The Modern Trolley Problem: Ethical and Economically-Sound Liability
Schemes for Autonomous Vehicles

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ABSTRACT

The paper synthesizes modern scholarship in the fields of Artificial
Intelligence law, Ethics, Corporate Liability, and Economics to develop potential
liability schemes that the automotive and insurance industries may impose when
autonomous vehicles eventually come to dominate the roadways. By addressing
the issues of whom the autonomous vehicle's AI protects and who bears liability
in the event of an accident—two issues that this author believes are critical to the
successful adoption of autonomous vehicle technology—the transition from
human drivers to AI drivers will be less contentious. Because of the prescient
nature of the topic, as well as a discussion of the intersectionality of Law,
Technology, Philosophy, and Economics, this paper will appeal to a broad
readership, especially those interested in autonomous vehicle technology and the
implications that their wide-spread use will have on the law.

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I.   INTRODUCTION

        The automobile fundamentally altered the way people travel by replacing the horse with the engine; "autonomous vehicles" are in a position to make the same transformation by replacing human drivers with computer algorithms and sensors. Experts and risk analysts from the private and public sectors believe the removal of human drivers will eliminate almost all automobileaccidents[1] However, even if all human drivers were removed from the road, there would still be a substantial number of automobile accidents, some of which would be caused by autonomous vehicles. These accidents raise a difficult question which automobile manufacturers, insurance companies, programmers, and the legal system need to answer before autonomous vehicles dominate the road, namely who is ultimately responsible for such accidents.

        This note will contemplate various solutions to the problem of accidents caused by autonomous vehicles. The first section of this paper will provide a brief survey of the current landscape of autonomous vehicles: how the industry and government currently categorize various computer systems which control the vehicle; recent accidents involving autonomous vehicles; as well as the government's current position with respect to autonomous vehicles. The second section of this note will examine: 1. how the vehicle's programming is designed to behave in the event of an accident; 2. whether it opts to protect the passengers of the vehicle or whether it seeks to limit amount of damage caused by the accident, even if it means sacrificing the health and safety of the passengers; 3.who will ultimately be liable in the event of an accident, and; 4. whether the individual driver is liable for the accident or if the auto-manufacturer and its program designers should be responsible. These four categories will be combined to create four "liability schemes:" protect the individual and individually liable (the current system); minimize losses and producer liability (the corporation's agent approach); minimize losses and individual liability (the *analytic a posteriori* approach); and protect the individual and producer liability (the fiduciary agent approach).[2] The final section of this note will analyze each of the four liability

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[1] Based on an analysis of crash data between 2005 and 2007, the NHSTA calculated around 94% of accidents on the road today are caused by some form of human error—driving too fast for road conditions, inattention, or driving under the influence of alcohol or other drugs, to name a few. Excluding accidents for which the cause could not be determined, approximately 2%, the remaining 4% of automobile accidents were either caused by purely environmental factors or issues with the vehicle. Nat. Highway Safety Admin., U.S. Dep't of Transp., *Traffic Safety Facts: Crash Statistics,* https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812115
[2] This paper will draw fairly heavily on philosophical concepts. The perhaps esoteric reference to *analytic a posteriori* refers to what is generally considered a contradiction of its two component terms, analytic propositions and *a posterioi* propositions.   The first is a proposition who's

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schemes based on the ethical, legal, and financial consequences of each system for both the individual drivers and autonomous vehicle manufacturers. Finally, based on the insights gained from the analysis, this paper will make a recommendation on how the industry and legal system should adapt to the inevitable introduction of autonomous vehicles on the road from a liability perspective, and conclude by recommending one or two of the best liability systems.

II.   AUTONOMOUS VEHICLES IN 2016: A SURVEY OF CURRENT TECHNOLOGY AND TRENDS

The technology behind autonomous vehicles has progressed quickly over the past year, and numerous automobile manufacturers have incorporated some or all of these technological innovations into their own vehicles.[3] The technological innovations of the past year have also allowed companies like Google and Tesla to begin "beta-testing" autonomous and semi-autonomous vehicles on the road, sometimes with controversial results, including the first recorded death caused by an error in the vehicle's auto-pilot system.[4] In addition to technological innovations, autonomous vehicle producers have received some help from the US government in the form of new rules and regulations issued earlier in 2016, which should pave the way for more autonomous vehicles on the road in the near future.

A. WHAT IS AN "AUTONOMOUS VEHICLE"

Autonomous vehicles are currently on the road today, although not in ways a person may typically expect; features that many consider standard on many modern vehicles such as lane departure systems or adaptive headlights are considered by the National Highway Transportation Safety Administration (NHTSA) to make a vehicle "semi-autonomous.[5]" Currently the NHTSA uses a six-level classification system for identifying autonomous vehicles, which it

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"predicate concept is contained in its subject concept," the second a "proposition whose justification… is validated by, and grounded in experience." As made evident later in the paper, it is oxymoronic—and quite frankly unjustifiable from an economic standpoint in most circumstances—to require the individual passengers of an autonomous vehicle or HAV to liable for an accident which they could not control which also carries an inherent risk that the passenger themselves will be injured if that means that the overall costs of the accident will be reduced by some, perhaps imperceptibly small, measure. *See* IMMANUEL KANT, THE CRITIQUE OF PURE REASON 95-96 (Marcus Weigelt ed., trans., Penguin Publishing 2008) (1781), *see also* PIERRE HASSNER, *Immanuel Kant*, in HISTORY OF POLITICAL PHILOSOPHY 581, 581-85 (Leo Strauss & Joseph Cropsey eds., University of Chicago Press 3d ed. 1987) (1963).

[3] James M. Anderson et al, *Autonomous Vehicle Technology, a Guide for Policy Makers* 5,15

[4] Pete Bigelow, *NTSB Issues Initial Report on Fatal Tesla Autopilot Crash*, CAR AND DRIVER, http://blog.caranddriver.com/ntsb-issues-report-on-fatal-tesla-autopilot-crash/ (Published July 26, 2016) (Last Accessed Nov., 27, 2016).

[5] Anderson, *supra* note 3 at xiv.

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adopted from SAE International in September of this year.[6] SAE International's system—ranging from Level 0, where all of the vehicle's functions are controlled by the driver, up through Level 5, a fully autonomous vehicle where the vehicle occupant has no control over how the car navigates the roadway—will be used by the NHTSA until it develops its own system[7]. In addition to the five levels, the NHTSA categorizes vehicle on whether or not the "human operator or the automated system is primarily responsible for monitoring the driving environment;" human operators are the primary operators of vehicles that fall between Levels 0 through 2, automated systems are the operators of the vehicles for Levels 3 through 5.[8] Additionally, the federal government considers all vehicles that fall within Levels 3 through 5 as "Highly Automated Vehicles" (HAV).[9]

Until very recently, all manufactured vehicles fell within Level 0, where the human operator performs "all aspects of the *dynamic driving task*, even when enhanced by warning or intervention systems."[10] At Level 1, the human driver is expected to control the majority of the *dynamic driving task*, but may be augmented by some aspects of an automated system, such as stability control or dynamic braking.[11] Vehicles that have a computer system built into them, including many vehicles built within the last five years, would fall within this classification.[12] At Level 2, the autonomous system is capable of controlling multiple tasks—steering, acceleration/deceleration, parking, etc.—using information it gathers from the driving environment. However, the human driver is still responsible for whatever remaining *dynamic tasks* the system is unable to perform at the time.[13] Vehicles that fall into this level have only recently entered the market. For example, Tesla released an "Autopilot" feature in October of 2016, which allow the vehicle's internal systems to operate the vehicle in place of the driver when activated.[14] As of October of 2016, the Mercedes-Benz S65

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[6] Nat. Highway Safety Admin., U.S. Dep't of Transp., *The Federal Automated Vehicle Policy* (Sept., 2016). Pg. 9-10

[7] *Id.* at 35

[8] *Id,* at 10

[9] *Id.*

[10] The SAE defines the "dynamic driving task" as "the operational (steering, braking, accelerating, monitoring the vehicle and roadway) and tactical (responding to events, determining when to change lanes, turn, use signals, etc.) aspects of the driving task, but not the strategic (determining destinations and waypoints) aspect of the driving task." SAE International, *Automated Driving* (2014), https://www.smmt.co.uk/wp-content/uploads/sites/2/automated_driving.pdf.

[11] *Id.* at 2.

[12] Hope Reese, *Autonomous Driving Levels 0 to 5: Understanding the Differences*, TECH REPUBLIC (Jan. 20, 2016,) http://www.techrepublic.com/article/autonomous-driving-levels-0-to-5-understanding-the-differences/.

[13] SAE International, *supra* note 11.

[14] Edward Niedermeyer, *The Only Thing Autopilot at Tesla is the Hype Machine*, BLOOMBERG NEWS (Oct. 21, 2016), https://www.bloomberg.com/view/articles/2016-10-21/the-only-thing-on-autopilot-at-tesla-is-the-hype-machine.

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AMG, BMW 750i, Tesla Model S, and the Infiniti Q50S—among a few others—also qualify as Level 2, semi-autonomous vehicles currently available for sale.[15]

Level 3 vehicles are the most basic form of the NHSTA's HAV designation. In addition to controlling the majority of the *dynamic driving task*, the vehicle is also capable of monitoring the driving environment and adjust to any changes. There is "an expectation that the human driver will respond appropriately to a request [from the vehicle] to intervene," and avoid a situation which the computer is unable to handle.[16] Currently, no auto-manufacturer offers a Level 3 vehicle for sale, but Google's current driverless vehicle would classify as a Level 3 autonomous vehicle; the "Google Car" uses adaptive sensors to determine its position relative to the road and other objects around it and the internal computer software "chooses a safe speed and trajectory for the car."[17] Level 4 vehicles have all the features of their Level 3 counterparts, but crucially do not require human intervention in emergency situations. In the event of a potential accident, this means that the human driver has the option to take control over the vehicle, but the vehicle does not require him to do so.[18] No vehicle has yet to reach this level, but Tesla CEO Elon Musk believes that his company will be able to produce vehicles at this level as early as 2018.[19] Finally, at Level 5, the human driver is completely eliminated from all functions of the *dynamic driving task*, as the vehicle can handle all driving situations that a human driver could, including emergencies.[20] The critical difference between Level 4 and Level 5 vehicles is that the human passengers have no ability to control any of the cars dynamic driving functions because the steering wheel and pedals have been removed.[21]

As stated earlier in this note, the classification system currently used by the NTHSA is subject to change when the agency finally develops their own independent system, however it is not unreasonable to imagine that the categorization scheme they eventually adopt will bear a striking resemblance to the current SAE International Guidelines. This note will mostly focus on the

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[15] Don Sherman, *Semi-Autonomous Cars Compared! Tesla Model S vs. BMW 750i, Infiniti Q50S, and Mercedes-Benz S65 AMG*," CAR AND DRIVER, HTTP://WWW.CARANDDRIVER.COM/FEATURES/SEMI-AUTONOMOUS-CARS-COMPARED-TESLA-VS-BMW-MERCEDES-AND-INFINITI-FEATURE (Feb., 2016); *see generally IntelliSafe Autonomous Vehicles*,VOLVO, *http://www.volvocars.com/intl/about/our-innovation-brands/intellisafe/intellisafe-autopilot* (last visited Nov. 27, 2016).

