UNIVERSITY OF MIAMI SCHOOL OF LAW RESEARCH PAPER

THE AWKWARD MIDDLE FOR AUTOMATED VEHICLES:

LIABILITY ATTRIBUTION RULES WHEN HUMANS AND COMPUTERS SHARE DRIVING RESPONSIBILITIES

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This essay describes a state statute which establishes when a human occupant of an automated vehicle has contributory negligence for her interactions with a driving automation system. Existing law is an insufficient basis for addressing the question of liability when a driving automation system intentionally places some burden for safe operation of an automated vehicle on a human driver. Without further statutory guidance, leaving resolution to the courts will likely significantly delay legal certainty by creating inefficient and potentially inconsistent results across jurisdictions due to the technological complexity of the area. To provide legal certainty, the approach recommended uses four operational modes: testing, autonomous, supervisory, and conventional. Transition rules for transfer of responsibility from machine to human clarify at what times a computer driver or human driver has primary responsibility for avoiding or mitigating harm. Importantly, specifying clear parameters for a finding of contributory negligence prevents the complexity of machine/human interactions from creating an over-broad liability shield. Such a shield could deprive deserving plaintiffs of appropriate recoveries when a computer driver exhibits behavior that would be negligent if a human driver were to drive in a similar manner.

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INTRODUCTION

THIS essay describes a proposed architecture for a state statute which establishes parameters to decide when a human occupant of an automated vehicle[1] has contributory negligence for her interactions with a driving automation system.[2] A law which clearly sets forth the behavior reasonably expected of a human occupant[3] in her interactions with a driving automation system will reduce uncertainty of outcomes and promote judicial economy by setting boundaries on the determination of contributory negligence and comparative fault.[4]

The legal architecture proposed in this essay uses four different modes of operation for a driving automation system: (i) testing mode; (ii) autonomous mode; (iii) supervisory mode; and (iv) conventional mode. The demarcation of driving modes is particularly important for answering questions about possible contributory negligence and guiding a comparative fault calculation because we reasonably expect different degrees of human oversight of, and intervention in, the operation of an automated vehicle depending on the design of the driving automation system and the mode in which the vehicle is operating at the time of any accident, collision, or other incident (and in the time period immediately preceding the incident).

The certainty provided by a statute is preferable to leaving the courts to delineate the human occupant's duties with respect to her

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[1] For our purposes, an automated vehicle is any motor vehicle that is equipped with a "Computer Driver". *See infra* text accompanying notes 5-12. Briefly, a Compute Driver is a vehicle capability for at least sustained automated control of vehicle steering. Such a capability might impose requirements on a Human Driver to maintain alertness and intervene with vehicle control when required.

[2] This is the generic term for a vehicle equipment configuration which can deliver one or more driving automation features. An automated vehicle performs at a given automation level per SAE J3016 terminology definitions depending on which driving automation features are engaged at any given time. *See* SAE INT'L, *infra* note 8.

[3] We say "human occupant" because not all occupants will be Human Drivers. Indeed, deployment objectives such as providing mobility options to those not able to drive ensure this will be the case at times. In some Automated Vehicle designs, a Human Driver's actions may be limited to initiating an urgent egress procedure.

[4] Comparative fault means that contributory negligence no longer is a complete bar to recovery. Contributory negligence remains a partial bar because the plaintiff's negligence proportionately reduces the total amount of damages attributable to the injury to which a nonnegligent plaintiff would be entitled in full. AM. LAW OF TORTS § 13:1.

interactions with a driving automation system because it would take courts a long time to develop appropriate parameters and the parameters may develop inconsistently in different jurisdictions.

For ease of reference, our presentation uses the concept of a "Computer Driver" which we developed in a prior essay—*Winning the Imitation Game*.[5] Our suggested driving modes might, however, be used independently of our recommendations in that essay.[6]

A "Computer Driver" is 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.[7] This has a larger scope than the term "Automated Driving System" (ADS) defined by SAE J3016[8] that is limited in applicability to its defined levels 3, 4, and 5. A category with

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[5] William H. Widen & Philip Koopman, *Winning the Imitation Game: Setting Safety Expectations for Automated Vehicles*, UNIVERSITY OF MIAMI SCHOOL OF LAW LEGAL STUDIES RESEARCH PAPER SERIES (April 25, 2023) [hereinafter *Winning the Imitation Game*], available at https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4429695. Detailed definitions and explanations of defined terms, including "Computer Driver," appears in Philip Koopman & William H. Widen, *Liability Rules for Automated Vehicles: Definitions & Details*, UNIVERSITY OF MIAMI SCHOOL OF LAW LEGAL STUDIES RESEARCH PAPER SERIES (May 10, 2023), available at SSRN.

[6] A defendant might use ordinary contributory negligence as a defense to a strict products liability action in some states. *See, e.g.*, Carter v. Unit Rig & Equip Co., 908 F.2d 1483 (1990)(interpreting Colorado comparative fault statute); *see also* RESTATEMENT (THIRD) OF TORTS: PROD. LIAB. § 17 (providing broad application of contributory negligence). A defendant might raise contributory negligence as a defense to a claim that an automated vehicle drove negligently even without adopting the statutory framework suggested in *Winning the Imitation Game*. *See* Nilsson v. Gen. Motors LLC, No. 18-471 (N.D. Cal. Jan. 22, 2018)(Answer and Demand for Jury Trial filed 3/30/18, Defenses and Affirmative Defenses. at 7, ¶ 2)(case settled before verdict). Under the classic common law doctrine of contributory negligence, any degree of fault on the part of a plaintiff was a complete defense to liability. RESTATEMENT (THIRD) OF TORTS: PROD. LIAB. § 17 cmt. a. Most state laws have abandoned this absolutist view and instead require a determination of comparative fault—with liability allocated based on the percentage of fault allocated to the parties (pure comparative fault), *see, e.g.*, Daly v. Gen. Motors Corp., 20 Cal. 3d 725, 732-35 (1978). See NY CPLR 1411 to 1413. In some jurisdictions a plaintiff cannot recover if she is 50% or more at fault. *See, e.g.*, FLA. STAT. § 768.81(6), (barring recovery where the plaintiff is 50% or more at fault) (applicable to claims filed after March 24, 2023).

[7] *See Winning the Imitation Game*, *supra* note 5.

[8] *See* SAE INT'L, TAXONOMY AND DEFINITIONS FOR TERMS RELATED TO DRIVING AUTOMATION SYSTEMS FOR ON-ROAD MOTOR VEHICLES J3016_202104

broader scope is needed for appropriate attribution of liability given the risks posed by control of steering on a sustained basis.[9] In *Winning the Imitation Game*, we suggested that the law define the category of "Computer Driver" and provide for the possibility of a "Negligent Computer Driver" for which the manufacturer would have liability if the Computer Driver did not mimic or exceed the ability to mitigate or avoid harm to road users that the law demands of human drivers in any given situation.[10] The law should provide a clear avenue for pursuit of a negligence claim against a Negligent Computer Driver (without a claim for defective product design) because, among other reasons,[11] proof of a product liability claim is complex and may be hampered by difficulty in getting access to technical information such as source code.[12] In discovery, the plaintiff generally has the burden to demonstrate a need to inspect source code.[13] There is no presumption of access based on the inscrutable "black box"

(2021) [hereinafter J3016], https://www.sae.org/standards/content/j3016_202104/.

[9] Risks include automation complacency. *See* text accompanying note 41.

[10] *See Nilsson v. General Motors LLC*. In *Nilsson*, the plaintiff relied solely on a theory of general negligence (and not defective design or failure to warn), claiming that the AV manufacturer had breached its duty of care because the vehicle itself—and not the backup driver—drove in a negligent manner that caused the plaintiff's injury (Compl. ¶¶ 15-16, Nilsson v. Gen. Motors LLC, No. 18-471 (N.D. Cal. Jan. 22, 2018), ECF No. 1). In its answer to the complaint, GM admitted that the *vehicle itself* was required to use reasonable care in driving (Answer ¶ 15, Nilsson v. Gen. Motors LLC, No. 18-471 (N.D. Cal. Mar. 30, 2018), ECF No. 18 (stating that "GM admits that the Bolt was required to use reasonable care in driving"). [Huu Nguyen describes *Nilsson* in *Artificial Intelligence and Tort Liability: The Evolving Landscape*, PRACTICAL LAW LITIGATION (maintained on Westlaw)]

[11] *See generally Winning the Imitation Game*, *supra* note 5.

[12] Source code is alphanumeric text in which most computer software is originally written by a computer programmer, consisting of coded instructions in a programming language, such as C++ or Java. The source code for a program (saved in one or more files) contains sequences of specific actions to be performed by the computer. Source code files are translated by a special purpose software program, such as a compiler or assembler, into object code that can be processed directly by a computer or other device to control its operation.

[13] Cochran Consulting, Inc. v. Uwatec USA, Inc., 102 F.3d 1224, 1231 (Fed. Cir. 1996) (vacating discovery order under FRCP 26(b) requiring the production of computer-programming code because the party seeking discovery had not shown that the code was necessary to the case).

nature of software.[14] Some federal district courts have default rules for handling disclosure of source code.[15] However, a defendant may argue that the default rule for source code should not apply. Examination of expert witnesses who form opinions based on a review of source code will be subject to challenge under factors described in *Daubert v. Merrell Dow Pharm., Inc*.[16]

The questions of liability attribution and allocation urgently need legislative answers because incidents of driving automation system failures continue to pile up[17] as manufacturers test and deploy on our highways and roads.[18] For example, Mercedes Benz plans deployment of Level 3[19] vehicles in Nevada later this year.[20] Cruise

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[14] People v. Superior Court of San Diego County, 28 Cal. App. 5th 223, 241 (Cal. App. 4th 2018) (concluding that the "black box" nature of software is not itself sufficient to warrant its production).

[15] *See, e.g.*, Magistrate Judge Sherry R. Fallon, Default Standard for Access to Source Code, United States District Court, District of Delaware [click on "Guidelines"], https://www.ded.uscourts.gov/judge/magistrate-judge-sherry-r-fallon (last visited May 2, 2023).

[16] 509 U.S. 579 (1993). *See also* FEDERAL RULE OF EVIDENCE 702.

[17] *See* 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.

While Cruise prototype deployments provide recent examples of failures, incidents have occurred with technology produced by others, including Waymo and Tesla. Reports of more severe incidents are made available by the California DMV atAUTONOMOUS VEHICLE COLLISION REPORTS, https://www.dmv.ca.gov/portal/vehicle-industry-services/autonomous-vehicles/autonomous-vehicle-collision-reports/ and by NHTSA at STANDING GENERAL ORDER ON CRASH REPORTING FOR INCIDENTS INVOLVING ADS AND LEVEL 2 ADAS https://www.nhtsa.gov/laws-regulations/standing-general-order-crash-reporting

[18] 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.

[19] "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*J3016.

[20] 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.

has sought permission to expand its testing of Level 4[21] robotaxis from San Francisco to operate throughout the state of California.[22]

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.[23] 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.

This essay proceeds by first providing a graphical introduction to our four driving modes. It then explains how these modes integrate into existing law and why they are needed, giving many examples of accident scenarios where the modes help a court produce a just result in a cost-effective way.

OUTLINE OF THE DRIVING MODES

Briefly, the four driving modes are:

- **Testing:** A human test driver oversees test vehicle safety.
- **Autonomous:** There is no human driver involvement required to operate the vehicle.
- **Supervisory:** A human driver oversees a computer that exerts sustained control over vehicle motion.

