UNIVERSITY OF MIAMI SCHOOL OF LAW
RESEARCH PAPER

WINNING THE IMITATION GAME:

SETTING SAFETY EXPECTATIONS FOR AUTOMATED VEHICLES

WILLIAM H. WIDEN[*] *AND PHILIP KOOPMAN*[**]

This essay suggests that legislatures amend existing law to create a new legal category of "computer driver" to allow a plaintiff to make a negligence claim against an automated vehicle manufacturer for loss proximately caused by any negligent driving behavior exhibited by the driving automation systems which it produced. Creating this new legal category will allow a status quo approach to attribution and allocation of liability, including permitting defendants to take advantage of contributory negligence and comparative fault rules. Creation of the category also allows for continued functioning of the structure of our existing liability laws and regulations for motor vehicles in which the federal government regulates automotive equipment, and the state governments regulate drivers, driving, licensing and registration.

The law often needs a statute to address changes in technology for which existing law understandably fails to provide answers. Creating the category of "computer driver" avoids the conceptual difficulties caused by an uncertain boundary between regulation of equipment and regulation of drivers—the very disruptive situation created by the new technologies of driving automation in which computer drivers replace human drivers. It prevents shifting regulatory responsibility for liability attribution to the federal government and away from state governments when the human driver is replaced by equipment in the form of certain sophisticated driving automation systems which we capture with the legal fiction of a "computer driver."

---

[*] William Widen is a Professor of Law at the University of Miami School of Law and an elected member of the American Law Institute. A graduate of the Harvard Law School, he is a corporate lawyer by training. His current research focuses on regulation of autonomous vehicles. Contact him at wwiden@law.miami.edu.

[**] Phil Koopman splits his time between teaching safety critical embedded systems at Carnegie Mellon University and helping companies around the world improve the quality of their embedded system software. He was the lead technical author of the UL 4600 standard, and authored the book HOW SAFE IS SAFE ENOUGH? MEASURING AND PREDICTING AUTONOMOUS VEHICLE SAFETY (2022). Contact him at koopman@cmu.edu.

I. INTRODUCTION

LAWMAKERS have largely ignored the difficult problem of how best to attribute and allocate financial responsibility for losses from accidents, collisions and other incidents involving automated vehicles.[1] Industry advocates argue that existing liability rules suffice to sort out claims for losses in automated vehicle incidents as a reason against amending existing law to accommodate new automation technology.[2] This argument, however, amounts to nothing more

[1] Though largely ignored by legislatures, the opposite is true for law reviews. The literature has a plethora of essays and articles which deal with the topic of liability attribution and allocation for automated vehicle accidents, suggesting different approaches. A recent example is Cassandra Burke Robertson, *Litigating Partial Autonomy*, Case Legal Studies Research Paper No. 4 (Mar. 2023), 109 IOWA LAW REVIEW (forthcoming 2023), available at SSRN: https://ssrn.com/abstract=4392073 [hereinafter *Robertson*]. This essay does not attempt a survey of the extensive literature. Interesting articles include many written as law student notes.

[2] Law reviews have considered this issue. *Compare* Jeffrey K. Gurney, *Sue My Car Not Me: Products Liability and Accidents Involving Autonomous Vehicles*, 2013 U. ILL. J.L. TECH. & POL'Y 247 (rev. 2015)(concluding that current products liability law will not be able to adequately assess responsibility to the party that caused the accident) *with* Jeremy Levy, *No Need to Reinvent the*

than a responsibility and cost avoidance strategy. Current events[3] highlight the urgent need for new legislation rather than continued delay and dodging.

The need for new legislation should surprise no one because the law often requires a statutory fix to address changes in technology for which existing law understandably fails to provide a clear answer.[4] Legal uncertainty inheres in any exercise trying to predict how courts will apply existing tort principles and rules to emerging and advanced technologies such as driving automation systems.

The questions of liability attribution and allocation urgently need legislative answers because incidents of driving automation system failures continue to pile up[5] as vehicle manufacturers test and deploy on our highways and roads.[6] For example, Mercedes Benz plans

---

Wheel: Why Existing Liability Law Does Not Need to Be Preemptively Altered to Cope with the Debut of the Driverless Car, 9 J. Bus. Entrepreneurship & L. 355, 384 (2016) (arguing that the current strict liability system is well suited to adapt to new technologies—"if it ain't broke, don't fix it").

[3] Brad Templeton, *Cruise Cars Crash Into San Francisco Muni Bus And Tangle In Fallen Trolley Wires*, FORBES.COM (Mar. 24, 2023, 05:28pm EDT), https://www.forbes.com/sites/bradtempleton/2023/03/24/cruise-cars-crash-into-san-francisco-muni-bus-and-tangle-in-fallen-trolley-wires/?sh=76fa29e837bd.

[4] *See* Tracy Hresko Pearl, *Compensation at the Crossroads: Autonomous Vehicles & Alternative Victim Compensation Schemes*, 60 WM. & MARY L. REV. 1827, 1855 (2019) [hereafter *Pearl*]. A classic example of the need for legislation in response to technology development are the federal and state statutes passed to clarify the status of an electronic "signature" for purposes of the statutes of frauds. *Compare* The Electronic Signatures in Global and National Commerce Act (ESIGN, Pub. L. 106–229, 114 Stat. 464, enacted June 30, 2000, 15 U.S.C. ch. 96) *with* the Uniform Electronic Transactions Act, recommended for enactment in all states by the National Conference of Commissioners on Uniform State Laws in 1999.

[5] See Templeton, *supra* note 3. While Cruise prototype deployments provide recent examples of failures, incidents have occurred with technology produced by others, including Tesla.

[6] Michael Liedtke, *Robotaxis aim to take San Francisco on ride into the future*, WASH. POST (April 5, 2023 12:07 a.m. EDT)(describing deployments in multiple cities by various driving automation system companies), https://www.washingtonpost.com/business/2023/04/05/driverless-cars-robotaxis-waymo-cruise-tesla/66ea4468-d367-11ed-ac8b-cd7da05168e9_story.html.

deployment of Level 3[7] vehicles in Nevada later this year.[8] Cruise has sought permission to expand its testing of Level 4[9] robotaxis from San Francisco to operate throughout the state of California.[10]

This essay adopts the strategy of creating a new statutory legal category of "Computer Driver" for application to certain sophisticated driving automation systems.[11] Creation of such a category provides a natural way to assign liability for automated vehicle accidents[12] within an existing legal framework in which the federal government regulates automotive *equipment* and the state governments

---

[7] "Level 3" refers to a level of driving automation technology described in the taxonomy of terms in SAE J3016 in which the Computer Driver is tasked with reacting to all potentially dangerous roadway objects and events that might be encountered during normal use. *See* SAE INT'L, TAXONOMY AND DEFINITIONS FOR TERMS RELATED TO DRIVING AUTOMATION SYSTEMS FOR ON-ROAD MOTOR VEHICLES J3016_202104 (2021) [hereinafter J3016:2021], https://www.sae.org/standards/content/j3016_202104/.

[8] Ron Stumpf, *Mercedes-Benz Gets Approval to Deploy Level 3 Driving Tech in Nevada*, THEDRIVE.COM (Jan 6. 2023, 4:36pm EST), https://www.thedrive.com/news/mercedes-benz-gets-approval-to-deploy-level-3-driving-tech-in-nevada.

[9] *See* J3016:2021.

[10] Scooter Doll, *California may soon see a lot more driverless robotaxis on the road from GM's Cruise*, ELECTREC (Mar. 21, 2023, 8:44am PT), https://electrek.co/2023/03/21/california-more-driverless-robotaxis-on-road-gms-cruise/. In light of the recall of the Cruise robotaxi fleet, the status of the permit for statewide testing remains uncertain. *See* David Shepardson, *GM's Cruise recalls 300 self-driving vehicles to update software after bus crash*, REUTERS (Apr. 7, 2023, 2:40 PM EDT), https://www.reuters.com/technology/gm-self-driving-unit-cruise-recalls-300-vehicles-after-crash-2023-04-07/.

