# The Reasonable Robot Standard: How the Federal Government Needs to Regulate Ethical Decision Programming in Highly Autonomous Vehicles

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# THE REASONABLE ROBOT STANDARD: HOW THE FEDERAL GOVERNMENT NEEDS TO REGULATE ETHICAL DECISION PROGRAMMING IN HIGHLY AUTONOMOUS VEHICLES

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## INTRODUCTION

A steam train is chugging along down a country track. You are a passenger, watching red and orange clustered hills pass by; fall is already here. You start to daydream about the last time you took this trip, how the summer had just begun and how quickly it went. Suddenly, reality hits. You awake from your daydream when you glance up and see five people strapped to the train tracks ahead of you. You know there is not enough time for the train to brake. Luckily, you happen to be sitting right next to the emergency switch, which would divert the train to another path at the fork just before the train reached the five captives. They would be saved. Just as you grasp the switch with both hands, ready to pull as hard as you can, the train approaches the fork revealing another unfortunate person, strapped to the alternate tracks.

What should you do? If you pull the switch, your action will result in the death of one person. Five people will be saved, but you will have made the choice to alter the train's path when you knew it would kill one person. The eager answer might be to save as many lives as possible and allow harm to come to as few lives as possible. But does your action of pulling the switch knowing someone will die count as killing someone? If you do not pull the switch, a chain of causation that has already been set in motion will result in the deaths of five people. You will not have acted, so you would not be responsible for their deaths. Or would you be? Does the fact that you *could* have acted to save their lives make you more responsible? Is inaction less culpable than action, in this case?

The classical vignette known as the trolley problem has been contemplated by philosophers and plagued the classrooms of first year law students for decades.[1] During a study conducted at Michigan University, 90% of respondents would choose to pull the switch and kill the single person rather than the group of five.[2] Killing the five had a much less confident response.[3] The rationalization for both outcomes makes it difficult to determine an ethically "correct" response to the dilemma.[4]

Now imagine that you are driving a car down a road. The same scenario unfolds, except here, the people are pedestrians. You cannot brake and the only other path to take would be down the edge of a very steep cliff. The vehicle can either continue going straight and kill five pedestrians, turn and kill the one pedestrian, or drive off the cliff saving all other lives but sacrificing yours. Would you veer off the cliff to save the pedestrians? Or would you swerve into the single pedestrian to save the five and yourself? In each scenario, the driver is acting rationally, weighing the potential outcomes as quickly as possible and making a choice.[5] In the end,

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\*    Staff Attorney, Nationwide Mutual Insurance Company. Notes & Comments Editor, J. C.R.    ECON. DEV., 2018-2019. St. John's University School of Law '19.

[1]    *See* Lauren Cassani Davis, *Would You Pull the Trolley Switch? Does it Matter?*, ATLANTIC (Oct. 9, 2015), https://www.theatlantic.com/technology/archive/2015/10/trolley-problem-history-psychology-morality-driverless-cars/409732/; Bert I. Huang, *Law and Moral Dilemmas*, 130 HARV. L. REV. 659, 659 (2016).

[2]    *See* Nick Belay, *Robot Ethics and Self-Driving Cars: How Ethical Determinations in Software Will Require a New Legal Framework*, 40 J. LEGAL PROF. 119, 120 (2015).

[3]    *See id.* (presuming that, if 90% would kill the single person, no more than 10% would kill the five).

[4]    *Id.*

[5]    According to Black's Law Dictionary, "rational" means "[b]ased on logic rather than emotion; attained through clear thinking; not absurd, preposterous, foolish, or fanciful." *Rational*, BLACK'S LAW DICTIONARY (11th ed. 2019). In this hypothetical, it is "not absurd, preposterous, foolish, or fanciful" that someone in this position would choose to let the train keep moving and kill the five people. *See id.* He or she might reason her intervention could create a worse outcome, and choose not to intervene knowing the result of both outcomes. On the other hand, it is also rationale for the person to alter the course of the train. He or she might believe it is logical one person should be killed instead of five. This would also be a conclusion which is "not absurd." *See id.* Both results are supported by philosophical theories. Those who subscribe to deontological moral theories support the notion where the overall results are significant, they are not the only factor; certain actions are inherently wrong and impermissible. *See* Eyal Zamir & Barak Medina, *Law, Morality, and Economics: Integrating Moral Constraints with Economic Analysis of Law*, 96 CALIF. L. REV. 323, 326 (2008) ("Certain acts are inherently wrong and are therefore impermissible even as a means to furthering the overall good. The central constraint is against harming other people."). However, under a utilitarian theory, the outcome that produces the greatest good is the correct outcome. *See id.* at 329 (stating that utilitarianism is a form of consequentialism, which holds that the morality of an act is determined by its consequences).

whatever the driver decides will be viewed in light of the unfortunate circumstances the driver was placed in.[6]

Now imagine that it is 2025 and you are in a completely automated car. The same scenario unfolds. The car must determine the pathway it will take. The potential reactions will be pre-programmed and not subject to the momentary judgement of the driver or the train passenger. Several questions spring to mind. Are any of the outcomes more rational than the other? How will the decisions of automated cars be viewed in light of societal ethical standards? Would this mean that the decision to kill one person over five was pre-meditated? Will automated cars be held to a higher ethical standard than humans?

While fully autonomous cars may seem like something out of a futuristic cartoon or movie, the reality is that they will be driving on the road within the next few years.[7] The development of autonomous vehicles has been underway for many years.[8] Most major

[6] Under tort law, persons are expected to exercise the standard of care that a reasonable person would, under the circumstances. *See* RESTATEMENT (SECOND) OF TORTS §283 (1965). The case *Vaughan v. Menlove* is largely credited with setting the standard for a reasonable person. *See* Vaughan v. Menlove, (1837) 132 Eng. Rep. 490 (CP); Charles R. Korsmo, *Lost in Translation: Law, Economics, and Subjective Standards of Care in Negligence Law*, 118 PENN ST. L. REV. 285, 298 (2012) ("The best-known early precedent for the rule that the reasonable person standard of negligence law is an objective standard is *Vaughan v. Menlove*."). In the case, a man stacked hay in a manner likely to provoke spontaneous combustion, despite warnings from his neighbors. *See id.* The court determined that he was liable for the damages the fire caused because he had not behaved as a prudent person would under the circumstances. *See id.*

[7] Tesla plans to have fully autonomous vehicles by 2019. *See* Faiz Siddiqui, *Tesla floats fully self-driving cars as soon as this year. Many are worried about what that will unleash*, WASH. POST (July 17, 2019, 10:16 PM), https://www.washingtonpost.com/technology/2019/07/17/tesla-floats-fully-self-driving-cars-soon-this-year-many-are-worried-about-what-that-will-unleash/ (discussing Tesla's goals of pushing full automation software for their autonomous capable vehicles as early as the end of 2019). Honda, Hyundai, Daimler, Volvo, Ford, and General Motors initially stated they would have fully autonomous vehicles by 2021. *See* Dan Fagella, *Self-driving car timeline for 11 top automakers*, VENTUREBEAT (June 4, 2017, 3:10 PM), https://venturebeat.com/2017/06/04/self-driving-car-timeline-for-11-top-automakers/; *see Learn more about General Motors' approach to safely putting self-driving cars on the roads in 2019*, GENERAL MOTORS, https://www.gm.com/our-stories/self-driving-cars.html (last visited Nov. 8, 2019). However, recent concerns have caused some auto manufacturers to slow down the timeline for the release of automated vehicles. *See* Neal E. Boudette, *Despite High Hopes, Self-Driving Cars Are 'Way in the Future'*, N.Y. TIMES (July 17, 2019), https://www.nytimes.com/2019/07/17/business/self-driving-autonomous-cars.html?auth=link-dismiss-google1tap.

[8] *See* Luke Dormehl & Stephen Edelstein, *Sit back, relax, and enjoy a ride through the history of self-driving cars*, DIG. TRENDS (Feb. 3, 2019, 9:00 PM), https://www.digitaltrends.com/cars/history-of-self-driving-cars-milestones/ (stating Google first started secretly developing their autonomous car project in 2009); *Your Autopilot has arrived*, TESLA (Oct. 14, 2015), https://www.tesla.com/blog/your-autopilot-has-arrived (stating Tesla offered their first Autopilot software for autonomous driving in Model S vehicles in 2014).

car manufacturers are already developing or deploying prototypes of autonomous vehicles; some models of autonomous vehicles are even operated on the roads today.[9] Fully autonomous vehicles may be widely available for consumers as early as 2020.[10] There are already autonomous vehicles operating in many states that are capable of performing all of the driving system tasks under some conditions—including those typically controlled by humans.[11]

Autonomous vehicles operate based on an extensive series of sensors and programming that work together to perceive and navigate through the surrounding environment.[12] These vehicles process environmental inputs gathered from the sensors through preprogrammed algorithms that evaluate conditions and determine the actions that the vehicle will take.[13] The way that autonomous vehicles are programmed to react to environmental stimuli will have dispositive impacts on the safety of those inside and outside of the vehicles.[14] For instance, in a dilemma situation such as the

[9]   *See* Alex Davies, *Waymo Has Taken the Human Out of its Self-driving Cars*, WIRED (Nov. 7, 2017, 2:02 PM), https://www.wired.com/story/waymo-google-arizona-phoenix-driverless-self-driving-cars/ (noting Waymo had been test driving driverless cars in Arizona and will soon allow passengers in their driverless cars); *see also* Associated Press, *California green lights autonomous car testing without drivers*, CBS NEWS (Feb. 27, 2018),      https://www.cbsnews.com/news/california-green-lights-autonomous-car-testing-without-drivers/ (discussing California's recent decision to allow driverless cars).

[10]   *See* Fagella, *supra* note 7 (explaining that Honda, Toyota, Renault-Nissan, Hyundai, and Daimler have all stated they will have some capacity of self-driving cars on the road by 2020, and could potentially begin selling them to consumers).

[11]   *See* Rob Verger, *Where to find self-driving cars on the road right now: Autonomous cars seem futuristic, but they're already on the streets*, POPULAR SCI. (Dec. 11, 2018), https://www.popsci.com/self-driving-cars-cities-usa/ (discussing the numerous programs throughout the country that utilize self-driving vehicles, including programs sponsored by ride-share companies like Uber and Lyft).

[12]   *See* Cade Metz, *How Driverless Cars See the World Around Them*, N.Y. TIMES (Mar. 19, 2018), https://www.nytimes.com/2018/03/19/technology/how-driverless-cars-work.html (describing the "light detection and ranging" (or LIDAR) devices and machine learning which the autonomous vehicles use to operate); *see also infra* footnote 156 and accompanying text.

[13]   *See* James Armstrong, *How do driverless cars work?*, TELEGRAPH (Nov. 2, 2018, 5:10 PM), https://www.telegraph.co.uk/cars/features/how-do-driverless-cars-work/ ("Finally, a central computer analyses all of the data from the various sensors to manipulate the steering, acceleration and braking."); Youjin Shin, Chris Alcantara & Aaron Steckelberg, *How does an autonomous car work? Not so great.*, WASH. POST (Sept. 10, 2019), https://www.washingtonpost.com/graphics/2019/business/how-does-an-autonomous-car-work/ (presenting an interactive animated learning experience and discussion about the shortcomings of autonomous vehicle technology).

[14]   Alissa Walker, *Are self-driving cars safe for our cities?*, CURBED (Mar. 8, 2019, 3:00 PM), https://www.curbed.com/2016/9/21/12991696/driverless-cars-safety-pros-cons (noting the effectiveness of autonomous vehicles' environmental analysis will have a major safety impact and also noting a failure of such a system during a test has already resulted in the death of a cyclist).

trolley problem above, the environmental stimuli will be processed through pre-programmed algorithms and will determine which path the car takes: towards five pedestrians, one pedestrian, or down the cliff to the detriment of the driver.[15] Since the car's responses to various stimuli are preprogrammed, the outcomes are predetermined too.[16] Without programming standards requiring the car to respond in a manner that is best for society, the car may be programmed based on other motives, such as protecting the passengers or the car at all costs.

This Note argues the federal government needs to regulate the ethical programming of autonomous vehicles because federal regulations will help ensure the enhanced safety potential of autonomous vehicles is maximized. Government regulation of ethical programming in autonomous vehicles is necessary when the vehicles are able to perform all driving tasks autonomously for a sustained period of time.[17] These vehicles will need uniform programming to achieve the desired safety enhancements promised by autonomous vehicles,[18] and to ensure that manufacturers are not programming for consumer safety above societal safety.

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[15] *See id.* (explaining automated cars employ robot decision-making processes, which lead them to make pre-programmed safety decisions, and, by extension, decisions such as those posed by the moral hypothetical above). *But see* Janet D. Stemwedel, *For Self-Driving Cars, Varied Designs or Uniform Standards?*, FORBES (Sept. 29, 2015), https://www.forbes.com/sites/janetstemwedel/2015/09/29/for-self-driving-cars-varied-designs-or-uniform-standards/2/#1696b86c63ea (stating shared standards will not mean all vehicles will behave in the same way to the same stimuli, or that they will be programmed for the ethically correct answer).

[16] Related to the issue of pre-programmed algorithms and pre-determined outcomes is liability. Although this issue is outside the scope of this paper, an inquisitive reader may be inclined to investigate how liability for car accidents will change. Liability may change to more of a strict liability scheme, and may change the auto-insurance landscape as we know it.

[17] Under the Society of Auto Engineers' categories for automation, discussed *infra* note 102 in connection with government regulations of self-driving cars, autonomous vehicles in levels three to five of automation are able to sustain the driving task autonomously. *See* SAE INTERNATIONAL, *SAE International Releases Updated Visual Chart for Its "Levels of Driving Automation" Standard for Self-Driving Vehicles* (Dec. 11, 2018), https://www.sae.org/news/press-room/2018/12/sae-international-releases-updated-visual-chart-for-its-"levels-of-driving-automation"-standard-for-self-driving-vehicles. Ethical programming for vehicles in the first two categories of automation is unnecessary because vehicles in the first two categories of automation include some autonomous functions, but those vehicles are unable to perform the driving task autonomously, without human intervention. *Id.*; AV START Act, S. 1885, 115th Cong. § 2 (2017) ("[T]he term 'automated driving system' means the hardware and software that is collectively capable of performing the entire dynamic diving task on a sustained basis, regardless of whether the system is limited to a specific operational design domain.").

[18] *See* Sasha Lekach, *Self-driving cars must be experts on ridiculously specific road rules*, MASHABLE (Aug. 28, 2019), https://mashable.com/article/autonomous-vehicles-inconsistent-rules-

Part I of this Note provides important background information on the evolution of safety features in motor vehicles. Part II discusses the evolution of the automated car, the Society of Automotive Engineers (SAE) six phases of automation, the widespread movement towards autonomous vehicles, and the safety features of automated cars. Part III discusses the ethical issues concerning programming. This part explains that ethical programming transcends simply dilemma situations and reaches every aspect of driving. Part IV discusses where current legislative responsibility for autonomous vehicles is allocated and discusses the federal government's attempt at legislation of autonomous vehicles, including proposed bills in Congress. This part will also examine the German government's approach to regulating the ethical programming of autonomous vehicles. Germany was the first country to enact legislation specifically relating to ethical programming of autonomous vehicles.[19] The methodology Germany used to develop its legislation could serve as a model for the methodology the United States could use to create its own legislation. Further, the legislation itself presents a largely utilitarian perspective[20] and could itself be used as a model for legislation implemented in the United States. Finally, Part V argues that the United States federal government should regulate the ethical programming of autonomous vehicles to minimize personal injury and, therefore, maximize societal welfare.

## I. EVOLUTION OF SAFETY FEATURES IN MOTOR VEHICLES: MOTOR VEHICLES AND SAFETY DEVELOPMENTS

Technology in cars has come a long way from the era of the Model T.[21] People are no longer seen bracing against the snow,

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of-the-road/ (discussing the difficulties of creating automated vehicle programming that can adopt to the different driving rules of various jurisdictions).

19  *See* David Tuffley, *At last! The world's first ethical guidelines for driverless cars*, CONVERSATION, http://theconversation.com/at-last-the-worlds-first-ethical-guidelines-for-driverless-cars-83227 (last visited Nov. 8, 2019).

20  *See* Peter Van Der Schaft, *Germany Creates Ethics Rules for Autonomous Vehicles*, ROBOTICS BUS. REV. (May 30, 2018), https://www.roboticsbusinessreview.com/unmanned/germany-creates-ethics-rules-autonomous-vehicles/ (noting the German rules were implemented with a moral imperative for human safety, which would make it the outcome leading to the greatest good); discussion of utilitarianism, *supra* note 5.

