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As the Role of the Driver Changes with Autonomous Vehicle Technology, so, Too, Must the Law Change

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ARTICLE

AS THE ROLE OF THE DRIVER CHANGES WITH AUTONOMOUS VEHICLE TECHNOLOGY, SO, TOO, MUST THE LAW CHANGE

NANCI K. CARR*

I.	Introduction.....	818
II.	What is an Autonomous Vehicle?	819
	A. Levels of Automation.....	820
	B. Availability of Vehicles.....	821
	C. Benefits of Autonomous Vehicles	822
	D. Testing.....	825
III.	What Can go Wrong?	827
	A. Accidents.....	827
	B. Programming Errors, Software Glitches, and Cybersecurity..	828
	C. Programming Moral Decision-Making.....	831
IV.	Liability and Legislation	832
	A. State Law	834
	B. Cities	835
	C. Semi-Autonomous and Autonomous Related Laws	835
	D. Federal Law.....	839

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V.	Future of Autonomous Vehicles—Not Just Consumer Automobiles.....	840
VI.	Conclusion	843

Getting a driver's license is a highly anticipated rite of passage for most teenagers. Being alone behind the wheel, in control of a 3,000-pound machine, is an honor, a privilege, and a sign of adult responsibility. How will that change when driver's licenses become licenses "to cause technology to engage" with the increased use of autonomous cars? Will driver's education courses, with their focus on safety rules and defensive driving techniques, be eliminated if all a vehicle operator needs to do is push a button and the vehicle does the rest? While arguably autonomous cars are safer, they will not be incident-free, so who is liable for the fender bender? If the vehicle operator did nothing more than push a button, current law that focuses on the actions of the tortfeasor might not apply, and the limited law related to autonomous computer systems may apply only in commercial transactions, not autonomous vehicles. Will the carmaker or the software programmer have liability, either for accidents or intentional damage caused by hacking? This paper discusses how the law must change to keep up with rapidly changing technology in autonomous vehicles.

I. INTRODUCTION

While many think of self-driving vehicles as something that can exist only in a futuristic Hollywood movie, they were conceived by General Motors at the 1939 World's Fair.¹ The technology is now developing quickly, with many states granting permission to test run or deploy self-driving vehicles.² Many manufacturers have already released cars with limited self-driving features, and others predict that they will make self-driving cars available to

1. See Tom Vanderbilt, *Autonomous Cars Through the Ages*, WIRED (Feb. 06, 2012, 6:30 AM), <https://www.wired.com/2012/02/autonomous-vehicle-history/> [https://perma.cc/QCU8-T9X6] ("The idea of autonomous vehicles gained widespread public exposure at GM's Futurama exhibit at the 1939 World's Fair, where the automaker envisioned 'abundant sunshine, fresh air [and] fine green parkways' upon which cars would drive themselves.")

2. See *Autonomous Vehicles*, GHSA.ORG, <https://www.ghsa.org/state-laws/issues/autonomous-vehicles> [https://perma.cc/8484-PELD] (detailing how thirteen states authorize studies, eight states authorize testing, eleven states and the District of Columbia authorize deployment, and of the nineteen authorizing testing and deployment, twelve allow testing or deployment without a human operator).

the consumer in the next few years.³ Questions about accident liability arise as this technology becomes more readily accessible to the general public.⁴ This article discusses the issues of liability concerning autonomous vehicles and how the law must change to address liability, whether it be of the manufacturer, the software designer, or the operator.

II. WHAT IS AN AUTONOMOUS VEHICLE?

Autonomous refers to “part-time operation of vehicles by intelligent systems capable of independently controlling some or all vehicle operations for part of a journey, or in specific roadway contexts.”⁵ Autonomous vehicles fall into two main categories: autonomous vehicles and semi-autonomous vehicles. Driverless cars, also known as autonomous vehicles,⁶ are those that do not require real-time human input to operate or navigate. “Instead, these vehicles use various sensors and computer software to collect and process information about the surrounding environment.”⁷ These sensors “collect information about both internal conditions, such as speed and direction, and external conditions, such as the environment and vehicle location.”⁸ Semi-autonomous vehicles, however, only direct “some aspects of safety-critical control function (e.g., steering, throttle, or braking) . . . [without] direct driver input,’ but require supervision from a licensed driver.”⁹

The multitude of semi-autonomous and fully autonomous vehicle technologies that (a) already co-exist[,] and (b) are likely to multiply in coming years[,] led the [Society of Automotive Engineers] (SAE) International, a global association of engineers, to divide vehicle automation into [the following] six levels to provide “common terminology for automated driving”

3. Carrie Schroll, *Splitting The Bill: Creating A National Car Insurance Fund to Pay for Accidents in Autonomous Vehicles*, 109 NW. U.L. REV. 803, 805 (2015).

4. *Id.*

5. Dorothy J. Glancy, *Autonomous and Automated and Connected Cars—Oh My! First Generation Autonomous Cars in the Legal Ecosystem*, 16 MINN. J.L. SCI. & TECH. 619, 629 (2015).

6. NHTSA Issues Long Awaited Policy Statement on Driverless Car Technology, FOLEY & LARDNER LLP (June 13, 2013), <https://www.foley.com/en/insights/publications/2013/06/nhtsa-issues-long-awaited-policy-statement-on-driv> [<https://perma.cc/9SY5-PH6Q>].

7. Kyle L. Barringer, *Code Bound and Down . . . A Long Way to Go and A Short Time to Get There: Autonomous Vehicle Legislation in Illinois*, 38 S. ILL. U. L.J. 121, 122 (2013).

8. *Id.*

9. Tracy Hresko Pearl, *Fast & Furious: The Misregulation of Driverless Cars*, 73 N.Y.U. ANN. SURV. AM. L. 19, 24 (2017) (quoting National Highway Transportation Safety Administration, *Preliminary Statement of Policy Concerning Automated Vehicles* (Sept. 2013)).

as well as to provide a technical description of the differences between levels of automation[.]¹⁰

A. *Levels of Automation*¹¹

Level 0—No Automation: In Level 0 vehicles, a human driver is in total control of the primary vehicle controls (brake, steering, acceleration) at all times and is responsible for monitoring both the road and the vehicle. For example, a car without cruise control capabilities would be considered a Level 0 vehicle.

Level 1—Driver Assistance: Vehicles at this level have automation options for “either steering or acceleration/deceleration using information about the driving environment and with the expectation that the human driver perform[s] all remaining aspects of the dynamic driving tasks.” An example of a Level 1 vehicle would be a car with cruise control or electronic stability control. The driver[,] [however][,] has overall control of the vehicle at all times

Level 2—Partial Automation: Level 2 vehicles have “automation of at least two primary control functions designed to work in unison to relieve the driver of control of those functions.” “[C]ombined functions” are the hallmark of Level 2 vehicles and include features like “adaptive cruise control [working] in combination with lane centering” that allow the driver to “disengage from physically operating the vehicle by having his or her hands off the steering wheel AND foot off the pedal[s] at the same time.” The driver, however, “is still responsible for monitoring the roadway . . . and is expected to be available for control at all times and on short notice.”

Level 3—Conditional Automation: Vehicles at this level “enable the driver to cede full control of all safety-critical functions under certain traffic or environmental conditions and in those conditions to rely heavily on the vehicle to monitor for changes in those conditions requiring transition back to driver control.” While the driver must be available for “occasional control,” the vehicle is designed to both ensure safe operation during automated driving and to provide the driver with a “sufficiently comfortable transition time” to reassume control over the vehicle. An example of a Level 3 vehicle would be a “self-driving car that can determine when the system is

10. *Id.* at 27.

11. *See id.* at 27–29 (explaining how the automation of vehicles is broken down by levels that correspond to the type of functions it can perform autonomously and the amount of required driver interaction).

no longer able to support automation, such as from an oncoming construction area, and then signals to the driver to reengage in the driving task[.]” The National Highway Traffic Safety Administration (NHTSA) also notes that “[t]he major distinction between level 2 and level 3 is that at level 3, the vehicle is designed so that the driver is not expected to constantly monitor the roadway while driving.” There are no Level 3 vehicles currently available to consumers

Level 4—High Automation: Level 4 vehicles are “designed to perform all safety-critical driving functions and monitor roadway conditions for an entire trip.” Unlike drivers of Level 3 vehicles, drivers of Level 4 vehicles are “not expected to be available for control at any time during the trip” other than to “provide destination or navigation input.” The entire responsibility for safe operation falls on the vehicle. However, “the automated system can operate only in certain environments and under certain conditions.” Level 4 vehicles are not yet available to consumers.