[16] SAE International, *supra* note 11.

[17] *Google Self-Driving Car Project*, GOOGLE, HTTPS://WWW.GOOGLE.COM/SELFDRIVINGCAR/HOW/ (last visited Nov. 27, 2016).

[18] SAE International, *supra* note 11.

[19] Dante D'Orazio, *Elon Musk Predicts a Tesla Will be Able to Drive Itself Across the Country in 2018,* The VERGE, (Jan.10, 2016) http://www.theverge.com/2016/1/10/10746020/elon-musk-tesla-autonomous-driving-predictions-summon.

[20] SAE International, *supra* note 11.

[21] Reese, *supra* note 12.

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liability for autonomous vehicles that fall within the Level 4 and Level 5 range, as these types of vehicles have the greatest potential to upset the current legal system.

    B. <u>"BETA TESTING" OF AUTONOMOUS AND SEMI-AUTONOMOUS VEHICLES IN 2016</u>

       Advocates and skeptics of autonomous vehicles have received plenty of evidence for their positions based on beta-testing performed in 2016. Both Google and Tesla have tested some form of their autonomous vehicles in the last year; Google through its "Google Car" and Tesla through the activation of its "Autopilot" software. While industry insiders and the public have generally reacted positively to such developments, the testing of these new vehicles not been without issue. Autonomous vehicles have been involved in a few accidents in 2016, including a fatal accident in May that has been attributed to a failure of the vehicle's sensors to properly identify another vehicle on the road.[22]

       Google has been testing some form of autonomous vehicle since 2009, often retrofitting existing vehicles with their technology.[23] Currently, Google operates a fleet of 58 vehicles—"24 Lexus RX450h SUVs and 34 prototype vehicles"—all of which are being tested in various locations around the United States, including: Austin, Texas; Phoenix, Arizona; Mountain View, California; and Kirkland, Oregon.[24] As of August, 2016, Google's vehicles have driven over 1.9 million miles in "Autonomous Mode," with an average of 20,000 to 25,000 miles per week.[25] Google also introduced a vehicle close to the Level 5 SAE classification without pedals or a steering wheel, although the vehicle has limited capabilities.[26] There have been few reported issues with Google's vehicles, and the majority of accidents that have taken place while in "Autonomous Mode" were caused by other drivers.[27] However, in February of 2016, Google reported the first accident caused by its own software; the vehicle attempted to maneuver out of the way of an obstacle in the road, only to sideswipe a bus in the process.[28] In its monthly report, Google claimed responsibility for the accident, stating "if

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[22] Bigelow, *supra,* note 4.

[23] Google Vehicles are driven in either manual mode, where the vehicle is operated by a human driver or autonomous mode, where "the software is driving the vehicle and the test drivers are not touching the manual controls." *Id.*

[24] *Id,* at 1

[25] Google Vehicles are driven in either manual mode, where the vehicle is operated by a human driver and autonomous mode, where "the software is driving the vehicle and the test drivers are not touching the manual controls." *Id*

[26] *Supra,* note 11

[27] SEA International, *supra* note 11, at 17.

[28] Alex Davies, *Google's Self-Driving Car Caused its First Crash,* WIRED (FEB. 29, 2016), https://www.wired.com/2016/02/googles-self-driving -car-may-cause-first-crash/.

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[the Google vehicle] hadn't moved there wouldn't have been a collision."[29] Since Google reported the accident in February, there have been no other accidents attributed to Google's vehicles operating in "Autonomous Mode."[30]

In October of 2015, Tesla enabled the "Autopilot" feature on some of its vehicles, allowing owners to test out autonomous mode in real-life situations.[31] Tesla sent out the update to all Model S and Model X vehicles sold since 2014.[32] Autopilot includes features like "Autosteer, Auto Lane Change, Autopark and Summon," which moves the vehicles from the NHTSA's Level 1 classification into Level 2.[33][34] The program has initially tested well in the United States, select Asian markets, and the European Union, including a few reports of the Autopilot feature preventing accidents.[35] However, the Autopilot system has been heavily criticized for its role in multiple accidents since its introduction, including a fatal crash in Central Florida.[36] According to an investigation by the National Transportation Safety Board (NTSB), Tesla's Autopilot system was engaged, but failed to notice the white tractor trailer of the vehicle beside it against the bright sky.[37] The Autopilot failed to stop or notify the Tesla driver when the other vehicle turned in front of his vehicle, resulting in his death.[38] In the case of less serious accidents, the Autopilot system was engaged by the drivers, but according to Tesla's internal investigations of the accidents, the drivers ignored multiple warnings for the driver to take control.[39] Owners of these vehicles dispute Tesla's

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[29] *Id.*

[30] Google, *supra* note 24, at 4.

[31] Neidermeyer, *supra* note 15.

[32] *Id.*

[33] Tesla describes the features of the Autopilot software as follows: "Autosteer and Traffic-Aware Cruise Control – Autosteer assists the driver on the road by steering within a lane. It relies on Traffic-Aware Cruise Control to maintain the car's speed in relation to surrounding traffic. Auto Lane Change – By engaging the turn signal when Autosteer is engaged, drivers can be assisted in transitioning to an adjacent lane on the right or left side of the car, when it is safe to do so. Autopark – When driving at low speeds on urban streets, a "P" will appear on the Instrument Panel when a Tesla detects a parking spot. The Autopark guide will appear on the touchscreen along with the rear camera display, and, once activated, Autopark will begin to maneuver the vehicle into the parking space by controlling vehicle speed, gear changes and steering. Summon – With Summon, you can move Model S in and out of a parking space from outside the vehicle using the mobile app or the key. "Tesla Press Information," from *Tesla.* https://www.tesla.com/presskit/autopilot#autopilot (Last Accessed Nov. 27, 2016).

[34] *Id.*

[35] *See generally* Yoni Heisler, "Model X Driver Details how Tesla's Autopilot Software Prevented a Huge Accident," BGR (OCT. 19, 2016), *http://bgr.com/2016/10/19/tesla-autopilot-model-x-crash-accident-prevention/*

[36] *Id.*

[37] Bigelow, *supra* note 4.

[38] *Id.*

[39] Fred Lambert, "Tesla Autopilot Crash in Montana: Drivers Reveals new Details and Claims a 'cover up' by Tesla," ELECTREK (Jul. 22, 2016), https://electrek.co/2016/07/22/tesla-autopilot-model-x-crash-montana-coverup/

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claim that they are solely at fault.[40] According to the driver involved in one accident while Autopilot was activated, the vehicle "suddenly veered right and crashed into the safety barrier post…[without] any warning beep.[41] Autopilot did not slow down at all after the crash, but kept going in the original speed setting and continued to crash into more barrier posts in high speed."[42] These accidents and Tesla's response to them have left some skeptical about the company's ability to release a fully autonomous vehicle in the near future.[43]

Google's and Tesla's beta-testing programs over the past year have revealed a lot about the current state of autonomous vehicle technology, and provided both companies information to better upgrade their systems. Tesla, for example, is using the data it has collected over the past year through its Autopilot program to make upgrades for an Autopilot 2.0 update, which was released in October of 2016.[44] Additionally, the few accidents caused by the vehicle's software have highlighted certain issues with legal liability in the case of accidents; Tesla has recently indicated that they will not accept liability for accidents involving the new Autopilot 2.0 unless it can be proven that software solely caused the accident and the human driver attempted to take control of the vehicle.[45]

C. NEW GOVERNMENT RULES AND REGULATIONS REGARDING AUTONOMOUS VEHICLES

Earlier in 2016, the NHTSA announced new rules updating their position on autonomous vehicles. As mentioned earlier in this note, one of the major changes to the NHTSA's rules is the adoption of the SAE International classifications of autonomous vehicle capabilities. In addition, the NHTSA policy reveals that the government is simultaneously looking to increase the safety and security of vehicles while providing a great deal of deference to the individual states and the autonomous vehicle producers to develop comprehensive safety and liability policies.[46]

The NHTSA's new rules indicate that the government views autonomous vehicles as an inevitability, and welcomes the advancement as a way to improve road safety, increase access to transportation, and reduce the environmental

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[40] *Id.*

[41] *Id.*

[42] *Id.*

[43] Neidermeyer*, supra* note 15.

[44] Tesla, s*upra,* note 33.

[45] Yoni Heisler, "Elon Musk: Tesla Will Only Pay for Autopilot Accidents if the Software makes a Mistake," BGR (Oct. 20, 2016) http://bgr.com/2016/10/20/tesla-autopilot-crashes-liability-elon-musk/

[46] *Supra,* note 6, 25-26.