21  *See* Royce Peterson, *How to Drive a Model T Ford*, MODEL T FORD FIX (Mar. 11, 2018), https://modeltfordfix.com/how-to-drive-a-model-t-ford/ (describing how users of the Model T used

rain, and sleet to manually crank start their engine.[22] Now, drivers simply have to be in the proximity of vehicles to start some vehicles remotely.[23] Drivers no longer have to force the wheel manually many times over thanks to the widespread use of power steering.[24] But some of the same problems persist from the first introduction of cars and the era of mass mobilization, the most prevalent of which is the pervasive risk of vehicular accidents.[25] As early as the 1890s, there were grave concerns about the safety risks and fatalities associated with motorized vehicles.[26] From 1915 to 1925, fatalities of motorists and pedestrians increased over three hundred times.[27] The car was seen as a neutral entity which responded to the driver's direction and was under the driver's exclusive control.[28] Preliminary attempts at stemming the accident and fatality rate caused by motor vehicles were centered around changing the driver's habits.[29]

Although the human driver was considered to be the primary source of car accidents, in the 1920s some automakers acknowledged that the design of the automobile impacted the safety of the

to have to start it with a hand crank); David Beard, *The Evolution of Car Keys is More Interesting Than You Think*, CAR AND DRIVER (Dec. 25, 2017), https://www.caranddriver.com/news/a14499282/the-evolution-of-car-keys-is-more-interesting-than-you-think/; *Tesla App Support*, TESLA, https://www.tesla.com/support/tesla-app (last visited Nov. 8, 2019) (describing how now some cars can be unlocked and driven without even a key).

22   *See* Peterson, *supra* note 21.

23   *See* Beard, *supra* note 21 (discussing the features of the Tesla app, including the ability to "[u]nlock and drive your car without [a] key").

24   *See* Dave Vanderwerp, *What is Power Steering and How Does It Work,* CAR AND DRIVER (June 11, 2019), https://www.caranddriver.com/features/a27888229/power-steering/ (discussing the evolution of power steering and how it has improved driving).

25   *See* Louis Anslow, *Forget self-driving car anxiety; In the early days human drivers were the fear*, TIMELINE (Nov. 3, 2016), https://timeline.com/forget-self-driving-car-anxiety-in-the-early-days-human-drivers-were-the-fear-55a770262c10.

26   *See id.* ("In the 1890s, the prospect of a person driving without the aid of a [horse] was a real concern."); Bill Loomis, *1900 –1930: The years of driving dangerously*, DET. NEWS (Apr. 26, 2015), https://www.detroitnews.com/story/news/local/michigan-history/2015/04/26/auto-traffic-history-detroit/26312107/ ("As early as 1908, auto accidents in Detroit were recognized as a menacing problem: In two months that summer, 31 people were killed in car crashes and so many were injured it went unrecorded."). In 1910, New York introduced the first laws which penalized drunk driving. *See* Josephine Y. King & Mark Tipperman, *The Offense of Driving While Intoxicated: The Development of Statutory and Case Law in New York*, 3 HOFSTRA L. REV. 541, 541 (1975).

27   Nat'l Museum of Am. History, *Automobile Safety*, SMITHSONIAN, https://americanhistory.si.edu/america-on-the-move/essays/automobile-safety (last visited Nov. 8, 2019).

28   *See id.*

29   *See id.*

machine.[30] In response, technical solutions such as shatter proof windshields, hydraulic brakes, and four wheel brakes were implemented.[31] Safe driving habits were enforced by traffic rules, fines, and traffic signals.[32] The first turn signals were offered in 1937.[33] In the 1920s, before these technological improvements, the National Safety Council continued to focus on the human driver as the source of the accident and embarked on educational campaigns to educate drivers and pedestrians alike about safe driving.[34] Automakers promulgated that design contribution to automobile safety was maximized and that the solutions to safety problems related to automobiles were found in better roads, rules, and driving licensing.[35] Notably, seatbelts, energy absorbing steering columns, and padded dashboards were not installed, although they had been invented.[36]

However, in the 1950s academics and doctors remained concerned about the accident rate and fatalities from motorized vehicles.[37] Universities started conducting safety studies on university campuses.[38] These studies indicated motor vehicles needed to

[30]   *See id.*

[31]   *See id.*; *History of Car Safety*, CRASHTEST, http://www.crashtest.org/history-car-safety/ (last visited Nov. 8, 2019) (discussing hydraulic brake development).

[32]   *See Automobile Safety*, *supra* note 27. The three-color red, yellow, and green, traffic signal that we still utilize today was introduced in the United States in 1930. *A Drive Through Time*, NAT'L HIGHWAY TRAFFIC SAFETY ADMIN., https://one.nhtsa.gov/nhtsa/timeline/index.html (last visited Nov. 9, 2019).

[33]   *See* Brett Berk, *Car Safety Evolved for the Better, Despite Some Terrible Ideas*, ROAD & TRACK (May 16, 2013), http://www.roadandtrack.com/car-culture/a4449/the-road-ahead-road-evolution-of-safety/.

[34]   *See Automobile Safety*, *supra* note 27. In 1953, President Eisenhower chartered the National Safety Council. *See* Richard F. Weingroff, *President Dwight Eisenhower and the Federal Role in Highway Safety*, 1, 28 (2013), https://www.fhwa.dot.gov/infrastructure/safety.pdf.      The mission of the National Safety Council includes "to further, encourage, and promote methods and procedures leading to increased safety, protection, and health . . . on streets and highways . . . ." National Safety Council Act, ch. 429, 67 Stat. 569 § 3 (1953). The safety council also established local chapters to promote safety at a local level, and was responsible for educating people on national highway safety. *Id.*

[35]   *See Automobile Safety*, *supra* note 27.

[36]   *See id.* For example, before seatbelts were made mandatory by 1968, very few cars offered them despite their invention decades earlier. *See id.* During the 1955–56 model year in New York, only 0.25% of Buicks came equipped with seatbelts, 0.3% of Chevrolets, and 0.3% of Fords. *Id.* Although some consumers knew of the potential benefits of seatbelts, few bought or wore them, and still others did not want to be trapped in the vehicle. *See id.*

[37]   *See id.*

[38]   *See id.*

envelope the driver with safety padding and seat belts.[39] These safety additions were soon implemented in most models of cars.[40] States reacted to these new findings by passing laws requiring seatbelts and other safety features.[41] In 1966, Congress passed an act allowing the federal government to set safety standards for new vehicles, codified in the Federal Motor Vehicle Safety Standards (FMVSS).[42] The first safety standard, FMVSS 209, was passed in 1967 and established safety requirements for seatbelt assemblies.[43] By 1968, seatbelts were required in passenger vehicles.[44] The use of seatbelts was widely accepted by the 1990s, and airbags were required in new vehicles by 1998.[45] By the 1990s, technological innovation was considered the "first line of defense in an accident."[46] However, the dangers of driving have remained through the turn of the century.[47]

The United States has the highest fatality rate for car crashes among high-income countries.[48] In 2016, over 37,461 people lost

[39] *Id.* A convincing study done by Lt. Colonel John Paul Stapp demonstrated that seat belts were successful at restraining a person subject to large forces. *Id.* He used a seat belt to affix himself to a sled on rails. *Id.* During his experiment, he went up to 632 miles per hour, and was subject to gravity forces equal to 46 Gs. *Id.* While this experiment was initially undergone to help devise the best methods for pilot ejection in supersonic aircrafts, Stapp was also interested in motor vehicle safety and used his knowledge of the seat belt to advocate for the use of seat belts in motor vehicles. *Id.*

[40] *See id.*

[41] *See, e.g.*, N.Y. VEH. & TRAF. LAW § 383 (McKinney 2019) (requiring seatbelts be installed in cars sold and driven in New York State after June 1964); WIS. STAT. § 347.48 (2019) (requiring seatbelts be installed in all vehicles sold or operated in Wisconsin).

[42] National Traffic Motor Vehicle Safety Act of 1966, Pub. L. No. 89-563, 80 Stat. 718-19, 727, 730 (allowing the National Highway Transportation Safety Agency to pass regulations setting minimum safety standards for the manufacture of Motor vehicles). This Act was passed in large part due to Ralph Nadar's widely read book *Unsafe at Any Speed: The Designed-in Dangers of the American Automobile*. *See* Christopher Jensen, *50 Years Ago, 'Unsafe at Any Speed' Shook the Auto World*, N.Y. TIMES (Nov. 26, 2015), https://www.nytimes.com/2015/11/27/automobiles/50-years-ago-unsafe-at-any-speed-shook-the-auto-world.html. In this book, Nadar suggested the automobile industry was ignoring scientific research studies and subjecting the American people to unsafe standards. *See id.*

[43] *See* U.S. DEP'T OF TRANSP., NAT'L HIGHWAY TRAFFIC SAFETY ADMIN., QUICK REFERENCE GUIDE (2010 VERSION) TO FED. MOTOR VEHICLE SAFETY STANDARDS AND REGULATIONS (2011), https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/fmvss-quickrefguide-hs811439.pdf; *see also* Federal Motor Vehicle Safety Standards, 49 C.F.R. § 571.209 (2019).

[44] *See Automobile Safety*, *supra* note 27.

[45] *Id.*

[46] *Id.*

[47] *See id.*

[48] *See* Erin K. Sauber-Schatz et al., *Vital Signs: Motor Vehicle Injury Prevention — United States and 19 Comparison Countries*, 65 MORBIDITY & MORTALITY WKLY. REP. 26, 672, 672 (July 6, 2016); *see also* Aria Hangyu Chen, *U.S. Has Highest Car Crash Death Rate, Despite Progress,*

their lives in car crashes in the United States alone.[49] That is an increase of 5.6% from 2015.[50] According to research done by the United States Department of Transportation (DOT), in 94% of cases from 2005 to 2007, the car crashes were considered to be caused by human error.[51] Of those accidents attributed to human error, 41% were attributed to recognition errors.[52] A recognition error "includes driver inattention, internal and external distractions, and inadequate surveillance."[53] Of the other fatalities attributed to human error, 33% were decision errors, which includes driving at the incorrect speed for the conditions or terrain, misjudging the actions of others, making illegal maneuvers, and miscalculating the space between vehicles.[54] Another 11% were performance errors.[55] These errors include overcompensation and poor directional control, often attributed to sleeping at the wheel.[56]

It was these unwavering safety problems that prompted the development of the modern concept of automated cars.[57]

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*CDC says*, CNN (July 7, 2016), https://www.cnn.com/2016/07/07/health/us-highest-crash-death-rate/index.html (discussing that, despite per capita decline, the death rate from car crashes remains very high in the United States). According to the authors, not only does the United States have a higher crash fatality rate than any other high-income country, the United States also ranked third lowest in front seat belt use, second highest in alcohol related impairment, and had the lowest percentage decline in the rate of motor vehicle fatalities between 2000 and 2013. *See id.* at 673.

[49]  Press Release, Nat'l Highway Traffic Safety Admin., USDOT Releases 2016 Fatal Crash Data (Oct. 6, 2017), https://www.nhtsa.gov/press-releases/usdot-releases-2016-fatal-traffic-crash-data.

[50]  *Id.* Significantly, the number of vehicles on the road did not increase proportionally, only increasing by 2.2%. *Id.*

[51]  *Improper Driving and Road Rage*, NAT'L SAFETY COUNCIL, https://injuryfacts.nsc.org/motor-vehicle/motor-vehicle-safety-issues/improper-driving-and-road-rage (last visited Nov. 9, 2019).

[52]  *Id.*

[53]  *Id.*

[54]  *See id.*

[55]  *Id.*

[56]  *Id.*

[57]  *See Automated Vehicles for Safety*, NAT'L HIGHWAY TRAFFIC SAFETY ADMIN., https://www.nhtsa.gov/technology-innovation/automated-vehicles-safety (last visited Nov. 9, 2019) (listing safety as the top benefit of self-driving cars). For an interesting timeline on the safety developments in vehicles, see Kiernan Hopkins, *The Evolution and History of Automobile Safety*, DISTRACTEDDRIVERACCIDENTS.COM (Apr. 13, 2014), https://distracteddriveraccidents.com/the-evolution-and-history-of-automobile-safety/.

## II. THE AUTOMATED CAR

Although manufacturers have recently made rapid strides towards developing fully autonomous vehicles, automated cars are not a new concept.[58] There have been several important milestones on the road to the modern concept of autonomous vehicles, beginning in the early twentieth century.[59] Overtime, the public perception of autonomous vehicles has shifted from the vehicles being seen as an unattainable model of safe driving to an imminent reality, ushering in a modern day anticipation and excitement for autonomous cars.[60] Autonomous vehicles are categorized into six different levels of automation developed by the SAE.[61] These levels indicate different autonomous features in the vehicles.[62] The development of autonomous vehicles with increased automation at each level has been driven by the belief that autonomous vehicles could increase traffic safety.[63] The modern concept of the autonomous vehicle is a result of an increasing interest in improving safety in vehicular travel.[64]

### A. *The Evolution of the Automated Car*

The concept of the automated car has existed in the imaginations of inventors and children alike since the early 1900s.[65] Even

[58] *See* P.E., *Self-Driving Cars Coming to a Street Near You*, ECONOMIST (Sept. 18, 2014), http://www.economist.com/news/business-and-finance/21618531-making-autonomous-vehicles-reality-coming-street-near-you (recalling how General Motors' exhibit at the 1938 World's Fair envisioned a world of self-driving cars).

[59] *See* Luke Dormehl & Stephen Edelstein, *Sit back, relax, and enjoy a ride through the history of self-driving cars*, DIG. TRENDS (Feb. 3, 2019, 9:00 PM), https://www.digital-trends.com/cars/history-of-self-driving-cars-milestones/.

[60] *See SAE International Survey Shows Public Enthusiasm About Self-Driving Cars*, SAE INT'L (Nov. 5, 2019), https://www.sae.org/news/press-room/2019/11/sae-international-survey-shows-public-enthusiasm-about-self-driving-cars (finding 82% of respondents are enthusiastic for autonomous vehicles and 76% of respondents "think a self-driving car experience is similar or superior to a human-driven experience.")

[61] *See Automated Vehicles for Safety*, *supra* note 57.

[62] *See id.*

[63] *See id.*

[64] Frankie Wallace, *Will Self-Driving Cars Reduce Accidents And Improve Safety?*, HEADSTUFF, https://www.headstuff.org/topical/will-self-driving-cars/ (last updated Feb. 26, 2019) (explaining that the entire purpose of self-driving cars is to eliminate accidents and improve safety).

[65] *See* MARKUS MAURER, ET AL., AUTONOMOUS DRIVING: TECHNICAL, LEGAL AND SOCIAL ASPECTS, 41-42 (2016) (ebook) (stating people have envisioned the concept of driverless cars since the first half of the twentieth century); *The Autonomous Vehicle: A Look Through History*,

when the first automobiles were manufactured, autonomous vehicles were seen as a utopian solution to pervasive problems, including car accidents.[66] During the first era of mass mobilization, following the assembly line production of the Model T, fatalities and car accidents had increased dramatically in the United States.[67] About 200,000 people died in car accidents in the 1920s when the United States had a population of over 100 million people.[68] Driver error was seen as the primary cause of the high accident rate, which prompted inventors to make the first attempts at eliminating the human component of driving.[69]

In 1921 the United States military developed the first automated vehicle.[70] This car was controlled by radio waves and lacked the capability to steer.[71] Other remote-controlled cars controlled by radio waves were developed into the 1930s.[72] A remote-controlled vehicle that was controlled by Morse code was used as the focal point of a transportation safety campaign that touched thirty-seven out of the forty-eight states.[73] Exposure to the

V2GOV, https://v2gov.com/autonomous-vehicle-history-912/ (last visited Nov. 5, 2019) (stating autonomous vehicles have been on people's minds for centuries). The public viewed the early remote-controlled cars as "robot car[s] or magic car[s]. These metaphors show the driverless car was perceived as a fantastical object from early on." *See* MARKUS MAURER ET AL., at 44.

[66] *See* MAURER ET AL., *supra* note 65, at 42 (explaining driverless cars were viewed as a solution to the prominent issue of car accidents in the early days of automobiles).

[67] *See* Mary Bellis, *History of the Automobile: The Assembly Line*, THOUGHTCO. (Sept. 24, 2018), https://www.thoughtco.com/history-of-car-assembly-line-4072559 (explaining that the assembly line led to mass mobilization of the Model-T); *Car Crash Deaths and Rates*, NAT'L SAFETY COUNCIL, https://injuryfacts.nsc.org/motor-vehicle/historical-fatality-trends/deaths-and-rates/ (last visited Nov. 9, 2019) (comparing statistics from the 1930s to 2017 to demonstrate the dramatically high rates of car accidents and fatalities in the 1900s after mass mobilization).

[68] *See* MAURER ET AL., *supra* note 65, at 42. The population of the United States in 1920 was approximately 106 million people. *POP Culture: 1920*, U.S. CENSUS BUREAU,
https://www.census.gov/history/www/through_the_decades/fast_facts/1920_fast_facts.html
(last visited Oct. 22, 2019). By 1930, the U.S. population was approximately 123 million people. *POP Culture: 1930*, U.S. CENSUS BUREAU, https://www.census.gov/history/www/through_the_decades/fast_facts/1930_fast_facts.html (last visited Oct. 22, 2019).

[69] *See* MAURER ET AL., *supra* note 65, at 42 (discussing how inventors sought to eliminate human component of driving with technology).

[70] *See id.* at 43 (stating the Air Service introduced the first driverless car in 1921). This book notes the first driverless car, which was actually a remote-controlled vehicle, was considered to be a "media story" because the military developed it. *Id.*

[71] *See id.* at 42-43 (stating radio waves controlled the car mechanisms since the car was not self-driving).

[72] *See id.* at 44 (stating subsequent remote-controlled automobiles also using radio waves made appearances in the 1930s).

