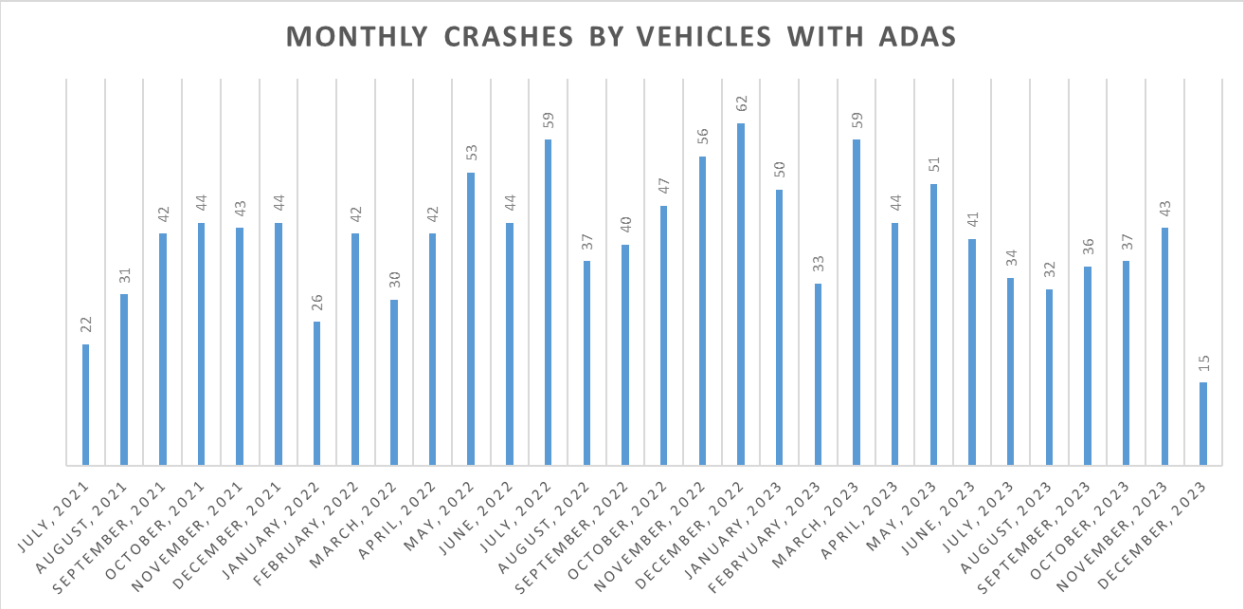
In June 2022, NHTSA published a report documenting crashes that occurred for Level 2 Advanced Driver Assistance Systems (ADAS).[1] The report, stemming from an NHTSA order in June 2021 which required automakers to report crashes involving ADAS vehicles, found that 392 crashes occurred over a year, with six documented fatalities (National Highway Traffic Safety Administration, 2022). Of note, this data is not comprehensive enough to provide sweeping, statistically sound conclusions. First, there is no longitudinal data, as this was the first full year of the NHTSA report. Second, the data on the number of vehicles employing ADAS on roadways is too incomplete to undertake a reliable per capita analysis. NHTSA has since published additional data on ADAS crashes, as illustrated by **Figure 2.**

NHTSA later revised its Standing General Order, requiring specifically named entities to report a crash if automated driving systems (ADS) were in use within 30 seconds of the crash and if the crash resulted in property damage or injury. Available ADS crash data, as illustrated by **Figure 3,** indicates a total of 508 crashes from July 2021 to December 2023 (National Highway Traffic Safety Administration, 2024).[2] Of note, Texas had the second highest number of crashes at 45 accidents during that timeframe, with California leading with 325 ADS crashes. Finally, of the 508 reported crashes, there were no injuries reported in 439 crashes, minor injuries reported in 40

1 Recall that Level 2 is partial driving automation, where acceleration, braking, and steering can be executed autonomously.