[11] *See* ANNEX A for a definition of Computer Driver. We determine whether a driving automation system is a "Computer Driver" by reference to control of steering on a sustained basis because we associate the delegation of steering on a sustained basis by a Human Driver to a Computer Driver as strongly correlated with the dangerous situation of automation complacency. *See, e.g.*, Nikol Figalova, et al., *Fatigue and mental underload further pronounced in L3 conditionally automated driving: Results from an EEG experiment on a test track*, IUI '23 COMPANION: COMPANION PROCEEDINGS OF THE 28TH INTERNATIONAL CONFERENCE ON INTELLIGENT USER INTERFACES (Mar. 2023), https://dl.acm.org/doi/10.1145/3581754.3584133.

[12] We prefer use of a negligence standard rather than assigning liability by using warranty or fraud claims because it most closely resembles traditional ways in which a plaintiff seeks to recover for loss in a vehicle accident. *Compare with Robertson*, *supra* n.1 at 59 (advocating for use of warranty and fraud claims as more accessible to judges and juries). Negligence is an even more accessible avenue for recovery in our view. Robertson identifies many problems with existing liability rules as applied to driving automation systems.

regulate *drivers*, *driving*, *licensing* and *registration*.[13] It avoids the conceptual difficulties caused by an uncertain regulatory boundary between equipment and drivers—the very disruptive situation created by the new technologies of driving automation in which "computer drivers" (nothing more than a sophisticated type of equipment) replace human drivers in taxis and other vehicles.[14]

The scope of this essay confines itself to recommending creation of a new statutory legal category of Computer Driver, using the category to define a form of negligence for a machine, and then designating the "Manufacturer" of the Computer Driver as a "Responsible Party" having financial responsibility for loss proximately caused by Computer Driver negligence when the driving automation system is engaged. We address important questions about the parameters of human contributory negligence and comparative fault for

[13] Matthew T. Wansley, *Regulating Automated Driving*, 73 EMORY L. J. (forthcoming 2023)(describing allocation of regulatory responsibility between federal and state regulators), at p. 37 in SSRN Apr. 19, 2023 ver., https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4190688.

[14] Observers have suggested various analogies to use for automated vehicle liability, including elevators, autopilot systems and human beings. *See, e.g.*, Stephani R. Johnson, *Autonomous Vehicles and Emerging Tort Implications*, 9 NAT. L. REV. [No. 101](Apr. 11, 2019)(summarizing different approaches), https://www.natlawreview.com/article/autonomous-vehicles-and-emerging-tort-implications. One student author has suggested using horse accidents as appropriate analogy. 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 (2018). *See also* K.C. Webb, *Products Liability and Autonomous Vehicles: Who's Driving Whom?*, 23 RICH. J.L. & TECH. 9, 33-37 (2016)(suggesting tort law adopt a "reasonable car" standard for liability), http://jolt.richmond.edu/2017/05/13/volume23_issue4_webb/. The problem with the "reasonable car" standard is that it would hold a manufacturer liable "only when the car does not act in a way that another reasonable AV would act." This misses the goal, and advertised promise, of driving automation technology to replace human drivers by producing an automated vehicle that imitates or exceeds the performance of an attentive and unimpaired human driver. Using this standard would require an impossible data driven comparison to the performance of similarly situated automated vehicles, especially when having to take into account that automated vehicles from different manufacturers will be deployed in diverse operational environments for the foreseeable future. It would also enable a potential outcome in which AVs much more dangerous than human drivers would be considered "reasonable" if that is the best the industry can do.

interactions between occupants[15] of an automated vehicle with a Computer Driver in a companion essay in progress.[16]

II. THE IMITATION GAME FOR COMPUTER DRIVERS

The strategy taken in this essay is to determine negligence based on whether a Computer Driver successfully imitates the risk management outcomes achieved by a hypothetical "reasonable man"[17] as the law uses that concept in determining negligence for a Human Driver.[18]

GM's Cruise self-driving unit develops driving automation systems to replace taxi drivers with "Computer Drivers." It tests them

---

[15] The scope of "occupants" is broader than the category of "Human Driver" because some automated vehicle designs may not have steering wheels, brakes and other equipment to allow for "driving" but may nevertheless contain an urgent egress feature which a non-driver occupant might activate in a perceived exigent circumstance.

[16] We believe contributory negligence is best managed by clear rules which set forth the limited duties of occupants of automated vehicles to intervene to assert control over a vehicle being driven by a Computer Driver. Establishing negligence liability for a new legal category of Computer Driver (the subject of this essay) is the pre-requisite for considering the parameters of contributory negligence and comparative fault. A legal structure for addressing contributory negligence and comparative fault requires addressing situations in which a Human Driver and a Computer Driver might share responsibilities for driving safety or alternate performing the role of primary vehicle driver. *See, e.g.*, *Robertson*, *supra* note 1 at 42. The liability mitigation strategy used by vehicle manufacturers involves blaming the human for every mishap while absolving the technology. *See* Madeleine Clare Elish, *Moral Crumple Zones: Cautionary Tales in Human - Robot Interaction*, 5 ENGAGING SCI. TECH, & SOC'Y 40 (2019).

[17] We sometimes use the masculine reasonable "man" rather than the preferred gender-neutral term reasonable "person" because legal discourse and case law often still refers to the negligence standard by a masculine reference. Any new legislation ought to use gender neutral terms when possible, without sacrificing clarity.

[18] We focus on the general case of an ordinary attentive and unimpaired human driver of a private automated vehicle. An automated vehicle used as a common carrier (which, for example, includes a ride sharing service by statute in California) would be held to a higher standard of care by virtue of its use. Similarly, different liability rules would apply to automated vehicles used as emergency vehicles. We do not expect Manufacturers to create three different models of automated vehicles for different uses. However, a Manufacturer might declare that a particular model or driving automation system is not suitable for certain uses—such as emergency vehicles for which the system has not been trained.

in San Francisco without back-up safety drivers.[19] A successful driving automation system in a robotaxi application deploys a Computer Driver that *imitates* (or exceeds) the driving safety performance outcomes we expect of an attentive and unimpaired Human Driver in various scenarios encountered on the road.[20]

A Computer Driver wins this "imitation game"[21] in an actual driving scenario when it meets or exceeds this performance standard.[22] If a Computer Driver always wins the imitation game during its operation, overall road safety would improve because attentive and unimpaired Human Drivers do not engage in risky behaviors such as drinking or texting while driving. We cannot conclude,

---

[19] Like most other industry players, Cruise does not follow the industry 's own safety standard which contemplates using safety drivers during testing. *See* SAE INT'L, GUIDELINES FOR SAFE ON-ROAD TESTING OF SAE LEVEL 3, 4, AND 5 PROTOTYPE AUTOMATED DRIVING SYSTEMS (ADS) J3018_201503J3018 (2015), https://www.sae.org/standards/content/j3018_201503/ (available for purchase; on file with the authors).

[20] In the taxonomy of SAE J3016, a Level 5 vehicle is designed to perform in all road scenarios, but such a vehicle is impracticable in the near- to mid-term future. In a Level 3 or Level 4 vehicle, the driving automation system is designed to perform in a set of limited scenarios knowns as an "operational design domain" (ODD). Vehicles at Level 3 and above have an ADS or automated driving system which functions as a Computer Driver. Level 2 automation features perform steering on a sustained basis and, for this reason, ought to be treated as Computer Drivers as well. An uncrewed robotaxi is a Level 4 vehicle. (Strictly speaking, SAE J3016 levels apply to features rather than vehicles. We use the common shorthand phrase "Level x vehicle" to mean "a vehicle equipped with a Level x feature.")

[21] We use the phrase "imitation game" to draw a parallel to the work of Alan Turing, discussed in the next section of this essay. *See infra* text accompanying note 42. Our use of Turing's concept of an "imitation game" differs from the application of this concept to analyze whether Level 2 vehicles induce potentially adverse effects in human drivers. *See* Ennio Cascetta, Armando Cartenì, & Luigi Di Francesco, *Do autonomous vehicles drive like humans? A Turing approach and an application to SAE automation Level 2 cars*, 134 TRANSP. RESEARCH PART C: EMERGING TECH. 103499 (2022), https://doi.org/10.1016/j.trc.2021.103499.