[73] *See id.* (explaining the remote-controlled car controlled by Morse code was used in transport safety campaigns across twenty-seven states). *Safety Parades* led by Captain J.J. Lynch

automated car as a model for safety in the safety campaign reinforced the idea that humans were the cause of safety concerns with driving, and asserted the superiority of the automated vehicle.[74]

In 1935, the concept of the automated car made its first appearance on the silver screen when General Motors launched a video campaign focused on the concept of the automated car as a model for safe and moral driving.[75] This video campaign, called *The Safest Place*, featured a car driving itself and cautiously obeying all the traffic rules.[76] In the campaign, the machine is a "living room on wheels" and the only risk factor is the driver.[77] The film emphasized that eliminating the errors of the driver effectively makes the automated car the safest place.[78] In other forms of media, futuristic versions of autonomous cars were popularized in futuristic exhibit shows like *Futurama*.[79] In 1958, Walt Disney released a movie called *Magic Highways USA*, which depicted a futuristic version of highways that would improve lifestyles and safety.[80] The movie features models of autonomous cars with

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portrayed the automated vehicles as a model for driving safety. *Id.* Between 1931 and 1949, Lynch gave safety demonstrations using the automated vehicle in 37 out of the 48 states. *Id.*

[74]   *See id.* (explaining the driverless vehicle served as a good example for human drivers since it obeyed traffic rules). In fact, "Lynch stressed that modern automobiles' safety depended on the driver." *Id.*

[75]   *See* MAURER ET AL., *supra* note 65, at 45-46 (explaining the automated car, which obeyed all traffic rules, served as a safe and moral model).

[76]   *See General Motors, 1930s The Safest Place on Earth,* YOUTUBE (Apr. 9, 2017), *https://www.youtube.com/watch?v=4RYwyuyJX7g* ("Only one thing is needed for safety, and that's a careful driver. If the manufacturer could equip every car with an automatic driving mechanism, the car would always do just what it should do when it got out on the road."). *See also* MAURER ET AL., *supra* note 65, at 45-46 (describing how the driverless car followed all traffic regulations in an exemplary fashion).

[77]   *See id.* at 46; *see also* Jason Torchinsky, *Chevy Safety Film From 1935 Predicts Autonomous Cars*, JALOPNIK (May 3, 2013, 1:15 PM), https://jalopnik.com/chevy-safety-film-from-1935-predicts-autonomous-cars-489326191 (describing the autonomous car as a "living room on wheels" that would one day eliminate human risk).

[78]   *See* Carl Engelking, *The 'Driverless' Car Era Began More Than 90 Years Ago*, DISCOVERY MAG. (Dec. 13, 2017, 10:22 AM), http://blogs.discovermagazine.com/d-brief/2017/12/13/driverless-car-houdini-houdini/#.XcdpsZJKgWo (explaining how a driverless car, which obeys all rules of the road, is the safest).

[79]   *See* MAURER ET AL., *supra* note 65, at 48.

[80]   *See* Matt Novak, *Disney's Magic Highway, U.S.A. (1958)*, GIZMODO (May 11, 2007, 4:32 AM), https://paleofuture.gizmodo.com/disneys-magic-highway-u-s-a-1958-512630663 (showing a clip of the movie *Magic Highway USA* that depicts a car operated by GPS, preprogrammed destinations, and autonomous driving where the family spends the commute doing leisure activities or on a business call); Álvaro Ibáñez, *This was how retrofuturism imagined the highways of today*, FERROVIAL BLOG (Nov. 7, 2018), https://blog.ferrovial.com/en/2018/11/retrofuturism-highways/ (discussing how Disney, through its movie, tried to explain the importance of highways to the development of society); *see also* MAURER ET AL., *supra* note 65, at 53 (discussing Disney's version

remarkable similarities to the prototypical models of soon to be released autonomous vehicles.[81]

The 1939 World's Fair also featured models of autonomous cars.[82] The fair had the motto "*Building the World of Tomorrow*" and focused on how technological advancements could improve society.[83] In an elaborate diorama of what the future could look like, thousands of tiny autonomous cars were commanded by radio waves, in perfect lines across a fourteen lane highway.[84] The depiction of autonomous vehicles as beneficial to society was widely accepted by the public, and fostered great interest in the development of autonomous vehicles.[85]

However, in the 1970s and into the 1980s the theatrical portrayal of the automated car changed, shifting from a helpful solution to human error to an entity with a mind of its own.[86] There were several movies that depicted cars coming to life and terrorizing drivers and communities.[87] Autonomous vehicles were no longer safety symbols removing dangerous humans from the

of the autonomous car as being beneficial to society, and that "it has seldom been clearer that future technologies are part of a promise of salvation.")

[81]    *See* Cadie Thompson, *Disney predicted the future of transportation in 1958 and was eerily correct about a lot of things*, BUS. INSIDER (Dec. 29, 2016), http://www.businessinsider.com/walt-disneys-magic-highway-predictions-in-1958-2016-12 (describing Disney's car predictions that came true or are on their way to becoming reality in modern autonomous vehicles); *see also* Leopold Bosankic, *The changing meaning of autonomous cars from the 1920s to 2017*, MEDIUM (July 13, 2017), https://medium.com/@leo_pold_b/the-changing-meaning-of-autonomous-cars-from-the-1920s-to-2017-f2adeab3ce42 (comparing the images of the Disney depictions of autonomous vehicles with the renderings of Mercedes' autonomous vehicle).

[82]    *See* MAURER ET AL., *supra* note 65, at 48.

[83]    *Id.*

[84]    *See id.* (noting thousands of tiny automatic cars in the showcase diorama dashed along a fourteen-lane highway, kept in lane by radio waves).

[85]    *See The Autonomous Vehicle: A Look Through History*, *supra* note 65 (discussing the public's continued interest in self-driving cars and eagerness to develop them).

[86]    *See generally* MAURER ET AL., *supra* note 65, at 57-58 (discussing the fundamental change in public's perception of driverless cars using scenes from the 1970s film *Duel* and the 1980s film *Christine*, where the automobiles, respectively, caused problems as opposed to solving them). This change in depiction of the autonomous car from being a helpful, promising figure to one that is haunting society parallels the rise of the energy crisis and increasing awareness of and problems from pollutants and emissions. *See id.* at 58 (discussing the rise in environmental issues attributed to mass motorization of vehicles). Autonomous cars were seen as symbolic of these environmental phenomena. *Id.* (stating the oil crisis was attributed to the era of cars and mass motorization).

[87]    *See id.* at 57-58 (discussing how films such as *Duel*, *The Car* and *Christine* depicted autonomous cars terrorizing people). In *Duel*, the car, while driven by a human, hunts the driver who cannot escape the terror of the vehicle. *See id.* at 57 (describing the truck hunting the driver). *The Car* depicts a vehicle that haunts an entire town. *Id. Christine* the automated car has its own soul, and is immune from the effects of accidents. *See id.* at 58.

driving equation, and instead technological developments associated with vehicles were seen as exacerbating the existing environmental problems threatening human lives.[88] As the oil crisis subsided and environmental concerns were being addressed by legislation,[89] the autonomous vehicle renewed its position as a "partner to humans" in the motion series *Knight Rider*,[90] reflecting the public's renewed interest in the development of the autonomous vehicle.[91]

The modern notion of the automated car, as an independent computerized entity, was developed in Germany beginning in 1984.[92] By 1987, that vehicle employed a visual autonomous guidance system using only cameras and a computing system to go twenty kilometers with a speed of up to ninety-six kilometers per hour.[93] The vehicle operated based on a "spatiotemporal dynamic model," which used cameras and time to determine its course.[94] The prototype was a very cumbersome vehicle that was only able to navigate a simple test course.[95] A study at Carnegie Mellon University was also experimenting with autonomous cars through its

[88] *See id.* at 58 (explaining film depictions ruined the positive image of autonomous cars by blaming automobiles for exacerbating environmental problems).

[89] *See From Oil Crisis to Energy Revolution – How Nations Once Before Planned to Kick the Oil Habit*, RESILIENCE (Apr. 17, 2019), https://www.resilience.org/stories/2019-04-17/from-oil-crisis-to-energy-revolution-how-nations-once-before-planned-to-kick-the-oil-habit/ (explaining resolutions to alleviate the oil crisis were accomplished through government legislation); *Summary of the Clean Air Act*, ENVTL. PROTECTION AGENCY, https://www.epa.gov/laws-regulations/summary-clean-air-act (last updated Aug. 15, 2019) (stating the federal government enacted Clean Air Act to address environmental issues). Under the Clean Air Act, car emissions were to be reduced by 90% in five years and required new cars meet EPA standards for emissions. *See* David M. Bearden et al., *Environmental Laws: Summaries of Major Statutes Administered by the Environmental Protection Agency* (2013) (stating requirement for 90% reduction in car emissions within five years and EPA emission standards); *History of Reducing Air Pollution from Transportation in the United States*, U.S. ENVTL. PROTECTION AGENCY, https://www.epa.gov/air-pollution-transportation/accomplishments-and-success-air-pollution-transportation (last visited Nov. 2, 2019) (discussing improvements in the air quality and environment as a result of regulation of pollution and emissions). Compared with cars from the 1970s, modern cars were 99% cleaner for common pollutants. *Id.*

[90] *See* MAURER ET AL., *supra* note 65, at 60-61 (stating cinema no longer demonized driverless cars and the car KITT was a partner to the ex-policeman).

[91] *See id.* (describing updates in KITT's dimensions to show public's renewed interest in developing autonomous cars that perform in a similar way).

[92] *See id.* at 59 (stating Ernst Dickmanns "developed for the first time visually guided autonomous cars" which had a processor on board).

[93] *See id.*

[94] *See id.* The process also "integrated a feedback of prediction errors" to operate. *Id.*

[95] *See id.* at 59 (explaining the van prototype required big sized camera, had no radar or GPS, and could only go a distance of twenty kilometers).

NavLab in the 1980s.[96] The first model vehicle developed in the NavLab was a van equipped with cumbersome computers and was able to drive down a road autonomously.[97] In 1998, the NavLab embarked on a drive across America during which a much smaller version of the original autonomous vehicle was able to operate 98% of the trip autonomously, including a 70 mile stretch without human intervention.[98] Soon thereafter, off-road operation vehicles were developed that utilized visual optimization and GPS systems to navigate around obstacles.[99]

Since the beginning stages of automation, companies have been heavily invested in developing new technologies to make fully autonomous cars a reality.[100] Now, more autonomous features are being offered in standard models of cars, and most of the major car manufactures are developing autonomous vehicles.[101]

### B. *Six Phases of Automation and Their Corresponding Safety Components*

According to the SAE, the process of vehicle automation occurs in six phases.[102] These phases have been adopted by the United States Department of Transportation.[103] The phases range from

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[96]  *See* Jeff Schneider, *TedxCMU: How Self-Driving Cars Will Transform Our Cities and Our Lives*, YOUTUBE (May 19, 2017), https://www.youtube.com/watch?v=CHV4AiCvSmw.

[97]  *See id.*

[98]  *See id.*

[99]  *See id.*

[100]  *40+ Corporations Working On Autonomous Vehicles*, CB INSIGHTS (Aug. 28, 2019), https://www.cbinsights.com/research/autonomous-driverless-vehicles-corporations-list/ (detailing all the different automobile companies that are investing large amounts of money into autonomous research and development).

[101]  *See* Keith Noonan, *What Does the Future Hold for Self-Driving Cars*, MOTLEY FOOL (Oct. 18, 2019, 5:15 PM), https://www.fool.com/investing/what-does-the-future-hold-for-self-driving-cars.aspx.

[102]  *See* SOC'Y OF AUTOMOBILE ENGINEERS INT'L, TAXONOMY AND DEFINITIONS FOR TERMS RELATED TO DRIVING AUTOMATION SYSTEMS FOR ON-ROAD MOTOR VEHICLES 2, 19 (2018) [hereinafter SAE AUTONOMOUS LEVELS GUIDE].

[103]  *See* U.S. DEP'T OF TRANSP., AUTOMATED DRIVING SYSTEMS 2.0: A VISION FOR SAFETY 1 (2017) [hereinafter VISION FOR SAFETY 2.0]. Since this paper was written, the Department of Transportation has released and updated a guide on its approach to autonomous vehicles and the challenges that they will present; the updated publication was released on October 4, 2018 and builds upon *Automated Driving Systems 2.0: A Vision for Safety*. *See* U.S. DEP'T OF TRANSP., PREPARING FOR THE FUTURE OF TRANSPORTATION: AUTONOMOUS VEHICLES 3.0 iii, viii (2018) [hereinafter A.V. 3.0]. According to the Secretary, *Preparing for the Future of Transportation: Autonomous Vehicles 3.0* "is the beginning of a national discussion about the future of our surface transportation system." *Id.* at iii. Since *Preparing for the Future of Transportation: Autonomous*

no automation to full automation.[104] Within each of these automation levels, there are accompanying safety innovations.[105]

At level zero, there is no automation and the driver performed all of the tasks associated with driving the vehicle.[106] At level one of automation, the steering *or* acceleration and deceleration becomes partially automated.[107] The human driver cannot disengage from driving or take his or her hands off of the pedal and the steering wheel at the same time.[108] In this stage, human drivers are responsible for all aspects of the driving task, but the car can use information about the driving environment to assist with steering or acceleration/deceleration.[109] The safety features at level one automation include antilock brakes and cruise control.[110] Most of the cars on the road in 2018 are level one autonomous vehicles.[111]

At level two of automation, there is partial automation.[112] Here, the vehicle has both automated steering and automated acceleration/deceleration components.[113] Level two autonomous cars include features like adaptive cruise control and lane assist.[114] These features allow drivers to take their hands off of the steering wheel at the same time they take their foot off of the pedal.[115]

Level three of automation is the first stage which includes an automated driving system that monitors the environment.[116] At

*Vehicles 3.0* builds on *Automated Driving Systems 2.0: A Vision for Safety*, this paper continues to refer to VISION FOR SAFETY 2.0 as the relevant authority.

[104] *See* VISION FOR SAFETY 2.0*, supra* note 103, at 4.

[105] *See Automated Vehicles for Safety*, *supra* note 57.

[106] *See* VISION FOR SAFETY 2.0, *supra* note 103, at 4.

[107] *See Automated Vehicles for Safety*, *supra* note 157.

[108] *See* Tracy Hresko Pearl, *Fast & Furious: The Misregulation Of Driverless Cars*, 73 N.Y.U. ANN. SURV. AM. L. 19, 27 (2017).

[109] *See id.*

[110] *See* Giles Kirkland, *What are the Levels of Autonomy for Self-Driving Vehicles?*, ROBOTICS BUS. REV. (July 26, 2019), https://www.roboticsbusinessreview.com/unmanned/unmanned-ground/what-are-the-levels-of-autonomy-for-self-driving-vehicles/.

[111] *See* Kyle Hayatt & Chris Paukert, *Self-driving cars: A level-by-level explainer of autonomous vehicles*, CNET (Mar. 29, 2018), https://www.cnet.com/roadshow/news/self-driving-car-guide-autonomous-explanation/.

[112] *See* VISION FOR SAFETY 2.0, *supra* note 103, at 4.

[113] *See Automated Vehicles for Safety*, *supra* note 57.

[114] *See* Jakob, *The 6 levels of autonomous driving*, AUTONOMOUS DRIVING (Mar. 20, 2018), https://autonomous-driving.org/2018/03/20/the-6-levels-of-autonomous-driving/.

[115] *See* Robert J. Szczerba, *Rise of the Machines: Understanding The Autonomy Levels Of Self-Driving Cars*, FORBES (July 19, 2018), https://www.forbes.com/sites/robertszczerba/2018/07/19/rise-of-the-machines-understanding-the-autonomy-levels-of-self-driving-cars/#1c6ea2f29593.

[116] *See Automated Vehicles for Safety*, *supra* note 57.

this level, there is an automated driving system that takes over all of the aspects of the dynamic driving task with the expectation that the human driver is alert and will respond appropriately to a request to intervene.[117] The task of monitoring the driving environment is controlled by the driving system along with the acceleration, deceleration, and steering.[118] The human driver may be required to take over driving under certain conditions, but the vehicle does not require human control.[119]

Currently, there are level three autonomous vehicles on the road that are owned and operated by commercial ride share agencies and level four vehicles will soon be available to consumers.[120] Through Waymo, Google's autonomous vehicles have driven over four million miles.[121]

Waymo, formerly Google's Self-Driving Car Project, is the first ride sharing company to offer rides from autonomous vehicles.[122] The autonomous vehicles in Waymo's fleet have driven autonomously for over four million miles throughout the country.[123] Waymo is offering an "early rider program" in the Phoenix area, which allows eligible members to use the autonomous vehicles as they would personal vehicles.[124] Waymo recently announced it would be offering rides without the safety engineer, meaning the only people in the vehicle would be the passengers.[125] Uber has

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[117]   *See* VISION FOR SAFETY 2.0, *supra* note 103, at 4; Matt Burgess, *When does a car become truly autonomous? Levels of self-driving technology explained¸* WIRED (Apr. 21, 2017), http://www.wired.co.uk/article/autonomous-car-levels-sae-ranking.

[118]   *See* SAE AUTONOMOUS LEVELS GUIDE, *supra* note 102 at 6, 22.

[119]   *See id.* at 19.

[120]   *See* Noonan, *supra* note 101 (noting that Tesla and Audi have cars that "fall in the Level 3-functionality tier" and that "true Level 4 functionality [is] still in the development and testing phases" but that some car manufacturers expect to have level 4 cars by 2021).