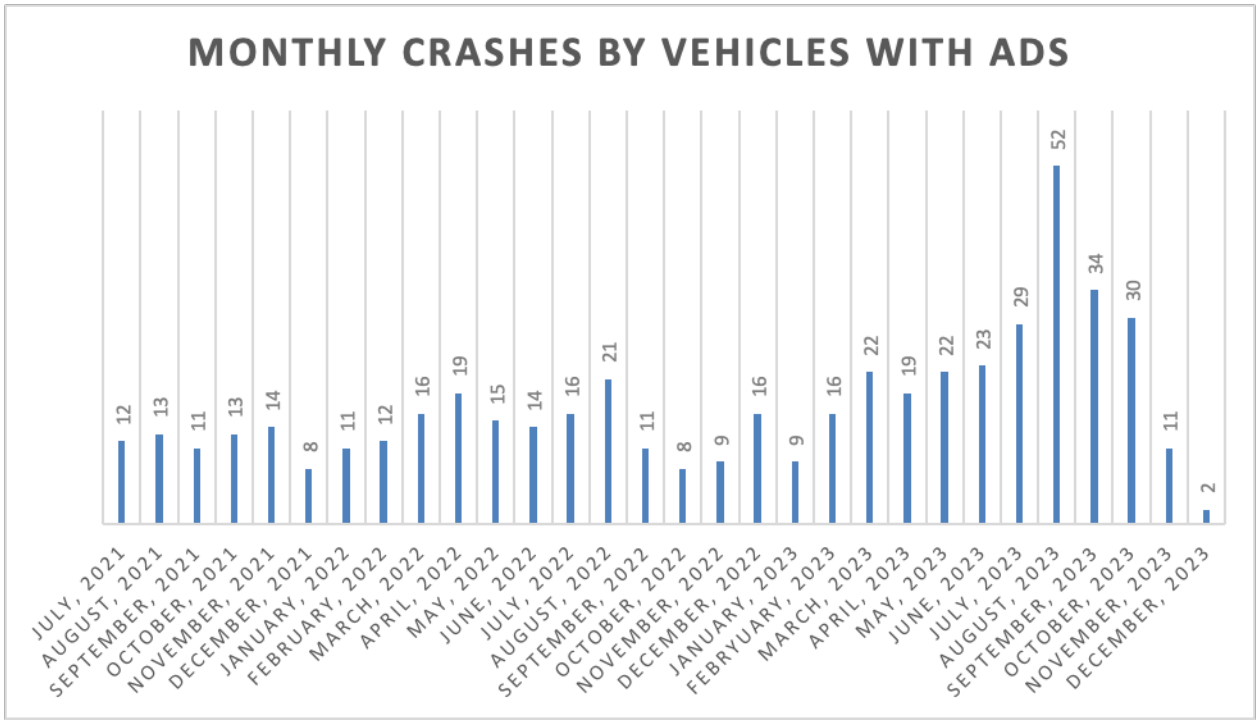
2 NHTSA qualifies that this data errs on the side of over reporting, due to the potential of having multiple sources for the same crash with slightly different information.

Figure 2



Note. Data from https://www.nhtsa.gov/laws-regulations/standing-general-order-crash-reporting

Figure 3



Note. Data from https://www.nhtsa.gov/laws-regulations/standing-general-order-crash-reporting

crashes, moderate injuries reported in nine crashes, serious injuries reported in four crashes, and the remaining 20 had insufficient data to determine the injury level.

Despite the far-from-perfect track record, self-driving vehicle optimists are quick to point out the low rates of crashes relative to human drivers. However, adopting a utilitarian lens while calculating the cost-benefit ratio between traditional automobile

safety and self-driving vehicle threats is not sufficient to determine public policy for this technology. Because of heightened public skepticism and fears surrounding a technology not readily adopted by the mainstream—a technology that introduces unique negative externalities—stakeholders and lawmakers must take additional factors into account.

Enhanced Mobility – Opportunity

The opportunities that Level 5 self-driving vehicles present for enhancing mobility are a strong motivator for stakeholders in the autonomous vehicle sphere. For populations such as the elderly or disabled, this technology would afford them a new degree of mobility. In addition to quality-of-life enhancements, there are certain economic benefits likely to be made manifest because of these groups' newfound accessibility to their cities, communities, families, education, health care, and economic activity. According to a study conducted by the U.S. Chamber of Commerce, researchers found that at a 25% adoption rate,