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impact of vehicle use in the United States.[47]   The NHTSA believes that the
introduction of autonomous vehicles will significantly reduce the number of
accidents on the road, as a majority of accidents are caused by human drivers.[48]
By replacing the human element with a machine, many of the mistakes in
judgement associated with human behavior will be eliminated.[49]   Accident
avoidance features, the NHTSA believes, will be critical in improving road safety
and saving lives.[50]   Furthermore, vehicle artificial intelligence (AI) is capable of
learning after one mistake and applying what it learned to all other autonomous
vehicles with the same AI. While human drivers will make the same mistake in
response to a situation, once any autonomous vehicle makes a mistake, it can send
that information back to the manufacturer and an update can be created to prevent
all other vehicles from making a similar mistake.[51]

The introduction of autonomous vehicles onto the roadway should
theoretically increase access to transportation for groups who may be
disadvantaged under the current system. Traditionally, access to an automobile
meant that the person usually owned the vehicle.[52] However, the rise of the
sharing economy with companies like Uber and Lyft, as well as "car sharing
clubs"—groups where members are able to rent vehicles for short periods of time
and pay based on their use—have greatly reduced the demand for owning
automobiles. These changes primarily benefit young professionals who live in
urban environments, but still critically leaves out those who do not have the
means to obtain a driver's license or pay for these options. Full implementation
of autonomous vehicles would allow those traditionally unable to drive the
mobility offered by owning a vehicle.[53]   The NHTSA believes that the
introduction of autonomous vehicles, combined with the lower ownership rates
associated with the sharing economy, means fewer vehicles will be transporting
more people.[54]

The NHTSA also contemplates various environmental benefits from the
implementation of fully autonomous vehicles, as fewer automobiles with a higher
utilization rate could result in a more efficient allocation of limited environmental
resources. The AI of an automated vehicle may be designed to make more fuel
efficient choices, either by driving at the most fuel efficient speed or

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[47] Kelsey D. Atherton, "What you Need to Know About the new Federal Rules for Driverless
Cars," POPULAR SCIENCE (Sept. 21, 2016), http://www.popsci.com/read-federal-rules-for-
driverless-cars#page-2
[48] Supra, note 1; see also Supra, note 6, pg. 5.
[49] Id. at 27-30.
[50] Id.
[51] Id. at 17-20.
[52] "The Driverless, Car Sharing Road Ahead, THE ECONOMIST.
http://www.economist.com/news/business/21685459-carmakers-increasingly-fret-their-industry-
brink-huge-disruption
[53] Supra note 6 at 4.
[54] Id.

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implementing other fuel saving techniques.[55] Furthermore, the NHTSA believes
that if those vehicles run on electricity, the environmental benefits of the switch to
autonomous vehicles would be compounded.[56] For example, if automated
vehicles were to switch from gasoline to electrical power, some sources estimate
that carbon-dioxide emissions from personal vehicles could drop by as much as
94%.[57] In addition, infrastructure needs may be significantly reduced, caused by
less "wear and tear" and the increased carrying capacity of existing roadways, as a
result of better utilization of and more efficient driving on the roadways.[58]

The NHTSA's new statement also indicates that the federal government is
expecting the individual States, insurance companies, and auto-manufacturers to
work out how autonomous vehicles will be introduced onto the road through its
Model State Policy.[59] Perhaps of greatest interest to this note is the NHTSA's
suggestion that the individual States figure out a liability scheme for autonomous
vehicles generally, and HAVs specifically, prior to full introduction.[60] The States
must determine important liability questions, including: who must carry insurance
for the vehicles—whether it be the driver of the vehicle, the auto-manufacturer,
the owner of the vehicle, etc.— or which party will be determined to be at fault in
the event of a HAV crash, to name a few.[61] In addition to creating a liability
system, the NHTSA advises that States consider the economic and legal impact of
imposing one liability scheme over another, as introducing a system that does not
adequately consider the costs or imposes a confusing regulations will create
undue hardship on the implementation of autonomous vehicles.[62] Numerous State
governments have taken the initiative in crafting legislation or issuing executive
orders regarding autonomous vehicles, including California, Arizona, and
Washington.[63]

Interestingly enough, the NHTSA also posits ethical considerations for
autonomous vehicles, and asks those involved with their design, implementation,
and regulation to consider these issues as well. Such moral and ethical
considerations are obviously important, as this is an instance of technology, the
law, and human life intersecting in a way that will become all too common in the
near future. By addressing such issues now, before full scale implantation of

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[55] *Id.*

[56] *Id.*

[57] Camille von Kaenel, "Driverless Cars may Slow Pollution," SCIENTIFIC AMERICAN (Jan. 19,
2016) https://www.scientificamerican.com/article/driverless-cars-may-slow-pollution/

[58] *Supra* note 6 at 4.

[59] *Id.* at 39-45.

[60] *Id.* at 44-45

[61] *Id.*

[62] *Id.*

[63] For a full list of states which have either passed, considered, or failed to pass legislation or
executive action on autonomous vehicles, see the map provided by Stanford Law. [Exhibit A]
https://cyberlaw.stanford.edu/wiki/index.php/Automated_Driving:_Legislative_and_Regulatory_
Action

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technology occurs, systems will be in place to allow for a smooth transition from human agents to non-human ones.

III.   THE FOUR CATEGORIES FOR UNDERLYING LIABILITY FOR AUTONOMOUS VEHICLES

Before considering possible liability schemes for autonomous vehicles themselves, it will be useful to explore their constituent parts. First, it is necessary to determine to whom a duty of care is owed: the individual or society at large. Autonomous vehicles are at a unique intersection in Tort law because they are both a product sold to individual consumers, who is owed several duties of care to ensure that the product they are sold does not intentionally injured them, and the individual driver, who owes a duty of care to others in the safe operation of their vehicles. Equally important is determining the party who is liable to others: either the individual owner/operator of the HAV, or the HAV's manufacturer. In this instance, engaging with a HAV AI blurs the line between an agent, who performs the *dynamic driving task* on behalf of the occupants but is created by the auto-manufacturer, and an inherently dangerous activity, where the individual must ultimately bear the responsibility for the actions of their HAV's AI. By exploring each of the individual facets, this note seeks to better inform its readers as to the costs and benefits of each position.

A. THE INDIVIDUAL OR SOCIETY: TO WHOM IS THE HAV'S DUTY OWED?

The problem posed by HAV's duty to protect is not a novel one, in fact it is nearly identical to the "Trolley Problem."[64] The HAV's AI, similar to the observer in the trolley problem, faces a decision, to save the lives of its passengers at the expense of others or to sacrifice the lives of its passengers in order to

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[64]The Trolley Problem describes a philosophical thought experiment often used in introductory philosophy classes to demonstrate two major modern philosophies: Utilitarianism and Deontology or Duty-based morality. The problem has many iterations, but is typically described as follows: a trolley is hurtling down a track towards five people. You are on a bridge under which it will pass, and you can stop it by putting something very heavy in front of it. As it happens, there is a very fat man next to you – your only way to stop the trolley is to push him over the bridge and onto the track, killing him to save five. Should you proceed? The two options demonstrate one of the philosophical positions; should one choose to sacrifice the fat man, they have taken the Utilitarian position by saving the five people on the track, netting four lives by their actions, while allowing the trolley to continue on its course without interference is the Deontological position, in which one respects the duty they owe to the fat man as a fellow human being and do not sacrifice his life in order to save the lives of the other people on the track. THOMAS CATHCART, THE TROLLEY PROBLEM OR WOULD YOU THROW THE FAT GUY OFF THE BRIDGE: A PHILOSOPHICAL CONUNDRUM, 1-2 (Workman Publishing, 2013); See also Nick Belay, Robot Ethics and Self-Driving Cars: How Ethical Determinations in Software Will Require A New Legal Framework, 40 J. Legal Prof. 119, (2015).

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maximize the utility of its actions. In order to determine a satisfactory answer to the problem, both positions contemplated by the problem—protecting the individual by respecting the duty of care owed to them or to minimizing the costs by sacrificing the life of an individual—should be examined to determine not only the economic and social costs that implementing such a policy may have, but also the potential human costs of adopting one position over the other.

i. THE HAV'S DUTY SHOULD BE TO PROTECT SOCIETY'S INTEREST BY MINIMIZING COSTS

By designing all HAVs to protect society's interest over the individual, and therefore minimize the overall costs of the accident, the law would be taking the most Utilitarian approach to the question.[65] HAVs would need to make calculations of the risk, reward, and cost of every potential act it could take in a given situation, and based on those calculations, execute a decision or series of decisions which would maximize "utility." Practically speaking, this would make the HAV's internal computer systems, and by extension the auto-manufacturer or programmer, the "least cost avoider".[66] In Level 5 HAVs, which lack any input systems for the passengers of the vehicle to control or override the decisions of the internal computer systems, the only party who would be capable of avoiding the accident would be the vehicle's internal systems.

For the designers and manufacturers of HAVs, such an arrangement makes economic sense; it would be far better for the HAV to limit the amount of damage it causes in an accident than it would be for it to take unnecessary and economically costly decisions in an attempt to save the lives of the passengers inside the vehicle. The vehicle's AI would be driving the vehicle, and like any other driver on the road, it owes duties of care to pedestrians, vehicles, and other property owners on or adjacent to the roadway. However, unlike human beings, the vehicle's AI does not have an irrational survival instinct, thus making it more accurate in balancing the probability of its passengers surviving the accident and

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[65]Utilitarianism as a moral philosophy argues that the moral worth of an act should be judged on the outcome of the act. Acts which result in the greatest amount of happiness—referred to as utility—for the greatest number of people possible are considered to be more morally good than acts which create less happiness for fewer people. Happiness in this context is best understood as well-being. In proscribing a course of action for those who follow this philosophy, agents should act in a way which they believe the outcome of their acts will create the greatest utility or limit the overall amount of suffering to a minimum. See J.J.C SMART & BERNARD WILLIAMS, UTILITARIANISM FOR & AGAINST, at 30-36 (Cambridge University Press, 2008).

[66] In Tort law, the least cost avoider is the party which could most easily and most cheaply avoided the accident involving the parties. For example, if two vehicles were involved in a collision, then the least cost avoider would be the party which could have most easily or cheaply prevented the accident, by say, swerving or changing speed. Giuseppe Dari-Mattiacci & Nuno Garoupa, Least Cost Avoidance: The Tragedy of Common Safety, Geo. Mason U. J.L. Econ. & Org. 3, (2007).