[22] To be clear, we are not suggesting that a Computer Driver must behave exactly like any specific human, including inaccurate or sloppy driving technique in normal driving. Rather, any mishaps and driving rule violations should be no worse than the type and frequency one would expect of competent, unimpaired human drivers in various scenarios, and preferably better. Moreover, the role that any unsafe driving behavior might have played in contributing to a mishap should be treated comparably under the law regardless of whether the driver is a human or a computer.

however, that a Computer Driver is safer than a Human Driver by simply noting that a Computer Driver does not drink or text and drive.

Computer Drivers exhibit behavior that is brittle in the face of novel situations for which they were not previously trained, and sometimes perform as if they lack common sense. Therefore, they are prone to making mistakes that a Human Driver might characterize as "stupid" due to failure to react reasonably to a situation not specifically addressed by their designers in advance of deployment by training a neural network or anticipating edge case scenarios. Nonetheless, it is incumbent on designers to ensure that safety-relevant scenarios have been addressed well enough to deploy an acceptably safe system.

Computer Drivers will be imperfect, making different mistakes than people would. It is not necessary to demand a Computer Driver be perfect. It is, however, reasonable to hold Computer Drivers accountable for at least meeting the same standard of driving behavior safety that applies to Human Drivers.

One way to look at the question of how safe a Computer Driver must be is to consider the frequency with which the Computer Driver loses the imitation game.

Note that use of the "imitation game" framework helps illuminate two very different aspects of the legal system. When used in an individual accident case, the question of whether the Computer Driver won or lost the imitation game answers the question of liability. A loss results in negligence liability. A court could use the imitation game model to instruct a jury tomorrow. No additional scientific or statistical data would be necessary, nor even help, because the liability question that needs answering is the same one answered every day in courts for Human Drivers. The legal system already knows how to do this.

The frequency with which a Computer Driver loses the imitation game is an entirely different matter. We can use the imitation game framework to answer the question of whether a Computer Driver is safer than average Human Drivers, at least in theory, by comparing the relative frequencies of imitation game losses to losses in accidents with Human Drivers. But to date no convincing and statistically meaningful data allows us to make this calculation. We know how to describe a positive risk balance in terms of relative frequencies of imitation game losses versus losses with Human Drivers, but we cannot yet make the calculation because we do not yet have sufficient data to do so.

The inability to make the calculation poses a problem for safety regulation and answering the important question of when a Computer Driver is safe enough to deploy at scale, but these data difficulties do not impact a liability calculation. Even if one could demonstrate that Computer Drivers were, on average, safer than Human Drivers, this fact in no way could absolve a Computer Driver from liability in an individual accident case. A very safe Human Driver may get a reduction in her insurance premium, but she does not get a free pass due to all the crashes she avoided if she later hits and kills a pedestrian due to negligence. General statistics do not influence liability in the individual case.[23]

The frequency with which a Computer Driver loses the imitation game, and the severity of losses which ensue, determines whether the deployment of automated vehicles creates a positive risk balance for society.[24] Even if 94% of fatal accidents for conventional vehicles were primarily caused by driver error (they are not), [25] that fact would reveal nothing useful about relative safety of automated vehicles until you know the frequency with which a Computer Driver loses the imitation game, which might conceivably result in a higher mishap rate than Human Drivers. A Computer Driver may lose the

[23] For example, if deployment of automated vehicles reduced annual traffic fatalities in the United States from 40,000 to 10,000, this dramatic improvement in overall safety would not excuse a Computer Driver from liability for any of the remaining 10,000 fatalities if the Computer Driver proximately caused the fatality by losing the imitation game. This no different than a hypothetical situation in which human drivers might become safer due to better driver training, societal change that reduced occurrences of driving under the influence, and improved road infrastructure that similarly reduced crashes – human drivers would still be held individually accountable for crashes due to negligence.

[24] Some researchers suggest using imitation learning techniques to enable robots to imitate expert human drivers. Dorsa Sadigh, *Influencing Interactions between Human Drivers and Autonomous Vehicle*s, 49 THE BRIDGE, NATIONAL ACADEMY OF ENGINEERING 48 (Winter 2019). One goal is to understand how driving interactions between automated vehicles and human drivers might influence safer traffic flow dynamics. Automated Vehicle behaviors which influence the behavior of human drivers have the potential to contribute to a positive risk balance. To our knowledge, this research program has not advanced to a stage which can make concrete recommendations for implementation. Merely developing a metric to identify differences between normal Human Drivers and Computer Drivers is insufficient to ensure safety.

[25] In fact, industry advocates wrongly claim that human error causes 94% of fatal accidents. *See, e.g.*, Don Kostelec, *The 94% Error: We Need to Understand the True Cause of Crashes*, STREETSBLOG USA (Oct. 14, 2020) (noting that the industry claim is not true), https://usa.streetsblog.org/2020/10/14/the-94-solution-we-need-to-understand-the-causes-of-crashes/.

imitation game for a variety of reasons, including the failure of the automated driving system to formulate and implement appropriate object and event detection and responses.[26]

III. LOSING THE IMITATION GAME

In testing and limited deployments in the real world, the Computer Driver does not always win the imitation game. Cruise taxis recently caused several disturbing incidents in California which suggest imitation game losses in two actual and unremarkable road scenarios: a Cruise taxi rear-ended a municipal bus for no apparent reason in perfect weather conditions;[27] and, multiple Cruise taxis ignored safety tape placed near downed tree limbs and powerlines, with the robotaxis driving through the tape and over the wires, also for no apparent reason.[28] One headline read: "Cruise DMV Crash Report Suggests Their Car At Fault In Hitting Bus." [29]

This headline identifies a key unanswered legal question for the driving automation systems industry: Can an automated vehicle be at fault?[30] The correct answer is that an automated vehicle can be at

---

[26] Object and event detection and response (or OEDR) is defined in J3016's taxonomy for discussing vehicle automation. We should expect imitation game loses in edge cases and unusual situations which an automated vehicle design team failed to anticipate, but which might in aggregate result in enough failures to present undue risk.

[27] The entire Cruise robotaxi fleet has been recalled based on this incident. *See GM Cruise recalls 300 robotaxis after crash involving bus*, ASSOC. PRESS (Apr. 7, 2023, 8:30am CT), https://www.msn.com/en-us/news/us/gm-cruise-recalls-300-robotaxis-after-crash-involving-bus/ar-AA19Ay8n.

[28] Brad Templeton, *Cruise Cars Crash Into San Francisco Muni Bus And Tangle In Fallen Trolley Wires*, FORBES.COM (Mar. 24, 2023, 05:28pm EDT), https://www.forbes.com/sites/bradtempleton/2023/03/24/cruise-cars-crash-into-san-francisco-muni-bus-and-tangle-in-fallen-trolley-wires/?sh=76fa29e837bd. The mandatory crash reports filed with regulators do not attempt to shift blame to another road user. Had the robotaxi been occupied, and the downed powerlines active, a robotaxi occupant could have been electrocuted.

[29] Brad Templeton, *Cruise DMV Crash Report Suggests Their Car At Fault in Hitting Bus*, FORBES.COM (Mar 31, 2023,10:13am EDT), https://www.forbes.com/sites/bradtempleton/2023/03/31/cruise-dmv-crash-report-suggests-their-car-at-fault-in-hitting-bus/?sh=722838423839.

[30] Some may assume that an automated vehicle has no fault in an accident unless a plaintiff can prove a pre-existing defect in the vehicle. *See, e.g.*, Jeremy Levy, *No Need to Reinvent the Wheel: Why Existing Liability Law Does Not Need to Be Preemptively Altered to Cope with the Debut of the Driverless Car*, 9 J. Bus. Entrepreneurship & L. 355, 384 (2016)[Pepperdine Univ.]. For the

fault. It is at fault each time its Computer Driver loses a round of the imitation game. The law can successfully adapt to a world full of Computer Drivers if a Computer Driver is found negligent each time it loses a round of the imitation game in a way that causes harm, if a reasonable Human Driver would have avoided causing that harm.