> Standard AVs should increase annual vehicle miles traveled (VMT) by older people by a total of 2.5 billion miles and the VMT of nondrivers by 1.3 billion miles. Advanced AVs should increase the annual VMT of persons with disabilities by 4.6 billion miles, the annual VMT of older people by 4.9 billion miles, and the annual VMT of nondrivers by 2.4 billion miles. (Shapiro & Yoder, 2023, p. 5)

In one study, undertaken by the National Disability Institute, the authors found that removing transportation barriers vis-à-vis autonomous vehicles would result in a total economic impact of 9.2 million new labor force participants, producing an additional $867.7 billion in GDP, $1.6 trillion in economic output, and $417 billion in new income (Modicamore et al., 2022, p. 16). As for qualitative markers, those who stand to benefit from the enhanced mobility associated with this technology cite employment opportunities, entrepreneurship and small business success, personal safety, independence, and health access as the most attractive components of this future technology.

Cybersecurity – Threat

The increasing digitalization of the automobile sector has introduced new vectors replete with cybersecurity risks, namely due to the connectedness of autonomous vehicles and the advanced software and technology employed to make intelligent decisions and navigate a hyper-dynamic environment. This threat is already transpiring, with an Upstream report suggesting a 380% increase in vehicular cybersecurity attacks in 2022 (Upstream, 2024). While contemporarily this could be more benign attacks, such as a disruption to infotainment screens or Apple CarPlay, in the future with fully automated driving and trucking, it is not unrealistic to envision a scenario where rogue actors halt the operation of tens-of-thousands of self-driving vehicles operating at high speeds, thus endangering thousands. This speaks to a tension associated with technological innovation broadly: balancing the desire to bring a product to market as fast as possible, while recognizing the inherent need for robust cybersecurity safeguards embedded on the front end. Policymakers need not wait for a catastrophic cybersecurity incident to set forth standards for cybersecurity safety prior to the mass deployment of self-driving vehicles.

There are also unique data privacy concerns associated with autonomous vehicles (Dunmoyer & Whiting, 2022). As the sophistication of this technology has increased, autonomous vehicles are collecting and processing large sums of data from numerous vectors, including sensors, smart devices integrated into the vehicles, and the vehicle itself. Specifically, "data such as speed, energy consumption, engine performance, location, driving habits, and objects detected in its surroundings will be processed, stored, and shared with different parties for various purposes, including driver profiling, traffic planning, [and] safety improvement" (VinUniversity, 2021). For years, automobile companies have been transferring driver data to third parties like insurance companies and law enforcement, albeit to the latter with a warrant. In certain jurisdictions, law enforcement is able to wiretap vehicles to listen in on conversations (McCandless, 2021). The Mozilla Foundation published research in 2023 that highlighted the starkness of the problem. They found that of the

25 major car brands studied, 100% of them violate data minimization standards and collect more personal information than is necessary, 84% share or sell consumer data to outside parties, and 92% give consumers no rights over their own personal data (Caltrider et al., 2023). Without strong consumer data privacy protections for those riding in "computers on wheels," one can imagine a future where insurance companies charge drivers higher premiums based on increasingly granular processed data —with those driving later at night denoting a higher propensity for risk, reaction times at stoplights informing risk profiles, and so on—or perhaps even more draconianly, your self-driving vehicle refusing to transport you to a gun store due to the software labeling you a risk due to search history, for example.

Improved Efficiency – Opportunity

There are two major ways self-driving vehicles are expected to improve driver efficiency. The first is through combatting traffic congestion and the second is freeing up the time we currently spend driving. Regarding the former, there is an expectation that self-driving vehicles will reduce the number of collisions, therefore mitigating congestion associated with crashes. Autonomous vehicles are engineered to have a communicative, symbiotic relationship with one another. Connected Autonomous Vehicles (CAVs), therefore, are receiving live-time updates on the movement of other self-driving vehicles to understand how to optimize speed, route, and timing to maintain a steady flow of traffic (Edward, 2023). Moreover, the single greatest contributor to traffic congestion is the stop-and-go behavior associated with human drivers, mainly attributed to the longer reaction times and perception errors associated with humans. In one simulated study, researchers found "that high penetration rates of CAVs provide significant improvement in traffic performance" (Garg et al., 2021, p. 2016).