[121]   *See* Kirsten Korosec, *Waymo's self-driving cars hit 10 million miles*, TECH CRUNCH (Oct. 10, 2018, 1:48 PM), https://techcrunch.com/2018/10/10/waymos-self-driving-cars-hit-10-million-miles/.

[122]   *See Our Journey*, WAYMO, https://waymo.com/journey/ (last visited Oct. 21, 2019).

[123]   *See* Korosec, *supra* note 121.

[124]   *See id.*

[125]   *See* Marco della Cava, *In a self-driving car first, ride with Waymo and no driver¸* USA TODAY (Nov. 7, 2017, 5:51 PM), https://www.usatoday.com/story/tech/2017/11/07/get-ride-google-and-theres-no-driver/838476001/. According to USA Today, Waymo, a ride sharing company owned by Google, is removing the safety engineer to Phoenix area residents. *See id.* This is a departure from typical practice for self-driving cars, which is to have a safety driver to take over the driving if needed. *See id.* Under the new program, the driver's seat will be completely empty and the autonomous vehicles will be used as personal vehicles would be, minus the driver. *See id.* To make users more comfortable with the developing technology, Waymo has included buttons

also deployed many autonomous vehicles and is offering rides with safety engineers.[126]

At level four of automation, the vehicle is capable of performing all driving tasks *under certain conditions*, but the driver may opt to control the vehicle.[127] The automated driving system (ADS) will respond appropriately to the driving environment even if the human does not respond to a request to intervene.[128] If the human driver does not respond to a request to intervene, the ADS will independently return the vehicle to a minimal risk condition.[129] Tesla CEO Elon Musk[130] believes between the end of 2019, a level four automated car will be available.[131] These vehicles can drive themselves, but not in all environments.[132] We are now entering into the fourth safety stage of automation, which includes partially automated safety features.[133] Lane assist, adaptive cruise control, traffic jam assist, and self-parking features are being offered in these semi-autonomous vehicles.[134] There are no commercially available level four vehicles, though.[135]

Level five of automation is the final level where cars will be equipped with full automation.[136] There are no level five vehicles commercially available yet.[137] At this level, the vehicle will be able to perform all of the functions associated with the dynamic driving

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which can call for live help. *See id.* Waymo states their goal is to make fully autonomous rides available in cities all over the world. *See id.*

[126] *See* Michael Laris, *You can ride in a driverless Uber in Pittsburgh starting later this month. You'll have a chaperone though.*, WASH. POST (Aug. 18, 2016, 11:08 AM), https://www.washingtonpost.com/news/dr-gridlock/wp/2016/08/18/you-can-ride-in-a-driverless-uber-in-pittsburgh-youll-have-a-chaperone-though/ (stating Uber's ride program in Pittsburgh, PA is now offering rides in autonomous vehicles with a safety engineer).

[127] *See* VISION FOR SAFETY 2.0, *supra* note 103, at 4.

[128] *See id.* at 8*; see also* Burgess, *supra* note 117.

[129] *See* VISION FOR SAFETY 2.0, *supra* note 103, at 6, 8.

[130] *See Elon Musk,* TESLA, https://www.tesla.com/elon-musk?redirect=no.

[131] Aarian Marshall, *Elon Musk Promises a Really Truly Self-Driving Tesla in 2020*, WIRED (Feb. 19, 2019), https://www.wired.com/story/elon-musk-tesla-full-self-driving-2019-2020-promise/ ("The Tesla CEO said the electric car maker's full self-driving feature will be completed by the end of 2019.").

[132] *See id.*

[133] *See Automated Vehicles for Safety*, *supra* note 57.

[134] *See id.*; *see also* SAE AUTONOMOUS LEVELS GUIDE, *supra* note 102.

[135] Kathleen Walch, *The Future with Level 5 Autonomous Cars*, FORBES (June 20, 2019), https://www.forbes.com/sites/cognitiveworld/2019/06/20/the-future-with-level-5-autonomous-cars/#5a3c495b4382.

[136] *See id.*

[137] *See id.*

task.[138] Here, the driver still may have the option to intervene if he or she so chooses, but there should be no reason to touch the controls.[139] Tesla is optimistic an autonomous vehicle equipped with level five automation will debut in 2020.[140] During this stage, the car will control the vehicle in its entirety and has the potential to eliminate all of the risk associated with human behavior.[141]

Almost all major car manufacturers have embarked on the development and implementation of automated vehicles.[142] According to Goldman Sachs, by 2030, autonomous vehicles could comprise up to 60% of automobile sales in the United States.[143] All Tesla cars are now being produced with the hardware necessary for a fully autonomous vehicle.[144] And several of the most popular transportation companies, including Uber and Waymo, are deploying autonomous vehicles.[145]

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[138]   *See id.*; *see also* SAE AUTONOMOUS LEVELS GUIDE, *supra* note 102.

[139]   Fred Lambert, *Elon Musk clarifies Tesla's plan for level 5 fully autonomous driving: 2 years away from sleeping in the car*, ELECTREK (Apr. 29, 2017), https://electrek.co/2017/04/29/elon-musk-tesla-plan-level-5-full-autonomous-driving/.

[140]   Tom Krishner & Michael Liedtke, *Tesla expects to have fully self-driving cars by next year*, PBS NEWS HOUR (Apr. 22, 2019), https://www.pbs.org/newshour/economy/tesla-set-to-unveil-fully-self-driving-car-technology.

[141]   INTERNATIONAL TRANSPORT FORUM CPB, AUTOMATED AND AUTONOMOUS DRIVING: REGULATION UNDER UNCERTAINTY 5 (2015), https://orfe.princeton.edu/~alaink/SmartDriving-Cars/PDFs/15ITF_AutonomousDriving.pdf ("Most crashes involve human error. If greater autonomous operation reduces or eliminates these errors, then benefits for road safety may be substantial.").

[142]   *See* James Armstrong, *How Driverless Cars Work*, TELEGRAPH (Nov. 2, 2018), http://www.telegraph.co.uk/cars/features/how-do-driverless-cars-work/. This includes manufacturers such as Ford, Tesla, Volvo, Mercedes-Benz, Audi, and BMW. *See id.*; *see also* Cadie Thompson, *Why driverless cars will be safer than human drivers*, BUS. INSIDER (Nov. 16, 2016), http://www.businessinsider.com/why-driverless-cars-will-be-safer-than-human-drivers-2016-11.

[143]   *See* Thompson, *supra* note 142.

[144]   The Tesla Team, *All Tesla Cars Being Produced Now Have Full Self-Driving Hardware*, TESLA (Oct. 19, 2016), https://www.tesla.com/blog/all-tesla-cars-being-produced-now-have-full-self-driving-hardware.

[145]   *See* Andrew J. Hawkins, *Uber's self-driving cars are now picking up passengers in Arizona*, VERGE (Feb. 21, 2017), https://www.theverge.com/2017/2/21/14687346/uber-self-driving-car-arizona-pilot-ducey-california (discussing Ubers' deployment of self-driving vehicles in Arizona); Ashley Hasley III & Michael Laris, *Blind man sets out alone in Google's driverless car*, WASH. POST (Dec. 13, 2016), https://www.washingtonpost.com/local/trafficandcommuting/blind-man-sets-out-alone-in-googles-driverless-car/2016/12/13/f523ef42-c13d-11e6-8422-eac61c0ef74d_story.html?utm_term=.07a32fa93cf8; Brian Fung, *Lyft will launch self-driving car rides by the end of this year*, WASH. POST (July 21, 2017, 11:00 AM), https://www.washingtonpost.com/news/the-switch/wp/2017/07/21/lyft-riders-in-boston-will-be-able-to-hail-a-self-driving-car-by-years-end/ (describing Lyft plans to deploy automated vehicles by the end of 2017).

## C. *Safety Features of Autonomous Vehicle*

Autonomous vehicles present many potential benefits to society, most significantly an increase in safety.[146] Autonomous vehicles eliminate the most dangerous element to driving: the human.[147] By eliminating the human component of driving, autonomous vehicles can increase traffic safety in two main ways. First, autonomous vehicles eliminate the errors caused by human misjudgment.[148] Since human error is a factor in 94% of vehicular deaths in the United States, eliminating humans from the driving equation could potentially eliminate hundreds or thousands of deaths from car accidents each year.[149] According to a report performed by the consulting firm McKinsey & Co., the widespread use of fully autonomous vehicles could eliminate about 90% of car accidents worldwide, thus saving thousands of lives and $190 billion dollars

[146] *See* The Tesla Team, *supra* note 144 (boasting Tesla's autonomous vehicles are "substantially safer than … human driver[s].") Most autonomous vehicle manufacturers state they are developing autonomous vehicles to increase traffic safety. *See id*; *SAFETY: Volvo Innovations and Intellisafe Technology*, VOLVO, https://www.volvocars.com/au/about/innovations/intellisafe/autopilot (last visited Feb. 11, 2019) (stating Volvo's autonomous features in its cars will take you safely where you want to go and that Volvo has a goal that no one should be killed or seriously injured in an autonomous Volvo); GEN. MOTORS, 2018 SELF-DRIVING SAFETY REPORT 2 (2018), https://www.gm.com/content/dam/gm/en_us/english/selfdriving/gmsafetyreport.pdf (last visited Dec. 28, 2019) (stating GM's purpose for developing autonomous cars is to increase safety); Pearl, *supra* note 108, at 16. Autonomous vehicles pose many benefits beyond just increasing the safety of vehicle transportation, but other benefits are outside the scope of this note. It is important to consider these benefits when holistically evaluating the purpose of autonomous vehicles. These benefits include traffic reduction since the vehicles will need less reaction time and will be able to utilize more of the available road space; total increase in human productivity since full attention will no longer need to be spent while driving. *See id.* at 19-20. For example, business transactions can be made during a person's commute. *See id.* at 20. Personal improvements, or general increase in personal welfare, could replace the stresses of the morning commute. *See id.* at 19-20. Accessibility will increase for people unable to retain a driver's license. *See id.* at 22. For people with disabilities—including the blind, elderly, and others who are unable to drive—having the opportunity to own an autonomous car is important because otherwise those who lack mobility can experience "a serious reduction in one's quality of life and health." *See id.*; *see also* Hasley III & Laris, *supra* note 145 (reporting a blind man was the first non-Google employee to ride in Waymo's self-driving car).

[147] *See* Bruce Brown, *Evidence stacks up in favor of self-driving cars in 2016 NHTSA fatality report*, DIG. TRENDS (Oct. 6, 2017), https://www.digitaltrends.com/cars/2016-nhtsa-fatality-report/ (discussing crash data results showing that humans are responsible for 94% of fatalities in car crashes, many of which are caused by inappropriate or distracted behavior); *see also* Pearl, *supra* note 108, at 17.

[148] Brown, *supra* note 147.

[149] *See id.* (stating that "more than 37,000 lives [were] lost on U.S. roads and highways [in 2016] . . . .").

each year.[150] Self-driving cars will not make the errors of judgment that human driven cars make.[151] They will not drink and drive, they will not fall asleep behind the wheel, they will not become victims of heart attacks, and they will not be subject to human error—such as over correction and vision impairment.[152] Even in the early stages of autonomous vehicles, at least one study found that self-driving cars had a much lower accident rate than those driven by humans.[153]

Second, the technology used in automated cars will soon be more efficient and effective than human perception.[154] Currently, autonomous cars have various technological mechanisms that improve the safety of motor vehicle transit beyond the capabilities of humans.[155] The technology varies from manufacturer to manufacturer, but all autonomous cars employ a series of sensors that work in conjunction to "map" and navigate the surrounding environment.[156] Autonomous cars have 360 degree sensing mechanisms

[150] Mike Ramsey, *Self-Driving Cars Could Cut Down on Accidents, Study Says*, WALL ST. J. (Mar. 5, 2017), https://www.wsj.com/articles/self-driving-cars-could-cut-down-on-accidents-study-says-1425567905 (discussing McKinsey & Co. release of a report explaining that autonomous vehicles may cut down on the accident rate and prevent billions of dollars in damages and health-costs annually).

[151] *Self-driving cars could dramatically reduce the road toll*, SWINBURNE (Sept. 26, 2017), http://www.swinburne.edu.au/news/latest-news/2017/09/self-driving-cars-could-dramatically-reduce-the-road-toll.php. ("Driven by artificial intelligence, [] vehicles will not make errors of judgement the way a human driver does[]" states Dr. Dia, who is chair of Swinburne's Department of Civil and Construction Engineering).

[152] Chris Isidore, *Self-driving cars are already really safe*, CNN BUS. (Mar. 21, 2018), https://money.cnn.com/2018/03/21/technology/self-driving-car-safety/.

[153] Aaron Mamiit, *Study Says Self-Driving Cars Are Safer Than Human-Driven Vehicles: Should You Believe It?*, TECH TIMES (Jan. 12, 2016), http://www.techtimes.com/articles/123214/20160112/study-says-self-driving-cars-are-safer-than-human-driven-vehicles-should-you-believe-it.htm (discussing a study that found the accident rate for human drivers was 4.2 crashes per million miles driven, whereas self-driving vehicles found themselves in 3.2 crashes per million miles driven). Of those crashes (the study was based on Google self-driving cars), none of the accidents were the fault of the autonomous vehicle, according to Google. *See id.*

[154] Isidore, *supra* note 152.

[155] *See id.* (describing how autonomous cars have sensors with a 360-degree view around the vehicle).

[156] Christian Gilbertsen, *Here's How the Sensors in Autonomous Cars Work*, DRIVE (Mar. 27, 2017), http://www.thedrive.com/tech/8657/heres-how-the-sensors-in-autonomous-cars-work. These sensors include a combination of ultrasonic, lidar, radar, image, and cloud communication sensors. *See id.* Lidar is a term short for light detection and ranging (distance). *See id*; Alex Davies, *What is Lidar, Why do Self-Driving Cars Need it, and Can It See Nerf Bullets?*, WIRED (Feb. 6, 2018, 6:08 PM), https://www.wired.com/story/lidar-self-driving-cars-luminar-video/. Lidar works much like Radar, but works by emitting pulses of infrared light (invisible to the human eye) and measures the how long it takes for the waves to bounce back. *See id.* This allows vehicles to determine how far away objects are and develop a 3D map known as a point cloud.

that allow them to continuously "view" and evaluate the surrounding area.[157] Autonomous vehicles have the capability to brake automatically if they detect something in their path.[158] They can see further, and under adverse conditions.[159]

Of course, they can compute and calculate outcomes of various scenarios much more instantaneously than humans.[160] Autonomous vehicles use algorithms to analyze the input data from the sensors to predict the actions of the objects around them and environmental stimuli.[161] According to Waymo, the autonomous vehicles in its fleet have safety technology that can detect objects from up to three football fields in every direction.[162] Autonomous vehicles communicate with each other and relay information to each other constantly.[163] Since testing and deploying self-driving cars, the number of circumstances where a safety driver has needed to

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*See id*; *see also* TheHub, *How Do Self-Driving Cars Actually Work? (Tesla, Volvo, Google)*, YOUTUBE (Nov. 17, 2017), at 58 sec., https://www.youtube.com/watch?v=xMH8dk9b3yA. Autonomous vehicles also have Inertial Measurement Unit systems which work in combination with Lidar and advanced GPS systems to pinpoint the "exact location of the car within ¼ inches." *See* TheHub, *supra* note 156. Tesla's autonomous vehicles do not use lidar, but use eight different cameras in combination with radar and ultrasonic technology. *See Future of Driving*, TESLA, https://www.tesla.com/autopilot?redirect=no (last visited Feb. 25, 2020). These cameras include forward looking side cameras, rearward looking side cameras, rearward looking cameras, and wide, normal, and narrow looking forward cameras. *See id.* The computer system implemented in the car to process these inputs is forty times stronger than the computer in the previous model. *See id.*

157   *See* Chris Urmson, *How a Driverless Car Sees the Road*, TEDTALK (Mar. 2015), https://www.ted.com/talks/chris_urmson_how_a_driverless_car_sees_the_road.

158   *Id.*

159   *Id.* During a test drive, the car slowed in the dark. *See id.* Although the safety engineer did not see the deer, the car did. See *id.*

160   *See* Evan Ackerman, *Study: Intelligent Cars Could Boost Highway Capacity by 273%*, IEEE SPECTRUM (Sept. 4, 2012), https://spectrum.ieee.org/automaton/robotics/artificial-intelligence/intelligent-cars-could-boost-highway-capacity-by-273 ("[Y]our car, being for all practical purposes a robot, can digest a huge amount of data and make a decision about the best course of action to take in approximately the same amount of time it takes for you to move your foot from the gas to the brake.").

161   *See* Urmson, *supra* note 157.