Finding a Computer Driver negligent for losing the imitation game is no different than finding a Human Driver negligent for failing to imitate a "reasonable driver" standard of safety. The standard is an objective one.[31] The law expects an actual Human Driver to perform the same way as a hypothetical attentive and unimpaired reasonable man would behave when driving a vehicle. The law can easily apply the same objective standard to evaluate the performance of a Computer Driver.[32]

The natural follow-up to the "fault" question presents itself. If a Computer Driver can have negligence liability when it loses the imitation game, then who is the party responsible for any losses proximately caused by the Computer Driver? The answer to this question is that law should treat the manufacturer of the Computer Driver as the legal person with financial responsibility for losses proximately caused by negligent computer driving.

Existing law does not clearly produce these outcomes. To promote fairness, certainty and judicial economy, legislatures should amend state laws to expressly acknowledge the possibility of a claim against a Computer Driver for negligence and to make the

---

reasons given in this essay, that assumption is incorrect when the law uses a traditional objective negligence standard to evaluate the performance of a Computer Driver.

[31] *See, e.g.*, RESTATEMENT (SECOND) OF TORTS s. 283, cmt. c (Am. Law Inst. 1965) (noting that "[T]he standard which the community demands must be an objective and external one, rather than that of the individual judgment, good or bad, of the particular individual").

[32] Driving performance measured by comparison with an attentive and unimpaired human driver is not the same as the type of driving performance for equipment regulated by NHTSA. For federal regulation "[a][performance] standard is objective if it specifies test procedures that are 'capable of producing identical results when test conditions are exactly duplicated' and performance requirements whose satisfaction is 'based upon the readings obtained from measuring instruments as opposed to the subjective opinions.'" Stephen K. Wood, et al., *The Potential Regulatory Challenges of Increasingly Autonomous Motor Vehicles*, 52 SANTA CLARA L. REV. 1423, 1452 (2012) (quoting Chrysler Corp. v, Dept. of Transp., 472 F2d 659, 675-76 (1972)). Performance by a Computer Driver is determined by reference to a hypothetical reasonable driver and not a repeatable scientific test.

manufacturer of the Computer Driver responsible for losses proximately caused by negligent computer driving for the reasons explained below. Such an amendment provides a natural accommodation for new technology while causing minimal displacement of existing law and legal concepts.

IV. REASONS FOR A CATEGORY OF COMPUTER DRIVER NEGLIGENCE WHICH CREATES MANUFACTURER LIABILITY

A. The Legal Category of "Computer Driver" Integrates Easily with Existing Laws and Regulatory Frameworks

Introducing the legal fiction of a Computer Driver and applying negligence liability to the actions of the Computer Driver for which the Manufacturer has financial responsibility requires the fewest changes to existing law needed to produce equitable, fair, and just results consistent with appropriate incentives for Manufacturers to create safe products.

The Legal Category of "Computer Driver" Integrates Easily with Existing Tort Law Doctrines and Principles

Many courts hold that violation of a traffic statute or ordinance applicable to a negligence action is negligence *per se*.[33] Other courts arrive at a similar substantive result by holding that a violation creates a presumption of negligence which a defendant may rebut by showing an excuse.[34] In some states a violation of an ordinance (as distinguished from violation of a statute) is at most evidence of negligence.[35]

Using the legal fiction of a Computer Driver does not require any adjustment to accommodate these state law variations. If a Computer Driver runs a red light or fails to stop at a stop sign, for example, the legal consequence of this violation by a Computer Driver is treated the same as the state law would treat a similar violation by a Human Driver.

Moreover, using the legal fiction of a Computer Driver makes a wide range of situations readily compatible with the use of judges and juries as finders of fact. They might reasonably have

---

[33] RESTATEMENT (SECOND) OF TORTS § 288B Effect of Violation, cmt. 2 & Rptr. Notes (1965).

[34] *Id*.

[35] *Id*.

considerable driving domain expertise that they can apply to interpreting what a "reasonable man" driver ought to have done, just as would be the case with a Human Driver involved in a similar mishap. There would be no need to go through the time and expense of considering the nuances of the technology involved in building a Computer Driver to understand that something like a car running a red traffic light involves a driver doing something inherently dangerous, regardless of whether that driver is a person or a computer.

Moreover, the Computer Driver's liability may be reduced or eliminated by considering the violation of a traffic statute or ordinance by another motorist. For example, consider a statute which provides that, after sunset, no person shall drive an unlighted vehicle on the highway.[36] If A, a Computer Driver, rear-ends B, a motorist driving an unlighted vehicle after sunset, B's violation of the statute is negligent (absent an excuse), which negligence may reduce or excuse the liability of A.

The legal fiction of the Computer Driver adapts easily to tort principles which require that a Human Driver recognize obvious risks. Consider two illustrations from the RESTATEMENT (SECOND) OF TORTS.[37]

> Illustration:
>
> 2. A, driving an automobile, approaches a railroad crossing marked with a warning sign. A reasonable man watching the road ahead would see the sign. A is conversing with a friend, is not watching the road, and does not see the sign. He drives onto the crossing and is injured by a train. A is negligent.

For the Computer Driver, attribution of negligence liability depends on the behavior of driving onto railroad tracks in the presence of a warning sign. Failing to respond appropriately to the warning by reducing speed to have sufficient time to identify the presence of an oncoming train results in an injury. Though Illustration 2 explains the "why" of the Human Driver's deficient behavior (conversing with a friend), from a liability standpoint the details of the "why" are not relevant. It is the deficient behavior in the presence of a warning sign that creates liability.

> Illustration:

---

[36] *Id*. illus. 1.

[37] RESTATEMENT (SECOND) OF TORTS § 289 Recognizing Existence of Risk, illus. 2 & 3 (1965).

> 3. A, driving an automobile, approaches an intersection where B, a pedestrian, is crossing the street. B is plainly visible, and a reasonable man in A's position would see him. Although A is looking ahead, he is preoccupied, and does not see B and runs into him, injuring B. A is negligent.

For the Computer Driver, attribution of negligence liability depends on the behavior of hitting a pedestrian in plain view of the Computer Driver's sensors[38] and failing to respond appropriately to the apparent risk by stopping for the pedestrian. Though Illustration 3 explains the "why" of the Human Driver's deficient behavior (preoccupation with other things), from a liability standpoint the details of the "why" are not relevant. It is the deficient behavior in the presence of a pedestrian that creates liability for both the Computer Driver and the Human Driver.

The Legal Category of "Computer Driver" Retains the Existing Allocation of Regulatory Responsibility between Federal and State Governments

Historically, federal laws and regulations govern automotive equipment and safety whereas state laws and regulations govern drivers, driving, licensing and registration. Automated vehicles are a disruptive technology for this regulatory framework because automation technology replaces Human Drivers and their behavior with equipment—Computer Drivers that use sensors and control machinery.

To maintain the status quo of the existing legal order in which a court can find *drivers* liable for negligent driving, the law needs to provide a framework in which the machine—the Computer Driver—can be treated as if it were a Human Driver. Creating the new legal category "computer driver" allows for use of all the existing legal machinery in place to regulate Human Drivers for negligence. Finding a machine negligent using a legal fiction is a very different exercise from finding a manufacturer responsible for a manufacturing or design defect.[39] Negligence is an objective legal

---

[38] While there might in fact be a design defect involving the type and placement of the computer sensors, there is no need to get into those details with this approach. If a Human Driver should have seen the pedestrian in this circumstance, so should have the Computer Driver.