However, these same researchers—along with a corpus of other available research—note that the benefits only accrue when a significant share of cars on the road are operating autonomously. This can be thought of as a network effect, with CAVs improving individual efficiency by feeding off other CAVs for information and data, and human drivers serving as a threat to improved road conditions. In another study, researchers concluded that "the only case where a reduction in congestion was obtained is when all the traffic is autonomous (100% AVs). When the non-AV percentage in traffic increases, congestion will occur, and could well be worse than that of all-non-AV traffic" (Malibari et al., 2022, p. 13). This outcome largely stems from the fact that CAVs need to communicate with one another to work as a symbiotic whole, with the presence of human drivers interrupting this process due to the incalculable and unpredictable nature of a human-driven car not sharing its operating system.

Furthermore, Americans spend 84 billion hours driving every year, and on average spend more than an hour driving every day (U.S. Department of Transportation, 2017; AAA Foundation for Traffic Safety, 2022). This means that the average American allocates close to 373 hours driving every year, forgoing activities that could otherwise be economically, societally, or personally productive. If the vehicle were to drive itself, then the time that the person would have spent driving could be freed up for other activities. This conception is attractive as an argument of economics and consumer convenience.

Liability – Threat

The insurance liability component associated with autonomous vehicles has been quite vexing for lawmakers, insurers, automobile manufacturers, software engineers, and virtually all stakeholders in this arena. As previously mentioned, after the codification of Senate Bill 2205, Texas holds the operator of a vehicle deploying automated driving system technology liable. However, the insurance regime surrounding this technology is not black and white.

Take, for example, Tesla Autopilot. Suppose that a Model S was on autopilot and free of driver intervention at the time of a crash, and that the vehicle did not command the driver to take over. In this instance, rather than negligence on the part of the driver, it could have been a technical glitch or a defect that the driver had no ability to rectify. Furthermore, insurance companies would not be able to rely on

statements from the "passenger" in the self-driving vehicle at fault and the driver of the other vehicle. This might then trigger the insurance company to request information from the self-driving vehicle's black box to determine whether the software or specific technical components of the vehicle failed, causing the accident. Other questions arise from these hypotheticals: what about ridesharing companies (like Uber) who have built their entire model of developing self-driving vehicle technology on the notion of providing a transportation service to customers who are not owners of the vehicle transporting them? Will they incur liability as a passenger upon accepting the terms of service? The point being, there are myriad insurance conundrums that are already arising, and surely more to come if public policy lags technological development in this space.

Public Planning – Opportunity

An interesting argument proffered by self-driving vehicle optimists is the potential to reimagine how we build and develop large urban cities across the country. For example, 17% of downtown Austin's surface area is reserved for parking. Moreover, parking lots and structures make up approximately one-quarter of downtowns in Houston, Dallas, and San Antonio (Price, 2023). And given the average American's car is parked 95% of the time, coupled with population density increasing in major urban areas, demand for parking is only increasing in certain areas (Morris, 2016). When Level 5 autonomy is reached, there would be no need to park our cars within walking distance of our destination. Rather, one could conceive of building large parking structures in a vacant site proximal to downtown areas. Your self-driving vehicle, after transporting you directly to the front door of your destination, could then drive itself outside the downtown area and park at the local mega-garage structure, awaiting your request once more.

While a lofty goal, this theoretical situation poses tremendous opportunities for optimizing downtown areas. This would free up substantial amounts of real estate to prioritize housing, commercial properties, businesses, and so on.

Vehicular Autonomy over Individual Autonomy

Previous sections have alluded to the philosophical tensions precipitating from this new technological frontier, but it is worth addressing head on. While all the above opportunities underscore technological progress, they come at the expense of human autonomy and—potentially—human dignity.