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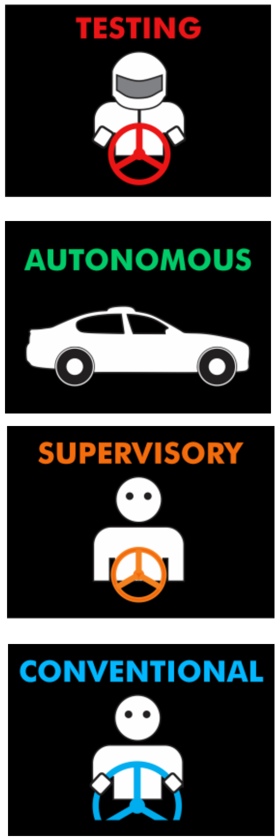
[21] *See* J3016.

[22] Scooter Doll, *California may soon see a lot more driverless robotaxis on the road from GM's Cruise*, ELECTREC (Mar. 21, 2023, 8:44 AM 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/.

[23] *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.

- **Conventional:** A human driver is primarily responsible for at least sustained vehicle steering.

DRIVING MODES



Testing:
- Prototype Computer Driver does the driving;
- Human Driver mitigates dangerous behavior to degree practical

Autonomous mode:
- Computer Driver does the driving;
- No Human Driver required

Supervisory mode:
- Computer Driver steers;
- Human Driver intervenes if necessary due to Computer Driver limitations;
- Vehicles may permit hands-off driving

Conventional mode:
- Human Driver steers;
- Driver Assistance features might be active, but do not provide sustained automated steering

Figure 1. Automated vehicle operational modes.[24]

Figure 1 provides a high-level overview of these modes. It is important to note that sustained control of steering is used as a decision threshold to differentiate whether the Computer Driver is engaged at any given time, but it is expected that the Computer Driver will likely also concurrently control other aspects of vehicle motion such as speed control as a practical matter.

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[24] *See* PHILIP KOOPMAN, HOW SAFE IS SAFE ENOUGH? MEASURING AND PREDICTING AUTONOMOUS VEHICLE SAFETY (Amazon 2022) [ISBN: 979-8848273397]; *see also* https://safeautonomy.blogspot.com/2022/01/simplified-proposal-for-vehicle.html (Jan. 2022) (containing the first presentation of the approach); and https://archive.org/details/2023-03-av-liability-one-pager-published-v-1-00.

As a general rule, the Computer Driver has liability both during testing mode operation and in all other cases when it is engaged (and for a short time period after disengagement to allow for a proper human driver takeover of driving responsibilities).

Testing Mode: In testing mode, a J3018[25] safety driver also may have liability for dereliction of duty, but safety driver fault should not absolve a manufacturer of liability by using the human driver as a scapegoat.[26]

Autonomous Mode: The Computer Driver in an Automated Vehicle operating in autonomous mode generally has liability because such systems by design have no expectation of a Human Driver intervening to mitigate risk. (If such an expectation were present, the vehicle would be operating in Supervisory mode under our proposed structure.) As part of the value proposition of spending money to ride in an autonomous vehicle, occupants would reasonably expect to be able to engage with entertainment media, devote their attention to a remote business meeting, take a nap, or read a book. For cargo vehicles there might not be any human present in the vehicle at all. Even for passenger vehicles, any people in the vehicle might not be qualified to drive due to age, physical condition, or lack of a required license.

Supervisory Mode: Supervisory mode is the most complex and can be thought of as a type of "collaborative driving"[27] that encompasses a wide span of vehicle automation capabilities that involve automation of a substantial portion of the driving burden, including at least sustained vehicle steering.

Enabling a supervisory mode feature creates an awkward middle of shared driving responsibilities which may vary over the course of an itinerary. A Human Driver is required to be attentive to some de-

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[25] *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). [hereinafter J3018]

[26] *See* Madeleine Clare Elish, *Moral Crumple Zones: Cautionary Tales in Human‐Robot Interaction*, 5 ENGAGING SCI. TECH, & SOC'Y 40 (2019).

[27] *See* 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).

fined degree. Additionally, the Human Driver is supposed to intervene to ensure safe vehicle operation when required to do so, according to some predefined set of expectations. The salient characteristic of such a system is that practical driving safety outcomes depend on a combination of Computer Driver behaviors and the potential for Human Driver intervention. Therefore, lacking a bright line set of rules, the degree to which each might have contributed to a mishap can be unclear.

Moreover, different driving automation system designs might require different levels of human engagement for safe operation. In one vehicle, the Human Driver might be told by the vehicle manufacturer that he must continually scan the road for hazards that the Computer Driver might have missed, while the Computer Driver handles mundane lane-keeping and speed control tasks. In another vehicle, the Human Driver might be told it is fine to watch a movie so long as she can respond to a vehicle takeover alarm within a reasonable time. But, even in such diverse systems, the central characteristic remains that the Computer Driver and Human Driver both make a contribution to, and have some responsibility for, safety outcomes.

In supervisory mode, the human driver can have some responsibility for mishaps when she unreasonably ignores prompts to stay attentive, or unreasonably fails to take over performance of the driving task in response to a request for takeover made by the Computer Driver.

In some cases, a deficient or unsafe response to a Computer Driver request for an intervention may constitute human negligence. Human negligence may extend to cases in which a human driver fails to maintain sufficient attention to her surroundings during an itinerary. In other cases, a human occupant may intentionally take a malicious action which proximately causes an accident or collision for which a Manufacturer ought not to have liability.

In yet other cases, it might be unreasonable to expect a Human Driver, who has been encouraged by the Manufacturer to take their eyes off the road, to intervene to avoid a crash if not notified that the Computer Driver is in trouble until the last second. The law needs a response for all these cases. That response will be haphazard, inconsistent, and uncertain if allowed to develop over time through case law decisions in the traditional manner of common law development. Moreover, the common law process of developing legal doctrine is a lengthy process, often taking years or decades for a clear articulation of a legal principle for a novel situation. [28]

Conventional Mode: When an automated vehicle is operated in conventional mode with the driving automation system disengaged, the human driver generally has liability just as during operation of a conventional vehicle without a driving automation system. The liability of the Computer Driver may extend beyond the disengagement of the driving automation system for a brief period needed to allow a reasonable human driver to assume safe operation of the vehicle in a transition from autonomous or supervisory mode to conventional mode.

ESSENTIAL STRUCTURAL DIFFERENCE WHEN HUMANS AND COMPUTERS SHARE DRIVING RESPONSIBILITIES

Tort law applicable to conventional motor vehicle accidents[29] has over time identified different categories of human-to-human interaction for which different liability analysis and factors are relevant. Consider an accident case type involving driver hand motions.

> Vehicle A stops behind Vehicle B. The driver in Vehicle B makes a hand motion to the driver in Vehicle A indicating that it is safe to proceed. Vehicle A proceeds in response to the "all clear" signal from the driver in Vehicle B but is hit by an oncoming Vehicle C.[30]

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[28] The digital signature example is legislative action to provide a statutory resolution of the proper legal effect of an electronic signature. Smooth operation of business required a certain and prompt answer which applied uniformly across all jurisdictions because we have a national economy.

[29] We use the term "accident" to conform to common nomenclature for legal discussions. Other terms such as "loss event" or "crash" can be more suitable for other discussions to avoid an unintended implication that the loss event was not preventable with systemic safety improvements. *See* J. SINGER, THERE ARE NO ACCIDENTS: THE DEADLY RISE OF INJURY AND DISASTER – WHO PROFITS AND WHO PAYS THE PRICE (Simon & Schuster 2022). [ISBN-13: 978-1982129668.]

[30] *See, e.g.*, Pell v. Tidwell, 139 So.3d 165 (2013)(describing inconsistent rules developed by courts in different jurisdictions to address the "hand motion" scenario). The inconsistent treatment of a common road scenario illustrates the need for a statute to address common scenarios presented by the human/machine interactions that might occur during operation of automated vehicles.

In an accident case type such as this, the law has developed generally applicable ground rules for allocating responsibility for the accident type. The generally applicable rule is that presence of a hand motion does not absolve the signaled motorist of her duty to use reasonable care in making highway maneuvers.[31] However, it remains a question of law whether the signaling driver can ever have contributory negligence for an accident by virtue of making the signal.

A minority of jurisdictions hold that, as a matter of law, the signaling motorist has no duty of care when making the signal.[32] The majority of jurisdictions take the opposite view, holding that under some circumstances the driver who makes a gratuitous hand signal may have liability for a signal given negligently.[33] Liability of a signaling driver in this accident type is context sensitive in those majority jurisdictions and depends on the details of the particular human-to-human interaction. Contributory negligence cannot be decided by reference to a generic accident type.

Introducing driving automation technologies complicates matters because Computer Drivers and Human Drivers can have shared responsibilities in which they take turns being responsible for safe operation of the vehicle. One must first determine whether the Computer Driver or Human Driver had responsibility for vehicle operation at the time of the incident. If the Computer Driver is engaged and performing steering on a sustained basis, in what circumstances can the Human Driver have contributory negligence for a failure to make an intervention? Are there some situation types in which, as a matter of law, the determination is not context sensitive?

We make the case below[34] that there are certain situation types related to human reaction time in which a Human Driver should not have liability as a matter of law (as in the minority jurisdictions addressing the hand motion accident type), and others in which the determination of contributory negligence is context sensitive as it is for most human-to-human interactions (and as the majority jurisdictions treat the hand motion accident type.

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[31] In *Pell* the signaled driver had an affirmative non-delegable duty to proceed safely by yielding the right-of-way to through traffic. *Id*. at168.

[32] *Id*.

[33] *Id*.

[34] *See infra* text accompanying notes 38-43.

The customary legal position taken by manufacturer/defendants is to find fault with the Human Driver for failing to avoid a crash in any accident involving a Computer Driver when a Human Driver is present.[35] Using Human Drivers as a scapegoat to shield manufacturers from liability for harm caused by an emerging technology is not just unjust; shifting the cost of accidents onto consumers and the general public removes important incentives to improve safety. Until now there was room for proponents of automotive companies to argue that it was a reasonable strategy to do this because the undertheorized state of the law provided room to maneuver. Our approach provides a structure to remedy the situation with the least amount of disruption to existing legal doctrine and practice—an important step as it is becoming increasing clear that the status quo "blame the human" approach places many Human Drivers in untenable liability positions as vehicle operators.

The advent of automation features that operate when the Human Driver is not continuously involved in the tactical driving task[36] renders the strategy of blaming the Human Driver for all accidents unworkable. The legal system should not find fault with Human Driver who takes advantage of advertised benefits of driving automation to watch a movie on an in-vehicle infotainment screen (or engage in

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[35] The manufacturer took this position in the fatal Uber accident in Tempe, Arizona. While an Arizona prosecutor did not find Uber criminally liable for negligent homicide, the safety driver faces trial in June 2023 on charges of negligent homicide. *Compare* David Shepardson & Heather Somerville, *Uber not criminally liable in fatal 2018 Arizona self-driving crash: prosecutors*, REUTERS (Mar. 5, 2019), https://www.reuters.com/article/us-uber-crash-autonomous-idUSKCN1QM2O8 (last visited May 6, 2023) *with* Associated Press, *Driver in Fatal Uber Autonomous Crash Set for June Trial*, WWW.USNEWS.COM (Apr. 25, 2023, 2:44 p.m.), https://www.usnews.com/news/us/articles/2023-04-25/driver-in-fatal-uber-autonomous-crash-set-for-june-trial (last visited May 6, 2023). *See also* Tom Krisher & Stefanie Dazio, *Felony charges are 1st in a fatal crash involving Autopilot*, APNEWS.COM (Jan. 18, 2022)(involving Tesla AutoPilot engaged), https://apnews.com/article/tesla-autopilot-fatal-crash-charges-91b4a0341e07244f3f03051b5c2462ae.