[39] Under the RESTATEMENT (SECOND) OF TORTS, for strict liability, a product can be defective for a design defect, a manufacturing defect or a failure to warn. RESTATEMENT (SECOND) OF TORTS § 402A (AM. LAW INST. 1965). A failure to

standard of behavior determined primarily by reference to an idealized reasonable person—a standard to which jurors have domain expertise. Strict product liability is an objective standard of product integrity determined primarily by reference to engineering processes: manufacturing and design. One is a legal exercise; the other is, first and foremost, an engineering exercise. Jurors have no domain expertise with respect to the inner workings of a driving automation system which even engineers do not fully understand and cannot explain.[40]

The complexity of a driving automation system using neural networks includes a logic that is inscrutable to humans—unlike a conventional algorithm in a computer program in which lines of computer code may be analyzed—an extremely high hurdle in its own right. [41] Even though the operation of a neural network is

---

warn standard seems facially inadequate for involuntary creditors such as a harmed pedestrian or cyclist plaintiff and impractical even for purchasers of automated vehicles. A manufacturer cannot effectively disclaim liability for personal injuries to consumers by contract because such a disclaimer is presumptively unconscionable. UCC Art. 2, § 2-719(3). RESTATEMENT (THIRD) OF TORTS contains revised principles for product liability claims, though many states still follow Restatement (Second) of Torts. For example, the Florida Supreme Court definitively ruled in Aubin v. Union Carbide Corp., 177 So.3d 489 (Fla. 2015), that Florida law follows RESTATEMENT (SECOND).

Our analysis is even more important in a state which follows RESTATEMENT (THIRD) because it is even more protective of manufactures by making proof of a design defect more difficult. Scholars consider the RESTATEMENT (THIRD)'s adoption of the risk-utility test to reflect a pro-manufacturer bias. *See, e.g*., Ellen Wertheimer, *The Biter Bit: Unknowable Dangers, The Third Restatement, and the Reinstatement of Liability Without Fault*, 70 BROOKLYN L. REV. 889, 927 (2005); Frank J. Vandall, *Constructing a Roof before the Foundation is Prepared: The Restatement (Third) of Torts: Products Liability Section 2(b) Design Defect*, 30 U. MICH. J.L. REFORM 261 (1997). In fact, the Third Restatement's version of products liability law is "a wish list from manufacturing America." *Id*.

[40] Many research agendas of PhD candidates focus on statistical techniques designed to show that an automated system using neural networks is safe—but none appear to have succeeded to date. *See, e.g.*, Chuchu Fan, Formal Methods for Safe Autonomy: Data-Driven Verification, Synthesis, and Applications, (2019) (Ph.D. dissertation, Univ. of Illinois, Urbana-Champaign), https://www.ideals.illinois.edu/bitstream/handle/2142/106202/FAN-DISSERTATION-2019.pdf.

[41] To our knowledge, one of the authors was one of the only pair of experts whose testimony successfully convinced a jury of a fatal automotive design defect at the level of analysis of the structure of computer code. Beasley Allen, Toyota Sudden Unintended Acceleration Lawsuit Ends In Landmark Verdict (Nov. 5, 2013)(involving proof at trial that the software that controlled the ETCS

accomplished via executing a set of deterministic computer instructions, given the current state of the art there is no generalized method to prove a design defect in a neural network by attempting to explain its inner workings. Only a liability test based on observed behaviors will work in practice given currently available techniques and diagnostic tools.

B. Negligence Liability for Computer Drivers Aligns the Law with the Goals of Driving Automation

The ultimate goal of driving automation system technology is to replace Human Drivers with Computer Drivers. The idea is to produce a machine that can at least imitate (if not improve upon) the risk management behaviors and the safety performance of an attentive and unimpaired Human Driver in a road scenario within its operational design domain.[42] Indeed, driving automation industry players often state that their automated vehicles will be safer than Human Drivers. Daniel Kahneman, a Nobel Prize winner for work in behavioral economics, opined about AV technology: "[b]eing a lot safer than people is not going to be enough. The factor by which they have to be more safe than humans is really very high."[43] If the Computer Driver merely performs at least as well as the reasonable Human Driver, then the Computer Driver should not have negligence liability for its operating performance.

Note that for negligence liability the issue is not "fault" in some subjective or moral sense. In law, the concept of fault for negligent behavior is a purely objective and functional test—comparing actual

---

was defectively designed and failed to conform to industry standards), https://www.beasleyallen.com/article/toyota-sudden-unintended-acceleration-lawsuit-ends-in-landmark-verdict-2/.

[42] Regulatory requirements in Germany and New York City contemplate a "safer than a human driver" standard as a condition to permitting deployment of automated vehicles. Such a requirement can be expressed as requiring a positive risk balance. Many state laws (including those in Arizona, Florida, Nevada and Texas) do not even attempt to provide a meaningful safe deployment condition, presumably because legislators are anxious to provide a favorable business environment with minimal regulation to attract industry and jobs.

[43] Tim Adams, *Interview, Daniel Kahneman: 'Clearly AI is Going to Win. How People Are Going to Adjust Is a Fascinating Problem'*, THE GUARDIAN (May 16, 2021) (reporting observations of Daniel Kahneman), https://www.theguardian.com/books/2021/may/16/daniel-kahneman-clearly-ai-is-going-to-win-how-people-are-going-to-adjust-is-a-fascinating-problem-thinking-fast-and-slow .

performance of the defendant with the performance of a hypothetical reasonable man.[44]

Applying this functional concept of fault to a Computer Driver, just as we apply it to a Human Driver, is the same strategy used by Alan Turing to address the question of whether a computer can think.[45] For Turing, asking whether a computer can think was the wrong question. The right question was to ask how the machine performs in an imitation game.

In Turing's imitation game, an evaluator poses questions to a subject via a computer terminal. The evaluator sends questions to a remote terminal and does not know whether a human subject is replying to the questions at the other end of the wire or whether a computer "subject" is replying to the questions. IF the computer's performance imitates the performance that we would expect of a human subject (such that the evaluator has no basis for concluding by the nature of the responses that a computer is the respondent), THEN the computer has objective, functional intelligence equal to that of a human regardless of what processes are going on inside the machine or what epiphenomena might result from its operation. Those questions about subjective "mental" states do not matter and, perhaps, make no sense. They certainly make no practical difference.

The liability attribution rules should clearly state that, as a matter of law, a Computer Driver owes a duty of care to automated vehicle occupants, road users and other members of the public.[46] The rules

---

[44] We do not engage with the academic debate about whether the reasonable man standard is positive or normative. *See* Alan D. Miller & Ronen Perry, *The Reasonable Person*, 87 N.Y.U. L. REV. 323 (2012) (analyzing whether a rational formulation of a reasonable person standard is positive or normative). For practical purposes, many (if not most) cases of Negligent Computer Driving will consist of negligence *per se* for violation of a traffic law. Traffic law certainly qualifies as positive law but it does not matter for liability purposes whether it has normative underpinnings. A driver may avoid *per se* negligence liability for violation of a traffic law if the violation was reasonably expected to create a lower risk of harm in a special circumstance. An example would be driving on the wrong side of the road to avoid a fallen tree blocking one lane on a two-lane road. *Compare* RESTATEMENT (3D) OF TORTS s. 14 (providing for negligence per se for a violation of law) *with* RESTATEMENT (3D) OF TORTS s. 15 (providing for excused violations of law).

[45] Alan Turing, *Computing Machinery and Intelligence*, MIND, LIX (236): 433–460, (Oct. 1950), [doi:10.1093/mind/LIX.236.433]

[46] We hope to avoid a debate over "duty skepticism" by a simple description of the duty of care "owed" by a Computer Driver. *See, e.g.*, Goldberg & Zipursky, *The Restatement (Third) and the Place of Duty in Negligence Law*, 54

should also state that the applicable Computer Driver Manufacturer is the Responsible Party for losses sustained when the Computer Driver breaches its duty of care.[47]

This duty of care extends to other drivers, pedestrians, motorcyclists, bikers, and any other person who might reasonably be expected to encounter the automated vehicle equipped with a Computer Driver during the course of its operation.[48]

To complete the proper pleading of a negligence claim against a Computer Driver, a plaintiff must proceed in the conventional way by showing (i) existence of a duty of care, (ii) breach of the duty of care, (iii) "but for" causation connecting the breach of the duty of care to the accident, collision, or other incident, (iv) proximate causation of the accident, collision or other incident by the breach and (v) damages proximately caused by the breach.[49]

In the recent Cruise incidents, the robotaxi's sensor suite should have identified the Muni bus and the warning tape marking downed wires, prompting the vehicle to halt before hitting the bus or driving through a danger zone.[50] An attentive and unimpaired Human Driver would have noticed the dangers and stopped. In these cases, the performance of the Computer Driver appears to have been negligent.