Large automobile manufacturers are pushing for fully self-driving vehicles despite the absence of consumer demand. According to a poll from Pew Research (Rainie, et al., 2022), nearly half of U.S. adults say that the widespread use of driverless cars would be a bad idea for society, with 29% undecided and 26% optimistic. What's more, nearly two-thirds of adults say they would not want to ride in a driverless vehicle if given the chance (2022). And the statistics over the last few years indicate that consumer sentiment is souring as the technology becomes more prominent. As research from AAA (2023) shows, driver attitudes toward self-driving vehicles has increased from 55% "afraid" in 2022 to 68% "afraid" in 2023. While many experts rightly point to safety concerns as an animating factor behind this skepticism, there is also something deeply American—and Texan—about driving one's own car. In a separate Pew Research study, drivers who reported a love for driving cited "alone time," "the ability to get away," and "freedom" as top reasons for wanting the autonomy to drive whenever they desire (Taylor et al., 2010). Unlike our European counterparts, whose transportation culture is more collectivistic in nature, Americans love their cars—so much so that the majority of Americans name their vehicle and nearly half admit to crying when parting ways with their cars (Dillard, 2023). And these statistics are not frivolous, especially when juxtaposing public skepticism and resistance toward autonomous vehicles with the technocratic ideal. That ideal, of course, is to realize the benefits that self-driving vehicles stand to offer. But as noted in the "Improved Efficiency" section above, there is a very high threshold of consumer adoption required to decrease traffic congestion and similar benefits—a threshold approaching 100% adoption. For the insurance conundrum, matters would be much more straightforward if claims were

submitted between self-driving vehicles alone (with a clear liability standard) versus human-driver autonomous vehicle collisions. If self-driving vehicles are a threat to cities across the country that are pushing for "Vision Zero"—an initiative to champion a future of transit where there are zero traffic deaths—it naturally follows that human drivers are a threat to that vision (Vision Zero Network, n.d.).

The famous thought experiment, the "trolley car dilemma," has been applied to the issue of self-driving vehicles in a way that highlights some of the software engineering decisions that must be made when considering an autonomous future. For example, if a self-driving vehicle is in a situation where it must decide between hitting a group of children running across the road or swerving into oncoming traffic and likely taking the life of the passenger, how should the software act? In *Why We Drive: Toward a Philosophy of the Open Road*, Matthew B. Crawford addresses this tension head on. He writes,

> Since utilitarianism is concerned only with outcomes or consequences, it doesn't really distinguish between my agency and someone else's. More than that, it insists that the agent himself view his own action from the perspective of the universal, and be indifferent to how it impinges on him uniquely. (Crawford, 2020, p. 119)

Naturally, this lens applies perfectly to the trolley car dilemma. But Crawford goes on to explain that this line of reasoning, left unchecked, will likely encroach on our data privacy, our ability to take faster routes if it is less "climate friendly," our freedom to visit locations that large corporations may deem unfit based on our profile, and ultimately, our own agency to deactivate autonomous software and drive for ourselves. Crawford points out that "as the space for intelligent human action gets colonized by machines, our intelligence erodes, leading to demands for further automation" (Crawford, 2020, p. 122). This is a crucial tension that lawmakers must consider when crafting self-driving vehicle legislation, lest Texans and Americans give away an essential freedom to companies like Google, Apple, and the like.

POLICY RECOMMENDATIONS

With the passage of Texas' Senate Bill 2205, Texas has a solid foundation focused on consumer-centric, light-touch oversight that ensures that the Lone Star State is the beacon of innovation nationwide. Key to this bill and Texas' coherent regulatory framework are the clear definitions of important terms and the prohibition on local governments introducing onerous, duplicative regulations that could thwart consistency and the responsible development of this technology. Now, with this technology's graduation from infancy to adolescence over the last seven years, there are a number of policy recommendations the Texas Legislature should consider to promote technological innovation that best serves humanity.

As discussed in the "Improved Efficiency" section, many of the espoused benefits of autonomous vehicles can only be realized with near-100% adoption of the technology. As such, there is a genuine concern that automobile manufacturers and large technology companies will continue to defy consumer demand trends and push to automate driving to the point of removing steering wheels, accelerators, and brakes from vehicles. To protect the dignity and autonomy of Texans, the Texas Legislature should consider passing a constitutional amendment affording Texans the right to have a steering wheel and manually operate their automobiles. In the 88th Legislature, a bill was introduced which contained a constitutional amendment to accomplish this goal (HJR 106, 2023). This amendment provides a model that can be modified and advanced in the 89th Legislature.