162   *Technology*, WAYMO, https://waymo.com/tech/ (last visited Feb. 13, 2020). The objects include, pedestrians, cyclists, vehicles, road work, and more. *Id.*

163   *See* Urmson, *supra* note 157. Although outside the scope of this note, cyber security is an important concern related to autonomous vehicles because autonomous cars will be operating almost exclusively based on computer programming and communication, thus raising concerns of hacking. *See* Jill Bowles, *Autonomous Vehicles and the Threat of Hacking*, CPO MAG. (Oct. 1, 2018), https://www.cpomagazine.com/cyber-security/autonomous-vehicles-and-the-threat-of-hacking/. In addition to the physical risk associated with a moving vehicle being hacked, there are also Fourth Amendment privacy concerns regarding the information that will be needed and produced by autonomous vehicles. *See* Dorothy J. Glancy, *Privacy in Autonomous Vehicles*, 52 SANTA CLARA L. REV. 1171, 1205, 1225 (2012).

intervene in the autonomous driving process has reduced significantly.[164]

In conclusion, the primary motivation for developing autonomous driving technology is to increase the safety of motor vehicle transportation.[165] In the most recent autonomous vehicle guidance, the Department of Transportation's Secretary stated, "most importantly, automation has the potential to impact safety significantly—by reducing crashes caused by human error, including crashes involving impaired or distracted drivers, and saving lives."[166] The technology autonomous cars are equipped with, combined with the widespread elimination of human error, will likely decrease accident and fatality rates dramatically.[167]

## III. WHY ETHICAL PROGRAMMING IS A CONCERN

The trolley problem scenario seems like a fantastical exercise, the benefits of which should remain relegated to philosophers and law school classrooms. While the literal scenario of hitting five pedestrians tied to a railroad track instead of acting and killing one may be more far-fetched than likely, the conundrum presented is not too far from the reality everyday drivers face. Human drivers constantly have to choose between braking for animals crossing the road and being rear ended as a result, or potentially killing the animal to reduce the risk to passengers in their car and others. As

[164] *See* Pete Bigelow, *In the Self-Driving Race, Waymo Looks to Be Way Out in Front*, CAR & DRIVER (Feb. 2, 2017), https://www.caranddriver.com/news/a15343824/in-the-self-driving-race-waymo-looks-to-be-way-out-in-front/ (showing the rate of driver disengagement of autonomous driving system decreased from 0.8 disengagements per 1,000 miles driven in 2015 to 0.2 per 1,000 miles driven in 2016).

[165] *See* A.V. 3.0 *supra* note, at 1.

[166] *Id.* at ii.

[167] Some car companies have stated they believe their autonomous vehicles could reduce the amount of accident related deaths. For example, Volvo has stated that it believes its autonomous car will be "death proof." *See* Peter Valdes-Dapena, *Volvo promises deathproof cars by 2020*, CNN (Jan. 21, 2016, 11:04 AM), http://money.cnn.com/2016/01/20/luxury/volvo-no-death-crash-cars-2020/index.html. Volvo safety engineer Erik Coelingh stated, "'With the development of full autonomy we are going to push the limits of automotive safety . . . because if you make a fully autonomous vehicle you have to think through everything that potentially can happen with a car.'" *Id.* Volvo cites adaptive cruise control, Auto lane keeping assistant, collision avoidance, pedestrian detection, and large animal detection among the technologies that will make Volvo's autonomous vehicles death proof. *See id.*

a practical matter, the fact that autonomous cars will be involved in accidents is inevitable.[168]

Ethical programming is a concern for autonomous vehicles because it creates pre-determined outcomes which may, inevitably, result in human injury or death.[169] This is a new frontier for automation and has numerous implications.[170] First, accidents involving autonomous vehicles will not be evaluated under the "reasonable person" standard that is applied to human drivers.[171] Second, ethical considerations involve all aspects of driving and are not restricted to dilemma situations.[172] Third, ethical programming means an assessment of surroundings and targeting a particular outcome to minimize harm.[173] Thus, proper ethical programming should ensure targeting is non-discriminatory and aligns with the overall goal for maximization of human safety and welfare. For these reasons, it is important to consider whose standards of ethics will apply and whether these ethics codify societal expectations.

[168] *See* Bonnefon et al., *The social dilemma of autonomous vehicles*, 352 SCIENCE, 1573, 1573 (2016); *See* MAURER, ET AL., *supra* note 65, at 71; *see also* GER. FED. MINISTRY OF TRANSP. AND DIG. INFRASTRUCTURE, AUTOMATED AND CONNECTED DRIVING, ETHICS COMMISSION: AUTOMATED AND CONNECTED DRIVING 6 (2017), http://www.bmvi.de/SharedDocs/EN/publications/report-ethics-commission.pdf?__blob=publicationFile [hereinafter ETHICS COMMISSION REPORT] (discussing the need for ethical programming since accidents cannot be entirely avoided). Autonomous vehicles have already been involved in multiple fatal accidents, including one involving a pedestrian and another involving the autonomous car driver. *See* Alan Ohnsman, *Investigators Say Tesla Model 3 Driver Killed In Florida Crash Was Using Autopilot*, FORBES (May 16, 2019, 12:13 PM), https://www.forbes.com/sites/alanohnsman/2019/05/16/investigators-say-tesla-model-3-driver-killed- in-florida-crash-used-autopilot/#22bfae1777d5 (discussing a fatal accident where a Tesla operating on autopilot crashed into another vehicle, killing the Tesla driver); Daisuke Wakabayashi, *Self-Driving Uber Car Kills Pedestrian in Arizona, Where Robots Roam*, N.Y. TIMES (Mar. 19, 2018), https://www.nytimes.com/2018/03/19/technology/uber-driverless-fatality.html (discussing a fatal accident where an autonomous Uber struck and killed a pedestrian crossing the street).

[169] *See* Sven Nyholm & Jilles Smids, *The Ethics of Accident-Algorithms for Self-Driving Cars: an Applied Trolley Problem?*, 19 ETHICAL THEORY & MORAL PRAC. 1275, 1275 (2016), https://link.springer.com/article/10.1007/s10677-016-9745-2.

[170] *See id.* (highlighting some of the ethical dilemmas ethical programmers will embrace with autonomous cars, such as: "[S]hould autonomous vehicles be programmed to always minimize the number of deaths? Or should they perhaps be programmed to save their passengers at all costs?").

[171] *See* David King, *Putting the Reins on Autonomous Vehicle Liability: Why Horse Accidents Are the Best Common Law Analogy*, 19 N.C. J.L. & TECH. 127, 144 (2018) ("[C]ourts have never applied the reasonable person standard to property, even when that property is autonomous.").

[172] *See* Johannes Himmelreich, *The everyday ethical challenges of self-driving cars*, CONVERSATION (Mar. 27, 2018, 6:42 AM), https://theconversation.com/the-everyday-ethical-challenges-of-self-driving-cars-92710.

[173] *See* Tobias Holstein et al., *Ethical and Social Aspects of Self-Driving Cars*, ARXIV (Feb. 5, 2018), https://pdfs.semanticscholar.org/387c/7e722b26f1ff154f0309540d91e34318274b.pdf.

### A.   Autonomous Vehicles will be Held to a Different Standard of Care than Human Drivers

Like human drivers of conventional vehicles, ADS will be required to "decide" the best possible crash outcome.[174] "In all cases, however, the behavior of the vehicle and its control algorithms will ultimately be judged not by statistics or test track performance, but by the standards and ethics of the society in which they operate."[175]

Currently, the legal system judges a driver's decisions and reactions based on the "reasonable and prudent" person standard.[176] This standard is purportedly an objective and easily applicable standard for jury members who are all assumed to be all reasonable men.[177] Further, the reasonable person standard is flexible and malleable to account for limitations on a human's ability to make the best decision at the best time.[178] Jury members, as with all other purportedly rational human beings, do not always agree with what is considered a reasonable reaction to circumstances in which they were not personally involved.[179] This begs the question: whose ethical standards should govern autonomous vehicles?

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[174]   *See* MAURER ET AL., *supra* note 65, at 87 (discussing all the different factors and decisions that autonomous cars will have to make during everyday driving).

[175]   *See id.* This chapter, entitled "Implementable Ethics for Autonomous Vehicles," highlights the idea that, although autonomous vehicles are machines and not humans, we will still review the consequences of their movements through an "ethical lens." *Id.* ("[I]t seems certain that other road users and society will interpret the actions of automated vehicles and the priorities placed by their programmers through an ethical lens.").

[176]   *See, e.g.*, Suttle v. Powers, No. 3:15-CV-29-HBG, 2015 WL 7283098, at *2 (E.D. Tenn. Nov. 16, 2015). The reasonable person standard under tort law considers the ordinary person under the circumstances, and "the term 'ordinary' should be given its true meaning by not requiring the conduct of an extraordinarily careful person." Whitman v. W.T. Grant Co., 395 P.2d 918, 920 (Utah 1964).

[177]   *See* Kevin P. Tobia, *How People Judge What is Reasonable*, 70 ALA. L. REV. 293, 299 n.17 (2018).

[178]   *See* Belay, *supra* note 2, at 121 ("[The reasonable person standard] takes into account limitations in a human's ability to make the best decision given specific circumstances . . . .") (citing RESTATEMENT (SECOND) OF TORTS § 283 (1965)).

[179]   *See* Ryan J. Winter & Edith Greene, *Juror Decision-Making*, *in* HANDBOOK OF APPLIED COGNITION 741 (Francis Durso ed., John Wiley & Sons, Ltd. 2d ed. 2007) ("The real juror, on the other hand, is not the blank slate that the judicial system prefers and presumes to exist.").

## B. *Ethics is Involved in all Components of Driving, Not Simply Dilemma Situations*

Stepping back from examining trolley-like, inevitable-dilemma crash situations, ethical considerations pervade other aspects of risk allocation associated with automated driving.[180] For example, where the car positions itself in a lane may have ethical components.[181] If the car chooses to remain closer to the smaller objects instead of the larger object, it is minimizing its risk altogether.[182] However, the risk for the smaller car increases when the automated car travels closer to it.[183] While there is not an unavoidable dilemma in this scenario, the ethical programming debate of whether automated cars should be programmed to maximize the safety of their passengers or societal welfare persists. The issue transcends the individual scenarios and permutations of the trolley problem; it is an overarching theme that designers of ADS will have to confront with even for the most basic of driving tasks, including where the car should be positioned in the lane.

A common argument made against the need to provide ethical programming is that the ADS should just be programmed with a default command for dilemma situations, such as braking.[184] However, this solution is not beneficial. Ethical programming does not just apply to dilemma situations but, as mentioned, impacts other operations of autonomous driving systems.[185] Additionally, there are many scenarios, even in conventional vehicles, where there is simply no default procedure that is applicable to all scenarios.[186] Braking would not be beneficial, for example, when a car hits a

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[180]  *See* Gus Lubin, *Self-driving cars are already deciding who to kill*, BUS. INSIDER (Dec. 29, 2016, 9:29 PM), https://www.businessinsider.com/self-driving-cars-already-deciding-who-to-kill-2016-12.

[181]  *See id.* (positing an autonomous vehicle is making an ethical decision by choosing to travel closer to a small car instead of a truck to minimize damage in event of a collision).

[182]  *See* MAURER ET AL., *supra* note 65, at 72 (describing an autonomous vehicle programed to crash into a smaller object when given a choice protects itself and its occupants over other concerns).

[183]  *See* Lubin, *supra* note 180.

[184]  *See* MAURER ET AL., *supra* note 65, at 71 (describing an argument for only programming a car to brake in dilemma situations is that it "could successfully avoid the majority of emergency situations a robot car may find itself it [sic], even if it regrettably makes things worse in a small number of cases. The benefits far outweigh the risks, presumably . . . .").

[185]  *See id.*

[186]  *See id.*

patch of ice; in fact, braking on ice could lead to more extensive damage than steering correction.[187] Further, simply braking will not necessarily result in crash optimization.[188] Maybe braking would prevent hitting another vehicle, but might somehow harm or kill a person in the process. Ethical programming for crash optimization cannot be achieved by one solution because the circumstances will vary extensively.[189]

## C.  *Ethical Programming Involves Targeting*

Ethical programming means targeting.[190] Evaluating the potential outcomes and using the information available to autonomous vehicles, including the safety features of adjacent vehicles, to react to a dilemma situation results in targeting one outcome over another.[191] Ethical programming also involves assigning costs and benefits to larger societal goals, including the allocation of justice and public policy issues.[192] In *Why Ethics Matters for Autonomous Cars*, Patrick Lin posits a scenario where an automated car is faced with the dilemma of hitting either the motorcyclist wearing a helmet, or the motorcyclist not wearing the helmet.[193] The motorcyclist wearing the helmet is more likely to survive the collision than the one not wearing the helmet.[194] However, should the motorcyclist wearing the helmet be exposed to more risk because he or she is abiding by the law? Concerns about the allocation of

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[187]  *See, e.g.*, *California Driver Handbook - Handling Emergencies*, CAL. DEP' OF MOTOR VEHICLES, https://www.dmv.ca.gov/portal/dmv/detail/pubs/hdbk/he_mechanical_tips  (stating drivers who hit ice should stop braking); *see also* MARKUS MAURER ET AL., *supra* note 65, at 74 (discussing why braking is not necessarily the safest default option, should not be used as a proxy for the most ethical option, and other maneuvers may be safer depending on the circumstances).

[188]  *See* MAURER ET AL., *supra* note 65, at 81 (explaining situations where braking would not result in crash optimization).

[189]  *See id.* at 74.

[190]  *Id.* at 72 ("The ethical point here . . . is that no matter which strategy is adopted . . . programming a car to choose a collision with a particular kind of object over another very much resembles a targeting algorithm.").

[191]  *See id.*

[192]  *See id.* at 73. Considerations such as the weight of a deterrent effect or positive reinforcement for following the law may also play into the ethical decisions; if society thinks those who take more safety risks deserve less protection, then the ethical programming should be programmed in favor of those who follow the rules, even if the result saves fewer lives. *See id.*

[193]  *See id.* at 72.

[194]  MAURER ET AL., *supra* note 65, at 73.

justice also play a role in ethical programming.[195] Some may believe non-helmet wearing motorcyclists should be targeted because they are intentionally disregarding their own safety and not abiding by traffic laws. Others would say encouraging the underlying public policy requiring people to wear helmets does not justify unfair risk of harm to the non-helmet wearing motorcyclist.

Additionally, constitutional issues are brought to the surface when autonomous vehicles choose between two undesirable outcomes.[196] For example, if the car must choose between hitting two pedestrians, which person should the car choose? According to a 2014 Google patent, a Google autonomous car may be programmed to hit the smaller of the two pedestrians.[197] However, this raises questions of discrimination because women and children are typically smaller than the average male.[198] Programming the car to hit the smaller object would be discriminatory in application because the smaller object would most often be a woman over a man. In response to surveys regarding autonomous vehicle moral decision-making, most respondents agreed that children should be saved at the cost of older adults.[199] The laws of the United States and many other countries prohibit discrimination on the basis of age, sex, and national origin.[200] Similarly, many organizations require non-discrimination on the basis of age, sex, and national origin.[201] In fact, the Institute of Electrical and Electronics Engineers (IEEE) requires its members to "treat fairly all persons and

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[195]   *See id.*

[196]   *See id.* at 69-70 (noting that the Fourteenth Amendment of the Constitution protects certain groups of people from discrimination, and thus ethical programing that targets a specific group over another may violate the Constitution). A full evaluation of the constitutional issues is outside the scope of this paper.

[197]   *See* Lubin, *supra* note 180.

[198]   *See Growth, Range of Height and Weight*, CIN. CHILDREN'S, https://www.cincinnatichildrens.org/health/g/normal-growth (last updated Mar. 2016) (comparing average height and weight of adolescent boys and girls); James Roland, *What's the Average Weigh for Men?*, HEALTHLINE (Feb. 27, 2019), https://www.healthline.com/health/mens-health/average-weight-for-men (comparing the weight and height of the average woman with the average man).

[199]   *See* Edmond Awad et al., *The Moral Machine experiment*, 563 NATURE 59, 60-61 (2018).

[200]   *See* U.S. CONST. amend. XIV, § 1; *Employment Discrimination*, DLA PIPER, https://www.dlapiperintelligence.com/goingglobal/employment/index.html?t=09-discrimination (detailing countries that legally prohibit gender-based discrimination).

[201]   The prohibition on discrimination is so widespread that the United States Equal Employment Opportunity Commission (EEOC) has promulgated tips for organizations to prescribe effective non-discrimination policies. *See General Non-Discrimination Policy Tips*, U.S. EQUAL EMP'T OPPORTUNITY COMM'N, https://www.eeoc.gov/employers/smallbusiness/checklists/general_non-discrimination_policy.cfm.

to not engage in acts of discrimination based on race, religion, gender, disability, age, national origin, sexual orientation, gender identity, or gender expression."[202] Programming the car to hit the smaller of the two objects will almost necessarily be discriminating based on age between children and adults to the disadvantage of children and contrary to widely accepted ethical standards.[203]

### D.   Ethics Should be Determined by Society Generally

The problem of *who* defines the reasonableness of actions takes on another dimension when discussing pre-determined actions. Private companies and universities are pouring resources into the ethical dilemma of programming automated cars to react to difficult Hobson's choice scenarios.[204] Programming ethical scenarios requires the application and assignment of values that are not discoverable by scientific experiments.[205] "Values are something that we humans must stipulate and ideally agree upon."[206] Programming to address these Hobson's choice scenarios will have to include ethical considerations if the benefits of autonomous vehicles are to be fully realized. Most designers agree the community should be engaged "to ensure that those values are represented correctly or at least transparently."[207] At the heart of this research

[202]  *See 7.8 IEEE Code of Ethics*, INST. OF ELECTRICAL AND ELECTRONICS ENGINEERS, https://www.ieee.org/about/corporate/governance/p7-8.html (last visited Feb. 15, 2020).