For liability purposes, it does not matter why the Computer Driver failed to perform—whether manufacturing defect or design defect. The "why" matters to the safety engineers and regulators who want to make sure the problem does not happen again by taking

---

VAND. L. REV. 657 (2001). A law specifying a duty must define a class before a court will adopt it. *See* RESTATEMENT (SECOND) OF TORTS § 286 When Standard of Conduct Defined by Legislation or Regulation Will Be Adopted.

[47] The Computer Driver, as a legal fiction, can owe a duty just as a corporation or other artificial legal person can owe a duty. The difference between the Computer Driver and a corporate entity is that the corporate entity is a legal person with asset available to satisfy a judgement whereas a Computer Driver is simply a complex piece of equipment. To complete the picture, a legal person must be the responsible party for the legal fiction.

[48] Restatement (Second) of Torts § 286.

[49] In this essay we formulate the items for pleading and proof using five individual elements. Courts in different states express the elements in different ways, but the substance of the legal requirements are substantively identical. Including a separate element of "but for" causation is designed to allow use of our formulation across multiple jurisdictions.

[50] Engineers refer to this process as object and event detection and response (OEDR). See J3016. In the two recent Cruise incidents, the OEDR system failed to operate properly. For liability purposes, it does not matter whether a manufacturing defect or a design defect proximately caused the incident.

corrective action—whether system upgrade or recall.[51] But addressing future safety is not the same as addressing liability—even though in theory there can be liability for a manufacturing or design defect.

C. The Legal Category of "Computer Driver" Allows for Equal Treatment of Plaintiffs

Beyond the convenience created by the legal category of "computer driver" (by applying existing legal rules for Human Drivers to Computer Drivers), an additional reason for the law to allow a negligence claim against a Computer Driver is to provide equal treatment among plaintiffs. In the case of an accident or collision of a vehicle piloted by a Human Driver, the plaintiff can make claims against three different types of parties with each type of claim having different elements: (i) a claim against the negligent Human Driver; (ii) a product liability claim against the manufacturer for a manufacturing defect or a design defect; and (iii) in some states (and to varying extents), a vicarious liability claim against the owner of the vehicle.

If the law does not allow a plaintiff to make a negligence claim against a Computer Driver for which some legal person is the responsible party, then the plaintiff in a Computer Driver accident case will have only two avenues for recovery, not three. Depriving a plaintiff in a Computer Driver case of a negligence claim may, in fact, deprive the plaintiff of the easiest and most natural theory of recovery to prove. In many simple cases (e.g. running a red light, a rear end collision with a municipal bus, and driving through warning tape), it will be easier to prove simple negligence than either a manufacturing defect or a product defect. Examination of computer code does not help with liability in the easy cases. A product liability claim based on strict liability can be more difficult to prove than simple negligence in many cases. Simple negligence consists of an objective failure to perform as the law expects an attentive and unimpaired Human Driver to perform.

[51] Cruise has issued a recall for its robotaxis in response to the incident in which a robotaxi rear-ended a bus. *See* Shepardson, *supra* note 10.

D. Reasons for Manufacturer Responsibility

Why should the manufacturer be financially responsible for losses from the negligence claim against the Computer Driver rather than the owner of the vehicle?

Requirement for Legal Person Responsibility. Some legal person must act as the responsible party for a Computer Driver's negligence because a plaintiff cannot seek recovery from a computer. A Computer Driver is not a legal person against whom a plaintiff may file a complaint. The Computer Driver simply consists of electronic equipment and computer programs which provide automation features.[52]

Vicarious Liability for Owners Inappropriate. Making the owner of the AV liable for negligent driving on a vicarious liability theory is inappropriate because the owner has no substantive control over driving performance. Contrast this complete lack of ability to predict or control the performance of a Computer Driver's latest software version (which might well be a mandatory update) with the control that the owner of a conventional vehicle possesses when she decides to loan her vehicle to another driver whom she considers reliable based on a long history of proven, mature judgement.

Other Reasons for Manufacturer Liability. The manufacturer should be financially responsible party for losses proximately caused by a Computer Driver (and not the vehicle owner) for several additional reasons beyond mere lack of control.

First, it is reasonable to assume that federal law eventually will provide that the manufacturer is the responsible party with respect to a Computer Driver. Draft legislation is circulating for comment which contains just such a provision.[53]

---

[52] The fact that a computer is not a legal person does not seem to have bothered the lawmakers in Oklahoma when creating a statute in which the automated driving system is responsible for complying with traffic and motor vehicle laws. *See* Oklahoma SB 1541 of 2022 regular session at p. 7, http://webserver1.lsb.state.ok.us/cf_pdf/2021-22%20ENR/SB/SB1541%20ENR.PDF.

[53] This is the same approach taken in draft automated vehicle legislation prepared by Reps. Debbie Dingell (D-Mich.) and Jan Schakowsky (D-Ill.) which has been circulated for comments prior to formal introduction of a bill. *See* Tanya Snyder, *House Dems floating reworked driverless car bill, minus forced arbitration*, POLITICO PRO (Mar. 14, 2023, 6:40 PM EDT) (paywall; on file with the authors), https://subscriber.politicopro.com/article/2023/03/house-dems-floating-reworked-driverless-car-bill-minus-forced-arbitration-00087090. The draft bill makes the manufacturer of the original automated driving system

Second, regardless of the form of future federal law, making the owner of the vehicle the responsible party would have the unfortunate effect of eliminating current distinctions made in different state laws related to vicarious liability of owners. Regardless of its form in a given state, when vicarious liability is recognized, it is specifically imposed in full recognition that the owner is not at fault personally for negligent operation of a vehicle.[54] In the case of negligent driving by a Computer Driver the owner similarly will not be at fault personally for negligent operation of a vehicle.

In some states, an owner may have vicarious liability for lending a car to another person (regardless of the status of that person). In other states, an owner may have liability only if the owner is the head of a household and loans the vehicle to a family member. In still other states, an owner will have no vicarious liability without fault of some sort. The identified fault in such a case typically would be fault for negligent entrustment of the vehicle to a risky or unsafe driver who the owner should have known was risky or unsafe. In no case would an owner have vicarious liability for negligent driving of a stolen vehicle. A special blanket rule for Computer Drivers that makes the owner liable for the "negligence" of a Computer Driver completely eliminates the different policy distinctions made by the various states to address liability of an owner without personal fault for negligent driving.

Moreover, RESTATEMENT (THIRD) OF TORTS specifically states that the "negligence of another person is not imputed to a plaintiff solely because of the plaintiff's ownership of a motor vehicle or permission for its use by the other person."[55] Thus, it would be inconsistent with RESTATEMENT (THIRD) to analogize the act of the owner engaging a driving assistance system with the mere act of the owner

---

the driver or operator of a highly automated vehicle under any applicable traffic law or traffic regulation of a state or a political subdivision of a state that governs the dynamic driving task. AV Staff Discussion Draft, 117th Congress, 2d Session (Mar. 13, 2023), available at link in Snyder. *Id*.

[54] The main reason for imposing vicarious liability on an owner is to allow third parties to access the owner's liability policy. This is a practical reason not based on fault or a desire to create incentives for safety.