To truly unleash innovation in Texas, public trust between residents and autonomous vehicle companies testing their technology must be improved. In Austin, Texas, there have been numerous instances where deployed self-driving vehicles have either halted in the middle of the road (causing considerable traffic jams) or even veered off course to aimlessly crash into buildings (Santana, 2023; Felton et al., 2023). What's more, emergency officials in Austin—and in other self-driving vehicle hotbeds like San Francisco—have made public their frustration with certain self-driving vehicle manufacturers who

are preventing law enforcement from doing their jobs swiftly and safely (Price & Cobler, 2023). These sorts of disruptions include vehicles obstructing the path of local fire departments, close call interactions or outright collisions with first responders' vehicles, and police being unable to get in contact with the operator of a vehicle that needs to be moved for safety or flow-of-traffic reasons. In one instance, revealed through a public information request, Austin firefighters responded to a Cruise vehicle that was stopped in the middle of the road, causing traffic congestion. Acting on the training they received from Cruise, the firefighters noted on the vehicle's screen that a crash had occurred, with minor damage done to the vehicle's side mirror. The firefighters got inside the vehicle to interact with a remote Cruise employee, but the employee refused to grant them permission to move the vehicle (Bernier, 2023). Stories like this highlight a pressing need for policy that allows emergency officials to do their jobs and secure the safety of their jurisdiction, regardless of whether a human driver is present. This outcome can be accomplished in two ways.

First, Texas should require law enforcement interaction plans. To operate a self-driving vehicle in Texas, manufacturers would be required to submit a law enforcement interaction plan to the appropriate authorities that outlines how the manufacturer will work with law enforcement in the event of an incident involving their technology, and in addition to how law enforcement can best work with human operators at the scene. For example, it would facilitate a faster response if law enforcement knew to scan a QR code on a vehicle to get in contact with a human operator, or if that specific autonomous vehicle has microphones inside for them to interact with the operator.

Second, the Legislature can require TxDOT to update its Texas Peace Officer's Crash Report (CR-3) to include a reporting option that a crash occurred involving an autonomous vehicle. The CR-3 stems from TxDOT's Crash Reporting and Analysis for Safer Highways (CRASH) program, which is a web-based application that allows law enforcement to swiftly submit a crash report. Though a small fix (a simple digital checkbox), this would provide valuable data for TxDOT and other stakeholders to have a concrete snapshot that provides information about the safety of autonomous vehicles being tested, which automobile companies are safest, what situations and environments are prone to autonomous vehicle crashes, and more.

With responsible guardrails in place and the ingredients for an innovative hotspot, Texas will continue to lead the nation as the exemplar of responsible technology that seeks to serve humanity, and not the other way around.

While the focus of this paper is on the transportation element of self-driving vehicles, understanding the cybersecurity and data concerns outlined earlier in the "Cybersecurity" section, the legislature should consider additional legislation pertaining to data privacy and protection. In the 88th Legislature, House Bill 4 was passed and signed into law, in turn positioning Texas as a national leader for online consumer data privacy. This framework affords Texans digital rights, such as the right to know what information is collected by companies, along with subsequent rights to delete, correct, and opt out of data processing (HB 4, 2023). Furthermore, the law institutes new cybersecurity safeguards, ensuring that data security practices promote the security triad of confidentiality, integrity, and accessibility for personal data. Lawmakers can build off this momentum by advancing legislation that provides consumer data privacy for the automobile sector as well, affording Texans these same digital rights—with strong enforceability and penalties for noncompliance—for their vehicles as well.

CONCLUSION

As a first principle, and for the sake of innovation broadly, it is crucial that Texas continue to hold the line on the regulation-heavy instincts of states like California and Illinois. Importantly, Texas' strong economy, entrepreneurial spirit, robust infrastructure,

and responsible, light-touch oversight will provide an innovative safe-haven for good actors looking to engineer solutions that elevate humanity and advance human flourishing. Given the previously outlined threats—namely, public safety concerns, human autonomy, and cybersecurity—the Texas Legislature should advance the following public policy:

- Legislation that enshrines Texans' right to drive their vehicle;

- Law enforcement interaction plans and reporting systems;

- Enhanced cybersecurity protections for the increasingly digitalized automobile sector; and

- Digital agency and consumer data privacy protections for drivers on Texas roadways.

With responsible guardrails in place and the ingredients for an innovative hotspot, Texas will continue to lead the nation as the exemplar of responsible technology that seeks to serve humanity, and not the other way around. ■

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