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the cost of executing maneuvers in order to ensure that its passengers survive. For example, if the vehicle's AI determines that taking extreme maneuvers in order to protect its passengers in the event of an accident would result in greater damage to property or human life than if it took less extreme measures that put its passengers at risk of harm, then the AI would opt for those less extreme measures.[67] Similarly, the vehicle's AI would most likely refuse to break the law in instances where breaking the law, such as a husband rushing his wife and soon-to-be-born child to the hospital, as the utility of breaking the law would be lower than breaking it.[68,69] This type of moral programming into the HAV's AI could also find a useful application when the vehicle has no human passengers—such as when the vehicle is in Tesla's "Summon" mode—or when the vehicle only contains cargo, such as long-distance trucking of goods across the country.[70]

However, this approach is not without its drawbacks, both philosophical and economical. To name a few examples without going too deeply into their philosophical underpinnings: how does the AI choose between two equally costly alternatives; how does the AI determine the value of human life, multiple human lives, or other objects which have no monetary values such as art, historic monuments, etc.; what unit does the AI use to measure the value of the objects in its environment? While such concerns may seem esoteric, the value judgements made by HAV programmers concern real human lives. Furthermore, these philosophical issues give rise to economic ones, especially if philosophical judgements made by AI designers conflict with the moral values held by their customers. Potential customers may desire that the vehicle operate under a moral system which protects them over pedestrians and others, or one that calculates the costs of the accident in a different manner, thus limiting the sales of the technology to those who do not have moral objections to the decision-making protocols of the AI.[71]

Treating the HAV's AI as "the rational driver," would benefit society as a whole through a more effective allocation of resources. Presuming that some

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

[68]Such a scenario provides a classic example of the difference between rule based utilitarian ethics and hedonistic utilitarianism. While a rule-based utilitarian, such as philosopher J.S. Mill, would argue that more utility is created by following the law—as society as a whole benefits from its individual members following the law—a hedonistic utilitarian, like philosopher Jeremy Bentham, would argue that more utility would be created by breaking the law and allowing the father to more quickly to deliver his wife to the emergency room, as the pain of the act, that is the cost of breaking the law, is relatively small compared to the pleasure gained from the same act, that is the peace of mind of safely delivering the wife to the hospital. See JEREMY BENTHAM, AN INTRODUCTION TO THE PRINCIPLES OF MORALS AND LEGISLATION, (Oxford Clarendon Press, 1907); See also, LEO STRAUSS & JOSEPH CROPSEY, HISTORY OF POLITICAL PHILOSOPHY, at 710-729 (3rd ed., Univ. of Chicago Press, 1987).

[69] *Id.*

[70] Tesla, *supra,* note 34;

[71] *Supra,* note 64.

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accidents will still occur despite the introduction of HAVs, many would argue that it would be best that those accidents do the least amount of damage to the fewest number of people possible. As such, having the HAV AI function as a means of reducing costs may be seen as a benefit to society, considering that human drivers will make irrational choices that may make accidents more expensive than they have to be.

### ii.	THE HAV'S DUTY SHOULD BE TOWARDS ITS PASSENGERS

In the context of the "Trolley Problem," this would be akin to not pushing the fat man over the bridge in order to stop the trolley from killing the five people down the track, taking the Deontological approach to solving the issue.[72] The observer in that situation has a duty to not act against his fellow human beings that trivialize or commoditize his existence; by throwing the fat man over the bridge to stop the trolley, the observer treats the man as a means to an end rather than an end-in-itself.[73] In a sense, the life of the fat man is in the hands of the observer, as his actions control whether he lives or dies. Similarly, the HAV, has total control over its passenger's lives, as it directs them through traffic. Additionally, the HAV could arguably have a duty, through its manufacturers as a product sold to and used by its owners, to protect those its passengers from undue harm.

In practice, this would mean that the HAV's AI would take every measure available to it in order to save the lives of its passengers, even if such measures would cause more damage than the economic value of its passengers' lives. The design would both model human's natural decision-making preference for self-preservation, and would act as a human driver would—or would attempt to act if it were within their power—in the event of an accident. Belay gives an interesting example in his article of a rather difficult choice a HAV may need to make; "imagine a scenario where a child runs in front of a car approaching a tunnel. The options are to either hit and kill the child or swerve into the wall and

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[72] Deontology, or duty-based ethics, argues that actions have moral worth based on the whether or not the act itself conforms to the ideals of duty that the agent owes to others. Acts which conform to these duties are considered morally good, even if the outcome does not meet or result in an optimal outcome, while acts which do not conform with duty are seen as immoral, even if the outcome would result in a net positive for all those affected by the act. In following this system of ethics, therefore, agents should always conform to the duties they owe others, regardless of what the outcome may be. *See generally,* Pierre Hassner, "Immanuel Kant," from *History of Political Philosophy,* 3rd Edition. Ed. Leo Strauss and Joseph Cropsey, (University of Chicago Press), pg. 581-85.

[73] In *The Critique of Pure Reason*, Immanuel Kant argues that humans, as moral agents, owe many moral duties towards one another, including treating others "as though they were an ends to themselves," or rather than human life is intrinsically valuable. *Supra,* note 2 at 95-96.

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kill the driver."[74]   In this instance, because the HAV's duty is towards its passengers, the HAV's AI would make choice to hit the child in order to protect the life of the driver. While such a choice may seem difficult or even cruel, such a decision is the preference of the majority of drivers currently on the road today; a survey conducted in 2012 indicated that a majority of drivers, 64%, would prefer that their vehicle protect themselves or their loved ones in the event of an accident over the lives of pedestrians or those outside the vehicle.[75]

Purchasers of HAVs would obviously prefer auto-manufacturers and programmers to design their vehicles in this way. Not only does this mimic the way that the purchasers themselves would probably react in a similar situation, but it could serve as a way to ease the apprehension of those skeptical of an autonomous vehicle's ability to keep its passengers safe. Because most passengers would believe that the vehicle they are inside is designed to keep them safe in an accident, programming the HAV's AI with a duty to protect the lives of its passengers above all others could prevent product liability claims.[76] However, this method is not without its drawbacks. First, programming the vehicle's AI to make potentially irrational decisions prevents autonomous vehicles as a whole from providing their full economic benefit to society. If the vehicle would behave like a human driver would in the event of an accident, then many of the cost saving benefits to society might be offset in an attempt to protect the lives of human passengers in situations where doing so—from a cost/benefit perspective—would be unwise. Additionally, programmers, auto-manufacturers, and insurers may be hesitant to implement systems which increase their costs in providing and protecting HAV users. Assuming that HAV producers will face liability in the event of accidents caused by their AI, they will have to pay out the damages that would have otherwise been borne by insurance providers.

B. THE INDIVIDUAL OR THE PRODUCER: WHO ULTIMATELY BEARS LIABILITY

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[74] *Supra,* note 64

[75] *Id.*

[76] Products Liability claims fall into one of three categories: manufacturing defect, where the product does not conform with its original, intended design; a failure by the manufacturer to provide adequate warning "when the foreseeable risks of harm posed by the product could have been reduced or avoided by the provision of reasonable instructions or warnings," thereby rendering the product unsafe; and design defect, where the "foreseeable risks of harm posed by the product could have been reduced or avoided by the adoption of a reasonable alternative design," and the failure to do so renders the product unsafe. Lindor and Marchant argue that the first two categories of products liability claim have little to do with the design of autonomous vehicles, but the third—design defect—does, as an alternative design to the HAV's AI could be argued to have likely prevented an accident in the future. Gary E. Marchant and Rachel A. Lindor, " The Coming Collision Between Autonomous Vehicles and the Liability System," from 52 SANTA CLARA L. REV. 1321 (2012); *See Also* Restatement (Third) of Torts: Prod. Liab. § 2 (1998).

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Another key question to answer prior to the full implementation of HAVs is to determine which party will bear liability in the event of an accident. Over the last couple years, two distinct camps have emerged within the research: individual liability for the HAVs decisions under a strict liability theory, and producer liability under an agency theory of liability.[77]

i.   HOLDING THE INDIVIDUAL LIABLE UNDER STRICT LIABILITY

Holding the individual liable, or requiring the individual to purchase insurance in order to protect society in general from any damage he makes while driving, is currently how liability in the United States functions. However, this is ultimately a result of the individual maintaining control of the vehicle through the majority of the *dynamic driving task*. Since HAVs will control essentially all of the driving task, and Level 4 and 5 vehicles ultimately do not require its passengers to control any part of driving, imposing such liability is not without its potential difficulties. Currently, US law requires that all operators of vehicles have sufficient insurance to cover damages from accidents they may be involved in.[78] Justifications for such laws vary, but two primary rationales appear to dominate modern thinking; either that human drivers, under a theory of negligence, will more likely than not make a mistake, or that the act of driving in-and-of-itself is a dangerous activity, and therefore a driver must be strictly liable for any accident they cause.

Typically, there are two different methods for holding a person liable for damages caused by their accidents, a negligence system and a strict liability system.[79] Both of these systems provide economic disincentives for causing accidents, although the means by which those effects are carried out differ by

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[77] Over the years, the idea of taking a products liability approach to autonomous vehicles has dropped out of favor due to problems associated with how the current legal system deals with the issue and the fact that such an approach may not be the most beneficial way of categorizing AI, especially as it becomes more and more complex. Generally speaking, products liability falls into three categories—as detailed in the previous footnote. Since none of these categorizations neatly details how a consumer may be protected in the event of an accident, there is already an issue in applying a products liability framework to autonomous vehicles. Compounding this issue are problems associated with products liability law generally, such as high litigation costs for widely sold products, marginal gains in safety improvements, and limited benefits for consumers. This author is convinced by the scholarship on both products liability generally and its specific application to AI in the future, that the products liability framework will not be used to assess damages in cases involving AI. *Supra,* note 64; *See Generally* A. Mitchell Polinsky; Steven Shavell, "The Uneasy Case for Product Liability," 123 HARV. L. REV. 1437.

[78] *See Generally,* Robert E. Helm, "Motor Vehicle Liability Insurance: A Brief History," 1 ST. JOHN'S L. REV. 43 (Jul. 1968).

[79] *See* Schafer, Hans-Bernd and Muller-Langer, Frank, "Strict Liability versus Negligence," GERMAN WORKING PAPERS IN L. AND ECON. (2008).

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system.[80] Under a negligence system, liability is determined by the behavior of the agent causing the accident compared to that of a "reasonably careful person" in a similar situation.[81] For example, if the agent acted at or above the level of care that a "reasonably careful person" would have, liability may be avoided; conversely, if the agent's actions are determined to be below the level of care that would have otherwise been exercised, they are likely to be found liable.[82] The system, in theory, creates a socially optimal level of risk-taking and avoidance, whereby agents are not overburdened by taking exorbitantly costly risks and society is protected from agents who do not undertake enough precautions.