[36] For these purposes we include any automation feature in which the Human Driver has reason to believe it is acceptable to look away from the road for more than a quick glance, whether due to explicit or implicit communications of the acceptability of that behavior by the Manufacturer. This leaves the Computer Driver's performance as the only practical means of avoiding accidents, regardless of any default rule for liability allocation. This includes features such as Advanced Lane Keeping Systems (ALKS), SAE Level 3, and so-called SAE Level 2+ systems in which manufacturers lead drivers to believe the car actually drives itself, and thus disengage from continuous monitoring of road conditions.

other activities) when a crash results from the dangerous behavior of her Computer Driver while she was not even looking at the road. There must be times at which the Computer Driver has a default presumption of responsibility, despite the presence of a Human Driver.[37]

Additionally, even if the Computer Driver warns a Human Driver to start paying attention to the road or resume primary control of driving, the transfer of responsibility for safe driving does not occur at a discrete instant. Rather, the transfer of responsibility is a process which requires a minimum amount of time for responsible completion.

Liability during at least some initial duration of this transfer of control period should not be context sensitive because of the physical abilities and limits of human drivers: there is a minimum reasonable length of time that a human driver should have to react and assume control of the vehicle for safe operation without incurring liability for contributory negligence.[38] The law should set a minimum lower bound for the time after which there might be potential attribution of contributory negligence to the Human Driver. Responsibility for any accident, collision or other incident that occurs at or within this minimum lower bound should not, as a matter of law, be attributed in whole or in part, to the Human Driver. Above this lower minimum bound, a court may determine attribution and allocation

[37] While we take a different classification approach using automation modes, the need for a presumption of Computer Driver responsibility is also inherent to the definition of SAE Level 3 in the J3016 terminology standard. When a Level 3 feature is active, the Computer Driver performs the complete Dynamic Driving Task, including both vehicle motion control and detecting/responding to objects and events. The Human Driver has no obligation whatsoever for noticing dangerous road situations or avoiding crashes when a Level 3 feature has been activated. It would be nonsensical to assign primary responsibility for safety to the Human Driver for normal Level 3 feature operation.

[38] Measured takeover reaction times vary from study to study due in part to the operational environment, presence of any secondary tasks, and age of the participants. One survey showed a range of up to 30 seconds advance warning is needed before a critical driving hazard will be encountered, and up to 15 seconds for a Human Driver to respond to an intervention request. Most numbers, however, tend to be under 10 seconds. *See* Alexander Eriksson & Neville A. Stanton, *Take-over time in highly automated vehicles: non-critical transitions to and from manual control*, 59(4) Human Factors Table 1 (2017) https://www.researchgate.net/publication/312922628_Takeover_Time_in_Highly_Automated_Vehicles_Noncritical_Transitions_to_and_From_Manual_Control (visited May 6, 2023).

of liability in the usual context sensitive way, taking into account the reasonable time that would be required for transition from Computer Driver to Human Driver in that particular situation for that particular automated vehicle's operational concept. Depending on the circumstances and a jury's determination of reasonable Human Driver responses in each scenario, a Human Driver may have no contributory negligence, some contributory negligence, or full responsibility after the lower minimum bound has expired.

We suggest setting this transfer window during which a Human Driver has no liability for contributory negligence at a lower minimum bound of ten (10) seconds. This selection does not indicate that the Human Driver should always be found negligent if it takes longer than ten seconds to intervene to avoid an accident. Rather, it means that the Human Driver should never be found negligent if a crash happens less than ten seconds after a transfer of control was requested by the Computer Driver. Beyond that time, any finding of fault should be context dependent.

Once a human engages the Computer Driver, the Computer Driver has full responsibility for safe operation of the vehicle indefinitely. That responsibility might be transferred back to the Human Driver. However, in any such transfer back this Computer Driver full responsibility continues during a black out window of ten (10) seconds during which the law may not assign contributory negligence to the human driver (absence a malicious intervention). After the expiration of the black-out window, the court determines contributory negligence just as it would in a conventional motor vehicle accident case. This may include a judicial determination that, based on the particular facts of the case, the Human Driver should reasonably have needed more than ten seconds to take over safe operation of the vehicle.

Every reasonable person would agree that some minimum lower bound is appropriate. Nobody can react within zero seconds to an imminent threat of harm, including both time to notice that the Computer Driver is unable to handle a driving situation, and time to physically intervene to regain physical vehicle control. So it is not a question of *if*, but rather of *how much* longer than zero should be allocated as a grace period before transferring responsibility to the Human Driver.

The issue for legislative decision is specification of the time-period threshold above which the minimum lower bound has been satisfied. We recommend a ten (10) second threshold as a conservative measure for which we expect no serious disagreement for several reasons. First, this is the amount of time recommended by the ALKS standard in a low-speed situation for highway traffic jam pilot-type automated driving systems.[39] It may be reasonable to specify a higher statutory number in high-speed or other more complicated scenarios. This indicates 10 seconds is a reasonable lower minimum bound in every case as a starting point, pending further experience with the technology that might motivate more stringent requirements on Computer Drivers. Second, empirical data from actual crashes indicates that a fatal accident can occur within ten seconds after activation of an automated driving feature.[40] Third, the well-known phenomenon of automation complacency confirms that it is completely unreasonable to expect an instantaneous transfer of responsibility for safe operation of a vehicle.[41] Fourth, J3016[42] recognizes that an unspecified "several seconds" of speed reduction is appropriate to allow time for a "DDT fallback-ready user to resume operation of the vehicle in an orderly manner."[43]

We apply this same 10-second transfer window in two mutually compatible ways: the time required for a Human Driver to intervene in vehicle control when there is an evident need to do so, and the

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[39] Ten seconds seems a reasonable time based on the UNECE 157 ALKS standard, which gives drivers 10 seconds to take over when alerted in low-speed situations. *See* United Nations Economic Commission for Europe, UN Regulation No. 157-Automated Lane Keeping Systems (ALKS) 11 (May 3, 2021), https://unece.org/transport/documents/2021/03/standards/un-regulation-no-157-automated-lane-keeping-systems-alks (last visited May 6, 2023).

[40] See, e.g., National Transportation Safety Board (NTSB), Collision Between Car Operating with Partial Driving Automation and Truck-Tractor Semitrailer, Delray Beach, Florida, March 1, 2019, HIGHWAY ACCIDENT BRIEF HWY19FH008 (Mar. 2019), https://www.ntsb.gov/investigations/AccidentReports/Reports/HAB2001.pdf; NTSB, Collision Between a Car Operating With Automated Vehicle Control Systems and a Tractor-Semitrailer Truck Near Williston, Florida, May 7, 2016, HIGHWAY ACCIDENT REPORT NTSB/HAR-17/02, PB2017-102600 (Sept. 12, 2017), https://www.ntsb.gov/investigations/AccidentReports/Reports/HAR1702.pdf.

[41] NTSB, *Collision Between Vehicle Controlled by Developmental Automated Driving System and Pedestrian, Tempe, Arizona, March 18, 2018*, HIGHWAY ACCIDENT REPORT NTSB/HAR19/03 at 43-44 (Mar. 2018) (discussing automation complacency, https://www.ntsb.gov/investigations/AccidentReports/Reports/HAR1903.pdf (visited May 5, 2023).

[42] *See* SAE INT'L, *supra* note 8.

[43] In the definitional taxonomy of J3016, a "DDT fallback-ready user" is the human driver that is expected to take over control of the automated vehicle (i.e. assume the "dynamic driving task") from the Computer Driver.

time given to a Human Driver to cure a lapse in attention after an alarm from a driver monitoring system.[44]

COMPLEXITY OF DETERMINATION OF HUMAN REACTION TIME REQUIRES STATUTORY INTERVENTION

The law needs to set reasonable expectations about minimum reactions times afforded to human drivers when operating in a situation which, by design, divides responsibility for driving between a human and a machine. The minimum reaction time should be a legal constant across different highway and road scenarios and across jurisdictions—and not context sensitive—because inherent limits to human response times are a feature of human nature, which is the same across all cases.

The science behind determination of reaction times is complex, with factors such as a person's age significantly affecting individual response time capabilities. However, the law does not specify a shifting standard of negligence liability for ordinary torts depending on the specific abilities and reaction time speed of an individual defendant. Rather, tort liability is set by reference to a hypothetical reasonable man—an objective standard.[45]

Similarly, the law can and should specify a uniform minimum grace period for human intervention during autonomous mode operation, because otherwise advertisements which offer to give drivers and occupants their time back are a chimera. No system will really

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[44] *See* text accompanying notes 46-47.

[45] This same approach recommends itself to treatment of reaction time allowed in law. The law generally does not set a higher or lower legal standard for negligence based on individual capabilities of a defendant. Exceptions exist, for example, with respect to children and persons with visual impairments or other physical disabilities but not for adults with cognitive disabilities. *See* J. Chriscoe & L Lukasik, *Re-examining Reasonableness: Negligence Liability in Adult Defendants with Cognitive Disabilities*, 6 ALA. CIV. R & CIV. LIB. L. REV. 1 (2015)(criticizing an objective reasonableness standard which fails to account for different capabilities). for the law holds an experienced driver to the same standard as a newly licensed teenage driver. A court might consider the capacity of the plaintiff to ascertain what duty the defendant owed to a plaintiff. *See, e.g.*, Daniels v. Senior Care, Inc., 21 S.W.3d 133 (Mo. Ct. App. SD2 (2000)(level of care required for elderly exceeds level of care for average person).

"give back time"[46] to anyone if the risk of contributory negligence lurks in the background with no grace period afforded to response time delays, and no allowance for the intrinsically imperfect concentration that is the most that can be expected of human beings.

There needs to be a uniform minimum allowance for Human Drivers to shift modes from monitoring automation to driving the vehicle, and a requirement to manage driver attention in a reasonable way to mitigate the inevitable effects of automation complacency. A bare minimum safe harbor for Human Drivers should be codified by statute rather than haggled over in the courts in a likely inconsistent way over a period of many years because reaction time and automation complacency are features of human nature common in all cases.

Proper attribution and allocation of fault to a plaintiff is important in negligence actions in all states because a defendant may assert ordinary contributory negligence as an affirmative defense to a negligence action. Proper attribution and allocation of fault to a plaintiff also can be important as an affirmative defense to a claim for strict products liability in many states.[47]

AUTOMATED VEHICLE DESIGNS THAT RELY ON HUMAN INTERVENTION

Many automated vehicle designs contemplate that a human occupant in an automated vehicle may intervene to take over control of the vehicle in certain circumstances. Even if an Automated Vehicle's design allows for a Human Driver to engage in other activities during a trip, the Human Driver may have the ability to either assume control of the vehicle or, at least, terminate the trip (bringing the vehicle to a stopped condition without undue risk).[48] During a

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[46] For example, Mercedes-Benz advertises automated driving features that give back time to their customers. Mercedes Benz Media Newsroom USA, *Mercedes-Benz world's first automotive company to certify SAE Level 3 system for U.S. market*, MEDIA.MBUSA.COM, https://media.mbusa.com/releases/mercedes-benz-worlds-first-automotive-company-to-certify-sae-level-3-system-for-us-market (last visited May 6, 2023).

[47] *See* Mary J. Davis, *Individual and Institutional Responsibility: A Vision for Comparative Fault in Products Liability*, 39 VILL. L. REV. 281 (1994).