Level 5—Full Automation: In Level 5 vehicles, “the automated system can perform all driving tasks, under all conditions that a human driver could perform them.” A human being is not needed to supervise, monitor, or control the vehicle in any setting, or be a “fallback” option in the event of system failure.¹²

B. *Availability of Vehicles*

There are approximately 1.4 billion cars on the road, and soon, millions of them may be self-driving.¹³ By 2035, industry insiders predict that “75 percent of vehicles sold worldwide will have some degree of autonomous capability.”¹⁴ Today, driverless cars are being developed by Lexus, BMW, Mercedes, and Tesla, and Google and Apple are working on the related technology.¹⁵ These driverless cars “rely on a range of sensors to interact with the world around them . . . [t]he most noticeable [of which] is the

12. *Id.* (citations omitted).

13. Olivier Garret, *10 Million Self-Driving Cars will Hit the Road by 2020—Here’s How to Profit*, FORBES, (Mar. 3, 2017, 9:00 AM) <https://www.forbes.com/sites/oliviergarret/2017/03/03/10-million-self-driving-cars-will-hit-the-road-by-2020-heres-how-to-profit/#77dd35927e50> [https://perma.cc/472C-D6CD].

14. Richard C. Balough, *Are Your Clients Ready for the Impact of Driverless Cars?*, AMERICANBAR.ORG, (May 20, 2016) https://www.americanbar.org/groups/business_law/publications/blt/2016/05/03_balough/ [https://perma.cc/LLZ3-W26U].

15. Victoria Woollaston & Curtis Moldrich, *Driverless Cars of the Future: How Far Away are we from Autonomous Cars?*, ALPHR, (Oct. 18, 2018), <http://www.alphr.com/cars/1001329/driverless-cars-of-the-future-how-far-away-are-we-from-autonomous-cars> [https://perma.cc/LQ7M-6C9K].

rotating roof-top LIDAR—a camera that uses an array of either 32 or 64 lasers to measure the distance between objects, building up a 3D map . . . and allowing the car to ‘see’ hazards.”¹⁶ There is an additional camera pointing through the windshield that detects pedestrians, cyclists, and traffic lights. In addition, there is a bumper-mounted radar to track vehicles in front of and behind the car, a technology that is already in use with cars equipped with cruise control.¹⁷ Furthermore, many driverless cars also have antennae for geolocation information from satellites and sensors on one of the wheels to monitor movement.¹⁸ However, the sensors cannot adjust to “extreme sunlight[,] weather[,] or even defective traffic lights.”¹⁹

According to Christoph Reifenrath, senior manager in technology marketing of Harman’s infotainment division, a supplier to Audi, BMW, and Mercedes, “[c]ar-to-car and car-to-infrastructure communication is essential for enabling autonomous driving[.]”²⁰ For example, cars driven by humans, including emergency vehicles, will need to be able to communicate with autonomous cars sharing the road.²¹

Apple—long engaged in its self-driving car project, Project Titan—has downsized its staff devoted to the project.²² However, Apple “continue[s] to believe there is a huge opportunity with autonomous systems, that Apple has unique capabilities to contribute, and that this is the most ambitious machine learning project ever.”²³ Such a change in its commitment to the project could be related to a fender bender in which a human Nissan driver rear-ended an Apple test vehicle.²⁴

C. *Benefits of Autonomous Vehicles*

One of the autonomous vehicle’s most important potential benefits is better safety, based on the fact that “94% of serious [vehicular] crashes are

16. *Id.*

17. *Id.*

18. *Id.*

19. *Id.*

20. *Id.*

21. *Id.*

22. Tom Hoggins, *Apple Cuts Hundreds of Employees from Secretive Self-Driving Car Project*, TELEGRAPH, (Jan. 24, 2019) <https://www.yahoo.com/news/apple-cuts-hundreds-employees-secretive-115953036.html> [<https://perma.cc/E7LV-HRK5>].

23. *Id.*

24. *See id.* (implying the fender-bender influenced Apple’s decision to restructure Project Titan).

due to human error.”²⁵ Motor vehicle crashes killed 37,133 people in the United States in 2017,²⁶ suggesting many lives will be saved if we remove the opportunity for human error. Mothers Against Drunk Driving supports the advancement of autonomous vehicle technology as it could end drunk driving and related traffic deaths.²⁷

Beyond impaired driving, autonomous vehicles would eliminate collisions, deaths, and traffic associated with distracted driving, . . . because the car would be responsible for driving. More so than solving existing bad driving habits, autonomous-vehicle technology can open transportation options for the elderly, blind, and others whose physical impairments currently prevent them from operating vehicles.²⁸

In addition to safety, autonomous vehicles present opportunities for savings on property damages and fuel. “Since self-driving cars could eliminate human driver error and be less likely to crash, . . . property savings would add up to \$190 billion in the U.S. alone.”²⁹ Because machines are more efficient than people, 15–31% in fuel savings could result from letting the cars be in control as they would be driven more efficiently with smoother traffic flows.³⁰ Since self-driving cars could drop off and pick up passengers at the curb, parking spaces could be made narrower since space would not be needed to allow for doors to open and passengers to get in and out.³¹ “That could free up 6.8 billion square yards in the U.S. that is

25. *Automated Vehicles for Safety*, NHTSA, <https://www.nhtsa.gov/technology-innovation/automated-vehicles-safety#issue-road-selfdriving> [https://perma.cc/XJ7K-7K3F].

26. *Driver Assistance Technologies*, NHTSA, <https://www.nhtsa.gov/equipment/driver-assistance-technologies> [https://perma.cc/C6GB-L96U].

27. *Advanced Vehicle Technology*, MADD, <https://www.madd.org/the-solution/drun-driving/secure-the-future/#av> [https://perma.cc/6S4T-SMLB].

28. Leesa Guarnotta, *Death of the DUI: Should Autonomous Vehicles be Considered Synonymous to Designated Drivers Under Georgia Law?*, 70 MERCER L. REV. 1113, 1121 (2019).

29. Chris Woodyard, *McKinsey Study: Self-Driving Cars Yield Big Benefits*, USA TODAY (Mar. 5, 2015, 3:57 AM), <http://www.usatoday.com/story/money/cars/2015/03/04/mckinsey-self-driving-benefits/24382405/> [perma.cc/NK7W-H8SX].

30. Jason Bordoff, *How Driverless Cars Could End up Harming the Environment*, WALL ST. J. (Apr. 27, 2016, 11:47 AM), <http://blogs.wsj.com/experts/2016/04/27/how-driverless-cars-might-actually-harm-the-environment/> [https://perma.cc/9REZ-JRPF]; THE GOLDMAN SACHS GROUP, INC., *Monetizing the Rise of Autonomous Vehicles*, CARS 2025: VOL. 3, 57 (Sept. 17, 2015), http://pg.irj.com.cn/acc/Res/CN_RES/INVEST/2015/9/17/f70472c6-f4ad-4942-8eab-3c01f3c717a7.pdf. [https://perma.cc/U25T-2XC9].

31. Woodyard, *supra* note 29.

currently being used for parking lots—the equivalent of the Grand Canyon and Zion national parks combined”³²

Of course, one of the greatest benefits is an improved commuter experience, since self-driving cars would allow commuters to do whatever they please as they travel to work.³³

Much like public transportation users, commuters in self-driving cars would be free to read, watch videos, work, or even sleep, but unlike public transportation, commuters could do these activities in the privacy of their cars.³⁴ Not only would this be a more pleasant experience for commuters—it would result in productivity gains of \$507 billion annually in the U.S., where Americans would otherwise spend seventy-five billion hours a year driving.³⁵ Productivity gains, combined with the health benefits of reduced stress from not battling traffic, means “autonomous cars could contribute \$1.3 trillion in annual savings to the U.S. economy alone, with global savings estimated at over \$5.6 trillion.”³⁶

Autonomous cars will be a “treasure trove for data,”³⁷ which may be seen as both a good and a bad thing. For example, the car will record which restaurants the operator frequents, resulting in invaluable information for competitors and allowing for targeted marketing.³⁸ However, consumers who are already concerned about data privacy may not be so excited about such marketing efforts.