[55] RESTATEMENT (THIRD) OF TORTS § 5 Negligence Imputed to a Plaintiff. The comments make clear that this "does not preclude proving that the owner of the motor vehicle was independently negligent, such as by negligently entrusting the vehicle to the operator." *See* Cmt. c. *Owners of motor vehicles*.

loaning the automated vehicle to another operator who appears capable of driving responsibly.[56]

Third, placing vicarious liability for negligent driving by a Computer Driver on the owner provides no incentive in the law for improvement of safety.[57] If, however, the manufacturer is the party responsible for negligent driving by a Computer Driver which it produces, then the manufacturer will have an added incentive to make a safer Computer Driver. The manufacturer can have a positive impact on safety whereas the owner cannot.[58] One of the prime theoretical justifications for the imposition of negligence liability is that it will motivate a party to take cost-effective safety measures.[59] Negligence liability will serve its traditional purpose and role if the manufacturer is the responsible person for negligent Computer Driving but not if the owner is the person responsible for negligent Computer Driving.

If you do not allow a plaintiff to make a negligence claim against a Computer Driver for which at least one party has responsibility for loss, then the plaintiff in a Computer Driver case is at a structural disadvantage as compared with the plaintiff in a Human Driver case because there is one fewer avenue for a plaintiff to pursue compensation for loss. For both theory and practice, the only sound choice is to make the manufacturer the responsible party for the performance of the Computer Driver—finding liability if the Computer Driver does not perform at least as well as the law expects an attentive and unimpaired reasonable person to perform in a similar loss incident.

---

[56] Mere loaning of a vehicle differs from a negligent entrustment. *Id*.

[57] One theoretical justification for tort liability is that imposing financial responsibility for accidents creates an incentive to act with greater care. Herring v. United States, 555 U.S. 135, 153 (2009) (Ginsberg, J., dissenting). If anything, imposing vicarious liability exposure on the vehicle owner would incentivize disabling the Comptuer Driver, which runs counter to the industry-and government-stated goals of encouraging use of the technology to improve road safety.

[58] Holding the manufacturer responsible prevents a disconnect between liability and accountability which would occur if only the owner of the automated vehicle had responsibility. *Cf*. Paula Kates, Note, *Immunity of State‐Owned Enterprises: Striking A New Balance*, 51 N.Y.U. J. INT'L L. & POL. 1223, 1224 (2019)(discussing an "accountability-liability" gap when state owned enterprises cause harm and rely on immunity).

[59] *Id*.

V. CONCLUSION

Creating the new legal category of "computer driver" allows a plaintiff to make a traditional negligence claim based on substandard driving performance. A traditional negligence claim comes with all the trappings under applicable state law of adjustments for contributory negligence and comparative fault. This is important to avoid distortion of incentives to create safe products.[60]

It eliminates the need for proof of a manufacturing or design defect. Resolving such a defect claim would likely require expensive and time-consuming efforts involving computer software source code analysis, statistical comparisons against Human Driver outcomes, vehicle testing, or other technical aspects of the Computer Driver's construction and operation. Instead basing liability on negligence requires a comparison to the risk management expected of a reasonable man. Using a reasonable man standard converts the liability inquiry to a form the judicial system is well-practiced at handling: did the Computer Driver in fact drive in a manner as one would expect of an unimpaired, undistracted, reasonable man Human Driver?

A liability standard which requires a jury to decide if the Computer Driver performed as well or better than an attentive and unimpaired Human Driver utilizes the judgement and real-life domain expertise of jurors based on their experiences with cars in the same way as a jury determines negligence liability for a person driving a conventional vehicle. Expertise in computer technology, machine learning arcana, and software safety engineering might be skipped in cases as obvious as a Computer Driver running a red light. What matters for liability should usually be that the car ran a red light, not what software defect or computer malfunction might have made that happen.[61]

---

[60] *See* Mark A. Lemley & Bryan Casey, *Remedies for Robots*, 86 U. CHI. L. REV. 1311, 1383 (2019) (arguing that contributory negligence is needed to create the proper balance of incentives and deterrence).

[61] For example, a defendant might assert that under the state of the art the manufacturer had no method to program the driving automation system to prevent injury to the plaintiff. *See* Jeffrey K. Gurney, *Crashing into the Unknown: An Examination of Crash‐Optimization Algorithms Through the Two Lanes of Ethics and Law*, 79 ALB. L. REV. 183, 237 (2016)

Equalizing the avenues for a plaintiff to recover for loss promotes justice, fairness, and judicial economy.[62] It is justified by the express claims made by manufacturers that automated vehicles will perform as well or better than conventional vehicles. The possibility of a negligence claim against a Computer Driver for which the manufacturer has liability merely binds manufacturers to the content of their advertising and statements to regulators about the promise and benefits of automated vehicles.

Sample statutory language to accomplish the appropriate legal structure appears as Annex A.

[62] It promotes justice and fairness by eliminating or reducing "liability gaps" when it is not possible to prove a traditional product defect. *See Robertson*, *supra* note 1, at 46-47; *see also* Bryant Walker Smith, *Automated Driving and Product Liability*, 2017 MICH. ST. L. REV. 1, 36 (2017) ("Defect in a legal sense, however, is not necessarily coterminous with failure in a technical sense.").

VI. ANNEX A—DEFINITIONS FOR A STATUTE ESTABLISHING A CATEGORY OF COMPUTER DRIVER NEGLIGENCE

A statute providing an architecture for state law liability rules attributing and allocating responsibility for losses based on a "negligent computer driver" should include the following definitions or their equivalents:[63]

"Automated Vehicle" means a motor vehicle equipped with a Computer Driver. The presence or use of a Driver Assistance Feature other than automated Steering, and momentary control functions that do not provide sustained directional control of the vehicle are not relevant to determining whether a vehicle is an Automated Vehicle. Notwithstanding technical characteristics, any statement by a manufacturer, distributor, or dealer to the effect that a vehicle can drive itself or that it contains self-driving or automated driving technology shall result in classification of that vehicle as an Automated Vehicle.

Comment: An automated vehicle might or might not have steering control active at any given time, depending on its operating mode. An automated vehicle might or might not require Human Driver supervision at any given time, depending on its operating mode.

"Breach of the Duty of Care" means, with respect to a Computer Driver, the deficient and unsafe operation of an Automated Vehicle as described below under "Duty of Care."

"Computer Driver" means a set of computer hardware, software, sensor, and actuator equipment that is collectively capable of Steering a vehicle on a sustained basis without continual directional input from a Human Driver.[64]

---

[63] It is commonplace for laws in the United States to use tort law to influence product design. *See, e.g.*, Harry Surden & MaryAnne Williams, *Technological Opacity, Predictability, and Self‐Driving Cars*, 38 Cardozo L. Rev., 178 (2016) (describing indirect regulation through the tort system).

[64] This has a larger scope than the term Automated Driving System (ADS) defined by SAE J3016 for defined levels 3, 4, and 5. It also includes a driving automation system that performs at least lateral vehicle motion control via steering on a sustained basis. While in practice most such capabilities are limited to a particular Operational Design Domain (ODD), liability is assigned without regard to whether the Computer Driver is inside or outside its ODD. The Computer Driver does, however, have the option of refusing to engage outside its ODD and either requesting a transfer of control to a human driver or terminating its mission if it finds itself about to exit its ODD.

Comment: The definition of Computer Driver is a superset of the concept of an Automated Driving System as defined in SAE J3016. The Computer Driver on SAE Level 3, 4, and 5 features is called the Automated Driving System (ADS). The Computer Driver on SAE Level 1 and 2 systems does not have a name defined by J3016 beyond being vehicle automation equipment capable of performing sustained steering.

"Driver Assistance Features" means a vehicle automation feature that does not automate Steering on a sustained basis.[65] Such features include, but are not limited to electronic blind spot assistance, automated emergency braking systems, adaptive cruise control, lane keep assist, lane departure warning, traffic jam speed assist, electronic stability control, or other similar systems that enhance safety or provide driver assistance, but are not capable, collectively or singularly, of vehicle control without sustained directional control being provided by a Human Driver who performs the task of Steering.[66]

"Driving" means the holistic task of operating a vehicle on public roads in conformity with applicable laws, regulations, and statutes, without creating Undue Risk for vehicle occupants and other road users.[67] "Drive" has the correlative meaning.