[48] Though used in J3016, the term "minimal risk condition" is potentially misleading because the risk posture of a vehicle may be comparatively lowered

single itinerary, control of the vehicle may transfer from machine to human and back again multiple times, and Human Drivers might at times be told (or reasonably infer based on a manufacturer's messaging) that they can take their eyes off the road or even take a nap.

Even in testing platforms that require the continual supervision of a trained, professional test driver, there may be equipment behaviors for which it is unreasonable to expect a Human Driver to ensure crash-free behavior. As an example, in 2022 a heavy truck test platform hit a center barrier at highway speed, narrowly missing a collision with an otherwise uninvolved public road user's vehicle in an adjacent lane. This was despite the test driver reacting quickly and apparently in a proper way in a not-fully-effective attempt to counteract an unexpected and clearly unsafe sharp turn command executed by the computer at highway speeds.[49]

If the law provides that a Computer Driver may have liability for negligent driving (as we suggest in *Winning the Imitation Game*), it

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while still being at undue risk given the circumstances. For example, a Computer Driver might be said to achieve a "minimal risk condition" via an in-lane stop on a busy freeway in response to an adverse event in a situation. However, a Human Driver experiencing an identical situation might have been able to pull the vehicle over onto a hard shoulder, with significantly lower risk of being subsequently struck by a high-speed heavy truck moving in the travel lane. *See* Philip Koopman, *Myth #13: A "Minimal Risk Condition" means the vehicle has been made safe*, SAE J3016 USER GUIDE, https://users.ece.cmu.edu/~koopman/j3016/#myth13 (visited May 6, 2023).The Computer Driver should mitigate risk at least as well as a competent Human Driver given the conditions at the time in the event of equipment failure or adverse road conditions that make it inadvisable to continue a trip.

[49] The crash was caught on camera, involving the test truck's Computer Driver commanding a hard left turn at 65 miles an hour due stale planning data carried over from a low speed turn a few minutes earlier. The truck crossed over an adjacent travel lane and a shoulder to strike a median divider. The safety driver reacted as quickly as one could ask (less than one second), and almost certainly prevented a worse outcome, but was unable to avoid the crash. While the company blamed the driver for failure to follow a required computer reset procedure (which could have, and arguably should have, been automated), the driver's response to the unsafe command issued by the Computer Driver itself was not criticized. This incident graphically demonstrates that it is unreasonable to expect a Human Driver to be able to compensate for an unsafe driving command by a Computer Driver, even given essentially ideal performance by that Human Driver. If a production vehicle operating in Supervisory mode were to exhibit this behavior, there should be no reasonable expectation that the Human Driver could have prevented the crash. *See* Andrew J. Hawkins, *TuSimple reportedly tried to pass off a self-driving truck crash as 'human error'*, WWW.THEVERGE.COM (Aug 4, 2022, 1:01 PM EDT), https://www.theverge.com/2022/8/4/23288794/tusimple-self-driving-truck-crash-investigation

also needs to set forth clearly when, and under what circumstances, the failure of a Human Driver, other human occupant, or remote safety supervisor to respond appropriately to a request for intervention (either by failing to intervene or failing to perform a reasonable intervention) will constitute negligence. The proposed legal architecture uses the different Operating Modes to determine contributory negligence of a Human Driver or other natural person who might be in a position to intervene to prevent or lessen the severity of an accident. We explain the structure of the rules below.

LIABILITY ATTRIBUTION IN THE DIFFERENT OPERATING MODES

A. Testing Mode

In general, the proposed liability attribution rules provide that the Automated Vehicle (AV) Manufacturer is responsible for losses from accidents, collisions, and other loss events when a vehicle is operating in testing mode (subject to limited exceptions) regardless of whether the human test driver or the Computer Driver is steering the vehicle on a sustained basis.

Placing this liability on the Manufacturer prevents unjust enrichment by allocating a cost to the permission granted by the state to the Manufacturer to use public highways and roads for testing which otherwise has no substantive cost. The fair cost allocation requires the Manufacturer to pay for accidents proximately caused by its testing activities.

The rules provide common sense exceptions to liability if the negligent or malicious actions of another motorist or other road user proximately cause the accident or collisions with the Automated Vehicle. While a test driver may independently have liability for failure properly to perform the duties of a test driver, a finding of test driver liability for failure to provide supervision which prevents loss does not relieve the Manufacturer of liability.[50]

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[50] The driver in the Uber ATG testing fatality in Tempe Arizona in 2018 currently faces criminal charges for her role in the crash, while Uber does not. *See* Shepardson, *supra* note 35. Uber did, however, reach a settlement with the victim's family members. The NTSB found that a poor safety culture at Uber ATG, inadequate risk assessment procedures, ineffective oversight of vehicle operators, and a lack of adequate mechanisms for addressing operators' automation complacency contributed to the crash. *See* NTSB, *supra* note 41.

In testing mode, the Manufacturer assumes responsibility for the actions of its employee or agent test drivers and should not have available the defense that the test driver was on a frolic and detour or otherwise operated outside the scope of her authority. The architecture contemplates that to obtain a testing permit and conduct testing in compliance with law, the Manufacturer must only use test drivers who are its employees or contracted agents. As a supplement, a state may require that the Manufacturer must test in compliance with the SAE J3018 test driver safety standard and implement a best-practice Safety Management System.[51]

B. Autonomous Mode

The rules provide that the Manufacturer is responsible for losses from accidents and collisions when the Computer Driver is operating negligently in autonomous mode. The Manufacturer is the Responsible Party because, for vehicles operating in autonomous mode, a human occupant need not pay attention to the road or remain prepared to take over control of the vehicle. Indeed, Manufacturers intend one benefit of autonomous mode operation is to enable the occupant to sleep during the itinerary, with another benefit being that people who are unqualified to operate vehicles might use them to improve access to transportation.[52]

The rules provide exceptions to Manufacturer liability if negligent, reckless, or malicious actions of another motorist or other road user proximately cause an accident or collision with the Computer Driver's vehicle. The rules also provide that a vehicle occupant may have liability for a malicious intervention during autonomous mode operation. A malicious intervention which proximately causes an accident or collision also can eliminate liability for the Manufacturer.

During autonomous mode operation, the occupant of an Automated Vehicle, if there is one, has no duty to pay attention to the road or to honor a request for an intervention to take control of the

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[51] For example, conforming to the AVSC00007202107. AVSC Information Report for Adapting a Safety Management System (SMS) for Automated Driving System (ADS) SAE Level 4 and 5 Testing and Evaluation (July 16, 2021), https://www.sae.org/standards/content/avsc00007202107/ (last visited May 3, 2023).

[52] *See* NHTSA, Automated Vehicles for Safety, (noting benefits of automated vehicles), https://www.nhtsa.gov/technology-innovation/automated-vehicles-safety (last visited May 3, 2023).

vehicle. Interventions by a Human Driver or occupant are permissive and not mandatory. No Human Driver or occupant can have contributory negligence for inattention or failure to intervene.

Moreover, no occupant can have liability for a reasonable permissive intervention undertaken in response to a request to intervene or in response to a perceived system failure or exigent circumstance. If the Computer Driver places a human occupant in an exigent circumstance or dangerous situation, the human occupant should not be at fault for any attempt to prevent injury or death. We expect Human Drivers and occupants to act in accordance with survival instincts (which a Computer Driver does not possess) when the Automated Vehicle operating in autonomous mode fails to keep the occupants out of harm's way and an occupant notices the imminent danger. Interventions might include emergency stops (for example, to avoid entering flood waters or keep-out yellow warning tape areas marking a road hazard not detected by the Computer Driver), or emergency motion (for example, to clear railroad tracks if the Computer Driver stops on a railway grade crossing[53]). Whether an intervention turned out to be necessary to ensure safety in hindsight should not be relevant to analysis so long as at the time the intervention was made the concern for safety prompting the intervention was reasonable and the intervention was performed in good faith.

C. Supervisory Mode

When an Automated Vehicle is operating in supervisory mode, the liability attribution rules generally place negligence liability for losses on the Human Driver or the Computer Driver depending on which driver is controlling steering on a sustained basis prior to a mishap, and under what circumstances. Subject to limited exceptions, the Manufacturer has liability for losses from accidents and collisions occurring while the Computer Driver is engaged and operating negligently in supervisory mode, subject to four limitations.

Limitation 1 is that the Human Driver has contributory negligence liability for failing to regain attention in response to a timely

[53] A food delivery robot apparently became stranded on a railway grade crossing and was indeed destroyed by a passing train as caught on video. Byron Hurd, *Autonomous food delivery pod meets fiery end under train*, WWW.AUTOBLOG.COM (Mar. 4th 2022 at 2:45PM), https://www.autoblog.com/2022/03/04/train-hits-autonomous-robot-crossing/ (last visited May 6, 2023).

and reasonably effective driver monitor alert issued in response to a loss of attention required to safely supervise the Computer Driver. The amount and type of attention and monitor will depend on the specifics of the AV and its operational concept. However, the presumption is that if the Computer Driver issues a driver monitoring attention alert, the Human Driver must respond by restoring attentive behavior to avoid incurring negligence liability for any accident or collision that might occur at or after ten seconds from the start of the warning.[54] The degree to which the human driver need be attentive is determined by the operational concept of the automated vehicle designed by the Manufacturer. The main intent is that the Computer Driver should monitor to ensure the Human Driver is displaying the level of supervisory attention required for the Computer Driver to operate without undue risk, given the operational concept.

Limitation 2 is that the Human Driver has contributory negligence liability for failing to take over control of driving in a timely and effective manner when it is reasonably evident that there is a need to do so to ensure safety, and it is practicable for a competent driver with reasonable skill to do so in a way that avoids harm given the circumstances.[55] To be reasonably evident, the Human Driver must have a reasonable expectation that the Computer Driver is unlikely to provide safe driving operation based on reasonably observable information including road conditions, actions by other road users, historical Computer Driver behavioral norms (expectations of

[54] A manufacturer who attempts to "game" this requirement by asserting a driver warning continuously the entire time the Computer Driver is active will run afoul of the "reasonably effective" portion of this limitation, because it is a reasonable expectation that people will come to disregard false alarms and essentially meaningless alerts, rendering such alarms ineffective.

[55] The reason to take over might have nothing to do with the mechanics of maneuvering the vehicle on the roadway. For example, if the cabin fills with smoke from a battery fire, an alert Human Driver would be expected to take over control of the vehicle to stop it as required to evacuate passengers. However, if an equipment failure such as the failure of an automated braking computer is not evident to the Human Driver (because braking might not be needed for long portions of a highway trip), the Computer Driver must inform the Human Driver of the failure and potential need to take over operation for that failure to qualify as being evident, with the 10-second takeover window starting only when such notification has been given.

the specific Human Driver involved set by previous trips in a particular model of automated vehicle),[56] vehicle equipment failures, and any evident sources of impairment of the Computer Driver. To be practicable, the Human Driver should have a minimum ten second window to take over safe operation of the vehicle from the time that she might reasonably have discerned a need to take over.

The “reasonably have discerned” qualifier is essential. The Human Driver is not expected to be an expert in the internal workings and potential faults of the Computer Driver. Therefore, any threat to safety that is not readily evident to a typical Human Driver (a “reasonable man” driver, not a trained specialist) must be identified and announced by the Computer Driver (for example, via a takeover alarm) to initiate a transfer of liability from the Computer Driver to the Human Driver. Factors to consider in whether the need for a takeover is reasonably evident would include: whether the Computer Driver issues a takeover alarm, whether the current behavior of the Computer Driver in response to a potential safety threat is markedly inconsistent with its customary behavior in such a situation that has previously mitigated a hazard with no intervention, and whether a situation ought to be so obviously dangerous to an attentive supervising Human Driver that a dramatic maneuver such as a panic braking maneuver is clearly warranted.