32. *Id.*

33. Jeffrey Zients and John P. Holdren, *American Innovation in Autonomous and Connected Vehicles*, WHITE HOUSE, (Dec. 7, 2015, 3:53 PM), <https://obamawhitehouse.archives.gov/blog/2015/12/07/american-innovation-autonomous-and-connected-vehicles> [https://perma.cc/ENX7-HY SY] (“And for the average American who spends 50 minutes a day commuting to and from work, autonomous and connected vehicles could free up hundreds of hours a year for other pursuits.”).

34. *Autonomous Cars: The Future Is Now*, MORGAN STANLEY (Jan. 23, 2015), <http://www.morganstanley.com/articles/autonomous-cars-the-future-is-now> [https://perma.cc/T9 KY-JMER].

35. *Id.*; see also Joel Hazan et al., *Will Autonomous Vehicles Derail Trains?*, BCG (Sept. 30, 2016), <https://www.bcg.com/publications/2016/transportation-travel-tourism-automotive-will-autonomous-vehicles-derail-trains.aspx> [https://perma.cc/645M-YLEF] (revealing that “increased productivity is the reason many drivers cite when they say they would consider buying or using . . .” an autonomous vehicle).

36. *Autonomous Cars: The Future Is Now*, MORGAN STANLEY (Jan. 23, 2015), <http://www.morganstanley.com/articles/autonomous-cars-the-future-is-now> [https://perma.cc/T9 KY-JMER].

37. Thomas Bloch, *The Next Great Media Channel Is the Self-Driving Car. Will Brands Be Ready?*, ADWEEK (Oct. 30, 2017), <http://www.adweek.com/agencies/the-next-great-media-channel-is-the-self-driving-car-will-brands-be-ready/> [https://perma.cc/X2NR-MPSZ].

38. *Id.*

In late 2017, Waymo, the company that started as Google's autonomous-car division, announced it integrated "several design elements intended to help the elderly and people with disabilities."³⁹ Although the company commenced the design of a smartphone app that will be "easy to use and accessible to those with disabilities,"⁴⁰ users may not agree with the assessment of *easy*. While Waymo plans for riders who are hearing-impaired to be able to follow the route on laptop-sized screens, Marjorie C. Younglof, who is deaf, wonders not only whether deaf people could successfully communicate with the cars, but also whether seniors would struggle, stating "They are not as quick as younger people are to latch onto new technology and incorporate it into their lives[.]"⁴¹ Waymo is further considering "ways in which a vehicle could give an audible signal to a blind person when it arrives for pickup."⁴² Moreover, "key control buttons in current Waymo Level 4 vehicles are marked in Braille."⁴³ Making the cars accessible for physically disabled riders may be more difficult, particularly accommodating wheelchairs. However, carmakers want to be sure to meet legal requirements, including the Americans with Disabilities Act of 1990.⁴⁴

D. Testing

While many states are permitting test run or deploy self-driving vehicles,⁴⁵ and sixty companies are testing 300 autonomous cars, California is a leader in autonomous car testing,⁴⁶ permitting autonomous cars without steering wheels, foot pedals, mirrors, and/or human drivers behind the

39. Ashley Halsey III, *Driverless Cars Promise Far Greater Mobility for the Elderly and People with Disabilities*, WASH. POST (Nov. 23, 2017), https://www.washingtonpost.com/local/trafficandcommuting/driverless-cars-promise-far-greater-mobility-for-the-elderly-and-people-with-disabilities/2017/11/23/6994469c-c4a3-11e7-84bc-5e285c7f4512_story.html?utm_term=.7c420ce987c5 [https://perma.cc/L8R7-GNL8].

40. *Id.*

41. *Id.*

42. *Id.*

43. *Id.*

44. *Id.*; see also 42 U.S.C. § 12101 (explaining how "physical or mental disabilities in no way diminish a person's right to fully participate in all aspects of society, yet many people with physical or mental disabilities have been precluded from doing so because of discrimination.").

45. See *Autonomous Vehicles*, *supra* note 2 (outlining different tests and studies states are conducting regarding self-driving vehicles).

46. Sam Shead, *There Are Now 39 Companies Testing Self-Driving Cars on Californian Roads*, BUS. INSIDER (Sep. 1, 2017), <http://www.businessinsider.com/dozens-of-companies-testing-self-driving-cars-on-californian-roads-2017-9?r=UK&IR=T> [https://perma.cc/6KCP-H6KF].

wheel to be tested on its roads.⁴⁷ Waymo,⁴⁸ a Google affiliate, tested its cars in Palo Alto, California suburbs, near the Google headquarters.⁴⁹ Its state of California permit allowed testing during both day and night, city streets, rural roads, and highways up to sixty-five miles per hour.⁵⁰ Waymo said:

Our vehicles can safely handle fog and light rain, and testing in those conditions is included in our permit[.] . . . We will gradually begin driverless testing on city streets in a limited territory and, over time, expand the area that we drive in as we gain confidence and experience to expand.⁵¹

In autonomous cars with a driver behind the wheel, the driver can always take over if the car does not respond appropriately. In driverless cars, however, what happens if the car has conflicting information or does not have the right programming to proceed? According to a Waymo statement:

If a Waymo vehicle comes across a situation it doesn't understand, it does what any good driver would do: comes to a safe stop until it does understand how to proceed. For our cars, that means following well-established protocols, which include contacting human engineers and testers at Waymo for help in resolving the issue.⁵²

47. Andrew J. Hawkins, *Waymo Gets the Green Light to Test Fully Driverless Cars in California*, VERGE (Oct. 30, 2018, 5:11 PM), <https://www.theverge.com/2018/10/30/18044670/waymo-fully-driverless-car-permit-california-dmv> [<https://perma.cc/Z5CB-HGNL>] (noting that any company holding a driverless permit must report any collisions involving a driverless test vehicle to the California Department of Motor Vehicles within ten days).

48. Victoria Woollaston, *Driverless Cars of the Future: How Far Away are we from Autonomous Cars?*, ALPHR (Oct. 30, 2018), <http://www.alphr.com/cars/1001329/driverless-cars-of-the-future-how-far-away-are-we-from-autonomous-cars> [<https://perma.cc/R4RL-RVPN>] (noting that Waymo combines two words in Google's mission to find "a new way forward in mobility"). "Waymo's mission is to make it safe and easy for people and things to get where they're going. The Waymo Driver can improve the world's access to mobility while saving thousands of lives now lost to traffic crashes." *Our Mission*, WAYMO, <https://waymo.com/mission/> [<https://perma.cc/7PLA-3KK6>].

49. Hawkins, *supra* note 47.

50. *Id.*

51. *Id.*

52. Phil LeBeau, *Waymo Can Now Test Driverless Cars on Public Roads in California*, CNBC (Oct. 30, 2018), <https://www.cnn.com/2018/10/30/waymo-can-now-test-driverless-cars-on-public-roads-in-california.html> [<https://perma.cc/9U45-7ATM>].

Uber is testing autonomous vehicles, many of which, including those in Pittsburgh, use two Uber employees in the front seat.⁵³

Uber uses the test drives to work out any kinks navigating in urban environments.⁵⁴ There have been many such kinks since, on average, the autonomous Ubers required employee intervention every 0.8 miles.⁵⁵ When tested in Berlin traffic, an autonomous Jeep “slams on its breaks every few hundred yards, like a nervous teenager with a learner’s permit,”⁵⁶ because grass or street litter triggers its sensors. Carmakers must continue to work perfecting the hardware and software to make autonomous vehicles safe.

III. WHAT CAN GO WRONG?

A. *Accidents*

Accidents can happen with autonomous vehicles. The first fatality in a car accident involving a partially self-driving vehicle occurred on May 7, 2016.⁵⁷ Joshua Brown, a forty-year-old business owner, and former Navy SEAL was driving his 2015 Tesla Model S down a highway in Williston, Florida when the vehicle “drove under the trailer of an eighteen-wheel truck” that had turned left in front of his vehicle moments before.⁵⁸ The impact sheared the roof off the Tesla,⁵⁹ and Mr. Brown was pronounced dead at the scene.⁶⁰ At the time of his death, Mr. Brown had the vehicle’s

53. Robert Siegel & Art Silverman, *Pittsburgh Offers Driving Lessons for Uber’s Autonomous Cars*, NPR (Apr. 3, 2017, 4:02 PM), <https://www.npr.org/sections/alltechconsidered/2017/04/03/522099560/pittsburgh-offers-driving-lessons-for-ubers-autonomous-cars> [https://perma.cc/XT6S-DJDR].