A strict liability scheme, on the other-hand, attempts to achieve the optimal level of societal risk by pinning all of the accident costs on the person who engages in the activity which causes the accident and making them determine the cost of such accidents. Through strict liability, according to Schafer and Muller-Langer, "the self-interested injurer's objective [is] to minimize her private costs…the injurer will have an interest to minimize total accident costs" because they bear full liability.[83] Here, optimal risk allocation occurs when the agent takes just enough precautions to cover the risk of loss in an accident. For example, a driver believing that their accidents will cost them $10,000 will take risk-preventing measures up to that value. Many legal scholars argue that this system provides better protection for both the injurer and the victim. Steve Schavell argues that while the frequency of claims is higher under strict liability than under a negligence system, fewer of those cases would enter litigation, thereby reducing the overall societal cost of injuries by eliminating adjudication costs.[84] Additionally, those in the position to cause accidents are better at determining the risks and costs associated with those accidents.[85] eaving optimization of risk up to the risk creators, thereby protecting potential victims and limiting costs for creators, are advantages that would benefit both victims and society.

Almost immediately, one can see the issue of holding drivers individually liable for the actions of autonomous vehicles that they do not directly control.

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[80] *Id.* at 4-5.

[81] *Id.*

[82] The explanation provided is a simplification of a relatively complex and nuanced concept in the law, especially considering that the "reasonably careful person," is a legal fiction used by courts to determine whether or not an agent's actions fall under a societally optimal level of risk-taking. The "formula" for determining negligence and liability was first described by Judge Learned Hand in *United States v. Carroll Towing Company* as B > PL, where B is the burden of reasonable precaution to prevent an accident, P is the probability of that accident occurring, and L is the damage resulting from that accident. If the B taken by the agent is greater than the likelihood and cost of the accident, then the agent will likely not be held liable for the action, and vice-versa. *Supra,* note 75 at 4; *See Generally United States v. Carroll Towing Company,* 159 F.2d 169 (2d. Cir. 1947).

[83] *Supra,* note 75 at .6-8.

[84] Shavell, Steven, *Strict Liability versus Negligence,* 9 J. OF LEGAL STUDIES (1980).

[85] *Supra,* note 75 at 7.

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Especially under a negligence scheme of liability, where human actors can negate liability by taking necessary precautions, holding individuals liable for the actions of their autonomous vehicles that they cannot mitigate or control is absurd. However, at least initially, a system of individual liability through strict liability might be a more palatable alternative. In a situation where the vehicle's AI determines that it could not handle the situation, drivers could be held strictly liable for the actions that their vehicle takes while in autonomous mode because they knowingly accept the risk of potential accidents since the driver has the ability to toggle autonomous mode on and off and take control of the vehicle. In doing so, early adopters of autonomous vehicle technology engage in the same type of decision-making rationale that Schafer and Muller-Langer discuss--the driver balances the personal costs of the accident with the societal costs of the accident.[86]

During the early stages of HAV introduction onto the roadway while there are still human drivers on the road, individual liability through strict-liability may appear to be an attractive first step to comfort human motorists. The liability would remind early-adopters that this technology is in its early stages and in need of human decision-making faculties in certain situations. In the NHTSA and Tesla's own analysis of the June 2016 crash, the driver was believed to have been inattentive—watching a movie on his iPad while the vehicle traveled down the highway—which prevented him from reacting when the vehicle's Autopilot systems informed him that it needed him to take over to prevent a crash.[87] It is likely that similar accidents, where the AI needs the human driver to take over for it, will occur as the technology is introduced and improved upon. Requiring individual liability insurance would, therefore, encourage individual responsibility in determining when it would be prudent to turn on autonomous mode and the safe operation of the vehicle during that time, especially in difficult driving situations, e.g. inclement weather. Additionally, such a move would eliminate any legal ambiguity regarding liability of the accident, and would allow victims a more direct cause of action against the owners or operators of HAVs.[88]

However, some experts believe that individual liability creates numerous problems for the implementation of HAVs in the future. First, the concept of strict liability for the act of driving would disincentivize many drivers from purchasing HAVs in the first place. These experts argue that requiring individuals to maintain liability insurance for their HAVs in case of an accident would defeat the government's objective of reducing accidents by keeping human drivers on the road. Additionally, individual liability "would (at least in part) remove incentives for the manufacturer to program smart decisions, as the manufacturer would share none of the risk associated with those decisions;" in other words, auto-manufacturers may choose to make economic choices which

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[86] *Id.*

[87] *Supra,* note 4.

[88] *Supra* note 75 at 7-8.

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result in less optimally designed HAV AI because they would not bear the costs of any mistakes or accidents caused by the vehicle.[89] As a result, individual liability in the long-run may prove to be unappealing, especially if Level 5 vehicles become the norm and provide the owner/operator an opportunity to use their own driving ability to prevent or lessen the damages of an accident.

Ultimately, the issues associated with individual liability will become problematic from both an ethical and legal perspective when fully-autonomous vehicles come to replace human and semi-autonomous vehicles in the near future. The level of human agency associated with the *dynamic driving task* will inevitably be limited to entering coordinates or addresses for the HAV's AI to follow, placing the responsibility for all major driving decisions with AI. Since any semblance of human agency over the driving behavior of the vehicle will disappear, individual liability must inevitably disappear when vehicles become fully automated.

ii. *HOLDING THE PRODUCER LIABLE UNDER AN AGENCY APPROACH*

Traditionally, the concept of agency law applies to human agents who are employed by a principal to provide services to a third-party client. As the AI enters more and more into daily life, the ability to hold an object's AI liable under a theory of pure product liability has potentially become more and more difficult. The concept of applying agency law to AI is a relatively new legal theory, but one that has garnered much interest and research over the past few years, especially in regards to autonomous vehicles and other "smart" devices.[90] The main problem with this approach, as many of its proponents note, is the idea that the object to which our legal system wishes to apply agency law to is not an agent in the traditional sense.[91]

In order to implement a system of liability where the auto-manufacturer is liable to the passengers and owners of the vehicle in the event of an accident caused by the HAV's AI, the issue of the HAV's AI authority to enter into contracts must first be resolved. Traditionally under agency law, the principal of an agent can be held liable for the acts of that agent. However, a party injured by an agent may only sue the principal if that agent had either the actual or apparent authority to enter into that contract.[92] This can be problematic given that AI is not typically considered a legal person capable of forming a contract. A solution to this authority problem, at least partially, exists by considering that the HAV's AI has the apparent authority to enter into contracts with the owner of the individual

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[89] *Supra,* note 64.

[90] *See generally,* Samir Chopra and Laurence White, Artificial Agents and the Contracting Problem: A Solution Via an Agency Analysis, U. ILL. J.L. TECH. & POL'Y (2009).

[91] *Id.* at 365.

[92] Restatement (Third) Of Agency § 7.03 (2006).

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vehicle. This system would both "[dispense] with the need for a manifestation of assent by the principal to the agent…[and] avoids any need to invoke the agent's consent to such a manifestation."[93]   However, as Samir Chopra and Laurence White argue in their article, such a solution may be insufficient and it may be prudent to give the HAV AI the actual authority to enter into contracts. [94] The final, and perhaps thorniest, issue presented by the implementation of agency law for AI is the question of legal personhood.

Chopra and White offer a potential solution to the problem; treating the artificial agent as an instrument which has the legal power to enter into contracts, but is not in itself a legal person.[95] Such an approach would call for principals—in this case, automotive producers and the programmers they hire to design the "mind" of the HAV's AI—to imbue their created agents with either the actual or apparent authority to enter into a "contract" with the owner/operators of the HAV.[96]   Chopra and White draw a rather useful analogy to Roman Law's treatment of slaves to demonstrate their argument:

> "Like artificial agents, Roman slaves were skillful, and often engaged in commercial tasks on the direction of their masters. They were not recognized as legal persons by the *ius civile*, or civil law, and therefore lacked the power to sue in their own names. But, Roman slaves were enabled, by a variety of legal stipulations, to enter into contracts on behalf of their masters. These could only be enforced through their masters, but, nevertheless, slaves had the capacity to bind a third party on their master's behalf. From this, [Ian R.] Kerr concludes that '[i]f . . . electronic commerce falls mainly in the hands of intelligent agent technology, the electronic slave metaphor could turn out to be more instructive than typical metaphors."[97]

Thus, by conceptualizing the AI as something akin to a slave in Roman Law—"an intelligent non-person actor with legal capacity to bind its principal"—and combining it with modern agency law's apparent and actual authority provisions, a system of liability may be created for the seemingly independent and numerous actions that a HAV's AI may need to take in completing the *dynamic driving task*.[98]

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[93] *Supra,* note 87 at 376.

[94] *Id.* at 377.

[95] *Id.*

[96] *Id.*

[97] *Id.*

[98] *Id.* at 378 (explaining the utility of Roman jurisprudence in understanding approaches to nonliving agents).

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Imposing such a system on the HAV AI carries with it a few distinct advantages. First, holding the manufacturer liable for the acts of the HAV's AI seems to be the most logical choice, as the manufacturer "creates" the agent. Also, from the perspective of agency law, the auto-manufacturer is the "least cost avoider," and is therefore in the best position to prevent accidents through its programming of the HAV's AI. Corporate liability also insures that parties who are injured have the ability to recover the full cost of their injuries. Finally, and perhaps most importantly, corporate liability would incentivize manufacturers to ensure that the vehicle's systems have minimized design flaws, as they would ultimately bear the cost of such flaws. Despite concerns by scholars like Belay that imposing liability on auto-manufacturers would stifle innovation, Google, Mercedes-Benz—among a few others—have stated that they would willingly accept liability when their vehicle's AI is found to be at fault for an accident, although, as recently demonstrated by Tesla's press-releases regarding its Autopilot 2.0 system, such a bar may be difficult for the consumer to prove.[99][100]

The imposition of corporate liability may create a "Moral Hazard Problem," caused by owners and passengers in HAVs becoming more complacent about safe vehicle operation because they will not be responsible for any damage caused by the vehicle in the event of an accident.[101] While corporations may be the "least cost avoiders," individual drivers determine the level of accident risk when they engage the vehicle's AI to drive, which may be in conditions that the system cannot handle. By eliminating the drivers may choose to have their vehicles drive in situations where they personally would not, knowing that in the event of an accident, they will not be liable for damages. These costs, borne by the auto-manufacturers, would slightly dampen the overall economic benefit of autonomous vehicles. One potential way for auto-manufacturers to limit their own liability in these situations would be to prevent the vehicle from driving in potentially dangerous situations, i.e. if the vehicle's AI decides that the driving conditions are dangerous, the vehicle will not drive. In Level 3 and Level 4 vehicles, the driver could still decide to take the risk of driving the vehicle in

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[99] Ryan Nakashima, Carmakers at Nevada Show: Driverless Cars Need Legal Framework, INS. J. (Jan. 13, 2014), http://www.insurancejournal.com/news/west/2014/01/13/316913.htm.