---

[65] This has a different scope than the term Driver Support Feature defined in SAE J3016. A Driver Support Feature is a generic term for Level 1 and Level 2 automation features which might in some cases included sustained automated steering, but excludes momentary intervention active safety features such as automated emergency braking. It should be noted that Level 2, which combines both automated steering and automated speed control, is not defined in SAE J3016 as a driver assistance feature, even though it is common to see an incorrect designation of Level 2 features as "driver assistance" rather than "driver support" features.

[66] This term is largely compatible with an intuitive notion of Advanced Driver Assistance Systems (ADAS), but not quite the same. It includes all momentary intervention and alert active safety functions, as does the typical usage of ADAS. It excludes SAE Level 2 features that automate both steering and speed control, which is also said to be "automation" rather than "assistance" by SAE J3016. However, while SAE J3016 would say that a steering-only automation feature that did not concurrently automate speed control would be a Level 1 "driver assistance" feature, by the definition in this paper such an automated steering Level 1 feature would still be said to have a Computer Driver.

[67] This includes, but has a significantly broader scope than the term Dynamic Driving Task defined in SAE J3016, which deals only with tactical vehicle motion considerations. A liability approach must consider the holistic driving task, which includes aspects such as route planning, post-crash driver responsibilities,

"Duty of Care" means, with respect to a Computer Driver, the operation of an Autonomous Vehicle without Undue Risk. The Duty of Care of a Computer Driver is owed to Automated Vehicle occupants, other motorists, bystanders, cyclists and pedestrians; the Duty of Care extends to any person (including, without limitation, the property of a person) who may reasonably be expected to be affected by the operation of the Automated Vehicle and who is injured by failure of the Automated Vehicle to operate without Undue Risk. A breach of the Duty of Care includes, without limitation, (i) the failure of the Automated Vehicle to operate in compliance with applicable motor vehicle laws, rules and regulations (including without limitation, prohibitions against speeding, running a red light, failure to stop for pedestrians in a crosswalk, failure to respond to signals from a traffic officer (unless in exigent circumstances a deviation from compliance is reasonable) and (ii) the failure to implement defensive driving maneuvers for operation without Undue Risk and reasonably expected to be performed by an attentive and unimpaired Human Driver in similar circumstances.

"Human Driver" means a natural person with a valid driver's license applicable to the class of vehicle being operated who is Driving a motor vehicle.

Comment: This includes a driver (SAE J3016 Levels 0-2), a fallback ready user (SAE J3016 Level 3), and a human occupant who might potentially assume operation of a vehicle with suitable controls (SAE J3016 Levels 4-5).[68]

"Manufacturer" means a developer, manufacturer, upfitter, programmer for, or any developer or supplier of, a Computer Driver or components for Computer Drivers. A "Manufacturer" is the legal entity who (a) is the vehicle manufacturer for a vehicle provided with a Computer Driver as factory equipment, (b) the system integrator of an aftermarket hardware device primarily intended to provide a Computer Driver, (c) the software provider for an aftermarket Computer Driver that does not involve use of an aftermarket hardware device primarily intended to provide a Computer Driver or

---

ensuring proper vehicle maintenance, law enforcement interactions, and other responsibilities customarily required of human drivers but disclaimed by the scope of J3016 and therefore not required of a J3016-defined ADS.

[68] It is sometimes, incorrectly, said that SAE Level 5 vehicles are ones that do not have human driver controls. Vehicles with Level 4 or Level 5 features might or might not have human-accessible controls. For the purposes of the approach presented in this paper, vehicle controls are optional for a fully autonomous vehicle, and the implications of having such controls apply only if they are present.

create Computer Driver functionality, or (d) solely for a test vehicle, the supplier performing testing if not otherwise the manufacturer of a Computer Driver end product.

Comment: The salient attribute of the manufacturer is that the manufacturer is the legal person who can substantively affect the behavior of the Computer Driver and its associated driving safety. Depending on the particulars of the vehicle, this might include a decision to use sensors of different types, such as familiar RGB sensors (found in digital cameras), as well as LIDAR, and narrow rather than aggressive specification of an ODD.

"Negligent Computer Driver" means a Computer Driver which operates in a deficient or unsafe manner which operation, if performed by a Human Driver, would constitute negligence. A Computer Driver is also negligent if, when it requests that a Human Driver take over control of an Automated Vehicle, it places a Human Driver in a situation in which it is unreasonable to expect the Human Driver had a reasonable opportunity to take over control of the Automated Vehicle and operate in a safe manner and without Undue Risk.

Operating Mode: the current operating situation which determines the Human Driver's responsibility for controlling the vehicle.[69] The four Operating Modes are: *conventional* (Human Driver is driving), *supervisory* (Human Driver is supervising the operation of a Computer Driver), *autonomou*s (the Human Driver has no responsibility for driving), and *testing* (the Human Driver is tasked with mitigating risk from public road testing of a potentially defective or incompletely implemented Computer Driver that is not yet released for series production, including without limitation so-called "beta" test versions of a Computer Driver).

Comment: The Operating Mode is used for determining contributory negligence and comparative fault of the Human Driver. This use of Operating Mode is explored in detail in a companion essay in progress. As a general rule, in our formulation the Computer Driver has liability during operation during testing mode and in other cases when it is engaged (and for a period after disengagement to allow for a proper Human Driver takeover). A J3018 safety driver also may have liability for dereliction of duty, but safety driver fault does not

[69] We explain the details of Operating Modes in a companion essay in process. The Operating Modes guide attribution and allocation of responsibility for accidents, collisions and other incidents based on contributory negligence and comparative fault to human drivers and occupants of automated vehicles.

absolve a manufacturer of liability by using the Human Driver as a scapegoat. The Computer Driver in an Automated Vehicle operating in autonomous mode generally has responsibility because such systems allow for human occupant disengagement with the driving task—for example, by taking a nap or reading a book. Supervisory mode is the most complex and is a type of "collaborative driving."[70] In supervisory mode, the Human Driver can have responsibility for accidents when she unreasonably ignores prompts to stay attentive or take over performance of the driving task.

"Responsible Person" means the Manufacturer.

Comment: The Manufacturer is the legal entity who has civil, criminal, and financial responsibility for ensuring Driving conformance to applicable laws, regulations, rules and statutes, without creating Undue Risk for vehicle occupants and other road users and persons to whom a Duty of Care is owed. For the avoidance of doubt, the Computer Driver as a physical system is not a Responsible Person under any circumstances because the Computer Driver is not a legal person, even though the Computer Driver performs the task of Steering and potentially other control functions.

"Steering" means actively providing sustained directional control for a motor vehicle. "Steers" has the correlative meaning.

Comment: Automated control of steering is the threshold decision criterion for transferring negligence liability between a Human Driver and a Computer Driver, and may be used by a state as a basis for subjecting a motor vehicle to regulation as an Automated Vehicle.[71]

"Undue Risk" means an overall risk of harm greater than that presented by attentive and unimpaired Human Drivers of vehicles

---

[70] *See Robertson*, *supra* n. 1 at note 269 *citing* Gary Witzenburg, *"Collaborative" Driving: Sharing Is Caring*, KELLEY BLUE BOOK, Jan. 1, 2019, at https://www.kbb.com/car - news/collaborative - driving - sharing - is - caring/ (defining "collaborative driving" as a system that "lets the car drive itself under ideal conditions but will warn and return control to the human driver on demand and when it senses it should" and falls "somewhere between Levels 2 and 3," on the SAE taxonomy).

[71] As a practical matter it will be common for Computer Drivers to perform not only steering, but also speed control and other aspects of the Dynamic Driving Task (DDT) as defined in SAE J3016 as well as safety-relevant functions beyond the DDT such as law enforcement interaction. Thus, the term Computer Driver is not intended to limit functionality only to steering, but rather uses the question of whether a feature provides sustained steering as the threshold decision criterion for whether it is a Computer Driver or a driver assistance capability.

equipped with comparable active and passive safety features, operating in similar environments, operating under otherwise similar conditions.