54. Johana Bhuiyan, *Uber’s Autonomous Cars Drove 20,354 Miles and Had to be Taken Over at Every Mile, According to Documents*, VOX (Mar. 16, 2017, 6:14 PM), <https://www.vox.com/2017/3/16/14938116/uber-travis-kalanick-self-driving-internal-metrics-slow-progress> [https://perma.cc/4EHP-7KFZ].

55. *Id.*

56. Elisabeth Behrmann, *Robo-Car Brakes for Balloons as Real World Tests Driverless Hype*, BLOOMBERG (Aug. 31, 2017), <https://www.bloomberg.com/news/articles/2017-08-31/robo-car-brakes-for-balloons-as-real-world-tests-driverless-hype> [https://perma.cc/M9FY-6X73].

57. Tom Krisher & Joan Lowy, *Tesla Driver Killed in Crash While Using Car’s ‘Autopilot’*, WASH. TIMES, (June 30, 2016), <https://www.washingtontimes.com/news/2016/jun/30/self-driving-car-driver-died-after-crash-in-florid/> [https://perma.cc/8MAU-EKCM].

58. Jeanne Dugan & Mike Spector, *Tesla Draws Scrutiny After Autopilot Feature Linked to a Death*, WALL ST. J., (June 30, 2016), <https://www.wsj.com/articles/tesla-draws-scrutiny-from-regulators-after-autopilot-feature-is-linked-to-a-death-1467319355> (last visited April 30, 2020).

59. Krisher & Lowy, *supra* note 57.

60. *Id.*

“Autopilot” engaged.⁶¹ A glitch in the Autopilot system was a partial factor in his death: “his car’s cameras failed to distinguish the white side of turning tractor-trailer rig from a brightly lit sky and didn’t automatically activate its brakes.”⁶² Media voiced their scrutiny regarding the safety of autonomous cars, including *The New York Times*, who brought the capability of computer operation into question.⁶³ Subsequent reports found that Mr. Brown may have been watching a *Harry Potter* movie at the time of his death, even though Tesla had explicitly warned customers its Autopilot feature was not reliable enough for a driver to stop paying attention to the road while the autonomous system was engaged.⁶⁴

Another fatality caused by an autonomous car occurred in Tempe, Arizona, where Uber was experimenting with the use of autonomous cars.⁶⁵ Elaine Herzberg, age forty-nine, was crossing the street outside of a crosswalk.⁶⁶

An Uber car in autonomous mode with a driver behind the wheel struck and killed Ms. Herzberg.⁶⁷ Uber halted its autonomous car program in several cities the following the incident, but stated “We’re committed to self-driving technology, and we look forward to returning to public roads in the near future In the meantime, we remain focused on our top-to-bottom safety review, having brought on former Chair Christopher Hart to advise us on our overall safety culture.”⁶⁸

B. *Programming Errors, Software Glitches, and Cybersecurity*

Just as hardware malfunctions, an autonomous vehicle’s software can malfunction or be hacked. Programming errors can cause the operating system to glitch, which in turn can cause the vehicle to crash. “As with

61. Dugan & Spector, *supra* note 58.

62. Krisher & Lowy, *supra* note 57.

63. Neal E. Boudette & Bill Vlastic, *Self-Driving Tesla was Involved in Fatal Crash, U.S. Says*, N.Y. TIMES, (June 30, 2016), <https://www.nytimes.com/2016/07/01/business/self-driving-tesla-fatal-crash-investigation.html> [<https://perma.cc/2A3Y-PXW6>].

64. Mahita Gajanan, *Tesla Driver May Have Been Watching Harry Potter Before Fatal Crash*, VANITY FAIR, (July 2, 2016), <https://www.vanityfair.com/news/2016/07/tesla-driver-may-have-been-watching-harry-potter-before-fatal-crash> [<https://perma.cc/XLC6-C9SC>].

65. Dani Kass, *Uber Removes Self-Driving Cars from Arizona After Crash*, LAW360, (May 23, 2018, 10:43 PM), <https://www.law360.com/articles/1046763/uber-removes-self-driving-cars-from-arizona-after-crash> (last visited April 30, 2020).

66. *Id.*

67. *Id.*

68. *Id.*

hardware malfunctions, these defects will subject the manufacturers of autonomous vehicles to strict liability, giving them a financial incentive to subject the vehicle's programming to reasonably safe methods of quality control."⁶⁹

Many people do small things indicating they give little thought to computer hacking: opening phishing emails, not installing anti-virus software, and often failing to backup data on external drives or in the cloud. But it will be important for people to be vigilant with respect to software maintenance and updates with a computer-operated car. Hopefully, the risk of physical safety will be more compelling than the risk of identity theft in encouraging consumers to bear some of the responsibility for protection against hacking.⁷⁰

Cybersecurity is another potential for manufacturer liability.⁷¹ Hackers may stage and implement an attack exploiting individual vehicle's electronics, such as its event data recorder system.⁷² This could pose severe risks, such as stalling vehicles in intersections and disrupting the flow of traffic or making real-time speed adjustments, both of which could cause significant damage and disruption.⁷³ "Such an attempt to exploit and gain control over an electronic control unit would likely subject the attacker to federal criminal liability under the Computer Fraud and Abuse Act of 1986, . . . Digital Millennium Copyright Act, . . . and [the] USA PATRIOT Act."⁷⁴ If an autonomous vehicle "crashes because a third party hacked into the operating system," and the "system did not function as expected or intended[,] [t]he malfunction would subject the manufacturer to strict

69. Mark A. Geistfeld, *A Roadmap for Autonomous Vehicles: State Tort Liability, Automobile Insurance, and Federal Safety Regulation*, 105 CAL. L. REV. 1611, 1692 (2017).

70. Alexis C. Madrigal, *7 Arguments Against the Autonomous-Vehicle Utopia*, ATLANTIC, (Dec. 20, 2019), <https://www.theatlantic.com/technology/archive/2018/12/7-arguments-against-the-autonomous-vehicle-utopia/578638/> [<https://perma.cc/AHR7-8Q6L>] (noting that, as argued by University of Washington legal scholar Ryan Calo, "the physical danger that cars pose is far greater, and maybe the norms developed for robots will be different from those prevalent on the internet . . .").

71. Geistfeld, *supra* note 69, at 1694.

72. William J. Kohler & Alex Colbert-Taylor, *Current Law and Potential Legal Issues Pertaining to Automated, Autonomous and Connected Vehicles*, 31 SANTA CLARA COMPUTER & HIGH TECH. L. J. 99, 133 (2015).

73. *Id.*

74. Christopher Wing, *Better Keep Your Hands on the Wheel in that Autonomous Car: Examining Society's Need to Navigate the Cybersecurity Roadblocks for Intelligent Vehicles*, 45 HOFSTRA L. REV. 707, 723 (2016).

liability, although the matter is not clear at this point.”⁷⁵ Even if the operating system is created or installed by a third-party, the vehicle manufacturer may be liable. “California defines the manufacturer of an autonomous vehicle as the one who ‘originally manufactures the vehicle and equips autonomous technology,’ whether or not that person is the original manufacturer of the underlying vehicle.”⁷⁶ Additionally, “the original manufacturer is not released from liability resulting from third-party installation of autonomous technology, and there is no designation that a third-party installer is liable for defects.”⁷⁷

Within the current legal framework:

[An] autonomous vehicle would subject the manufacturer to tort liability only for crashes caused by malfunctioning physical hardware[,] . . . malfunctions of the operating system caused by either programming error . . . or third-party hacking[,] . . . the manufacturer’s failure to adopt a reasonably safe design or to provide adequate warnings for ensuring safe deployment of the vehicle[,] . . . or the manufacturer’s failure to treat consumers and bystanders equally when designing the vehicle⁷⁸

In order to adequately allocate the risk of this innovation, a liability system is required in which the manufacturer is neither overexposed to liability, as this would discourage innovation, nor underexposed to liability, as this would undermine the purpose of liability law—namely the prevention of accidents and the compensation of victims.⁷⁹

Some argue that commercial aircraft have operated on autopilot for years, but the aircraft software is probably safe “because it does not rely on machine-learning algorithms” as autonomous car software does.⁸⁰ The car software may work well for the one hundred cases for which it has a programmed response. But what about the one case for which it has no programmed response?