[100] HEISLER, *supra,* note 41 (voicing Tesla's regulatory concerns).

[101] This problem, known as "moral hazard," is a common argument brought against a variety of programs which limit liability for parties that may otherwise be responsible for unsafe or negligent behavior. As a result, parties protected from the liability of their actions are more likely to engage in riskier behavior and/or take fewer precautions in order to mitigate their risk or loss. Widely discussed in both economic and insurance circles, the argument of moral hazard has been applied to problems ranging from Federal Deposit Insurance requirements—which make consumers less concerned with a bank's financial performance because their money will be protected by the federal government—to mandatory seat-belt laws, where drivers believe that their seatbelt will protect them in the event of an accident and will, in theory, drive more recklessly. *See generally,* Paul Krugman, *The Return of Depression Economics and the Crisis of 2008* (W.W. Norton Company Ltd., 2008), at 30.

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conditions, although this may require a separate level of individual insurance. This issue becomes amplified in Level 5 HAVs, because if the vehicle's AI decides not to drive, the vehicle will not drive.[102] For example, in the evacuation of a major city in the event of a large storm, the vehicle's AI could decide that road conditions are too dangerous to evacuate a person, trapping them. There may be a few potential work-arounds for this situation, such as an emergency override from the auto-manufacturers to allow travel or the use of the legal system to determine whether or not the driver was negligent in deciding to drive, akin to current tort cases.

Corporate liability through agency law does have issues that it must overcome before it is fully workable in the US legal system. However, the distinct advantages it carries for both the consumer and the avoidance of major ethical problems mean that this system should become the dominant means of determining liability moving forward.

IV.   FOUR LIABILITY SCHEMES FOR AUTONOMOUS VEHICLES

Having now examined each of the four components of our liability scheme—duty towards the individual or duty towards the society at large and individual liability or corporate liability—this note will now examine the four liability schemes that result from the individual combinations of each of the elements: duty towards the individual and individual liability; duty towards the society at large and corporate liability; duty towards the society at large and individual liability; and duty towards the individual and corporate liability. In examining each of these four schemes, this note will examine both the economic costs--those by the owner/operators, the producers and programmers of HAVs, and society generally as well as any ethical issues that may arise from imposing such liability programs on the same parties.

A. DUTY TOWARDS THE INDIVIDUAL AND INDIVIDUAL LIABILITY (THE CURRENT SYSTEM)

The duty towards the individual and individual liability for accidents involving HAVs bears a striking resemblance to the current system. The AI's duty towards its owner and passengers is similar to the human driver's instinct in self-preservation; that is to say that an AI which seeks to protect the lives of its passengers as its highest duty reflects an overwhelming majority of human driver's own attitudes. In addition, individual liability during the operation of a vehicle, even one with significant assistance from computer systems such as autopilot in commercial airliners, has routinely been imposed by courts in jurisdictions around the United States.[103]

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[102] SAE *supra* note 11.
[103] Brouse v. United States, 83 F. Supp. 373, 374 (N.D. Ohio 1949).

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Protecting the lives of its passengers despite the cost it may have on society as a whole should ease the transition from Level 2 autonomous vehicles where the driver controls the majority of the driving task to Level 3 HAVs and beyond by creating peace of mind for drivers, who know that their vehicle's AI will do everything within its power to protect their lives. As mentioned earlier, a majority of drivers would prefer that their vehicle's AI would protect them or their loved ones instead of others outside of the vehicle in the event of an accident.[104] If the goal governments and auto-manufacturers is to replace all Level 0, 1, and 2 vehicles on the road with Level 5 vehicles in the long term, then consumers must be comfortable with the short term solutions of Level 3 and 4 vehicles; one way to create that comfort would be for auto-manufacturers to design or install their HAV's AI with a prerogative to protect the lives of its passengers at all costs.

Individual liability for the HAV's actions is appropriate when a human operator is responsible for the safe operation of the vehicle in difficult situations which the AI is unable to handle on its own. These early, Level 3 HAVs require its operators remain attentive and able to take control in the event that the AI encounters a situation—inclement weather, sensor failure, impending accident, etc.—which it is unable to handle.[105] These warning systems are designed to give the operator adequate time to take notice of the situation and react appropriately, giving all or almost all control of the *dynamic driving task* back to the driver. Level 3 HAVs function like autopilot on modern commercial airlines; the pilot taxis, takes-off, and lands, but the autopilot flies the aircraft once engaged by the pilot at a certain altitude. In the event of a situation in which the autopilot is unable to control the aircraft, the pilot is required to take physical control and guide the aircraft until the situation which the autopilot could not handle is abated or the aircraft has landed.[106]

However, if the pilot fails to take control of an aircraft when the autopilot can no longer safely operate, then he or she can be held liable for their failure to action. In *Brouse v. United States*, the pilot of an aircraft was held liable for the damages caused when his aircraft crashed into another while the autopilot was engaged. The US District court held that the operator of an aircraft has "[an] obligation of those in charge of a plane under robot control to keep a proper and constant lookout" in order to safely operate the aircraft.[107] Additionally, the court found that, "had a proper lookout been maintained the collision would not have occurred." [108] Individual liability, as understood through *Brouse*, would require that operators of HAVs be on the lookout for any potential hazards while their vehicle is on the road, and to avoid the accidents themselves when the situation

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[104] *Supra,* note 64
[105] *Supra,* note 10.
[106] *Supra,* note 64.
[107] *Id.* at 374.
[108] *Id,* at 375.

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requires. However, if an accident occurs and it is deemed to be because of the operator's own negligence, they would not be able to rely on the fact that their HAV was in autopilot mode in order to avoid liability.[109]

While the autopilot analogy and individual protection with individual liability may succeed in the short term, especially with transitioning consumers into the market, this liability scheme will ultimately be phased out in favor of some of the other systems discussed below. First, individual liability will be a difficult sell long term with Level 4 and especially Level 5 HAVs. Individual liability for Level 4 HAVs could be a difficult sell considering that operators are not required to intervene in the event of an imminent collision.[110] A possible scenario of individual liability would probably be utilized by auto-manufacturers or their insurance companies in a subrogation action to recover against a driver who negligently overrode the HAV's AI to control the vehicle in the event of an accident. For example, if a Level 4 HAV indicated to its driver that the vehicle was to be involved in an accident, and the driver then took control of the vehicle instead of letting the AI direct the crash only to cause substantially more damage than would have occurred, a potential right of action by the insurer could be theorized to recover for the difference in damages caused by the behavior of the operator. However, because Level 5 HAVs completely lack any means for its passengers to control the *dynamic driving task*, individual liability borders on the absurd; it would be the equivalent of holding the passengers of an aircraft liable for the pilot's decisions in an accident. Therefore, as autonomous vehicles continue to rely less and less on their occupants for assistance in the *dynamic driving task*, a system of individual liability, at least for vehicles with human occupants, should eventually disappear entirely.

B. DUTY TOWARDS SOCIETY AT LARGE AND CORPORATE LIABILITY (THE CORPORATION'S AGENT)

Under this liability scheme, the HAV's AI would be designed to reduce the costs of its accidents and those who designed the AI would bear the costs of the accident. This system would be the purest incarnation of agency law applied to autonomous vehicles; HAV AI would be designed to serve the best interests of its producers by limiting its liability in the event of an accident by pursuing the lowest cost outcome. Combining the exact opposite set of values and liabilities creates a completely different set of costs and benefits for this system, both economically and morally. While the system would be a difficult for individual consumers to accept for their own personal vehicles, this system could be attractive to large corporate clients and shipping companies to reduce the costs and potential loses for the transportation of everyday goods.

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[109] *Id.*

[110] SAE, *supra,* note 11.

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HAV AI designed to minimize the cost of accidents is an attractive alternative to a duty to unilaterally protect its passengers when there are no human passengers to protect, such as cargo shipments across the US. Fully autonomous vehicles would completely eliminate the need for commercial truck drivers, who serve no other purpose than to guide the vehicles and their cargo from point A to point B. Therefore, the duty for the HAV's AI to protect its passengers is rendered moot. In the event that a HAV cargo transportation vehicle is involved in an accident, the HAV's AI would seek to limit the damage caused by the accident. Accidents involving a cargo transportation HAV and non-human entities—such as an imminent collision with non-human objects—would seek to limit the cost based on the AI's analysis of cost based on its programming, while accidents involving a cargo transportation HAV and humans would presumably seek to limit the injury to human parties.[111] This system could reduce the overall costs for shipping companies around the US, who routinely spend 75% of the shipping cost per vehicle on labor. Additionally, the introduction of HAV shipping would further reduce shipping costs by allowing vehicles to travel for a longer duration without stopping for rest; currently, truck drivers are "restricted by law from driving more than 11 hours per day without taking an 8-hour break," while a HAV would be able to travel for twenty-four hours continuously.[112] These benefits, however, are not without their costs, namely the replacement of nearly 1.6 million truck drivers in the United States.[113] However, the savings for shipping companies, in terms of labor, cost of upgrading the fleet to HAVs, and efficiency gains, would greatly reduce the cost of shipping via trucks, potentially passing on such gains to the consumer.