[203]  *See* Awad et al.*, supra* note 199, at 60 (showing the public prefers to spare children instead of adults in crash situations). Programming the cars to protect their consumers and passengers above all others could also lead to discriminatory effects with regard to race because more white people own and operate cars than do minorities, and more minorities use alternative means of transportation. *See Cost of Car Ownership: Data and Survey*, ZEBRA (Oct. 15, 2019), https://www.thezebra.com/car-ownership-statistics/; Monica Anderson, *Who relies on public transit in the U.S.*, PEW RES. CTR. (Apr. 7, 2016), https://www.pewresearch.org/fact-tank/2016/04/07/who-relies-on-public-transit-in-the-u-s/. If vehicles are programmed to protect their users, more of whom are white, than to minimize harm in dilemma crash scenarios, the cars will disproportionately harm more minorities than white people. Unfortunately, a complete analysis of this issue is beyond the scope of this Note.

[204]  *See generally* MIT, *Moral Machine,* http://moralmachine.mit.edu/ (describing MIT's "platform for gathering a human perspective on moral decisions made by machine intelligence, such as self-driving cars."); MERRIAM WEBSTER, *Hobson's choice*, https://www.merriam-webster.com/dictionary/Hobson%27s%20choice (defining a Hobson's choice as "an apparently free choice when there is no real alternative.").

[205]  *See* MAURER ET AL., *supra* note 65, at 75.

[206]  *Id.*

[207]  *Id.*

is the question of who should decide what choices are ethically correct and should, therefore, be programmed into the cars.

MIT has developed an experimental survey called the Moral Machine.[208] This online survey presents various random scenarios an automated car might face.[209] The person taking the survey determines which outcome is more acceptable.[210]

Another experiment was conducted through Amazon Mechanical Turk.[211] The researchers conducted six online surveys of nearly 2000 people total.[212] The survey results indicate the respondents overwhelmingly preferred to maximize welfare and minimize the number of casualties.[213] However, it was clear the respondents were significantly less likely to purchase an autonomous car when they imagined themselves and their family in the automated vehicle.[214] The researchers thus concluded that while people agreed everyone would be better off if the automated vehicles were utilitarian, these same people would prefer to ride in a vehicle that would protect themselves as opposed to others.[215] "Accordingly, if both self-protective and utilitarian [autonomous vehicles] were allowed on the market, few people would be willing to ride in utilitarian [autonomous vehicles] even though they would prefer others to do so."[216]

Indeed, in 2014 when asked about what a Google autonomous car would do in a dilemma situation, Google X founder Sebastian Thrun stated, "[i]f it happens that there is a situation where the car couldn't escape, it would go for the smaller thing."[217] This programming makes the car more self-protective because the damage to the car and potentially the car's passengers will be minimized if

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208  *See* MIT, *supra* note 204.
209  *See id.*
210  *See id.*
211  *See* Bonnefon et al., *supra* note 168.
212  *See id.*
213  Evan Ackerman, *People Want Driverless Cars with Utilitarian Ethics, Unless They're a Passenger*, IEEE SPECTRUM (June 23, 2016), https://spectrum.ieee.org/cars-that-think/transportation/self-driving/people-want-driverless-cars-with-utilitarian-ethics-unless-theyre-a-passenger [hereinafter *People Want Driverless Cars with Utilitarian Ethics, Unless They're a Passenger*] (discussing how people want utilitarian ethics in autonomous vehicles, but are inclined to choose a vehicle that protects them above all others if they or their family are in the car).
214  *See* Bonnefon et al., *supra* note 168, at 1574.
215  *See id.* at 1575.
216  *Id.*
217  Lubin, *supra* note 180.

the vehicle hits the smaller of the two potential objects.[218] Google proceeded to patent a technology which determines the positioning of the automated car based on the size of the vehicle it is next to.[219] This technology would direct the Google car to move closer to the smaller object.[220] For example, the car would drive closer to a smaller vehicle as opposed to an eighteen-wheel truck. Currently, this consumer-first programming aligns with consumer preferences for their own safety when riding in a vehicle because consumers want to maximize their own safety foremost.[221]

In 2016, Google described the automated vehicle technology as being designed to avoid hitting unprotected users, such as pedestrians or motorists as the first priority.[222] Secondly, it would try to avoid moving objects.[223]

Although geared towards gathering information about socially desirable outcomes, these "trolley problem" experiments have undergone significant criticism.[224] Rodney Brooks, robotics inventor, heavily criticized these dilemma scenarios as being impractical and unlikely to result in any "'practical regulations about what can or cannot go into automobiles.'"[225] He argues the scenarios are too fantastical to be practical and consist of scenarios that are unlikely to present themselves in reality.[226]

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[218]    *See id.*

[219]    *See Controlling vehicle lateral lane position*, GOOGLE, https://patents.google.com/patent/US8781670B2/en (showing Google's patent for autonomous technology that evaluates objects based on their individual characteristics).

[220]    *See id.*

[221]    *See People Want Driverless Cars with Utilitarian Ethics, Unless They're a Passenger*, *supra* note 212 (discussing consumer preferences towards purchasing a car that will minimize harm to the consumer, not society generally).

[222]    *See* Lubin*, supra* note 180.

[223]    *See id.* This programming aligns more with Germany's new regulations on automated vehicles. The first priority seems to be minimizing harm to human life, especially towards pedestrians and unprotected motorists; according to the German regulations, the automated vehicles need to be prepared to sacrifice property to save human lives. *See* ETHICS COMMISSION REPORT, *supra* note 168, at 11.

[224]    *See* Patrick Lin, *Robot Cars and Fake Ethical Dilemmas*, FORBES (Apr. 3, 2017, 8:00 AM), https://www.forbes.com/sites/patricklin/2017/04/03/robot-cars-and-fake-ethical-dilemmas/#678dd52713a2 ("Something feels dishonest about the moral panic over self-driving cars. It usually involves bizarre crash scenarios that would (probably) never happen in real life. Does it matter that the scenarios are artificial or unrealistic?".).

[225]    *See id.* (discussing how Rodney Brooks—former professor of robotics at MIT and founder of iRobot—does not believe that the ethical dilemmas are worth considering, in part because even if ethical dilemmas do occur, the increase in safety will still be so drastic as to warrant implementation of autonomous vehicles).

[226]    *See id.*

However, there are two main problems with this criticism. First, it is hard to tell exactly how far-fetched the scenarios are.[227] When human drivers are plunged into dilemma situations requiring action, they do not necessarily have recollection of everything that happened.[228] Nor can they accurately perceive all of the components creating their circumstances.[229] Therefore, it is possible human drivers face scenarios where there are many moving parts and potential outcomes that they do not have the capacity to realize or even to consider.[230]

Second, this criticism largely misses the point. There will be circumstances during which autonomous vehicles will have to determine how to act, and to determine which of the possible negative outcomes is the most desirable.[231] Those experiments, seemingly imaginary and removed from reality, can still generate very useful information about what factors people consider when determining the most ethical or desirable choice.[232] These experiments evaluate the significance of factors, such as number of potential victims, when determining the appropriate outcome of a dilemma scenario.[233]

Stephen Zoepf, director of the Center for Automated Research at Stanford, also believes that contemplating the trolley problem is unhelpful.[234] Zoepf, who has been working to develop ethical programming for automated cars, believes the central question

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[227]  *See id.*

[228]  *See* Rachel Nuwer, *Why Can't Accident Victims Remember What Happened to Them?*, SMITHSONIAN MAG. (Aug. 1, 2013), https://www.smithsonianmag.com/smart-news/why-cant-accident-victims-remember-what-happened-to-them-21942918/.

[229]  *See id.*

[230]  *See* Ron Carucci, *Stress Leads to Bad Decisions. Here's How to Avoid Them*, HARV. BUS. REV. (Aug. 29, 2017), https://hbr.org/2017/08/stress-leads-to-bad-decisions-heres-how-to-avoid-them.

[231]  *See* Will Knight, *How to Help Self-Driving Cars Make Ethical Decisions*, MIT TECH. REV. (July 29, 2015), https://www.technologyreview.com/s/539731/how-to-help-self-driving-cars-make-ethical-decisions/ (quoting Chris Gerdes, a professor at Stanford, as describing a scenario where the car will have to choose between hitting a child or injuring the occupant of the vehicle and concluding,"[t]hese are very tough decisions that those that design control algorithms for automated vehicles face every day.")

[232]  *See* Lin, *supra* note 224 (discussing how these ethical dilemma situations are "intuition pumps" which test particular beliefs regardless of the probability of occurring).

[233]  *See id.*

[234]  *See* Alex Shashkevich, *Stanford scholars, researchers discuss key ethical questions self-driving cars present*, STAN. NEWS (May 22, 2017), https://news.stanford.edu/2017/05/22/stanford-scholars-researchers-discuss-key-ethical-questions-self-driving-cars-present/ (stating it is not productive to consider the trolley problem because people make bad decisions all the time and autonomous cars will overall improve decision-making).

should be what level of risk society is willing to accept as a result of the implementation of self-driving cars.[235] He believes contemplating the various scenarios that cars will face is not helpful because if autonomous cars can improve on the number of accidents and fatalities, they should be implemented into society regardless of the possible ethical determinations or outcomes.[236]

Autonomous cars will have to face dilemma situations and will have to be programmed to address these scenarios. Surveys that present trolley problems and help determine which outcomes are valued by society generally should be the determining factor and should dictate how autonomous vehicles are programmed. The results will indicate the ethical values of society as a whole. Therefore, adhering to the ethical standards of society as a whole will promote good of the whole, rather than of a few members.

## IV. THE CURRENT "STATE" OF LEGISLATION FOR AUTONOMOUS CARS

Currently there are no federal regulations for autonomous vehicles in the United States.[237] The federal government and state governments regulate different aspects of vehicle safety.[238] Under the current regulatory scheme, the National Highway Traffic Safety Administration (NHTSA), an agency formed by Congress to promote traffic safety, is responsible for setting and enforcing uniform vehicular safety regulations.[239] These safety standards are

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[235]  *See id.* (stating how regardless of the ethical dilemma, autonomous cars should be implemented if they improve the bad decisions human drivers make).

[236]  *See id.* (noting Zoepf believes the inherent tradeoff between safety and mobility needs to be central to the discussion, rather than ethical dilemmas).

[237]  *See* Shang Kong, *Autonomous Vehicle Federal Regulation*, NAT'L L. REV. (Jan. 15, 2019), https://www.natlawreview.com/article/autonomous-vehicle-federal-regulation.

[238]  An in-depth analysis of the division between the authority to regulate the driver, e.g., the "human driver" and the automated driving system is outside the scope of this paper. It is important to note that there is a blurred line between the states' authority to establish a regulatory system for licensing drivers/control traffic regulations and the federal government's authority to regulate vehicle safety. This blurred line reinforces the nuanced challenges the automated driving systems will bring to the current regulatory system.

[239]  *See* NAT'L HIGHWAY TRAFFIC SAFETY ADMIN., THE ROAD AHEAD: NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION STRATEGIC PLAN 2016-2020 8 (2016). The NHTSA "was established by the Highway Safety Act of 1970, as the successor to the National Highway Safety Bureau, to carry out safety programs under the National Traffic and Motor Vehicle Safety Act of 1966 and the Highway Safety Act of 1966." *Understanding the National Highway Traffic Safety Administration (NHTSA)*, U.S. DEP'T OF TRANSP., https://www.transportation.gov/transition/understanding-national-highway-traffic-safety-administration-nhtsa (last updated Jan. 31, 2017).

codified in the FMVSS and represent the minimum safety performance requirements for motor vehicles.[240] These standards and regulations are problematic for emerging ADS because the FMVSS is written to regulate human drivers, and have not yet been modified or adapted for ADSs.[241]

Presently, states are responsible for "licensing human drivers and registering motor vehicles in their jurisdictions; enacting and enforcing traffic laws and regulations; conducting safety inspections, when states choose to do so; and regulating motor vehicle insurance and liability."[242] To date, several states have passed legislation specifically aimed at regulating autonomous vehicles, all requiring different standards for ADS operation.[243] This ADS regulation presents an unprecedented issue with vehicular safety regulation because, with ADSs, there is no separation between the

The NHTSA establishes the requirements in the FMVSS, which are codified in 49 C.F.R. § 571. *See* NAT'L HIGHWAY TRAFFIC SAFETY ADMIN., UNDERSTANDING NHTSA'S REGULATORY TOOLS 8, 21 n.1, https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/understanding_nhtsas_current_regulatory_tools-tag.pdf. NHTSA also partners with state and local governments to enforce safety campaigns nationally and allocates federal funds to state governments to help them achieve highway and motor vehicle safety standards. *See Understanding the National Highway Traffic Safety Administration (NHTSA)*, *supra* note 239. For more on NHTSA's history, visit https://www.transportation.gov/transition/understanding-national-highway-traffic-safety-administration-nhtsa.

[240] *See U.S. Government Agencies: U.S. National Highway Traffic Safety Administration*, AM. NAT'L STANDARDS INST., https://www.standardsportal.org/usa_en/USG/nhtsa.aspx (last visited Nov. 10, 2019) [hereinafter *ANSI*].

[241] *See* ANITA KIM, DAVID PERLMAN, DAN BOGARD, & RYAN HARRINGTON, REVIEW OF FEDERAL MOTOR VEHICLE SAFETY STANDARDS (FMVSS) FOR AUTOMATED VEHICLES 1 (2016), https://pdfs.semanticscholar.org/fae6/fba98970e9ee60f9cd1b96ba75ff2345c400.pdf. The preliminary report was conducted in two phases. *Id.* at 3. During the first primary scan, the analysts calculated the number of incidences that the FMVSS either implicitly or explicitly identified a "human driver.*" See id.* During the second advanced scan, the analysts determined a portfolio of FMVSS concepts that might pose problems for certification of automated cars. *See id. But see* Letter from Paul Hemmersbaugh, Chief Counsel of Nat'l Highway Traffic Safety Admin., to Chris Urmson, Dir., Self-Driving Car Project, Google (2016), https://isearch.nhtsa.gov/files/Google%20-%20compiled%20response%20to%2012%20Nov%2015%20interp%20request%20—%204%20Feb%2016%20final.htm#_ftnref3 (responding to Google's request to interpret provisions of the FMVSS that may apply to autonomous cars despite language in those provisions indicating that it only applies to human drivers, so that Google can better understand how the regulation is applicable to its autonomous vehicle).

[242] Sean Slone, *NHTSA's Model State Policy on Autonomous Vehicles*, COUNCIL OF ST. GOV'T (July 31, 2017, 2:46 PM), https://knowledgecenter.csg.org/kc/content/nhtsas-model-state-policy-autonomous-vehicles.

[243] *See, e.g.*, CAL. VEH. CODE § 38750 (West 2012); N.C. GEN. STAT. ANN. § 20-401 (West 2017); FLA. STAT. ANN. § 316.85 (West 2012); *see also Autonomous Vehicle: Self-Driving Vehicles Enacted Legislation*, NAT'L CONF. OF ST. LEGISLATURES (Oct. 9, 2019), http://www.ncsl.org/research/transportation/autonomous-vehicles-self-driving-vehicles-enacted-legislation.aspx (listing each state's enacted legislation regarding autonomous vehicles).

operator of the vehicle and the vehicle itself.[244] This begs the question of where the line should be drawn between state regulation and federal regulation of autonomous cars.[245]

While there are currently many autonomous vehicles on the roads in the United States, there is no legislation regulating the ethical concerns ADS will need to address.[246] The NHTSA acknowledges ethical concerns are important considerations when designing ADS, but only acknowledges that there will have to be a solution to the unresolved issue.

Ethical considerations are essential to automated driving technology development. However, currently, there is no consensus around acceptable ethical decision-making given the depth of the element is not yet understood nor are there metrics to evaluate against. NHTSA plans to work with industry, States, and safety advocates to further research the establishment of an industry developed framework for addressing ethical considerations and fostering transparency in automated driving technology decision making. The Agency will also collaborate with industry to develop standard test and simulation scenarios that culminate in an ethical decision.[247]

There have been bipartisan proposals in Congress to establish regulations for autonomous vehicles, but none have been codified yet.[248] Moreover, even if these bills were to pass, neither addresses

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[244]  *See* Jeremy A. Carp, *Autonomous Vehicles: Problems and Principles for Future Regulation*, 4 U. PA. J. L. & PUB. AFF. 82, 84 n.7 (2018) (discussing the challenges new regulation of autonomous vehicles presents because there are no human drivers).

[245]  An in-depth analysis of the division between the authority to regulate the driver, e.g., the "human driver" and the automated driving system is outside the scope of this paper. The point is that there is a blurred line between the states' authority to establish a regulatory system for licensing drivers and control traffic regulations and the federal government's authority to regulate vehicle safety. This is important to note because it reinforces the nuanced challenges the automated driving systems will bring to the current regulatory system.

[246]  *See* Todd Spangler, *Self-driving cars will have to choose who dies*, DET. FREE PRESS (Nov. 21, 2017, 1:29 PM), https://www.freep.com/story/money/cars/2017/11/21/self-driving-cars-ethics/804805001/.

[247]  *See Automated Driving Systems: FAQ*, DEP'T OF TRANSP., NAT'L HIGHWAY TRAFFIC SAFETY ADMIN., https://www.nhtsa.gov/vehicle-manufacturers/automated-driving-systems#automated-driving-systems-faq (last visited Nov. 10, 2019).