75. Geistfeld, *supra* note 69, at 1694.

76. Wing, *supra* note 74, at 721.

77. *Id.*

78. Geistfeld, *supra* note 69, at 1694.

79. *Regulating Emerging Robotic Technologies in Europe, Guidelines on Regulating Robotics*, ROBOLAW 63 (Sept. 22, 2014), http://www.robolaw.eu/RoboLaw_files/documents/robolaw_d6.2_guidelinesregulatingrobotics_20140922.pdf [<https://perma.cc/YM5Q-D5VJ>].

80. Madrigal, *supra* note 70.

Another concern is hacking for a criminal purpose or weaponizing technology. For example, recently, in *Eichenwald v. Rivello*,⁸¹ defendant Rivello, knowing that plaintiff Eichenwald suffered from epilepsy, sent a tweet containing a strobe light with the intent to cause a seizure.⁸² Eichenwald argued that Rivello “use[d] the electronic capabilities of a computer as a weapon”⁸³ Since autonomous cars rely entirely on computer systems, hacking could have devastating results. After learning that hackers could wirelessly control things like acceleration, windshield wipers, and the radio, Fiat Chrysler recalled 1.4 million Jeep Cherokees.⁸⁴ During testing, researchers learned that car sensors could be confused by stickers on road signs, often placed by vandals. The stickers could cause the sensors to ignore a stop sign, which could result in a serious accident.⁸⁵

C. *Programming Moral Decision-Making*

One of the challenges of autonomous cars is programming the ability to make moral decisions. For example, if the car must choose between striking a garbage can at the curb, or a pedestrian jaywalking, the car will make that choice based upon its programming. Edmond Awad, a postdoc at the MIT Media Lab, was involved in a study to determine how humans make such decisions in order to guide programming decisions.⁸⁶ In the study, “participants were asked ‘How should autonomous vehicles be programmed?’” in response to several hypothetical situations.⁸⁷ He said that the study “is . . . trying to understand the kinds of moral decisions that driverless cars might have to resort to”⁸⁸ After studying responses from over “2 million online participants from over 200 countries,” some findings were expected, such as human life has precedence over animal life

81. *Eichenwald v. Rivello*, 318 F. Supp. 3d 766 (D. Md. 2018).

82. *Id.* at 769–70.

83. *Id.* at 775.

84. See Curtis Moldrich & Victoria Woollaston, *Driverless Cars of the Future: How Far Away are we from Autonomous Cars?*, ALPHR (Oct. 30, 2018), <http://www.alphr.com/cars/1001329/driverless-cars-of-the-future-how-far-away-are-we-from-autonomous-cars> [https://perma.cc/5PP7-5BX7] (evaluating the negative impacts hackers’ abilities to wirelessly control autonomous cars poses).

85. See *id.* (considering the consequences of autonomous cars misinterpreting traffic sign stickers).

86. *People Want Autonomous Cars to Save Young, Not Old People if Forced*, STAR ONLINE (Oct. 31, 2018), <https://www.thestar.com.my/tech/tech-news/2018/10/31/people-want-autonomous-cars-to-save-young-not-old-people-if-forced> [https://perma.cc/7JV2-ZKfQ].

87. *Id.*

88. *Id.*

and the lives of many take precedence over the life of an individual.⁸⁹ However, surprising was that the lives of young people take precedence over older people.⁹⁰

IV. LIABILITY AND LEGISLATION

Autonomous vehicles will have a broad impact on society, from commuting to insurance, which will impact how legislation is developed.⁹¹ In the event of a crash involving an autonomous vehicle, there are many directions to look to assess liability. We might look to the operator, the car manufacturer, the software manufacturer, or—in the case of smart cities—the government of that city.⁹² But when these various components are working together, how do we assign liability to one party over another and will current law adequately answer this question?

Volvo Car Group President and CEO Håkan Samuelsson announced in October 2015 that Volvo would “accept full liability whenever one of its cars is in autonomous mode.”⁹³ “While some academics assert that the manufacturers of AVs [autonomous vehicles] should be held liable for their crashes under a products liability model,⁹⁴ others claim that products liability would strangle the introduction of self-driving cars and advocate for

89. *Id.*

90. *Id.*

91. See generally Kurt M. Gosselin, *Navigating the Policy Landscape to Bring You Autonomous Vehicle Legislation to Your State*, 2015 N.Y.U. J. LEGIS. & PUB. POL'Y QUORUM 85 (2015) (examining the benefits autonomous cars will provide to society).

92. California law currently considers the “manufacturer” of an autonomous vehicle, for legal purposes, to be the entity that modifies the vehicle by installing autonomous technology. Cal. Veh. Code § 38750(a)(5) (West 2015). In the case of an intelligent road system that helps to control vehicles, the road designer, likely a government employee, could lead to government liability. Gary E. Merchant & Rachel A. Lindor, *The Coming Collision Between Autonomous Vehicles and the Liability System*, 52 SANTA CLARA L. REV. 1321, 1328 (2012).

93. Kirsten Korosec, *Volvo CEO: We Will Accept All Liability When Our Cars Are in Autonomous Mode*, FORTUNE (Oct. 7, 2015, 3:34 PM), <http://fortune.com/2015/10/07/volvo-liability-self-driving-cars/> (last visited April 30, 2020).

94. See generally Jeffrey K. Gurney, *Sue My Car Not Me: Products Liability and Accidents Involving Autonomous Vehicles*, 2013 U. ILL. J.L. TECH & POL'Y 247 (commenting on how current laws are ill equipped to deal with the challenges that new technology like autonomous vehicles present in assessing liability between driver and manufacturer when autonomous vehicles are involved in accidents.); Kevin Funkhouser, Note, *Paving the Road Ahead: Autonomous Vehicles, Products Liability, and the Need for a New Approach*, 2013 UTAH L. REV. 437, 452 (explaining how the introduction of autonomous vehicles will present new challenges for car manufacturers and their potential liability for accidents).

‘strict liability to autonomous car owners.’”⁹⁵ Current products liability law was not written with autonomous vehicles in mind and, therefore, may need to be revised to address issues specific to such vehicles.

Liability questions arise when a car is in a self-driving mode.⁹⁶ “Is the driver negligent for not taking control of the car prior to the accident?”⁹⁷ The answer to that would depend, in part, on whether there was a driver or merely an operator, based upon the degree of automation.⁹⁸ Perhaps the software designer would be liable because the program did not avoid the accident. In *Bookout v. Toyota Motor Corp.*,⁹⁹ a jury heard extensive testimony from embedded systems experts for the first time.¹⁰⁰ Plaintiffs argued the source code in Toyota’s electronic throttle system caused a September 2007 Oklahoma accident where plaintiff Jean Bookout was seriously injured and plaintiff Barbara Schwarz died—each receiving \$1.5 million from the jury, suggesting that juries will award damages for computer error.¹⁰¹ Should the car manufacturer bear the risk? The challenge there will be allocating liability since the software is embedded in the manufactured car.¹⁰²

While there is already a robust body of law pertaining to automotive and highway safety, it seems likely that those laws will need to be amended since they are based on the assumption that a human being is in control of the vehicle, rather than artificial intelligence. Given that “autonomous technology innovations are severely outpacing legislation designed to allow

95. Jack Boeglin, *The Costs of Self-Driving Cars: Reconciling Freedom and Privacy with Tort Liability in Autonomous Vehicle Regulation*, 17 YALE J. L. & TECH. 171, 174 (2015) (citing Sophia H. Duffy & Jamie Patrick Hopkins, *Sit, Stay, Drive: The Future of Autonomous Car Liability*, 16 SMU SCI. & TECH. L. REV. 453, 453 (2013)).

96. See Balough, *supra* note 14, at 7 (acknowledging liability as a key issue arising in self-driving car accidents).

97. *Id.*

98. See SAE International, SAE International Releases Updated Visual Chart for its “Levels of Driving Automation” Standard for Self-Driving Vehicles, SAE.ORG, (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> [https://perma.cc/X7D5-F3N7] (charting degrees of automation in self-driving cars).

99. *Bookout v. Toyota Motor Corp.*, 2013 WL 5596096, at *1 (D.C. Okla. Sept. 13, 2013).

100. See *id.* at *1 (deciding a case in which a vehicle made by Toyota was involved in an accident which led to severe injuries and death).