In addition, this liability scheme may be attractive to those who are willing to accept a, relatively speaking, higher level of risk which lowers or eliminates their costs for personal insurance. The best current analogy to such a system is found in health insurance, with high-deductible/ low premium plans. These plans offer much lower monthly premiums combined with much higher out-of-pocket costs in the event of an accident.[114] These plans are most attractive to those who have few or no health problems which require consistent management, but do not have the means to—or do not wish to spend their income on more—lower deductible, higher premium plans, such as young, healthy adults who have

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[111] As discussed previously in the section about "Duty towards Society," Utilitarianism may sometimes lead to an issue where human life, based on certain evaluation criterion, could be considered less valuable than certain objects. *Supra,* note 65.

[112] Ryan Petersen, *The Driverless Truck is Coming, and it's Going to Automate Millions of Jobs*, TECH CRUNCH (Apr. 25, 2016), https://techcrunch.com/2016/04/25/the-driverless-truck-is-coming-and-its-going-to-automate-millions-of-jobs/.

[113] *Id. see also,* Todd Litman, *Autonomous Vehicle Implementation Predictions*" VICTORIA TRANSP. POLICY INST. 12 (Feb. 9, 2018*),* http://www.vtpi.org/avip.pdf.

[114] Reed Abelson, *Is High Deductible Health Insurance Worth the Risk?* N. Y. TIMES (Oct. 31, 2016), http://www.nytimes.com/2016/11/01/business/is-high-deductible-health-insurance-worth-the-risk.html.

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recently entered the workforce.[115] In the context of HAVs, such a system would be attractive to those who fall into a "low-risk" pool, such as those who do not drive often and/or those who drive in lower accident prone areas or during lower traffic hours.[116] Millennials would be an ideal consumer under this liability scheme; Millennials among other qualities, have a lower rate of car ownership than other generations, live in urban environments where vehicle use is rare, and have lower levels of income which they may be unwilling to spend on car insurance, etc.[117]

Corporate Liability via agency law in the context of programming the HAV's AI to limit the overall cost of an accident is a viable solution, as the automobile corporation is the "least cost avoider." Under the concept of agency law, the principal is generally held liable for the actions of their agents in the event of an accident because they are best able to avoid the costs of the accident as opposed to either of the involved parties (namely the agent or the injured third party).[118] The auto manufacturer is the least-cost avoider, and therefore the rightful bearer of liability, because they ultimately design the HAV AI and how it will interact with the outside world. Thus, holding the auto-manufacturer liable is appropriate when the vehicle is designed to create the least economic damage possible.

Although the courts have previously taken a products liability approach in holding auto manufacturers liable for accidents involving vehicles internal systems, such as cruise control, these cases provide an example of how the courts may consider individual cases for holding auto manufacturers liable for accidents. In *Cole v. Ford Motor Company,* the court allowed for a products liability action to proceed against the Ford Motor Company for a defectively designed cruise-control setting.[119] The plaintiff drove his vehicle with the cruise control engaged, and had turned off the vehicle without turning off the cruise control.[120] When the plaintiff drove the vehicle again, he did not turn on the cruise control, but when the plaintiff attempted to stop the vehicle, the vehicle suddenly sped up, causing the plaintiff to crash into a guard-rail and injure himself.[121] The Oregon Court of Appeals upheld a decision by the trial court that the defective design of the cruise control was the cause of the accident; even though the driver did not personally

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[115] Mark Pauly & Bradley Herring, P*ooling Health Insurance Risks* (1999).

[116] *Where Car Accidents Happen Most*, ESURANCE https://www.esurance.com/info/car/where-car-accidents-happen-most.

[117] *Millennials: Coming of Age*, GOLDMAN SACHS*, http://www.goldmansachs.com/our-thinking/pages/millennials/.*

[118] *Supra* note 63.

[119] Cole v. Ford Motor Corp., 900 P.2d 1059, 1063 (Or.Ct. App.1995).

[120] *Id.* at 1063.

[121] *Id.*

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engage the cruise control, there was sufficient evidence to show that the cruise control engaged itself and caused the accident.[122]

Treating the HAV's AI as an artificial agent and holding auto-manufacturers for designs or defects which result in accidents while also ensuring that accidents cause the least damage possible allow society to reap the most economic benefit from the transition to autonomous vehicles. The millions saved from accident cost avoidance and the ability to hold the "least cost avoider" liable for accidents will allow for efficient allocation of resources and incentivize auto-manufacturers to design HAV AI which seeks to avoid accidents.

C. DUTY TOWARDS THE SOCIETY AT LARGE AND INDIVIDUAL LIABILITY (THE *ANALYTIC A POSTERIORI*)

Unlike the previous two liability schemes, this one seems rather difficult to mesh together in a way that resembles any current scheme under the law or one that may perceivably exist in the future. The system would, in essence, ask operators and passengers of vehicles to accept personal liability for the driving decisions of the HAV's AI while also risking that, in the event of an accident, the vehicle would seek to minimize the total damage caused without concern for passengers inside the vehicle. Such a system would create obvious disincentives for those inside the vehicle; it is difficult to expect one to pay for the damages of an accident that they themselves did not cause while inside a vehicle that would so willingly sacrifice their safety and well-being if the HAV's AI determines that the cost of their lives is less than the potential cost of attempting to save those lives. As a result, such a liability system would, at best, only be limited to commercial shipping, where there would no risk of harming the driver, and could be used in situations where auto-manufacturers would be unwilling to accept liability for potential accidents where costs would be extremely high, as is the case with accidents involving the transportation of toxic waste or other similarly environmentally hazardous products.

Auto-manufacturers would likely be unwilling to accept liability for vehicles involved in accidents where the cost of such accidents would be exceedingly high, as is the case with toxic or radioactive materials. Despite safety precautions taken by the transportation industry to reduce the likelihood that the materials will spill out in the event of an accident, if the material does manage to spill out onto the roadway, the costs can be extremely high. Since auto-manufacturers would likely seek to avoid such costs, and are under no legal obligation to provide their services to such customers, they would have the ability to require that certain classes of commercial transportation retain the liability for accidents involving the vehicle.

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[122] *Id.* at 1063.

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D. DUTY TOWARDS THE INDIVIDUAL AND CORPORATE LIABILITY (THE FIDUCIARY AGENT)

The final liability scheme contemplated by this note would require HAV AI to be designed to keep its human occupants safe at all costs while the auto manufacturers would retain liability for all accidents caused by the AI. Similar to the fiduciary duties owed in the agent-principal relationship, this system would, in essence, treat the HAV's AI as the agent of the auto-manufacturer "hired" by the purchaser of the vehicle to protect the physical well-being of its occupants in the event of an accident at all costs. As a result, owners would expect, and vehicles would be designed to, take any and all steps in order to protect the lives of its passengers. Despite the seemingly high cost of such a liability scheme on auto-manufacturers, this system will ultimately lead to lower costs for both the corporations and to society at large by incentivizing driver adoption of the new technology and prudent AI development.

Generally speaking, the agent typically owes a fiduciary duty to their principal. The fiduciary principle consists of two separate and legally distinct duties, the duty of loyalty and the duty of care. The duty of care requires that the fiduciary "[act] as a prudent person does in the management of his own affairs of equal gravity," while the duty of loyalty requires the fiduciary to "maximize the investors' wealth rather than [their] own."[123] When one party acts as a fiduciary to another, like an agent and principal, one party acts in accordance with the best interests of the other party, even at the expense of their own interests.[124] In the event that the fiduciary does not act in the best interests of the other party, the other party has the ability to sue their fiduciary for violating that duty, which sometimes carries harsh financial penalties for the breaching party. According to Frank Easterbrook, the fiduciary duty is used in place of a traditional contract to assign duties when uncertainty of future circumstances requires greater flexibility than a contract would otherwise allow.[125] There is a "divergence of interests" of the two parties, and replacing "prior supervision with deterrence" of unfaithful acts lowers the cost of compliance.[126]

For many of the reasons described by Easterbrook, the concept of fiduciary duty would work well in the context of autonomous vehicles. First, it would be difficult, if not nearly impossible, to create a contract between the HAV AI and the operator or occupants of the vehicle that could account for all driving decisions the AI will need to make. Just as management of a corporation requires flexibility from its managers to respond to changes in the market to make "optimal investment and management decisions," autonomous driving requires

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[123] Frank H. Easterbrook & Daniel R. Fischel, *The Economic Structure of Corporate Law* 103 (1991).
[124] Restatement (Third) Of Agency § 8.01 (AM. Law Inst. 2006)
[125] Easterbrook, supra note 119.
[126] *Supra* note 120, at 91-94.

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the HAV's AI to make many decisions involving the safety of its occupants whenever it is engaged.[127] Secondly—and perhaps the most compelling reason to implement a fiduciary duty—fiduciary duties are used to protect against the divergent interests of the two parties involved. The auto manufacturer would want the HAV's AI to limit the financial cost of any accident, while any passenger in the autonomous vehicle wants to avoid as much personal injury as possible; a defined fiduciary duty towards the occupants of the vehicle would likely eliminate this conflict of interest. Finally, the fiduciary duty of the HAV's AI to its passengers will create peace of mind as occupants will know that the vehicle is designed to put their well-being first. Just as shareholders of a corporation do not have to constantly monitor every decision that the board of directors makes because the fiduciary duty either protects their interests or provides them with recourse, owners and passengers of autonomous vehicles would know that all the driving decisions made by the HAV's AI are performed to protect their safety above all else.[128]

Practically speaking, treating the HAV's AI as a fiduciary of the driver is most similar to the "common-carrier" duty in tort law, which requires that the driver of a common carrier vehicle, "one who holds himself out to the public as engaged in business of transportation of persons or property from place to place for compensation, and who offers services to the public generally," to protect the life and safety of its passengers as the highest duty.[129] These "common carriers" may either be individual drivers who operate a service or a driver under the employ of a corporation who own multiple vehicles which they allow their employees to drive in order to transport passengers.[130] Additionally, the common carrier status is often defined through legislation which is designed to protect passengers from harm by through the legislatures imposition of this duty.[131] In litigation, passengers of common carriers who are injured while riding with a common carrier are entitled to recovery from that carrier, even if an employee or agent of that company causes the injury.[132] As a result of these similarities, at least

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[127] *Id.* at 91.

[128] *Id.* at 93.