Even though a Human Driver might be attentive, it is possible for the Computer Driver to put that Human Driver in an unrecoverable situation. This is especially true if the Computer Driver conducts a sudden, dramatic maneuver that might lead to an accident or crash, such as suddenly swerving into oncoming traffic or swerving

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[56] This helps account for automation complacency. If a Human Driver becomes accustomed to a particular Computer Driver handling situations in an aggressive way, expectations have been set, and it is unreasonable to require a Human Driver to intervene in what they have come to understand is normal Computer Driver behavior that has successfully avoided crashes many times previously – even if such behavior might be judged as dangerous in the absence of that historical context. As a simple example, if the Computer Driver is programmed to stop aggressively at the very last second for red lights so it can maintain speed in case they turn happen to turn green, the Human Driver should not be held responsible for failing to intervene before the customary stopping distance has been passed in a case where the Computer Driver in fact failed to sense the red light and enters the intersection before the Human Driver has a reasonable chance to intervene.

into a tree or other obstacle on an otherwise clear and empty roadway.[57] So too, the Computer Driver should not be able to use an alertness warning of questionable validity or even just turn off the Computer Driver entirely as a tactical tool to shed blame onto a Human Driver immediately before an impending collision.[58] Once a Computer Driver assumes sustained control of steering, liability should only be shifted back onto the Human Driver in situations that permit the Human Driver a reasonable chance, including sufficient reaction, time to cure any drift in attention and/or regain both situational awareness and control ability over the vehicle to resume safe driving. We set that time as a minimum of 10 seconds in all cases, with the potential for a court to decide a longer time is appropriate if justified by the circumstances.

The liability of the AV Manufacturer commences in supervisory mode once the Computer Driver engages.[59] Exclusive AV Manufacturer liability potentially ceases (i) ten (10) seconds after a driver monitoring system sounds an effective alarm and/or other alerts designed to reestablish the Human Driver's attention if the driving automation system determines that the Human Driver is inattentive,[60]

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[57] *See* Hawkins, *supra* note 49 (describing TuSimple crash and potential deception).

[58] A number of Tesla crashes involve the so-called Autopilot feature being shut off less than one second before a crash impact. It is unclear whether this was a deliberate strategy or a side-effect of reasonable design decisions. Nonetheless, any such strategy introduces the potential for abuse if used to shed blame onto the Human Driver. *See* Alexander Stoklosa, *NHTSA Finds Teslas Deactivated Autopilot Seconds Before Crashes*, WWW.MOTORTREND.COM (June 15, 2022) https://www.motortrend.com/news/nhtsa-tesla-autopilot-investigation-shutoff-crash/.

[59] The Computer Driver might refuse to engage if the vehicle is being operated outside the intended conditions it was designed for, preventing a Human Driver from dumping liability onto the system before a crash by activating the Computer Driver. One example of such a situation is attempted operation outside the Operational Design Domain (ODD) as defined in SAE J3016. Note that if a Computer Driver engages outside its ODD, or departs its ODD once driving, the Computer Driver becomes responsible for driving from that point on regardless of whether it is then inside or outside its ODD – unless and until it follows a suitable takeover request process to complete returning control to a Human Driver.

[60] Ten seconds used for consistency with the other ten-second timespans stated. The limiting case is one in which a hazard requiring an intervention arises concurrently with the loss of driver attention. In this situation the Computer Driver

(ii) 10 seconds after the Computer Driver makes a request for the Human Driver to take over control of active steering on a sustained basis due to a system fault detected by the driving automation system, (iii) 10 seconds after the Computer Driver makes a request for the Human Driver to take over control due to an Operational Design Domain (ODD) exit detected by the driving automation system, and (iv) ten seconds after the Computer Driver makes a request for the Human Driver to take over control due to a driving automation system determination that the Computer Driver is unable to continue operation without undue risk.[61]

The liability of the Manufacturer ceases ten seconds (or more) after a hazard becomes reasonably evident even if the Computer Driver does not activate a takeover request if a readily observable road hazard is encountered and the Human Driver providing supervision is both (i) shown to be alert in fact (regardless of whether any driver monitor detects a deficit in alertness or not),[62] (ii) has reasonable time to respond to mitigate the road hazard by taking over control of steering and other vehicle motions. The degree of alertness required and length of time that is reasonable will depend on both

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is required to ensure 10 seconds of safe operation in response to the hazard regardless of driver attention. So using that same ten-second time for a driver monitoring alarm response time imposes no additional technical cost on the Computer Driver's capabilities.

[61] Categories (ii), (iii), and (iv) are simply different ways in which the Computer Driver might signal it should not continue to be responsible for safe driving. They are enumerated to make it clear that system faults and ODD exits are not an excuse for transferring liability to the Human Driver without a sufficient time allocated for the Human Driver to take over control in reasonable way. 10 seconds was chosen as an absolute minimum time that must be provided even in the most favorable circumstances. Longer times will be appropriate based on the situational context. Further research might reveal a longer time is necessary for some slow reacting but otherwise qualified licensed drivers. Nonetheless, 10 seconds seems a reasonable absolute minimum number in all scenarios given the current state of knowledge. *See* Eriksson, *supra* note 38.

[62] Due to the relative nature of the required Human Driver alertness with regard to the vehicle's operational concept, this will leave the Manufacturer exposed to liability only when their driver monitor permits the Human Driver to be less attentive than is required to supervise the Computer Driver without undue risk. This is intended to motivate the use of an effective driver monitoring system in the likely many-year interim before driver monitoring equipment standards can be created, while not requiring the monitoring to be more capable (and expensive) than appropriate for the operational concept in use. The driver monitor for a mobility pod that travels in a dedicated roadway at walking speed might well require different capabilities than one associated with a heavy truck traveling at highway speeds.

the AV operational concept and the hazardous situation—with a ten second window as the standard minimum amount of reaction time, potentially with a longer time if appropriate to the situation.[63] The possibility of a transfer of liability to a Human Driver notwithstanding, the Computer Driver retains liability if it does not also implement a best-effort hazard mitigation maneuver in response to the detected situation even after a reasonable response time from the Human Driver has elapsed.[64] The 10-second window for both driver monitoring alerts and response to an evident need to intervene run concurrently if the two situations should overlap.

As a concrete example, consider a vehicle operating in supervisory mode encountering a stopped fire truck in a travel lane.[65] The Computer Driver would be negligent for crashing into the fire truck unless the crash were caused by one of the following situations:

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[63] A vehicle in which the driver has been told it is acceptable to watch a movie on the dashboard will as a practical matter need to alert the driver to most if not all hazards rather than counting on the driver to notice them, and will have to support a comparatively long response time. A vehicle with aggressive driver monitoring encountering a very apparent road hazard might be judged to accomplish liability handover in a comparatively short time, perhaps as documented by video of the severity of the road hazard, eye tracking data showing that the Human Driver spent enough gaze time at the hazard that they should have recognized it, and of the Human Driver clearly reacting to take sustained, stable control over vehicle motion including steering.

[64] By "best effort," what is meant is that a technically reasonable response to the situation, even if it is not the best that might be done by a Human Driver beyond the mandated 10 second transfer window. For example, an in-lane stop on a busy highway is likely to be preferable to crashing when encountering a sudden snow squall that is outside the Computer Drivers's ODD, even if it is not as safe as pulling to the side of the road. The rationale would be that the in-lane stop is temporizing in a way that reduces risk while waiting for the Human Driver to intervene. Note that the standard for acceptable behavior for the Computer Driver is as good as a reasonable man Human Driver for the first ten seconds, then degrading to this best effort standard after ten seconds. This limits the expense and design complexity of redundant driving control systems compared to an indefinite requirement to be as good as a Human Driver with no time limit.

[65] There have been multiple crashes involving supervisory mode technology. *See, e.g.*, NTSB, *Rear-End Collision Between a Car Operating with Advanced Driver Assistance Systems and a Stationary Fire Truck, Culver City, California, January 22, 2018*, HWY18FH004 (describing an accident without injuries), https://www.ntsb.gov/investigations/Pages/HWY18FH004.aspx ; Tori Gaines, *Tesla in I-680 fire truck crash was operating on driver assist, crash data shows*, WWW.KRON4.COM (Apr. 18, 2023 12:49 PM PDT)(describing a fatal accident), https://www.kron4.com/news/bay-area/tesla-in-i-680-fire-truck-crash-was-operating-on-driver-assist-crash-data-shows/.

- The Human Driver had become inattentive and an effective driver monitoring alarm had activated and continuously attempted to regain driver attention for more than ten seconds before the crash, but the driver remained inattentive and therefore was not able to recognize and respond to a potential crash.[66]
- The Human Driver was in fact as alert as required by the vehicle's operational concept[67] but failed to respond to an evident need to take over vehicle operation.[68] The Human Driver has a duty to intervene when there is an evident need to do so, but is not expected to have superhuman response times, not expected to have extraordinary driver skills, not expected to be able to detect other-than-obvious Computer Driver limitations, not expected to be able to compensate for Computer Driver design defects as a test driver might, and not expected to enforce limitations

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[66] If the Human Driver had become inattentive due to a medical emergency, after the ten seconds had elapsed the situation would be treated as if that medical emergency had happened to a Human Driver in a conventional vehicle. Note that the Computer Driver still has an obligation to execute a best effort attempt to mitigate harm as previously described, regardless of any lack of intervention by an incapacitated Human Driver.

[67] Driver alertness might be established in a crash investigation via examination of an internal driver-facing video camera. Lack of a driver monitoring alert is generally insufficient to show driver alertness due to potential insufficiencies in the driver monitor. The degree of alertness required will vary depending on the operational concept. In some vehicles, the driver would be expected to be continually scanning the road to maintain situational awareness. In other vehicles, the driver might be permitted to relax by watching a movie on the vehicle console, but not permitted to sleep. There is an implication that any gap between the driver monitoring capability and the operational concept of how alert the driver needs to be places liability on the Computer Driver rather than the Human Driver. Human Drivers should be confident that so long as they are not being intentionally malicious, they are being attentive enough if the driver monitoring system is not complaining to them about their attention posture.

[68] The need might be evident due to a takeover alert issued by the Computer Driver. It might also be evident due to the situation (e.g., an alert driver whom the driver monitoring system ensures is scanning the road ahead sees the fire truck approaching without the Computer Driver slowing down). However if a reasonable Human Driver would expect that the Computer Driver would handle the situation safely, for example due to a history of safely handling maneuvering around dozens of fire trucks parked in travel lanes on previous trips, liability would not transfer to the Human Driver.

on acceptable operational conditions that are not identified by the Computer Driver in the form of mandatory intervention requests.

- The Human Driver performed a malicious intervention.

Another road user might instead be liable (but not the Human Driver of the AV itself) due to negligent, reckless, or malicious actions of another motorist or other road user that proximately causes an accident or collision with the AV.

D. Conventional Mode

When a vehicle is operating in conventional mode, the Human Driver is responsible for negligence losses (subject to ordinary exceptions). The Computer Driver may have liability for operation in conventional mode if the system assumes control of some or all of the dynamic driving task in a manner that a reasonable Human Driver would not expect and the unanticipated assumption of control by the Computer Driver proximately causes an accident or collision. There might also be Computer Driver liability if the Human Driver reasonably believes that an automated driving feature has been engaged (e.g., due to an acknowledgement chime in response to an engagement request that the Human Driver normally associates with an engagement of Autonomous or Supervisory mode) when in fact it has not.