101. See *id.* (noting once after the award was announced, the parties reached a settlement to avoid punitive damages).

102. See *id.* (acknowledging discourse between experts on whether embedded systems in automated cars allocated liability).

for its use,”¹⁰³ lawmakers should be feeling pressure to address a new set of laws suited to driverless cars.

A. *State Law*

States are already taking steps to keep up with autonomous technology. Twenty-nine states have enacted or adopted laws pertaining to driverless cars.¹⁰⁴ “As growing numbers of states pass ‘a patchwork of rules’ pertaining to driverless cars, industry officials have grown concerned about inconsistencies between those rules and about their ability to manufacture autonomous vehicles that will comply with the laws of all fifty states,”¹⁰⁵ urging Congress to enact federal legislation to regulate the use of autonomous vehicles.¹⁰⁶

Two types of provisions appear repeatedly in state laws and pending legislation: (1) “operator” provisions, those which define the human who engages an automated vehicle as the “operator” of that vehicle, and (2) “override” provisions, those which require some degree of supervision and/or intervention on the part of the human occupants of automated vehicles in given scenarios.¹⁰⁷

“Traditional motor vehicle laws defined the term ‘operator’ to mean the individual actively controlling the vehicle—typically from the driver’s seat.”¹⁰⁸ Therefore, those laws will be inadequate to address autonomous vehicles.

103. Marcus E. Johnson, *The Drive for Autonomous Vehicles: Idaho’s Race To Catch Up*, 59 *ADVOC.* 28, 28 (2016).

104. See *Autonomous Vehicles | Self-Driving Vehicles Enacted Legislation*, NAT’L. CONF. STATE LEGISLATURES, (Oct. 9, 2019) <https://www.ncsl.org/research/transportation/autonomous-vehicles-self-driving-vehicles-enacted-legislation.aspx> [<https://perma.cc/J7DC-PE3Y>] (identifying Alabama, Arkansas, California, Colorado, Connecticut, Florida, Georgia, Illinois, Indiana, Kentucky, Louisiana, Maine, Michigan, Mississippi, Nebraska, New York, Nevada, North Carolina, North Dakota, Oregon, Pennsylvania, South Carolina, Tennessee, Texas, Utah, Virginia, Vermont, Washington, and Wisconsin, as well as Washington D.C. as states which have enacted legislation concerning driverless cars).

105. Pearl, *supra* note 9, at 45 (acknowledging the growing call for federal legislation).

106. See *id.* (acknowledging the growing call for federal legislation).

107. *Id.* at 47–48.

108. *Id.* at 48.

B. *Cities*

Technology lies not just in the cars, but with the infrastructure of the roads. For example, Daimler, BMW, and Audi spent \$3.1 billion for the Nokia Here mapping service, which is:

[L]aying the foundations for the next generation of mobility and location based services. For the automotive industry, this is the basis for new assistance systems and ultimately fully autonomous driving. Extremely precise digital maps will be used in combination with real-time vehicle data in order to increase road safety and to facilitate innovative new products and services.¹⁰⁹

“The types of advanced vehicles under development will interact with ‘smart cities’ that use state-of-the-art sensors to monitor and adapt to traffic flows in real time, accelerating the flow of people throughout the city.”¹¹⁰ But how will that impact liability? If the city has a programming error, or the internet connection is lost, there could be massive traffic jams or worse yet, multi-car crashes. While cities are developing the technology to be “smart,” they must also implement laws to address such technology.

C. *Semi-Autonomous and Autonomous Related Laws*

Semi-autonomous cars are those that use Driver-Assistance Systems (DAS), which are incorporated into conventional vehicles and are capable of taking over one or more functions of the dynamic driving task under certain operating conditions. Levels 0, 1, 2, and 3 Vehicles fall under this category. “These functions improve the interface between the driver and the vehicle in such a way as to provide better control or more convenient operation but do not fundamentally alter the roles of the driver and vehicle in executing the [driving task].”¹¹¹ Levels 1, 2, and 3 vehicles are not intended to operate fully autonomously, and thus, human supervision of these vehicles (and intervention when appropriate) is a critical component

109. Woollaston & Moldrich, *supra* note 15.

110. Zients & Holdren, *supra* note 33.

111. Crash Avoidance Metrics Partnership (CAMP) Automated Vehicle Research (AVR) Consortium, *Key Considerations in the Development of Driving Automation Systems*, NHTSA.GOV, <http://www-esv.nhtsa.dot.gov/Proceedings/24/files/24ESV-000451.PDF> [<https://perma.cc/82YT-HKEG>].

of their safe operation.¹¹²

“Historically, both criminal and civil liability for automobile accidents or traffic law infractions attached to the operator of a vehicle.”¹¹³ California’s law states that the “‘operator’ of an autonomous vehicle is the person who is seated in the driver’s seat, or, if there is no person in the driver’s seat, causes the autonomous technology to engage.”¹¹⁴ These laws seem to be “based on the belief that the person who presses the ‘start button’ should accept the consequences of what that entails. Thus, the captain should be responsible for her ship.”¹¹⁵

When it comes to override provisions, these laws appear to be rooted in a very significant assumption that human-driven cars are safer than autonomously-driven ones.¹¹⁶ These laws presume:

(1) human drivers will adequately supervise autonomous vehicles, (2) human drivers have the capacity to regain control of autonomous vehicles quickly and safely when necessary, and (3) human intervention is the safest option available (or at least not more dangerous than leaving control with the automated technology) if and when autonomous vehicles malfunction or encounter difficulties on the road.¹¹⁷

But override provisions do not make sense for levels 4 and 5 vehicles because neither of them (a) require human supervision or (b) have a way for humans to take control.¹¹⁸

What would be the case for fully autonomous vehicles in which the human driving element is eliminated? “A vehicle is autonomous in the sense that it can drive without human assistance (or indeed, any human in the vehicle at all).”¹¹⁹ “When the vehicle’s occupant is no longer executing the dynamic driving task, human driving error is no longer the cause of an accident.”¹²⁰

112. National Highway Traffic Safety Administration, *Preliminary Statement of Policy Concerning Automated Vehicles*, (2013) https://www.nhtsa.gov/staticfiles/rulemaking/pdf/Automated_Vehicles_Policy.pdf [<https://perma.cc/HJ3D-LCLE>].

113. Pearl, *supra* note 9, at 48.

114. CAL. VEH. CODE § 38750(a)(4) (West 2017).

115. Pearl, *supra* note 9, at 49.

116. Andrew Swanson, “*Somebody Grab the Wheel!*”: *State Autonomous Vehicle Legislation and the Road to a National Regime*, 97 MARQ. L. REV. 1085, 1113 (2014).

117. Pearl, *supra* note 9, at 58.

118. *Id.* at 64.

119. Geistfeld, *supra* note 69, at 1629.

120. *Id.*

“Instead, the manner in which the vehicle executed the driving task becomes the focus of inquiry.”¹²¹ “The vehicle, however, cannot be legally responsible for its performance (it is, after all, not truly autonomous), which leads to the question of who should be responsible for the vehicle’s operation: The consumer of the product (the owner and, potentially, users) or the manufacturer?”¹²² An important question in cases involving autonomous cars, “therefore, has been who, specifically, was in control of the vehicle at the time of the incident.”¹²³ This legal responsibility is totally different from those involving conventional or semi-autonomous vehicles.¹²⁴

Are human beings in all of these situations the “operators” of these vehicles? Thus far, states have answered that question with a resounding “yes.” . . . These types of provisions, however, raise two questions: (1) can human beings be held legally responsible for actions of autonomous vehicles driving in autonomous mode, and (2) if so, is this form of liability fair? With regard to the first question, under current laws, the answer seems to be “yes.”¹²⁵

In semi-autonomous vehicle cases, holding drivers liable for accidents makes sense, but in autonomous vehicles, it is not easy to hold the driver liable. If a vehicle experiences a system glitch in full autonomous mode and causes an accident, we cannot hold the driver liable, because in this case, a human is not the cause of accident or injury. “The problem, however, is that states with ‘operator’ provisions make *all* autonomous vehicle-related traffic or driving infractions strict liability offenses, much like the rest of the traffic and driving violations currently on the books in most states.”¹²⁶ Holding human “operators” liable for the actions of autonomous vehicles is extremely problematic because it is inconsistent with some of the most fundamental philosophical underpinnings of criminal law: the goals of retribution, deterrence, and rehabilitation.¹²⁷

With an autonomous vehicle like Google’s prototype, certainly, no objectives of punishment are served by holding the operator criminally liable for traffic violations. . . . The vehicle lacks a steering wheel, accelerator, and brake pedal. Therefore, the operator does not cause, nor has any opportunity to prevent,

121. *Id.*

122. *Id.*

123. Pearl, *supra* note 9, at 49.

124. *Id.* at 23.