[129] See Tilson v. Ford Motor Co., 130 F.Supp 676, 678 (E. D. Mich. Apr. 20, 1955) (holding that the estate of an employee of Ford Motor Company who operated one of their trucks as a driver was not entitled to recovery under the common carrier standard because Ford did not hold itself out to the public as providing transportation services to the public at large).

[130] *Id.; See also* Kieronski v. Wyandotte Terminal R. Co., 806 F.2d 107, 108 (6th Cir. Dec. 2, 1986) (holding that "The distinctive characteristic of a common carrier is that he undertakes to carry for all people indifferently, and hence is regarded in some respects as a public servant.").

[131] *See Kieronski, 806 F.2d at 108 .*

[132] *See* Doe v. Uber Techs., Inc., 184 F.Supp 774, 787 (N.D. Cal. May 4, 2016) (holding that Uber is a common carrier as it holds itself out to the public as a means of transportation, resulting in a higher standard of care than would normally be required of it, and is therefore responsible for damages caused by an employee who sexually assaulted two passengers while conducting rides on behalf of Uber).

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in terms of how courts have traditionally handled the injured parties, common carrier cases provide an example of how this liability scheme would seek to give the fiduciary duty to passengers of HAVs and how damages may work in the event of an accident.

The question now becomes how the fiduciary duty as traditionally understood transfer from the auto-manufacturer to the purchaser of the HAV. Under modern agency law, the HAV AI would be considered the agent of the auto-manufacturer, performing a service on behalf of the auto-manufacturer for the occupants. While the HAV's AI would owe some duty of care towards its occupants, its fiduciary duty would be towards the auto-manufacturer, meaning that it would seek to limit the financial costs of the accident. This approach has already been discussed as a liability scheme in Section IV:B. One possible solution to this issue would be to take the common carrier approach and legislate the duty towards the passengers. The other solution is offered by Chopra and White in combining modern agency law and concepts of Roman Slavery.[133] Under this approach, when the vehicle is purchased, the owner also purchases the service of the HAV's AI, who now becomes the agent's the new principal. However, since the "agent" lacks any resources of its own—much like slaves in Roman society—their creators, the auto-manufacturers, would be required to step in to cover any damages the HAV AI causes to the occupants.

Through protecting the lives of the human occupants at all costs and replacing individual liability for accidents with manufacturer liability, this liability scheme has the most potential to convince almost all drivers to transition to autonomous vehicles. As mentioned in previous sections, individuals would much rather have their HAV's AI protect them and their passengers over the lives of those outside the vehicle.[134] In addition, this liability scheme eliminates the major ethical and economical issue involved with holding individuals responsible for the decisions of the HAV's AI when the vehicles become fully autonomous. Furthermore, requiring the HAV AI to protect its individual occupants and auto-manufacturer liability will likely decrease the overall costs of accidents to both the individual occupants and to society as a whole because auto-manufacturers will be liable for any damages. As a result, auto-manufacturers will be incentivized to design HAV AI and vehicles that respond to accident situations in the most optimal manner, one of the goals of transitioning away from human drivers in favor of AI. Purchasers of autonomous vehicles may be willing to pay a premium if this liability system exists as an alternative to the overall cost-limiting, manufacturer liability contemplated in Section IV:B. If that system appeals to people who do not use their vehicles often—urban dwellers or Millennials, for example—then perhaps this system would appeal to consumers who spend a significant portion of their time in their vehicles or are more invested

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[133] Chopra, *supra* note 87.
[134] *Supra* note 64.

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in personal safety, such as stay-at-home parents or individuals with families. Finally, if consumers believe that the vehicles are optimally designed to avoid accidents and will seek to protect them in the unlikely event that an accident should occur, consumer trust in autonomous vehicle technology will allow the technology to almost fully replace all human drivers on the road.

The costs to the auto-manufacturer is perhaps the largest hurdle to implementation of this liability scheme. Accidents where the HAV's AI is required to take all steps necessary will likely cost auto-manufacturers thousands of dollars in property and other damages, such as those caused to other drivers.[135] Additionally, an auto-manufacturer may face a risk of litigation from injured passengers or the estates of passengers killed in accidents, who believe that the AI violated its fiduciary duty towards them. Finally, costs from designing HAV AI sufficient to meet the needs of consumers could also be high. These concerns appear, on the surface, to doom this liability system from inception; the financial costs would overburden already struggling auto-manufacturers with costs that they are, for the most part, already able to avoid. However, it should first be noted that the implementation of such a system is a long way off; most experts and industry insiders believe that autonomous vehicles will only enter the roadway in the next ten to fifteen years.[136] In addition, these early vehicles will likely only be Level 3 or 4 vehicles, meaning that a system of individual insurance could persist as drivers will need to take over for the HAV's AI in certain situations.[137] Early estimates put claim that Level 5 HAVs will only become the dominant means of transportation on the roadway by 2040.[138]

This time between initial implementation of autonomous vehicles and Level 5 HAVs is crucial for a few reasons. First, the initial test run of Level 3 and 4 HAVs will allow auto-manufacturers to continually test out AI in real world driving situations, similar to the beta-testing being performed by Google, Tesla, and other auto-manufacturers. The information from the initial implementation will be far more valuable from the current beta-testing occurring now because there will be millions of drivers in vehicles providing data back to the auto-manufacturers, and the testing will also detail how autonomous vehicles interact with one another. These results may allow for improved AI design in future

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[135] The NHTSA estimates that the overall economic costs of accidents in 2010 was roughly $242 billion. If other crash statistics by the NHTSA are correct and only 4% of accidents were caused by non-human errors, auto-manufacturers as an industry would have been responsible under this liability scheme with autonomous vehicles for $9.68 billion, an amount which would likely seriously damage the industry as a whole. Nat. Highway Safety Admin., U.S. Dep't of Transp., *The Economic and Societal Impact of Motor Vehicle Crashes*, (2010), https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812013.

[136] A collection of articles and expert opinions puts the initial implementation of autonomous vehicles around the year 2020. Driverless Future, *Forecasts*, http://www.driverless-future.com/?page_id=384 (Last Accessed Nov. 27, 2016)

[137] *Id.; see also* SAE Int'l*, supra* note 11.

[138] SAE Int'l, *supra* note 11.

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autonomous vehicle models, which would be better designed to eliminate accidents. Additionally, the continued use—at least for some time in the near future—of individual liability for accidents would delay the inevitable shift towards manufacturer liability. This would allow auto-manufacturers to study accidents and implement technological changes that either reduce the costs of that type of accident or eliminate it altogether.

Designing the HAV's AI to protect its occupants while holding auto-manufacturers liable appears to be the most economical, ethical, and logical approach to fully implementing autonomous vehicles onto the roadway in the future. Through a fiduciary duty owed by the HAVs AI to the occupants of the vehicle, consumers would know that the vehicle would seek to protect them in the event of an accident, while holding the auto-manufacturer liable would eliminate the ethical issue of holding the occupants responsible for acts over which they have no control. Although this system appears to have high financial costs, many of these costs would be eliminated or reduced in the future as autonomous vehicle technology improves and future sales would likely defray all expenses from accidents.

V.   CONCLUSION

In exploring the issue of potential liability systems that may be imposed on HAVs as they are introduced onto the roadways, it is clear that the options presented have varying degrees of usefulness and fairness. As time moves on and the technology and societal views towards HAVs advance, liability schemes will inevitably fall out of usefulness, and ones that could not have been applied when the vehicles first appeared on the road will become the dominant systems.

First, for many of the reasons outlined in Section IV;C, the concept of having a vehicle aim to minimize damage at the expense of the driver and individual liability is a fairly unattractive option to begin with except perhaps in commercial circumstances. Individual liability would be a difficult sell for most potential purchasers of HAVs in general, and combining individual liability with the idea that the vehicle will injure or kill the driver if the internal AI determines that such a course will result in an overall lower cost is likely to make such a liability scheme untenable for individual drivers. However, there is a possibility that auto-manufacturers could use this system to allow for the transportation of materials which they believe that, in the event of an accident, would severely damage their bottom line and, therefore, do not wish to be liable for.

Creating HAVs which have a duty towards the individual and individual liability most clearly models the current system of automotive liability by mirroring both the incentives of human drivers and the intendant risks involved with them. This system would probably see the most use during the initial introduction of HAVs, and especially Level 3 vehicles, where the driver would be required to take control of the *dynamic driving task* in emergency instances when

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the vehicle is unable to drive properly or avoid an accident by itself. However, it is clear that this system will become obsolete as Level 4 and 5 vehicles come to dominate the road, as individual liability will become unattractive to the majority of drivers.

The last two liability schemes contemplated in this note, appear equally appealing as possible solutions to the issue of HAV liability, depending on various factors. A system in which the HAV's duty is to protect the interests of the society at large while the corporation is liable for accidents would be attractive to many individuals for a variety of reasons. First, in areas where the risk of serious injury is relatively low and accidents are less serious—urban environments with stop-and-go traffic or commercial shipping, for example— would be ideal implementations of this liability scheme. Especially if certain classes of occupant are willing to accept a slightly higher level of risk for a lower overall cost, this system could succeed in personal use. More likely, the commercial shipping industry, the only "occupants" in the vehicle are cargo and therefore expendable compared to human lives that may be inside other vehicles, will utilize this system. Additionally, parties who ship their goods using commercial carriers would likely appreciate the lower costs associated with an overall lower cost of accidents.

Finally, a liability scheme which protects the individual drivers and holds the auto-manufacturer liable for accidents will most likely be how automobile insurance is handled in the future. It not only mirrors the choices that human drivers would make when placed in a similar situation, it also eliminates the issue of holding someone individually liable for the actions of a vehicle over which they had no control. As a result, individuals would be more willing to adopt this new technology, as it would be seen to have their best interests, allowing society as a whole to achieve its two goals of autonomous vehicle technology: full adoption by consumers and overall reduced costs from automobile accidents. While this system appears to have high costs for auto-manufacturers using current numbers, it should be noted that this system of liability is still a long way off, and auto-manufacturers can use that time to decrease costs of accidents and development to significantly lower levels in the future.

Autonomous vehicle technology will soon come to dominate the roadway, here in the United States and around the world. Preparing for the inevitable now, and understanding how to best protect individual consumers from harm in the event of an accident, will allow for the smooth and complete transition from human to AI drivers.