[248]  *See* Teresa L. Johnson et al., *DOT Accelerates Toward Autonomous Driving, While Congress May Be Stopped in Traffic*, ARNOLD & PORTER (May 20, 2019), https://www.arnoldporter.com/en/perspectives/publications/2019/05/dot-accelerates-toward. The first bill introduced was the SELF DRIVE Act, proposed on July, 25, 2017, and passed by the House of Representatives on September 6, 2017. *See H.R. 3388 - SELF DRIVE Act*, CONGRESS.GOV, https://www.congress.gov/bill/115th-congress/house-bill/3388 (last updated Sept. 7, 2017). This bill includes several modifications to existing FMVSS law. *See* SELF DRIVE Act, H.R. 3388,

ethical programming.[249] While the United States is not the only country that has yet to implement federal regulations for ethical programming of autonomous vehicles,[250] Germany has already adopted regulations for autonomous vehicles, including ethical regulations.[251]

Germany was the first federal government to adopt regulations for the ethics of automated cars.[252] In late August 2017, the German Transport Administer presented a report on automated

115th Cong. (2017). Importantly, the bill includes an expansion of federal preemption. *See id.* § 3. Federal Preemption would remove the power of the states to regulate the operator of a highly automated vehicle. *See id.* Additionally, the SELF DRIVE Act requires the NHTSA to update the FMVSS to include the autonomous vehicle categorization. *See id.* § 4. Significantly, this bill does not mandate any specific safety standard for autonomous vehicles but requires the NHTSA to set guidelines and to study what changes might be necessary. *See id.* This bill requires entities developing autonomous vehicles to submit a "safety assessment letter" to the NHTSA. *See* SELF DRIVE Act. Additionally, the bill provides for limited exemptions from specific safety standards for companies implementing and testing autonomous vehicles and establishes an advisory council that would continue to monitor the development and implementation of autonomous vehicles. *See id.* §§ 6, 9. The Senate introduced AV START Act, which is similar to the SELF DRIVE Act. *See* AV START Act, S. 1885, 115th Cong. (2017). The AV START Act includes the same preemption provision as the SELF DRIVE Act. *See id.* § 3. The bill prohibits laws or regulations pertaining to regular vehicles that constitute unreasonable restrictions on the design, construction, or performance of highly automated vehicles. *See id.* This bill further prohibits a State from issuing licenses for dedicated highly automated vehicles in a discriminatory manner against those with disabilities. *See id.* § 3. The AV START Act requires an accelerated process for updating the FMVSS and updating references to human drivers. *See id.* § 4. However, companies manufacturing autonomous vehicles will be permitted to begin testing even if such vehicles do not comply with the FMVSS. *See id.* § 5. This bill also has the same scheme for safety exemptions for companies implementing and testing autonomous vehicles as the SELF DRIVE Act has. *See* AV START Act § 6. This bill also requires that manufacturers submit a safety evaluation report to the DOT, including information about the following: system safety, data recording, cybersecurity, human-machine interface, crashworthiness, documentation of capabilities, post-crash behavior, applicable laws, and automation function. *See id.* § 9. Additionally, the bill establishes an advisory council, consisting of fifteen members, that provides recommendations to the DOT. *See id.* § 10. Furthermore, the Secretary of the DOT is required to work with State and local governments to research how the highly automated vehicles will impact law enforcement and traffic safety. *See id.* § 13. Finally, there is also a provision for cybersecurity requiring the manufacturers of ADS to develop a plan for reducing cybersecurity risks. *See id.* § 14.

249 *See generally* AV START Act, S. 1885, 115th Cong. (2017) (demonstrating that this bill does not include a mention of ethical programming).; SELF DRIVE Act, H.R. 3388, 115th Cong. (2017) (demonstrating this bill does not include a mention of ethical programming, either).

250 *See* Tuffley, *supra* note 19.

251 *See id.*

252 *See id.* (describing Germany's rules as the world's first ethical regulations on autonomous vehicles). Earlier in the year, Germany had passed a law requiring that a driver be behind the wheel of an automated car at all times. *See* Thomas Escritt, *Germany adopts self-driving vehicles law*, REUTERS (May 12, 2017, 7:20 AM), https://www.reuters.com/article/us-germany-autos-self-driving/germany-adopts-self-driving-vehicles-law-idUSKBN1881HY. The ethics considerations focus on Levels 4 and 5 of degrees of automation from the Verband de Automobilindustrie ("VDA") (German Association of Automotive Industry). *See* ETHICS COMMISSION REPORT, *supra* note 168, at 14.

driving to the German cabinet detailing twenty ethical guidelines for autonomous vehicles.[253] The cabinet quickly adopted the regulations.[254] The ethical guidelines were developed by an Ethics Commission composed of experts from various fields and with the advice of others in various fields outside of the Commission.[255]

The paramount principle in these regulations is that the autonomous vehicles must be programmed to avoid the injury or the death of people at all costs: "[t]he protection of individuals takes precedence" over all other considerations.[256] "On our scale of values, the protection of human life is a *summum bonum*"[257] and enjoys "unconditional priority."[258] The ADS must choose to damage animals or property if it means that human lives may be protected.[259] The car cannot determine its course of action based on any "personal features," including the age, sex, or physical

[253]   *See* Tuffley, *supra* note 19.

[254]   *See id.*

[255]   *See* ETHICS COMMISSION REPORT, *supra* note 168, at 7.
"The Ethics Commission on Automated and Connected Driving, which was appointed by the Federal Minister of Transport and Digital Infrastructure[,]" was composed of experts from a variety of disciplines with a mission "'to develop the necessary ethical guidelines for automated and connected driving.'" *See id.* "The Ethics Commission is made up of fourteen academics and experts in ethics, law, and technology." *Regulation of Artificial Intelligence: Europe and Central Asia*, LIBR. OF CONGRESS, https://www.loc.gov/law/help/artificial-intelligence/europe-asia.php#skip_menu (last updated July 22, 2019). The chair was a former Federal Constitutional Court Judge, Dr. Udo di Fabio. *See* ETHICS COMMISSION REPORT, *supra* note 168, at 7. The Commission was divided into five working groups, each headed by a different expert. *See id.* Working group 1 was "Situations involving unavoidable harm." *Id.* Group 2 was "Data availability, data security, data driven economy." *Id.* Group 3 was "Conditions of human-machine interaction." *Id.* Group 4 was "Consideration of the ethical context beyond road traffic." *Id.* Group 5 was "Scope of responsibility for software and infrastructure." *Id.* External experts were consulted and provided information on various other considerations. *See* ETHICS COMMISSION REPORT, *supra* note 168, at 7. One presentation was on the objectives and activities of Germany's federal government in the field of automated and connected driving. *See id.* Professor Julian Nida-Rumelin, former minister of State, now professor, spoke on ethical aspects concerning dilemma situations. *See id.* Speakers addressed issues relating to data protection, ethical issues for new technologies in other settings, and responsibility in emerging systems. *See id.* The Commission established twenty ethical rules for automated and connected vehicular traffic addressing a wide range of ethical concerns, including dilemma situations. *See id.* at 10-13 (indicating rules five and eight address ethical dilemmas). The report was adopted by the Government on August 23, 2017. *See* Alexander Duisberg & Benedikt Vogel, *German Government to adopt ethical rules for automated driving*, BIRD & BIRD (Sept. 2017), https://www.twobirds.com/en/news/articles/2017/germany/german-government-to-adopt-ethical-rules-for-automated-driving.

[256]   *See* ETHICS COMMISSION REPORT, *supra* note 168, at 10.

[257]   *Id.* at 17. *Summum bonum* means "the greatest good" in Latin. *See Summum bonum*, BLACK'S LAW DICTIONARY (10th ed. 2014).

[258]   *See* ETHICS COMMISSION REPORT, *supra* note 168, at 17.

[259]   *See id.* at 11.

condition of any people involved.[260] Autonomous vehicle manufacturers were aware that ADSs would be required to avoid discrimination in ethical programming, even prior to the enactment of legislation.[261] A press release issued by Daimler states that "neither programmers nor automated systems are entitled to weigh the value of human lives," and the company is not legally allowed to favor one life over another in Germany and other nations.[262]

The German legislation makes it clear that autonomous vehicles should prevent accidents wherever possible.[263] Autonomous cars must drive in a defensive and anticipatory manner, so as to minimize the potential dilemma-type situations.[264] In an emergency situation, the car must return to a safe condition, without requiring the intervention of the human driver.[265] If there is no way for the vehicle to return to a safe condition and there is a genuine dilemma situation, such as the decision between one human life and another, "[t]hose parties involved in the generation of mobility risks must not sacrifice non-involved parties."[266] In other words, those outside the vehicle may not be sacrificed to save those inside of the vehicle.[267] However, self-protection of the individual is not necessarily subordinate to the protection of other individuals.[268]

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[260]  *See id.* ("In the event of unavoidable accident situations, any distinction based on personal features (age, gender, physical or mental constitution) is strictly prohibited.").

[261]  *See generally* MAURER, ET AL., *supra* note 65, at 72 ("The ethical point here, however, is that no matter which strategy is adopted by an . . .auto manufacturer, programming a car to choose a collision with any particular kind of object over another very much resembles a targeting algorithm").

[262]  *See* DAIMLER, *Daimler clarifies: Neither programmers nor automated systems are entitled to weigh the value of human lives* (Oct. 18, 2016), http://media.daimler.com/marsMedia-Site/en/instance/ko/Daimler-clarifies-Neither-programmers-nor-automated-systems-are-entitled-to-weigh-the-value-of-human-lives.xhtml?oid=14131869 (refuting a statement made by a Daimler executive that Daimler would prioritize its passengers over pedestrians if only one life could be saved; the official statement of the company is that they will not weigh the value of human lives and will not discriminate).

[263]  *See* ETHICS COMMISSION REPORT, *supra* note 168, at 10.

[264]  *See id.*

[265]  *See id.* at 13.

[266]  *Id.* at 11.

[267]  *See id.* at 18.

[268]  *See id.* at 19. Interestingly, the Ethics Commission admits it has not "been able to reach a consensus in every respect" with regard to there being no obligations of solidarity imposed on individuals requiring them to sacrifice themselves to others. ETHICS COMMISSION REPORT, *supra* note 168, at 18. Further, the Ethics Commission "refuses to infer . . . that the lives of humans can be 'offset' against those of other humans in emergency situations so that it could be permissible to sacrifice one person in order to save several others." *Id.* "It classifies the killing of or the infliction of serious injuries on persons by autonomous vehicles systems as being wrong without exception." *Id.* However, in situations where there would be more people harmed than the

Thus, the goal remains to preserve as many lives as possible, thereby minimizing the risk of personal injury.

In order to ensure that autonomous cars are programmed to minimize harm, the regulation of autonomous vehicles in Germany was relegated to the public sector through nationwide legislation.[269] This legislative relegation includes the regulation of the ethical considerations for autonomous driving.[270] "The purpose of all governmental and political regulatory decisions is thus to promote the free development and the protection of individuals."[271] By passing legislation mandating that manufacturers adhere to specific ethical guidelines, Germany is eliminating the possibility that manufacturers would program their vehicles to give preference to their consumers over minimizing overall harm.

These regulations align with the utilitarian view of ethics, minimizing harm and thereby maximizing the welfare of society.[272]

## V. THE UNITED STATES FEDERAL GOVERNMENT NEEDS TO REGULATE THE ETHICAL PROGRAMMING OF AUTONOMOUS VEHICLES

### A. The Federal Government Should Implement Ethical Programming Standards to Ensure the Safety Advantages of Autonomous Vehicles are Optimized

The federal government should implement requirements within the FMVSS that regulate the ethical programming of autonomous vehicles. There are already many autonomous vehicles operating on the roads today, and there have already been accidents and traffic violations involving autonomous vehicles.[273] Despite the

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individual, "it would be reasonable to demand that the course of action to be chosen is that which costs as few human lives as possible." *Id.*

269    *See* ETHICS COMMISSION REPORT, *supra* note 168, at 10.

270    *See id.* at 11.

271    *Id.* at 10.

272    *See generally* Darin Gates, *Doing Harm Vs Allowing Harm*, BYU WHEATLEY INST. (Aug. 2, 2019), https://wheatley.byu.edu/doing-harm-vs-allowing-harm/ ("Utilitarians claim the greatest good comes from impartially maximizing human happiness or well-being. Thus, morally right actions are those that either maximize happiness, or minimize harm. Because all that matters for utilitarianism is that the overall good is maximized . . . .").

273    *See, e.g.*, Neal E. Boudette, *Tesla's Self-Driving System Cleared in Deadly Crash*, N.Y. TIMES (Jan. 19, 2017), https://www.nytimes.com/2017/01/19/business/tesla-model-s-autopilot-fatal-crash.html?_r=0 (discussing how a Tesla car's occupant was killed while the car was using

virtual consensus that autonomous vehicles will significantly re-duce the number of motor vehicle fatalities and accidents, colli-sions and accidents involving autonomous vehicles are inevita-ble.[274] There is no doubt the choice between consumer self-interest and maximum societal safety is a social dilemma because "[t]he critical feature of a social dilemma is a tension between self-inter-est and collective interest."[275] Because manufacturers will have to choose between programming cars to protect the collective inter-ests of society and minimizing harm, and programming cars to pro-tect consumers self-interests, the ethical programming dilemma is a variation on the tragedy of the commons.[276]

The results from MIT and Amazon Turk's surveys indicate that consumers prefer utilitarian ethical standards—except when they are passengers.[277] Consumers want to maximize the lives that are saved theoretically, but only want to ride in a car that will protect them at all costs.[278] According to the conductors of the Amazon Turk experiments, "[f]or the time being, there seems to be no easy way to design algorithms that would reconcile moral values and personal self-interest."[279] Consumers are unlikely to purchase a car pre-programed with utilitarian ethics if they can purchase a

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its Autopilot feature); *see also* Johana Bhuiyan, *Uber's autonomous cars drove 20,354 miles and had to be taken over at every mile, according to documents*, VOX, https://www.re-code.net/2017/3/16/14938116/uber-travis-kalanick-self-driving-internal-metrics-slow-progress (last updated Mar. 16, 2017, 6:14 PM) (detailing some of the autonomous cars utilized in Uber's fleet have broken traffic laws).

[274]   *See* Boudette*, supra* note 273; *see also* MAURER, ET AL., *supra* note 65, at 95, 358.

[275]   Peter Dizikes, *Driverless cars: Who gets protected?*, MIT NEWS (June 23, 2016), http://news.mit.edu/2016/driverless-cars-safety-issues-0623 (discussing the survey results indi-cate that people support utilitarian ethical programming, but want to be in a car that protects them at all costs).

[276]   *See* Chelsea Harvey, *Kill the pedestrian or the passenger? The complicated ethics of self-driving cars*, MASHABLE (June 23, 2016), https://mashable.com/2016/06/23/ethics-of-self-driving-cars/ ("[T]he 'tragedy of the commons' — an economic theory suggesting that, when shared re-sources are at stake, individuals will act in their own self-interest instead of taking the common good into account, thereby depleting the resource and causing harm to everyone.").

[277]   *See* Dizikes, *supra* note 275; *see also* HILLARY ABRAHAM ET AL., CONSUMER INTEREST IN AUTOMATION: PRELIMINARY OBSERVATIONS EXPLORING A YEAR'S CHANGE 1 (MIT AgeLab ed., 2017), http://agelab.mit.edu/sites/default/files/MIT%20-%20NEMPA%20White%20Paper%20FINAL.pdf (summarizing and describing the survey re-sults on consumer preferences). The survey indicated that younger drivers are more open to au-tonomous technologies, but older drivers were less willing to give up control over the vehicle. *See id.* at 8. The survey showed an overall decrease in willingness of those surveyed to drive a completely autonomous vehicle from 2016-2017. *See id.*

[278]   *See* Dizikes, *supra* note 275.

[279]   *Id.* (quoting Bonnefon et al., *supra* note 168).

car that will protect them.[280] Not surprisingly, consumers were strongly opposed to government regulation requiring utilitarian programming.[281] According to the survey results, consumers were one-third as likely to purchase a car that was subject to government regulated programming.[282]

Consumer attitudes towards utilitarian regulation result in a new twist on the classic tragedy of the commons problem.[283] The purpose behind developing and implementing automated cars is to benefit society as a whole by making vehicular transportation much safer and more convenient.[284] If the government does not regulate the ethical algorithms of cars, however, consumers will be able to act in their own self-interest and will be much more inclined to purchase cars which guarantee their own safety to the detriment of society generally.[285]

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[280]   *See* Bonnefon et al., *supra* note 168, at 4; *see also* Associated Press, *For Driverless Cars, a Moral Dilemma: Who Lives and Who Dies?*, NBC News, https://www.nbcnews.com/tech/innovation/driverless-cars-moral-dilemma-who-lives-who-dies-n708276 (last updated Jan. 18, 2017, 11:57 AM) (noting that traffic laws and behavioral norms have created a "trust that this entire system functions in a way that works in our interests . . . .") (internal quotation marks omitted). This is differentiated from an autonomous driving system, as Iyad Rahwan—an associate professor at MIT—describes: "'[t]he problem with the new system [sic] it has a very distinctive feature: algorithms are making decisions that have very important consequences on human life.'" *Id.* Rahwan is concerned that safety improvements that could be made with autonomous cars will be stalled because of hesitation for adoption of autonomous vehicles. *See id.*

[281]   *See* Dizikes, *supra* note 275.