125. *Id.* at 49–50.

126. *Id.* at 52.

127. Stephen J. Morse, *Inevitable Mens Rea*, 27 HARV. J. OF L. & PUB. POL’Y 51, 61–64 (2003).

the violation. In such a case, the person does not have any blameworthiness to punish; no one—the operator or society—is deterred because owners of a vehicle like Google's prototype can do nothing to prevent the violation; isolating the person will not provide any benefit to society; and no additional instruction could prevent the offense in the future.¹²⁸

Additionally, holding human operators strictly liable for the actions of their autonomous vehicles may actively deter people from using autonomous cars at all.¹²⁹

If humans are concerned that they may be charged for an accident or violation caused by a vehicle that (a) they do not have the ability to control and (b) they may not have even been present in at the time of the incident, owning and operating a driverless car is likely to be viewed as too risky by all but the most courageous (and amply insured) of us.¹³⁰

This would be a net loss for society because we would lose the extraordinary benefits that can come from greater use of autonomous vehicles.¹³¹

“Liability law serves the two main purposes of compensation and deterrence, that is, protecting the injured party by ensuring compensation and providing incentives for the ‘responsible’ person to take adequate measures to prevent the occurrence of damage.”¹³² In order to incentivize the manufacturer to make incremental improvements in safety design, “[t]he vehicle manufacturer is the adequate risk bearer[,]”¹³³ particularly in levels 4 and 5 vehicles.

Even though the vehicle keeper can take some measures to reduce the risk of malfunction of the vehicle, it is chiefly the manufacturer who can influence product safety through diligent design and construction and who can instruct the user about the product's risks. Manufacturers profit from the business of

128. Jeffrey K. Gurney, *Driving into the Unknown: Examining the Crossroads of Criminal Law and Autonomous Vehicles*, 5 WAKE FOREST J. L. & POL'Y 393, 417 (2015).

129. *Id.*

130. Pearl, *supra* note 9, at 54–55.

131. Gurney, *supra* note 128, at 402–03 (discussing the benefits of autonomous vehicles).

132. Melinda Florina Lohmann, *Liability Issues Concerning Self-Driving Vehicles*, 7 EUR. J. OF RISK REG. 335, 338 (2016), <https://www.cambridge.org/core/journals/european-journal-of-risk-regulation/article/liability-issues-concerning-selfdriving-vehicles/9363DA9F4173E5EA0F828C29D4EC7E2F> [<https://perma.cc/8HQ7-QPCP>].

133. *Id.*

selling automated vehicles and can transfer some of the costs back to consumers through higher vehicle prices.

....

... Manufacturers must make a business decision whether or not to invest in this type of vehicle innovation. If they do so, it is their duty to provide the expected safety, or else they will be faced with claims. The possibility of recourse against the manufacturer does not impede him from escaping liability if he proves that he was not able to detect the defect in conformity with state of the art at the time of placing his product on the market.¹³⁴

D. *Federal Law*

“[E]stablished by the Highway Safety Act of 1970[,]” the mission of the National Highway Traffic Safety Administration (NHTSA), part of the Department of Transportation (DOT), is to “achiev[e] the highest standards of excellence in motor vehicle and highway safety.”¹³⁵ The NHTSA achieves those standards “by setting and enforcing safety performance standards for motor vehicles and motor vehicle equipment, and through grants to state and local governments to enable them to conduct effective local highway safety programs.”¹³⁶ In connection therewith, it is responsible for developing safety standards for autonomous cars.¹³⁷

Congress may be helpful with respect to assigning liability as it has previously passed legislation clarifying that individuals can be held to contracts entered into by their electronic agents so that could be extended to self-driving cars.¹³⁸ While it is true that courts have not assigned legal personhood to robots,¹³⁹ Congress lent support for an agency

134. *Id.* at 338–39.

135. *About NHTSA*, NHTSA, <https://www.nhtsa.gov/about-nhtsa> [<https://perma.cc/RU8U-FT4M>].

136. *Who We Are and What We Do*, NHTSA, <https://one.nhtsa.gov/About-NHTSA/Who-We-Are-and-What-We-Do> [<https://perma.cc/4EXY-VVN4>].

137. John Markoff, *Google Car Exposes Regulatory Divide on Computers as Drivers*, NY TIMES (Feb. 10, 2016), <http://www.nytimes.com/2016/02/11/technology/nhtsa-blurs-the-line-between-human-and-computer-drivers.html> [<https://perma.cc/2SQU-D956>].

138. 15 U.S.C. § 7001(h) (2000) (“A contract or other record relating to a transaction in or affecting interstate or foreign commerce may not be denied legal effect, validity, or enforceability solely because its formation, creation, or delivery involved the action of one or more electronic agents so long as the action of any such electronic agent is legally attributable to the person to be bound.”).

139. Samir Chopra, *Computer Programs Are People, Too*, NATION, (May 29, 2014) <http://www.thenation.com/article/180047/computer-programs-arepeople-too> [<https://perma.cc/53DT-X8Q7>] (suggesting that legal personhood should be extended to robots much like it was

theory.¹⁴⁰ That could be helpful, as a popular approach to liability has been the law of agency rather than products liability, on the theory that the car is the agent of the operator.¹⁴¹ However, one hurdle might be that generally, tort law treats taxi drivers as the agents of the taxi company, not of the person paying the fare.¹⁴² It might take further revision to the law in order to make the car the electronic agent of the owner.

V. FUTURE OF AUTONOMOUS VEHICLES— NOT JUST CONSUMER AUTOMOBILES

The future of autonomous vehicles is not just consumer automobiles. Mikael Makinen, president of Rolls-Royce Marine, has predicted that “[a]utonomous shipping is the future of the maritime industry. As disruptive as the smart phone, the smart ship will revolutionise the landscape of ship design and operations.”¹⁴³ The *Sea Hunter* is a fully autonomous unmanned surface vessel christened in April 2016 by the U.S.

extended to corporations, and asking whether autonomous vehicles should “be treated like a pet or a child or something else?”).

140. See, e.g., Samir Chopra & Laurence White, *Artificial Agents and the Contracting Problem: A Solution via an Agency Analysis*, 2009 U. ILL. J.L. TECH. & POL’Y 363, 393 (advocating for the adoption of an “agency law approach to artificial agents [because it] would permit the legal system to distinguish clearly between the operator of the agent . . . and the user of the agent . . .”); Stephen T. Middlebrook & John Muller, *Thoughts on Bots: The Emerging Law of Electronic Agents*, 56 BUS. LAW. 341, 354 (2000) (“Given that we would turn to the law of agency in order to understand the relationship between a person and a human servant, it seems prudent to look to the same body of law to inform, although perhaps not to govern absolutely, the relationships between people and their software servants.”).

141. See generally *The Omnipotent Programmer: An Ethical and Legal Analysis of Autonomous Cars*, 15 RUTGERS J. L. & PUB. POL’Y 213, 253–84 (explaining how using the law of agency to hold the operator of an autonomous vehicle is a better solution than products liability because it would, for example, “allocat[e] the costs of victims injured by autonomous vehicles and continue to incentivize innovation in this area.”).

142. See *Montague v. Goolsby*, 237 F.2d 776, 776 (D.C. Cir. 1956) (asserting cab companies will be held liable for the acts of their taxidriver under the law of agency if there is sufficient evidence “to show that [the cab company] owned, maintained, operated or controlled the cab at the time of the accident for purposes of imposing financial responsibility.”); see also *Smith v. Deutsch*, 200 P.2d 802, 803 (Cal. Dist. Ct. App. 1948) (holding that the act of driving a cab for the benefit of a taxicab company is enough to create liability for the company for the actions or omissions of their agent, even if the driver is not officially a member of the company, but merely acting with apparent agency); *Ass’n of Indep. Taxi Operators v. Kern*, 13 A.2d 374, 377 (Md. 1940) (holding that unless evidence contrary exists, the cab driver is presumed to be the agent of the company); William D. Bremer, *Liability of Taxicab Company for Cabdriver’s Negligence*, in 41 Am. Jur. 2D Proof of Facts 239 § 1 (1985) (explaining how a cab company will be held liable for the accidents caused by the cab driver if sufficient proof is established showing the driver is the agent of the company).