This provision for Computer Driver liability applies even if the Computer Driver does not transition to providing sustained steering of the vehicle. For example, if the Computer Driver induces a momentary extreme steering command or initiates a panic brake for no reason (often called "phantom braking"), the Computer Driver would have liability even if not engaged by the Human Driver.

E. Mode Changes

Changes between modes carry with them the possibility of a liability burden shift as well as potential confusion as to what the responsibilities of the Human Driver might be. Additionally, a mismatch between a Human Driver's expectation of the current operational mode and the actual operational mode can lead to mishaps.[69] Mode confusion, in which a Human Driver has a different mental model of the current operational mode than the Computer Driver, has been found in other domains such as aviation to be a significant source of risk. [70]

If a Human Driver is non-maliciously confused about the current operational mode, liability for any crash rests with the Computer Driver for not ensuring that the Human Driver is aware of the current mode.

Additionally, laws should not allow the Computer Driver to unilaterally force a mode change onto a Human Driver as a way of shedding blame for an impending crash or inability to operate. A Computer Driver in supervisory or test mode can use a driver takeover request to transfer liability to the Human Driver. As a practical matter, such a driver takeover process might end with a transfer to conventional mode, so long as the mode change is readily evident to the Human Driver.

A Computer Driver in autonomous mode might request a transition to Supervisory or Conventional mode, but does not have the right to demand or force such a mode change during vehicle operation. Once a request to change into autonomous mode has been accepted by the Computer Driver, the Computer Driver cannot unilaterally exit autonomous mode without an explicit takeover action from a Human Driver. At the end of a driving cycle, a Computer Driver might transition to an "off" state, for example once the vehicle is safely parked, and exit autonomous mode in that manner as well.

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[69] An autonomous test vehicle crash into a truck was said to be caused by the test driver thinking the vehicle had its Computer Driver enabled when in fact the Computer Driver was not active. The vehicle then failed to stop as expected and collided with the truck it was approaching. *See* Mick Akers, *Vehicle in self-driving test crashes just off Las Vegas Strip*, LAS VEGAS REVIEW-JOURNAL (Nov. 15, 2022, 4:30 PM), https://www.reviewjournal.com/local/traffic/vehicle-in-self-driving-test-crashes-just-off-las-vegas-strip-2677041/.

[70] There might not be a Human Driver present when activating or deactivating autonomous mode. It should be readily apparent to any passengers when they are and when they are not responsible for driving. Responsibility for driving should not be unilaterally thrust upon any person once Computer Driver starts operation in Autonomous Mode.

IDENTIFICATION OF LIKELY ACCIDENT & COLLISION SCENARIOS

The need for an effective approach to liability when Computer Drivers play a role in a crash is far from an abstract hypothetical issue. Crashes are already happening involving property damage and injuries that are attributable in part or in whole to Computer Driver actions that a potential plaintiff could reasonably characterize as potentially negligent in a claim for compensation if a human driver exhibited the same behavior. Some examples include:[71]

- A vehicle suddenly served and crashed into a tunnel wall, leading to a multi-car pileup with nine people including one juvenile being treated for "minor" injuries. The driver claimed that automated steering was activated at the time of the crash and caused the sudden swerve.[72]
- NHTSA has a long-standing, still-open investigation into the supervised use of a Computer Driver crashing into emergency response scenes. As of June 2022 there had been 15 injuries and one death attributed to the use of the Computer Driver on that one vehicle type.[73]

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[71] These examples assume that the most straightforward interpretation of the observed and reported situation would be found to be accurate by a finder of fact. These are solely motivating examples to show that situations are already occurring in which a synthetic negligence approach would be applicable, and no implication should be taken to indicate whether any such negligence actually occurred in a listed incident. Additional information might come to light on these incidents, but even if such information should for example indicate the Computer Driver was not actually activated at the time of the crash, the incident is still illustrative of the types of crashes that will inevitably be caused by Computer Drivers at some point in the future. *See infra* text accompanying notes 83-90 (providing additional examples of mishaps).

[72] Matt McFarland, *Tesla 'full self-driving' triggered an eight-car crash, a driver tells police*, WWW.CNN.COM, (December 21, 2022, 5:41 PM EST), https://www.cnn.com/2022/12/21/business/tesla-fsd-8-car-crash/index.html

[73] Lauren Aratani, *Tesla investigation deepens after more than a dozen US 'Autopilot' crashes*, WWW.THEGUARDIAN.COM (June 9, 2022, 14:54 EDT), https://www.theguardian.com/technology/2022/jun/09/tesla-autopilot-crashes-investigation-nhtsa The fire truck collision in February 18th 2023 makes it two fatalities acknowledged as of May 2023. *See* note 61 *supra*.

- A robotaxi developer issued a recall after being struck by another vehicle while making an unprotected left turn.[74] While the company claims that the oncoming vehicle was more to blame for the multi-injury crash,[75] it does not hold that it has no blame, making contributory negligence a potential factor if any lawsuit were to arise from the crash. It is not out of the question to make a case, at least in some states, that stopping in an oncoming vehicle's travel lane while making a left turn and then being hit is negligent driving behavior on the part of the vehicle turning left, regardless of any contributory road rule violations by the other vehicle.
- A review of the initial data set released by NHTSA as part of their Standing General Order data reporting requirement for SAE Level 2 and above automated vehicles included nearly 400 crashes serious enough to trigger a reporting requirement (generally involving an air bag deployment, reported personal injury, or tow truck) over 10 months. Those crashes included six fatalities, and five serious injuries – that the car makers knew about to report.[76] Crashes have continued to occur as reflected by subsequent data releases.
- A vehicle that required Human Driver supervision ran a red light at speed, hitting a crossing vehicle, resulting in two fatalities. That driver faces felony criminal charges.[77]

Based on these mishaps, it is clear that regardless of industry hype about AV safety, crashes involving the technology can be ex-

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[74] Matt McFarland, *Cruise recalls its robotaxis after passenger injured in crash*, WWW.CNN.COM (Sept. 1, 2022 3:27 PM EDT), https://www.cnn.com/2022/09/01/business/cruise-robotaxi-recall/index.html.

[75] Cruise LLC, Report of Traffic Collision Involving an Autonomous Vehicle, filed with the California DMV on June 10, 2022 (reporting incident on June 3, 2022), https://www.dmv.ca.gov/portal/file/cruise_060322-pdf/.

[76] Neil E. Boudette, Cade Metz & Jack Ewing, *Tesla Autopilot and Other Driver-Assist Systems Linked to Hundreds of Crashes*, WWW.NYTIMES.COM (June 15, 2022), https://www.nytimes.com/2022/06/15/business/self-driving-car-nhtsa-crash-data.html.

[77] Andrew J. Hawkins, *Tesla owner is the first to face felony charges for deadly Autopilot crash*, WWW.THEVERGE.COM (Jan. 18, 2022, 2:50 PM EST), https://www.theverge.com/2022/1/18/22889768/tesla-autopilot-criminal-charges-la-fatal-crash.

pected to occur. In some cases lack of proper Human Driver supervision might be a contributing factor, but in others (especially vehicles with no Human Driver tasked with monitoring Computer Driver road behavior) the responsibility for negligent driving behavior must rest squarely and entirely on the Computer Driver.

We can identify some illustrative accident and collision scenarios which we think it likely the law will need to address in the near future. Actual accidents and collisions involving existing driving automation systems motive some of these scenarios. When we can identify situations in which the courts must resolve questions of liability, legislators can best promote judicial economy by providing an amendment or supplement to their statutes which addresses the expected uncertainty.

ACCIDENT SCENARIOS EXPRESSED IN TERMS OF SAE LEVELS

Most, if not all, state regulations that address automated vehicles are currently keyed to the "Levels" in SAE J3016 ranging from 0 to 5. Typically, regulations refer to "highly automated vehicles" which are defined as Levels 3-5, with Levels 0-2 being regulated as conventional vehicles (which means for practical purposes Level 1-2 vehicle automation features are unregulated except for Standing General Order data reporting requirements[78] and via potential NHTSA recalls). In some cases J3016 is explicitly referenced, and might even be incorporated by reference. At other times, terminology has been cut-and-pasted from J3016 without a reference. However, either way, any use of the defined J3016 levels as a basis for regulation in general is unsuitable for liability purposes. A Level 2 feature which controls steering on a controlled basis might be more or less safe than a Level 3 vehicle controlling steering on a sustained basis along with other functions. The driving automation system in a Level 3 vehicle is no more or less safe than in a Level 4 vehicle

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[78] U.S. Dept. Trans., Nat. Highway Traffic Safety Admin., In re: Second Amended Standing General Order 2021-01, Incident Reporting for Automated Driving Systems (ADS) and Level 2 Advanced Driver Assistance Systems (ADAS) (Apr. 5, 2023), https://www.nhtsa.gov/laws-regulations/standing-general-order-crash-reporting.

simply based on the Level that corresponds to its design capabilities.[79] The stated Level of an automation feature is not predictive of its operational safety. Even a dramatically defective automation feature might meet the technical requirements to be designated at a high J3016 Level.

Importantly, J3016 is not a safety standard, nor does it purport to be. Indeed, specification of safety is beyond its scope despite its use (or misuse) in existing laws and regulations. J3016 is not even a fully established engineering standard. It is an "information report" (not an actual standard) containing a taxonomy of definitions to facilitate technical communications about driving automation systems technology and the capabilities of various automation features. Its initial version in 2014 did not contemplate its use in law or regulation. Without supplementation of its basic initial structure, the 2016 version included a reference to possible use of the taxonomy for legal purposes. This reference remains in the current 2021 version. Despite this reference to possible legal or regulatory use, current law will have a gap even if a legislature decides to incorporate J3016 by reference or borrow its language for use in laws and regulations.

Among the reasons that J3016 is not suitable for use for liability are the following.

- It bases levels on "Manufacturer intent" rather than vehicle capability displayed on public roads. This makes it easy to aggressively game the declared intent of levels to evade regulatory and liability requirements by declaring that any vehicle is "intended" to be Level 2, and therefore not subject to state regulations on automated vehicles. This technique can be especially problematic if a safety driver for a bug-ridden test vehicle is instead said to be a Level 2 fallback ready user (i.e., a normal Supervisory Human Driver), resulting in unregulated public road testing.
- Level 2 vehicles fully automate the control of vehicle motion, but require neither driver monitoring nor automated

[79] *See* J3016 at 8.3. p. 36 which states: "While numbered sequentially 0 through 5, the levels of driving automation do not specify or imply hierarchy in terms of relative merit, technology sophistication, or order of deployment. Thus, this taxonomy does not specify or imply that, for example, Level 4 is "better" than Level 3 or Level 2."

enforcement of the Operational Design Domain (ODD).[80] It is inevitable that such an approach will lead to automation complacency and subsequent blame being placed on Human Drivers for, in essence, not being superhuman.

- It defines the term Automated Driving System (ADS) based on being at Level 3 and above, implicitly excluding from scope discussion of liability associated with Level 2 systems, and even steering-only Level 1 systems.[81]
- A number of technical details make the definitions problematic for use with liability. As an example, while a commonly held understanding is that with a Level 3 system the ADS is supposed to alert the Human Driver to the need to take over and ensures a delay, SAE J3016 provides for both no alert and no delay in some circumstances.[82] For liability purposes the proposed framework described herein addresses those topics in a concrete manner, whereas J3016 leaves considerable room for uncertainty as to how driver liability would be assigned for an equipment failure that does not result in the Computer Driver providing an explicit takeover request to the Human Driver.

To the maximum degree practicable, the use of terminology and concepts within this framework does not conflict with J3016. However, due to the unsuitability of using J3016 as the sole foundation for a liability approach, complementary terms and concepts have been defined.