[282]   *See id.*

[283]   *See generally* Harvey, *supra* note 276 and accompanying text. Originally, the tragedy of the commons was exemplified through the concept of sheep grazing on public land (called the "commons"). *See* Wayne Eastman, *Telling Alternative Stories: Heterodox Versions of the Prisoners' Dilemma, the Coase Theorem, and Supply-Demand Equilibrium*, 29 Conn. L. Rev. 727, 750 (1997). If every shepherd permitted his or her sheep to graze in unlimited amounts on the common land, the grass would be consumed quickly. *See id.* As a result of the overgrazing, the public resource (the common) would dissipate quickly, and the sheep would not be able to eat for very long. *See id.* However, if the shepherds agreed to limit the amount that their sheep grazed, the grass would be able to replenish, and all of the shepherds and sheep would benefit from the continued use of the common grazing area and the community as a whole would be better off. *See id*; *see also* Garrett Hardin, *The Tragedy of the Commons*, 162 Science 1243, 1248 (1968) (applying the theory to consequences of individuals acting in their own self-interest and arguing self-restraint is critical to preserving resources). The Tragedy of the Commons theory has become one of the most cited theories by biologists and is commonly cited in other fields in academia. *See, e.g.*, Frank van Laerhoven & Elinor Ostrom, *Traditions and Trends in the Study of the Commons*, 1 Int'l J. Commons 3, 19 (2007).

[284]   *See* Boudette, *supra* note 273 and accompanying text.

[285]   *See* Dizikes, *supra* note 275. As seen in the historical development of seatbelt acceptance in cars, when initially presented with the option to obtain a safer vehicle, consumers may choose not to utilize the safer option. *See Automobile Safety*, *supra* note 27 (describing that even though scientific findings, laws, and safety campaigns emphasized the safety benefits of seat belts since at least the 1960s, "most motorists didn't wear seat belts" until the 1990s).

To avoid this conflict of self-interest and safety optimization, the federal government should require *all* vehicles meet certain ethical standards. Regulation of ethical programming for vehicles is similar to regulation of other safety standards, such as emissions. For example, in 1970, the federal government codified The Clean Air Act, which allowed the Environmental Protection Agency to place strict limitations on vehicular emissions that were contributing to environmental damage.[286] The restrictions were implemented to protect the public welfare.[287] Similarly, ethical programming standards would restrict manufacturers' ethical programming options to ensure that autonomous vehicles are as beneficial as possible to the general public.[288]

The FMVSS establishes a series of other safety requirements vehicles must meet in order to be introduced into commerce in the United States.[289] Since the ethical programming of automated vehicles will determine how the car reacts to various scenarios, and thus implicates safety, the government should develop a set of standards that all manufacturers are held to—just as the government holds manufacturers to safety standards regarding emissions.[290]

The varying legislative and regulative approaches states have taken concerning the use of autonomous vehicles within their jurisdictions show states could enact wildly deviating requirements for the ADS, including different requirements for the ethical standards of ADSs.[291] Besides the obvious hurdles for

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[286]  *See* 42 U.S.C. § 7401 (2020); U.S. ENVTL. PROTECTION AGENCY, *Evolution of the Clean Air Act*, https://www.epa.gov/clean-air-act-overview/evolution-clean-air-act#caa70 (last updated Jan. 3, 2017).

[287]  *See* 42 U.S.C. § 7401 (2020).

[288]  Information on whether consumers will react to ethical programming by not purchasing autonomous vehicles is not readily available and will probably not be available until fully autonomous vehicles have been on the market for a significant amount of time.

[289]  *See ANSI*, *supra* note 240.

[290]  *See* 42 U.S.C. § 7401 (2020) et seq. Included in the Clean Air Act are provisions that car emissions be below a certain level to reduce overall carbon emissions. *See* 42 U.S.C. § 7521 (2020). Since ethical programming also has implications for the safety of consumers and non-consumers alike, ethical programming should be viewed as another aspect of safety regulations, just like emissions, seatbelts, airbags, etc.

[291]  *See* Ben Husch & Anne Teigen, *Regulating Autonomous Vehicles*, NAT'L CONF. ST. LEGISLATURES, 25 LEGISBRIEF (2017), https://www.ncsl.org/LinkClick.aspx?fileticket=adMI3-NK_hY%3d&tabid=31251&portalid=1 ("Eleven states and the District of Columbia have passed legislation related to autonomous vehicles. Additionally, governors in Arizona and Massachusetts hve issued executive orders. These laws vary in scope, however.").

manufacturers trying to meet the standards for fifty states, separate regulation of autonomous ethical standards could inhibit the deployment of autonomous vehicles if the standards conflict. Both the autonomous car industry and technology companies have requested the federal government regulate autonomous vehicles.[292] Chris Urmson, former leader of Google's driverless car initiative (before it became Waymo) testified before a Senate Committee on Commerce, Science and Transportation: "If every state is left to go its own way without a unified approach, operating self-driving cars across state boundaries would be an unworkable situation and one that will significantly hinder safety innovation . . . of autonomous vehicles."[293]

Uniform ethical standards are also needed so vehicles behave in the same way so that consumers can anticipate their reactions. There will be a significant overlap in time when there are autonomous vehicles and non-autonomous vehicles on the road.[294] Part of the NHTSA's guidance for entities producing autonomous vehicles is to educate their consumers and distributers about the capabilities of the autonomous vehicles.[295] If there is not a consensus among vehicles about how they will react to dilemma scenarios, human drivers will not be able to adequately anticipate the movement of the autonomous vehicles.[296]

Opponents to uniform ethical programming regulations may argue consumers cannot predict the movement of other human drivers, and therefore uniformity of responsive programming to dilemmas is not necessary. However, this argument runs afoul of the whole purpose of autonomous vehicles: to make the roads safer for

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[292]  *See* Nathan Bomey, *Self-driving car leaders ask for national laws*, USA TODAY (Mar. 15, 2016, 10:27 PM), http://www.usatoday.com/story/money/cars/2016/03/15/google-alphabet-motors-lyft-senate-commerce-self-driving-cars/81818812/.

[293]  *Id.*

[294]  *See* MAURER, ET AL., *supra* note 65, at 195 (displaying a graph showing the timeline for the deployment of autonomous vehicles). Just like the implementation of other technologies, autonomous vehicles will actively interact and coexist with non-autonomous vehicles operated by human drivers. As discussed, cars must be built with technology which enables them to become autonomous. Since car owners keep their vehicles for several years, human drivers and ADS will be operating vehicles that share the road with each other. *See generally* Trent Gillies, *Car owners are holding their vehicles for longer, which is both good and bad*, CNBC (May 28, 2017, 11:48 AM), https://www.cnbc.com/2017/05/28/car-owners-are-holding-their-vehicles-for-longer-which-is-both-good-and-bad.html (discussing the amount of time that consumers retain their vehicles and that older vehicles without modern technology remain on the road despite innovations).

[295]  *See* VISION FOR SAFETY 2.0*, supra* note 103, at 15.

[296]  *See id.* at 20.

society as a whole.[297] If uniformity for ethical programming is not required and the actions of autonomous cars remain as sporadic as non-autonomous cars, autonomous cars would not decrease accidents as much as they could if other drivers could anticipate their actions.[298]

While there are several important reasons for enacting uniform ethical programming legislation, the process for implementing ethical programming regulations seems extensive and daunting. However, the United States can use Germany's legislation as a model.

## B. *The United States Should Use Germany's Legislation as a Model*

The United States should use Germany's newly passed legislation[299] as a model for the development of its own legislation regulating the ethical programming of autonomous vehicles. Like Germany's legislation, the underlying principle of autonomous programming legislation in the United States should reinforce the purpose of autonomous vehicles in the first place: to increase safety and reduce fatalities associated with motor vehicles.[300] To assure that society becomes safer, it is necessary to implement a utilitarian basis for ethical standards.[301] The regulations passed in the United States should, first and foremost, seek to maximize the welfare of society as a whole. The legislation would require vehicles to be programmed to damage property, including vehicles, before harming humans inside or outside of the vehicle.

Like Germany, the United States should establish an ethics committee composed of legal scholars, ethics professors, experts in autonomous car programming, car manufacturers, and traffic

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[297] *See id.*

[298] *See* Stemwedel, *supra* note 15 ("Different combinations of self-driving algorithms and human drivers' expectations in the same environment may create dynamics that are unexpected (and hard to navigate) for all.").

[299] *See generally* ETHICS COMMISSION REPORT, *supra* note 168.

[300] *See id.* at 10 ("The primary purpose of partly and fully automated transport systems is to improve safety for all road users.").

[301] If Utilitarian ethics were not implemented, consumers would select vehicles that protected them, rather than optimizing safety for society as a whole. *See People Want Driverless Cars with Utilitarian Ethics, Unless They're a Passenger*, *supra* note 212, and accompanying text (using survey results to conclude that consumers would choose self-protection over utilitarian ethical programming if given the option).

safety experts to develop regulations.[302] Like the Ethics Commission in Germany, the members of the ethics commission in the United States should consult with colleagues in their fields so multiple perspectives within each of the fields are considered.[303] However, the requirements and guidelines for the commission should be stricter in the United States than they were in Germany. The experts should be *required* to base their advice about autonomous vehicle ethical regulation on data collected which is representative of the views of the general public, including up-to-date surveys. Diverse surveys derived from large sample sizes should be taken and used to develop the principles to which the ethical algorithms must conform. Advice from experts, derived from information gathered from the public in their analysis and reports, should also be mandated. There should also be more members on the United States ethics commission than there were on the German commission.[304]

Like Germany, the United States should implement legislation as soon as possible. Autonomous vehicles are arriving, and soon.[305] If the government does not make changes and implement legislation addressing autonomous vehicles, including legislation addressing the ethical programming of autonomous vehicles, there will be detrimental effects.[306] For instance, the implementation of autonomous vehicles could be delayed because manufacturers will be required to meet different ADS standards in all fifty states.[307] Additionally, it is also possible that manufacturers will not risk deployment of their vehicles due to uncertainty about how the government will respond.[308]

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[302] *See* ETHICS COMMISSION REPORT, *supra* note 168, at 7 (describing the composition of the members of the German Ethics Commission).

[303] *See id.* (detailing that external experts were consulted for their opinions).

[304] *See* ETHICS COMMISSION REPORT, *supra* note 168, at 8-9 (showing the German Ethics Commission on Automated and Connected Driving consisted of fourteen members, pulled from government, academic institutions, and industry).

[305] *See id.* at 6 (describing partially autonomous cars are already in use throughout the world and that fully autonomous cars are in the testing stage).

[306] *See* Bomey, *supra* note 292 (explaining one Google representative stated that a lack of federal regulation will "hinder safety innovation, interstate commerce, national competitiveness and the eventual deployment of autonomous vehicles.").

[307] *See id.*

[308] *See id.* (noting a lack of uniform governmental regulations will likely impede the "eventual deployment of autonomous vehicles.") (internal quotation marks omitted).

Furthermore, delay in regulation may produce a chilling effect for consumers. Consumers may not want to purchase autonomous vehicles because they are not sure how the government will respond. Moreover, there will be public uncertainty resulting from lack of government regulation about safety, liability, and ethical standards of ADS. This uncertainty may make the cost of owning and utilizing an autonomous vehicle prohibitive. If autonomous vehicles are not purchased and utilized, the safety benefits of autonomous vehicles will not be realized. Beginning the legislative process for ethical programming now will allow a commission substantial time to formulate acceptable ethical guidelines and for manufacturers to respond to the new legislation. The more time manufacturers have to implement the changes, the less the regulations will hinder the deployment of autonomous vehicles.

One criticism for passing federal legislation is federal government regulation of the ethical programming of autonomous vehicles could result in the federal government being perceived as too paternalistic.[309] Legislation by the federal government mandating private industry to conform with "correct" ethical values may present a host of tort and constitutional dilemmas, including concerns about consumer choice[310] and state regulatory powers, respectively.[311] The Ethics Commission that developed the ethical programming guidelines for Germany noted and shared concern for the potential paternalism of government.[312] Interestingly, the Commission noted the decision would not be the passenger's choice with or without government regulation since the car would be

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[309] *See* Tina Bellon, *Autonomous Vehicle Regulation Highlights Federal vs. State Divide*, INS. J. (Sept. 19, 2017), https://www.insurancejournal.com/news/national/2017/09/19/464721.htm (stating critics of proposed federal bill felt "overruled" by federal legislature).

[310] *See* Mark A. Geistfeld, *A Roadmap for Autonomous Vehicles: State Tort Liability, Automobile Insurance, and Federal Safety Regulation*, 105 CALIF. L. REV. 1611, 1628 (2017) (describing categorical liability, its applicability to autonomous cars, and the courts rejection of that type of liability in order to "preserve the role of informed consumer choice across product categories").

[311] *See* Bellon, *supra* note 309.

[312] *See* ETHICS COMMISSION REPORT, *supra* note 168, at 16 ("On the one hand there is the danger of the state acting in a very paternalistic manner and prescribing a 'correct' ethical course of action (to the extent that programming prescribes this)."). The Commission notes that attributing the decision of regulation of ethics to the government as implemented by the programmer might conflict in some ways with the Kantian ethics where the right to moral self-determination is the basis of an existence determined by reason. *See id.* The Commission appeared to balance this with the reality that, even if the government did not regulate the ethics of the autonomous vehicles, programmers would have to determine what course the vehicle would take, and would thus be substituting their will for what otherwise would be the driver's decision. *See id.*

responding based on pre-determined algorithms.[313] A solution to potential perception of government overstepping might be to have some non-governmental ethics commission members. This way, members outside the government will work in conjunction with the government to develop these standards.[314]

Federal governments, whether in the United States or Germany, must determine whether the risk of paternalism supersedes the potential benefits of maximizing the welfare. By adopting the ethical regulations, the German government believed the regulations were necessary to achieve the greater societal goal of safety for the most amount of people.[315] The United States should follow Germany's lead and develop ethical programming regulations for autonomous vehicles to ensure that the safety benefits from autonomous vehicles are maximized. The legislation should be implemented immediately, and then reevaluated periodically to ensure the ethical standards set are necessary and functioning to achieve the goal of maximized safety.[316]

## CONCLUSION

If there continues to be no ethical regulation for autonomous vehicles, they may not be programmed to minimize harm.[317] Instead, automated vehicles may be programmed to protect the consumer at all costs.[318] Companies, too, will be acting in their rational self-

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[313]  *See id.*

[314]  This dilemma raises the question: which might be worse for the utilitarian programming objective? Having a private representative determine ethical outcomes, or the government? While this is outside the scope of this paper, it would be an interesting inquiry whether consumers preferred their vendor determining ethics, or their government. Additionally, there are some obvious concerns about the potential for private industry to influence the governmental officials and circumvent the ideal ethical programming in favor of manufacturer financial gain. To avoid this, a first step might be to ensure commission members do not have ties to manufacturers.

[315]  *See* ETHICS COMMISSION REPORT, *supra* note 168, at 6, 10. The guidelines will be reevaluated in two years. Tuffley, *supra* note 19.

[316]  Both of the bills that have been proposed in Congress have review periods but do not implement the legislation until that period of time has elapsed. *See* SELF DRIVE Act, H.R. 3388 § 4, 115th Cong. (2017); AV START Act, S. 1885 § 4, 115th Cong. (2017).

[317]  *See* Lubin, *supra* note 180.

[318]  *See* Lubin, *supra* note 180 (indicating autonomous vehicles may be programmed to protect their passengers at all costs). After all, the companies producing these vehicles want to ensure that they have safe and happy customers, all of whom will be acting rationally in their own self-interest. According to the surveys taken already, consumers will choose to purchase a car that protects them over a car that minimizes harm. *See People Want Driverless Cars with Utilitarian Ethics, Unless They're a Passenger*, *supra* note 212. However, it is possible that

interest by producing cars which are programmed to protect the consumer foremost because that is what the market will demand.[319] Similar to the evolution of safety features in conventional motor vehicles, manufacturers will not necessarily implement nuanced technological applications geared towards ultimate safety.[320] We should learn a lesson from the seatbelts of the 1930s;[321] utilitarian ethical algorithmic programming should be mandated in autonomous vehicles now, rather than waiting years to implement technology that could save thousands of lives. The full potential of safety improvements associated with autonomous vehicles will not be realized unless all companies are mandated to program autonomous cars with utilitarian-focused ethical programming.

manufacturers would be entirely prohibited from programming cars to protect consumers over non-consumers (e.g. pedestrians) due to already existing constitutional constraints. As mentioned above, the constitutional debate over ethical programming is beyond the scope of this paper but should be considered extensively when determining what ethical guidelines are imposed or necessary.

[319]  *See* Lubin, *supra* note 180.

[320]  *See Automobile Safety*, *supra* note 27 (describing instances where consumer safety advocates had to overcome the automobile industry's resistance to mandatory safety devices, even when overwhelming evidence supported the advocates).

[321]  *See The History of Seat Belt Development*, CTR. FOR AUTO SAFETY, https://www.autosafety.org/history-seat-belt-development (last visited Nov. 8, 2019) (showing although physicians began installing seat belts in their own cars as early as the 1930s, automobile manufacturers were not mandated to install them to specific safety standards until 1967).