143. Esa Jokioinen, *Introduction*, in REMOTE AND AUTONOMOUS SHIPS—THE NEXT STEPS 4 (2016).

Navy that looks for enemy submarines and underwater mines.¹⁴⁴ Also, in 2016, Rolls-Royce announced its autonomous cargo ship, also referred to as a drone ship,¹⁴⁵ that should be ready to cruise waters without a crew, allowing shipowners to “optimize operations and maximize profit.”¹⁴⁶ Without the cost and weight of a crew, the ship will burn less fuel and have more room for cargo.¹⁴⁷ While this may be the future of commercial shipping, it raises questions about how international treaties will govern these activities and where liability will fall if something goes wrong. After all, when these treaties were written, the standards of minimum manning and proper manning did not contemplate an unmanned vessel.¹⁴⁸

Similarly, duties assigned to the master of a ship¹⁴⁹ will need to be assigned elsewhere, whether to a remote operator, if the ship is considered to be a drone, or perhaps to the manufacturer or software developer if it is considered to be an autonomous vehicle. Further, the Convention on the International Regulations for Preventing Collisions at Sea (COLREGS) provides that every vessel must “at all times maintain a proper look-out by sight and hearing.”¹⁵⁰ Proponents of the autonomous technology will likely

144. Phil Stewart, *U.S. Military Christens Self-Driving ‘Sea Hunter’ Warship*, REUTERS (1:55 PM, Apr. 7, 2016), <https://www.reuters.com/article/us-usa-military-robot-ship-idUSKCN0X4214> [<https://perma.cc/383H-B8TS>].

145. *Rolls-Royce Reveals Future Shore Control Centre*, ROLLS-ROYCE (Mar. 22, 2016), <https://www.rolls-royce.com/media/press-releases/2016/pr-2016-03-22-rr-reveals-future-shore-control-centre.aspx> [<https://perma.cc/4TNS-9JBA>]; James Vincent, *Rolls-Royce is Partnering with Intel to Make Self-Driving Ships a Reality*, VERGE (2:18 PM, Oct. 15, 2018), <https://www.theverge.com/2018/10/15/17979252/self-driving-autonomous-ships-drones-intel-rolls-royce-partnership> [<https://perma.cc/BU74-P8CV>].

146. Danielle Sullivan Kaminski, *Who’s to Blame When No One is Manning the Ship?*, JDSUPRA (Oct. 4, 2016), <https://www.jdsupra.com/legalnews/who-s-to-blame-when-no-one-is-manning-38644/> [<https://perma.cc/WJM8-YHA9>].

147. *Id.*

148. See Int’l Mar. Org. [IMO], Res. A. 1047 (27), *Principles of Safe Manning*, at 5 (Nov. 30, 2011) (listing factors considered for determining safe manning guidelines, including the “size and type of ship,” and “cargo to be carried”). Under 46 U.S.C. § 8301(a), the United States has required all U.S. flagged vessels, subject to Coast Guard inspection, to carry a minimum number of crew. See 46 U.S.C. § 8301(a) (2018) (establishing crew minimums according to vessel weight). However, this section does not contemplate an unmanned vessel. In addition, the Carriage of Goods by Sea Act (COGSA) requires a ship to be “seaworthy” before a voyage commences, which includes being properly manned. Carriage of Goods by Sea Act of 1936 § 3(1)(a), 46 U.S.C. § 30705(a)(1).

149. See The International Convention for the Safety of Life at Sea annex, reg. 11(c), Nov. 1, 1974, 32 U.S.T. 47, 1184 U.N.T.S. 2 (creating obligations for masters to report vessel accidents and defects).

150. Convention on the International Regulations for Preventing Collisions at Sea art. IX, pt. B, § 1, r. 5, Oct. 20, 1972, 28 U.S.T. 3449, 1050 U.N.T.S. 16.

argue that advanced radar and sonar installed on the autonomous ship will satisfy the COLREGS requirement and might be better than human monitoring due to the lack of human fatigue.¹⁵¹

Another off-highway application for autonomous technology is the mining business. Mines in Western Australia are experiencing great success using autonomous trucks for round-the-clock mining operations, achieving a 20% improvement in productivity.¹⁵² According to Sandvik Mining's Asia Pacific business line manager for load and haul, Malcolm Mauger, "[w]e're in a situation now where mines are going really deep, we've got hot temperatures, you don't want to have your people exposed to it and there's also emissions."¹⁵³ Fortescue Metals Group Chief Executive Elizabeth Gaines said that "[s]ince the introduction of the first [autonomous haulage system] AHS truck . . . in 2012, AHS trucks have safely travelled over 24.7 million kilometres."¹⁵⁴ However, in 2019, two AHS trucks at the mine collided after Fortescue's control center lost Wi-Fi coverage, demonstrating another risk of autonomous vehicles.¹⁵⁵ On another continent, at the Syama underground goldmine in Mali, Africa, resolute managing director John Welborn estimated twenty-two pieces of automated equipment would increase safety and cut mining costs up to 30%.¹⁵⁶ It will be important to establish rules and regulations not only in the consumer operator context but also for industrial uses of autonomous technology.

151. Kaminski, *supra* note 146.

152. *Autonomous Trucks at Gold Mine for Australia*, SMMT (Oct. 25, 2017), <https://www.smmmt.co.uk/2017/10/autonomous-trucks-gold-mine-australia/> [<https://perma.cc/PQ6L-X25G>].

153. Jarrod Lucas, *Aussies Have Eyes on World's First Fully Autonomous Underground Gold Mine in Africa's Mali*, ABC NEWS (3:28 PM, Aug. 8, 2018), <https://www.abc.net.au/news/2018-08-09/worlds-first-fully-autonomous-underground-mine-in-africa/10090932> [<https://perma.cc/7KMP-VG45>].

154. Cecilia Jamasmie, *Not So Autonomous: Wifi Outage Results in Driverless Truck Crash at Fortescue Mine*, MINING.COM (5:21 AM, Feb. 15, 2019), <https://www.mining.com/driverless-trucks-not-flawless-two-crash-fortescue-mine-australia/> [<https://perma.cc/27B4-BMXS>].

155. *Id.*

156. Lucas, *supra* note 153.

VI. CONCLUSION

“Autonomous and connected vehicles have the potential to transform lives and the global economy, and we need an all-hands effort to ensure that the United States remains at the leading edge of developing and testing this technology.”¹⁵⁷ While that may be true, we still have a long way to go to establish guidelines for liability. State lawmakers have stepped up with some legislation, but ultimately, we are going to need a federal law to regulate the use of and liability for autonomous vehicles. In many European countries, a practical solution is already in place, holding the vehicle owner strictly liable for the operational risk of autonomous systems.¹⁵⁸ “Compensation of the victim is ensured by the possibility of taking action against the holder of the self-driving car or preferably against his mandatory insurer.”¹⁵⁹ Furthermore, this system “requires insurers to be able to take recourse against the vehicle manufacturer in case the automated vehicle fault for the accident was indeed defective.”¹⁶⁰ Additionally, lawmakers seeking passage of fair and practical driverless car laws must prudently “tailor those laws to the specific types of autonomous technologies at issue”¹⁶¹ as “[p]artially autonomous cars raise an entirely different set of regulatory challenges than fully autonomous cars and thus should be treated differently under the law.”¹⁶² The biggest challenge will be whether federal lawmakers can act quickly enough to pass federal legislation in advance of the widespread use of autonomous vehicles. Otherwise, “the question of calibrating and maintaining all that equipment would be entrusted to people like me, who don’t wash their car for months at a time.”¹⁶³

157. Zients & Holdren, *supra* note 33.

158. Lohmann, *supra* note 132, at 336.

159. *Id.* at 339.

160. *Id.* at 338.

161. Pearl, *supra* note 9, at 72. It has been suggested that the type of liability for automatic vehicle accidents “depends on (a) the type of autonomous car being driven and (b) the nature of any traffic infraction or injury that occurs.” *Id.* at 50.

162. *Id.* at 72.

163. Madrigal, *supra* note 70.