Despite SAE J3016 not being a safety standard nor demarcating different levels of risk, we set forth below different scenarios described in terms of Levels for which our structure of operating modes proves useful for analysis. In each scenario, it can be instructional to ask oneself whether the Human Driver or the Computer

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[80] Press Release, Tesla Crash Investigation Yields 9 NTSB Safety Recommendations, NTSB (Feb. 25, 2020), https://www.ntsb.gov/news/press-releases/Pages/NR20200225.aspx.

[81] In contrast, the generic term in the J3016 taxonomy of a "driving automation system" includes Level 1 and Level 2 features.

[82] See Philip Koopman, Myth #6: SAE J3016 Level 3 features always[s] notify the driver to take over via an ADS request to intervene, SAE J3016 USER GUIDE (discussing J3016 sections 3.22 and 5.4), https://users.ece.cmu.edu/~koopman/j3016/#myth06 (last visited May 7, 2023).

Driver should be responsible for causing and/or failing to avoid a crash:

Case 1. The Human Driver of a vehicle with an "SAE Level 2" sustained automated steering feature engaged is diligently monitoring the performance of their vehicle on a divided highway, following their normal daily commuting route. Upon entering a tunnel, the vehicle suddenly swerves hard to the side, cutting off other traffic in the high-speed lane, impacting a tunnel wall. Other vehicles crash into it, forming a pileup. Several occupants of other vehicles are injured, and one is killed. Subsequent analysis finds that the Level 2 feature was being used as required by Manufacturer instructions, but reasonable attentive Human Driver would not have been able to react to such a dramatic, unexpected swerve in time to avoid the crash. Drivers in other vehicles were following safe vehicle spacing best practices for the conditions, but could not have avoided the pileup due to the unexpected swerve and crash.[83]

This scenario is based on a real-life mishap in November 2022 involving a Tesla vehicle with autopilot engaged which resulted in injuries, but fortunately no fatalities.[84]

Case 2. The driver of a vehicle with an "SAE Level 2" feature engaged which advertises that it is capable of fully self-driving (but with Human Driver supervision also required), does not properly respond to activated and highly conspicuous school bus warning displays, injuring a debarking student. The Human Driver has previously experienced that the vehicle comes to an aggressive stop only a few feet from such a school bus, and thus waited until the usual short distance was reached before realizing something was wrong. Once that short distance had been reached, there was insufficient reaction time available to process the failure to stop, assert control, and avoid the crash.

This scenario is inspired by a real-life mishap that involved a Tesla vehicle in March 2023 that is being investigated by NHTSA.

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[83] Generally, safe following distance is with regard to the vehicle in front of one's own, and does not take into consideration a sudden cut-in of a lower-speed vehicle from an adjacent lane.

[84] Umar Shakir, *Tesla's Full Self-Driving is blamed for eight-car pileup in California*, WWW.THEVERGE.COM (Dec. 22, 2022, 6:25 PM EST), https://www.theverge.com/2022/12/22/23523201/tesla-fsd-braking-crash-bay-bridge-california-chp2.

The deviation from a normally last-second expected stopping behavior aspect of this scenario is hypothetical.[85]

Case 3. The driver of a vehicle with an "SAE Level 3" feature engaged has been told they are permitted to take their eyes off the road so long as they are available to intervene when requested. On a routine drive the takeover alarm sounds. In the Human Driver's experience takeover alarms are uniformly of low urgency, indicating the end of a driver on a particularly benign piece of roadway that is a normal part of the commuting route. The driver looks up to see that their vehicle is going at the full speed limit approaching a red traffic light with insufficient distance to stop. A child (obeying their pedestrian "walk" signal) is in the crosswalk directly in front of the vehicle. The driver slams on the brakes, but the child is hit anyway. Subsequent analysis finds that the Level 3 feature was being used as required by Manufacturer instructions, but a 50th percentile driver would not have been able to stop in time given the late warning and prevalent road conditions.

This scenario is inspired by a real-life fatal mishap that involved an Uber ATG test vehicle in 2018, which involved a test vehicle that failed to see a pedestrian at an unofficial road crossing point, rather than the series production vehicle that is hypothesized in this example scenario.[86]

Case 4. The driver of a vehicle with an "SAE Level 4" feature is riding as a passenger, trusting the vehicle to handle driving safety. They happen to notice an overturned truck in the road ahead. Trusting the technology, which they have been relentlessly told is safer than a person driving, they go back to watching the scenery out the side window. Unfortunately the vehicle crashes into the overturned truck. Subsequent analysis finds that the crash could have been avoided if the passenger had pressed the big red "emergency stop" button in the passenger compartment, but the passenger did not realize this was expected of them. Moreover, the passenger was a 16-year-old who was using a Level 4 robotaxi instead of a private vehicle due to having failed their driver test.

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[85] Hannah Schoenbaum, *US probes NC crash involving Tesla that hit student leaving bus in Halifax County*, WWW.CBS17.COM (Apr. 7, 2023, 6:53 PM EDT), https://www.cbs17.com/news/local-news/us-probes-nc-crash-involving-tesla-that-hit-student-leaving-bus-in-halifax-county/.

[86] See NTSB HAR-19-03, supra note 41.

This scenario is inspired by a Telsa Autopilot crash into an overturned truck, with the presence of an unqualified passenger instead of a qualified driver being introduced as a hypothetical.[87]

Case 5. The driver of a vehicle with an "SAE Level 4" feature is riding as a passenger, but notices that the car has not changed lanes to avoid a fire truck parked at an emergency response scene, and is continuing at full highway speed. Judging that there is not enough time left to brake to a stop, the passenger (who has a valid driver license) takes over vehicle control and swerves into an adjacent lane, sideswiping another car. An ensuing multi-vehicle crash results in severe injuries. Subsequent analysis shows that the automated driving system detected the adjacent vehicles and would have slowed to only 3 mph at the time of the crash due to its planned use of extreme braking force, resulting in no substantive damage and no injuries if the passenger had not intervened.

This hypothetical scenario uses a real Tesla crash into a fire truck as a point of departure.[88]

Case 6. A driver supervising the testing of an "SAE Level 4" feature permits the vehicle to enter an intersection. Another vehicle enters the same intersection and begins performing "donuts" (recklessly spinning in circles in the intersection with high engine power, which in this case is being done by a manually driven other vehicle) in an apparent attempt to harass the test vehicle. The safety driver lets the Computer Driver proceed to make a left turn at the intersection, but is hit by the other reckless vehicle.

This scenario is inspired by a real life mishap that involved a Cruise LLC testing vehicle on March 6, 2023.[89]

Case 7. An SAE Level 4 robotaxi runs through emergency scene yellow tape and becomes tangled in live power lines that came down during a storm that same night. A passenger in the vehicle panics, and leaves the vehicle, only to be electrocuted.

This scenario is inspired by multiple uncrewed Cruise robotaxis entering a downed power line scene and getting both power lines

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[87] Rob Stumpf, *Autopilot Blamed for Tesla's Crash Into Overturned Truck*, WWW.THEDRIVE.COM (updated Jun. 16, 2020, 10:07 AM EDT), https://www.thedrive.com/news/33789/autopilot-blamed-for-teslas-crash-into-overturned-truck.

[88] *See* NTSB HWY18FH004, *supra* note 65.

[89] Cruise LLC, Report of Traffic Collision Involving an Autonomous Vehicle, filed with the California DMV on Mar. 15, 2023 (reporting incident on Mar. 6, 2023), https://www.dmv.ca.gov/portal/file/cruise_030623-pdf/.

and emergency scene tape tangled on their sensors. Fortunately the power lines were not live (although there would be no way for a passenger to necessarily have known that at the time), and the robotaxis happened to be empty.[90]

All of these crashes have a basis in prior incidents, though mostly with less severe consequences. As more automated vehicles are tested and deployed, the law will inevitable confront more crashes like these, and others we have yet to imagine.

WHY THE LAW SHOULD USE STEERING ON A SUSTAINED BASIS TO ALLOCATE LIABILITY

The most significant risks from driving automation systems surface when a driving automation system steers a motor vehicle on a sustained basis. For completely automated vehicles steering is always automated. However, for vehicles that can operate with shared Computer Driver and Human Driver responsibility for safety, steering serves as an important litmus test for determining whether the Human Driver is actually engaged in driving, or is instead watching the Computer Driver operate the vehicle.

Automated steering is the most significant risk because steering on a sustained basis by a Computer Driver creates the well-documented phenomenon of automation complacency in a Human Driver.[91] Vehicles that require either continuous Human Driver supervision[92] or that require a Human Driver to be immediately responsive to takeover requests issued by the Computer Driver[93] are both subject to degradation of system safety due to automation complacency. This is not simply a matter of a Human Driver who is lazy

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[90] *See* Templeton, *supra* note 17.

[91] The US National Transportation Safety Board (NTSB) has identified automation complacency as a primary safety issue with vehicle automation technology, especially with regard to their recommendations H-20-3 and H-20-4 stemming from crash investigations involving Tesla Autopilot. *See* NTSB, Automated Vehicles-Investigative Outcomes, https://www.ntsb.gov/Advocacy/safety-topics/Pages/automated-vehicles-investigative-outcomes.aspx (last visited May 7, 2023).

[92] Examples include Tesla's Autopilot and Full Self-Drivingoptions; GM's Super Cruise option; and Ford's BlueCruise. These options are generally advertised as Level 2 systems.

[93]*See* Stumpf, *supra* note 20 (describing Mercedes-Benz' planned deployment of a Level 3 option)..

in paying attention, but rather is a fundamental cognitive limitation of all Human Drivers.[94]

The approach of using automated steering as the litmus test for determining if a Computer Driver is active differs from the common legal approach based on SAE J3016 Levels 3-5, often referred to in aggregate as "highly automated vehicles" (HAVs) in that using steering as a litmus test also includes all Level 2 features, and even some possible Level 1 features.[95] However, the US federal regulator NHTSA has in practice begun regulating SAE Level 2 vehicles on a par with HAVs by requiring Level 2 vehicles to report crash data in a manner similar to HAVs.[96] Thus, there is precedent for treating Level 2 vehicles as having Computer Drivers.[97]

EVENT DATA RECORDING FEATURES TO ASSIST WITH THE LIABILITY ATTRIBUTION & ALLOCATION

The limitations to liability for the Computer Driver are based on two factors that are amenable to in-vehicle monitoring: the alertness posture of the Human Driver, and whether the specifics of any particular crash were amenable to an effective Human Driver intervention to mitigate or avoid harm. Both of those factors should motivate Manufacturers to install instrumentation to measure and record both driver alertness and situational understanding for events leading up

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[94] *See text* accompanying notes 36-44 (describing the rationale for the 10 second window).

[95] An SAE Level 1 feature might automate steering or speed control, but not both. An SAE Level 2 feature automates speed and steering, but requires a Human Driver to compensate for limitations in the object and event recognition and response capabilities of the Computer Driver by continuously supervising the driving task. In contrast, a Level 3 feature completely automates tactical aspects of driving, but requires a Human Driver to be available to take over if the Computer Driver requests it, and in some other limited situations depending on the particular vehicle.

[96] The NHTSA Standing General Order on Crash reporting requires crash reports for Level 2-5 vehicles. *See* U.S. DOT, *supra* note 78.

[97] As a practical matter there are no known Level 1 passenger vehicles on US public roads that automate steering but do not also have an ability to automate speed, so the absence of Level 1 vehicles from those NHTSA reporting requirements reflects a lack of Level 1 automated steering rather than an obvious intent not to regulated automated steering. Thus, this approach is in practice compatible with current NHTSA actions.

to any accident. In the absence of evidence indicating a proper transfer of control to a Human Driver, liability will remain with the Computer Driver once the Computer Driver assumes control of steering on a sustained basis.

While not required to implement the proposed negligence laws, equipment specifications regarding data recording prior to crashes could greatly assist determination of negligence liability for a Computer Driver. The liability rules proposed create an incentive to include instrumentation for recording events relevant to the shift in liability back to a Human Driver. A draft bill being circulated for comments contains the outline of this type of equipment specification.[98]

> "(3) EVENT DATA RECORDERS.—
>
> "(A) IN GENERAL.—Not later than 5 years after the date of the enactment of this section, the Secretary shall issue a final rule updating part 563 of title 49, Code of Federal Regulations, to—
>
> "(i) specify requirements for the collection, storage, and retrievability of event data of partially automated vehicles and highly automated vehicles to account for, as practicable—
>
> "(I) whether the partial driving automation system or automated driving system was performing the entirety or subtasks of the dynamic driving task;
>
> "(II) the occurrence of a malfunction or failure of the partial driving automation system or automated driving system;
>
> "(III) whether the partially automated vehicle or highly automated vehicle was operating within its operational design domain when the partial driving automation system

[98] The draft bill, as of March 13, 2023, is being promoted by Reps. Debbie Dingell (D-Mich) and Jan Schakowsky (D-Ill). *See* Tanya Synder, *House Dems floating reworked driverless car bill, minus forced arbitration*, POLITICOPRO (Mar. 14, 2023, 6:40 PM EDT)(appearing in a subscription service)(draft bill on file with authors).

> or the automated driving system was performing the entirety or subtasks of the dynamic driving task;
>
> "(IV) the performance of the dynamic driving task;
>
> and
>
> "(V) additional event data needed to assess the
>
> performance of the vehicle; and
>
> "(ii) update pre-crash data elements to account for, as practicable, the performance of advanced driver assistance systems.

If Congress enacted proposed legislation of this sort, and NHTSA issued appropriate regulations to implement the law, administration of an architecture for negligence liability for Computer Drivers could function smoothly and at very low cost.

Existing FMVSS already require the collection of important data that could help make this determination, but that data does not contemplate the role a Computer Driver might play in vehicle operation. Data which indicated whether the Computer Driver was engaged at the time of the crash and, if not engaged, at what point in time the Computer Driver ceased to be engaged, would help allocate liability for operation when autonomous and supervisory mode use might be relevant to a crash investigation.[99] This is a very easy feature to add as an engineering matter. If law enforcement officers could access this information through the already-mandated OBD-II data access port in each vehicle, it would greatly facilitate production of accurate and useful police reports.

In addition, retaining and producing data from video sensors in perhaps the three minutes prior to an accident or collision would greatly assist any determination of negligent or malicious behavior by other motorists and third parties.

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[99] This data is already required for NHTSA Standing General Order reporting, if available. *See* U.S. DOT, *supra* note 78. However, it is common for such data to be unavailable, particularly after a severe crash that might destroy data storage devices not part of the Event Data Recorder (EDR) crash data equipment requirements mandated by NHTSA. It is also common for such data, if available, to be difficult to retrieve for parties other than the Manufacturer.

A forensic ability to report the operational mode and indicia of driver attention will be especially important for at least the 10 second window before a crash to correspond with the 10 second liability transfer window, although 30 to 90 seconds would be preferable.[100] The operational mode at the time of a crash does not necessarily reflect whether the Computer Driver caused a situation that put the Human Driver in a no-win situation in which a crash was inevitable, whether the Human Driver had lost attention and only regained attention only at the last second, or whether the Computer Driver performed an improper mode change without giving the Human Driver the benefit of a reasonable handoff procedure.[101]

Capturing and preserving crash data will require a more nuanced approach than current EDR mechanisms. As currently designed, EDRs snapshot data immediately preceding somewhat severe crashes based on experiencing a high deceleration spike. It is common for EDRs to fail to capture data for low-speed events (especially ones that do not involve airbag deployment). Crashes into a pedestrian that do not dramatically change the speed of the vehicle at impact are particularly problematic for that type of data recording trigger. While EDR data requirements will need to be updated to provide robust forensic crash data relevant to Computer Drivers, the triggering mechanism will also need to change to be related to mishap scenarios detected by the Computer Driver, regardless of whether that mishap happened to involve the vehicle decelerating dramatically due to hitting a high-mass or rigidly fixed obstacle.

While EDR standards are maturing, there should be no incentive for Computer Driver Manufacturers to fail to retain data relevant to

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[100] We recommend 30-90 seconds to account for situations in which more than the 10 second mandatory lowest limit time are captured in full. We note that the current NHTSA Standing General Order's data collection require 30 seconds. *See* U.S. DOT, *supra* note 78.

[101] Analysis of NHTSA crash report data identified 16 instances in which Tesla Autopilot turned off its Computer Driver function less than one second prior to the first impact. This would tend to make any statement that "Autopilot was off at the time of the crash" misleading at best. While no evidence of nefarious purpose has surfaced at a technical level, such situations show the importance of having forensically useful information about pre-crash operation. *See* Andrew J. Hawkins, *The federal government's Tesla Autopilot investigation is moving into a new phase*, WWW.THEVERGE.COM (June 8, 2022, 106 PM EDT)(noting that "On average in these crashes, Autopilot aborted vehicle control less than one second prior to the first impact"), https://www.theverge.com/2022/6/9/23161365/tesla-autopilot-nhtsa-crash-investigation-emergency-vehicle.

crashes in an attempt to provide themselves with plausible deniability. A failure to collect data that would normally be available during system operation should not form a basis of transferring liability to a Human Driver. Rather, in the absence of data it should be assumed that any data that might have been collected but was not would tend to show the Computer Driver to be negligent. This approach incentivizes, but does not create equipment requirements for, Manufacturers to collect and retain data on Computer Driver and Human Driver behavior for a reasonable amount of time before a crash or accident.

In the absence of federal law on EDR systems, state law nevertheless might structure presumptions to encourage Manufacturers to include these features as part of their driving automation systems. A simple presumption might be that, at the time of the accident or collision, the Computer Driver was active. If internal data reflects the state of the Computer Driver at the time of the accident or collision (and during a 10-90 second prior interval) that data must be provided to a prospective plaintiff, law enforcement and insurance providers free of charge.[102]

CONCLUSIONS

A legal system needs rules which produce an equitable, fair, just, and cost-effective attribution and allocation of responsibility for loss events, crashes, and accidents involving automated vehicles. A key issue that these rules must address centers on the scope of potential liability of a plaintiff for contributory negligence in any incident. If a defendant can successfully assert contributory negligence as a defense in almost every case[103] based on a simple failure of a Human Driver to intervene to prevent an accident (regardless of whether it

[102] As it stands now, a frequent concern of plaintiff attorneys is the struggle to obtain evidence of whether a Computer Driver feature was active at the time of the crash beyond verbal statements of the driver involved, much less access to detailed vehicle operational data immediately preceding a crash.

[103] In some states, contributory negligence may not be asserted as a defense to a strict liability claim whereas product misuse and assumption of risk may be asserted. *See, e.g.*, Jimenez v. Sears, Roebuck and Co., 183 Ariz. 399 (1995). State law has been evolving to expand the use of contributory negligence as a defense to even a strict product liability claim. *See* Indiana House Bill No. 1022, First Regular Session of the General Assembly (2023) (proposing a bill to allow use of contributory negligence as a defense in a strict products liability case for failure to wear seatbelts).

was reasonable to expect a competent driver to do so given the specifics of the situation), the Human Driver functions as a "moral crumple zone"[104] which insulates a Manufacturer from liability for losses which a neutral observer or reasonable person would fairly attribute to a technology failure.

The effective elimination of liability (or its substantial reduction) created by a failure of legislatures to act in the face of technological development, removes an important incentive for Manufacturers to produce a safe product. Beyond incentives, however, remains a question of equity, justice, and fairness. Scholars generally acknowledge that the nationwide railroad system developed over the prior two centuries in the shadow of liability reducing rules (primarily centered on a narrow scope given to the proximate cause of an accident).[105] Though the nation and the population as whole benefitted enormously from the development of the transcontinental rail system, the railroad companies (headed by so-called "robber barons") did not bear many costs associated with this development and expansion. Rather, the fraction of the public who lived near the path of the railroad tracks bore the brunt of uncompensated losses (not the shareholders who made immense profits from implementation of rail technology).

Even if one could demonstrate that Computer Drivers were, on average, safer than Human Drivers—a result that would benefit the nation and the population as a whole, this fact in no way should absolve a Computer Driver from liability in an individual accident case in which a Human Driver would have incurred liability by acting the same way as the Computer Driver did. 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

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[104] *See* Madeleine Clare Elish, *Moral Crumple Zones: Cautionary Tales in Human‑Robot Interaction*, 5 ENGAGING SCI. TECH, & SOC'Y 40 (2019).

[105] *See, e.g.*, Ryan v. N.Y. Cent. R.R. Co., 35 N.Y. 210 (1866) (protecting a railroad from liability for a fire its equipment clearly caused by application of the "proximate cause" doctrine). *See generally* MORTON J. HORWITZ, THE TRANSFORMATION OF AMERICAN LAW, 1870–1960: THE CRISIS OF LEGAL ORTHODOXY 13 (Oxford Univ. Press 1992). We discuss the potential similarities to railroad development elsewhere. William H. Widen & Philip Koopman, *Autonomous Vehicle Regulation & Trust: The Impact of Failures to Comply With Standards*, 27(3) UCLA J. L. & Tech. 169, 256-260 (2022), https://uclajolt.com/autonomous-vehicle-regulation-trust-the-impact-of-failures-to-comply-with-standards/ .

liability in the individual case.[106] Drivers, either human or computer, should not accumulate free passes on negligent behavior based on their overall statistical driving record.[107]

Put simply, Computer Drivers should be held to the same standards as Human Drivers when determining negligence. While this might not ensure that they are safe enough to satisfy the needs and requirements of all relevant stakeholders, deploying habitually negligent Computer Drivers should not be acceptable to anyone. Individual acts of negligence should be called to account just as they are for Human Drivers. Because this standard of behavior is based on the well-practiced process of comparison to a "reasonable man" driver, this will in effect put a floor on how unsafe Computer Drivers are allowed to be that can be assessed by non-specialist finders of fact. The liability transfer rules presented in this essay provide actionable guidance on how to assess the transfer of liability between Human and Computer Drivers for this purpose.

Manufacturers develop driving automation technology in a more socially conscious environment than was prevalent in the era of railroad development. Proponents of AV technology do not hesitate to emphasize the potential environmental benefits of deploying automated vehicles nor the benefits to handicapped persons and marginalized communities of expanded transportation opportunities. In light of positive and socially conscious goals used as selling points with federal and state legislatures, it would be an odd result indeed if these same companies opposed laws which made the industry bear the true costs of accidents from testing and deployment of driving automation systems.

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[106] 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 to only 10,000 per year – human drivers would still be held individually accountable for crashes due to negligence.

[107] Perhaps a clean driver record might be taken into account at some point in weighing the consequences for having been negligent. But an exemplary driving record does not somehow turn negligent behavior into something that is non-negligent.

This essay proposes a legal architecture which ameliorates the manifest shortcomings of the robber baron era for a new transportation system in a bygone age. It remains to be seen whether the automated vehicle industry can walk-the-socially-conscious-walk by taking a different path to develop and deploy their new transportation technology. Such a path does not export the cost of accidents onto innocent bystanders to enhance the profits for shareholders.