Autonomous Vehicles and Tort Liability

By Roya Butler

Introduction

Driving is an essential part of American life. Ninety-four percent of traffic accidents are caused by human error, and advancement in the coding of autonomous vehicles seeks to alleviate that risk.[1] That being said, no technology is one hundred percent safe. What happens if an autonomous vehicle injures a human being or damages property? Existing liability models may not provide a fair, efficient method for balancing the concern for physical safety against the need to incentivize necessary innovation to develop these robots. Determining which model of tort liability should apply to users and manufacturers of autonomous vehicles is challenging because autonomous vehicles will have evolving technological capabilities that we have not yet encountered. Lawmakers will have to take into consideration all the new technological aspects of autonomous vehicles if they wish to regulate them at all.[2]

Judge Frank Easterbrook, at a cyberspace conference held at the University of Chicago, told the audience that a "'law of cyberspace' would muddle rather than clarify."[3] Easterbrook's argument was that creating overly-specific laws would be inefficient compared to applying common law, and that existing laws/doctrines should be applied to the new facts that nascent technology presents."[4] He further argued that lawmakers should focus on amplifying economic efficiencies by providing clear but minimal regulations; "laws should be clear so parties can find efficient resolutions."[5] With this in mind, current tort liability models could likely be applied to autonomous vehicles, but there are challenges. For example, current tort liability models may be inadequate. In particular, any tort liability model must properly incentivize both manufacturers and owners to take safety precautions.

This paper will examine existing liability models and challenge Judge's Easterbrook argument that existing legal principles are capable of covering new technology. This paper first examines law and theory and why negligence is an inadequate model for autonomous vehicles. Next, this paper examines strict liability and finds that a hybrid of vicarious with joint-and-several liability would

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[1] NHTSA, USDOT Releases 2016 Fatal Traffic Crash Data, U.S. DEPT. OF TRANSPORTATION (Oct. 6, 2017), https://www.nhtsa.gov/press-releases/usdot-releases-2016-fatal-traffic-crash-data; *see also* Bruce Brown, Evidence stacks up in favor of self-driving cars in 2016 NHTSA fatality report, DIGITAL TRENDS (Oct. 6, 2017, 4:42 P.M.), https://www.digitaltrends.com/cars/2016-nhtsa-fatality-report/.

[2] *See* Lawrence Lessig, *The Law of the Horse: What Cyberlaw Might Teach*, 113 HARV. L. REV. 501 (Dec. 1999, 10:19 AM), https://cyber.harvard.edu/works/lessig/finalhls.pdf.

[3] Lessig, *supra* note 2 at 501. Frank H. Easterbrook is a judge of the United States Court of Appeals for the Seventh Circuit and a Senior Lecturer at the Law School of the University of Chicago.

[4] *See* Frank H. Easterbrook, *Cyberspace and the Law of the Horse*, 207 U. CHI. LEGAL F. (1996), https://chicagounbound.uchicago.edu/cgi/viewcontent.cgi?referer=&httpsredir=1&article=2147&context=journal_articles. The reference is to an argument by Gerhard Casper, who, when he was dean of the University of Chicago Law School, boasted that the law school did not offer a course in "The Law of the Horse." *Id.* at 207 (internal quotation marks omitted). The phrase originally comes from Karl Llewellyn, who contrasted the U.C.C. with the "rules for idiosyncratic transactions between amateurs." *Id.* at 214.

[5] *Id.*

efficiently promote economic welfare. This model would also encourage manufacturer innovation, effectively compensate victims, and discourage negligent behavior.

Law and Theory

Courts can theoretically apply pre-existing common law principles to nascent technology, however, these principles may not reflect the reality of such technology and lead to absurd results.[6] Autonomous vehicles can guide themselves without human conduction. These "non-biological autonomous agents capture the essence of [] regulatory and technological challenges."[7]

Application of law to technology, cyberlaw, "has revealed one particularly important lesson: when thinking about new technologies in legal terms, the metaphors we use to understand them are crucially important."[8] Creating analogies, comparing scenarios in cyberlaw, such as autonomous vehicles, can assist in developing areas of the law.[9] This methodology, when applied to theories of tort liability, could reduce the chance of coming to an absurd result.[10]

Existing tort liability models pose challenges when applied to autonomous vehicles because the "reasonable person" standard is construed with human actors in mind. The policy goals and societal values of liability models must be kept in mind when applying them to autonomous vehicles. The tort system serves the important goals of reducing injuries, deterring negligence, and imposing liability to the party who can most efficiently avoid the harm. The reasonable person standard deters negligence by requiring society to adhere to a standard of care.[11] Strict liability, for example, serves the goal of reducing injuries by making harmful actions costly. The Learned Hand Formula, under negligence, is focused on the least cost avoider and looks to overall economic efficiency by requiring the party to prevent harm only when the cost of prevention is less than the expected harm. Keeping in mind that autonomous vehicles do not have a human actor, the ways that current liability models enforce reasonableness with moral responsibility or punish with retribution may not work and new ways of meeting those values must be deliberated.

1. Negligence Liability Model for Autonomous Vehicles

Under a negligence liability model, four elements must be met: duty, breach, causation, and damage.[12]

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[6] Lessig, *supra* note 2.
[7] Richards, Neil M. and Smart, William D, *How Should the Law Think About Robots?* SSRN (May 10, 2013), https://ssrn.com/abstract=2263363.
[8] *Id.*
[9] *Id.*
[10] *Id.; see* Lessig, *supra* note 2.
[11] In tort law, the standard of care is the degree of prudence and caution required by an individual actor. https://www.law.cornell.edu/wex/standard_of_care.
[12] *See, e.g.*, FRANCIS WHARTON, LAW OF NEGLIGENCE § 3 (1874)); WILLIAM B. HALE, HANDBOOK ON THE LAW OF TORTS § 19, at 44 (1896); David G. Owen, *The Five Elements of Negligence*, 35 HOFSTRA L. REV. 1671, 1674 (2007).

A. Duty

A duty of care, the first element of a negligence claim, is a legal obligation which is imposed on an individual requiring adherence to a standard of reasonable care while performing any acts that could foreseeably harm others.[13] The element of duty, which is informed by social values, fairness, and social policy allows courts to reduce social harms.[14]

Typically, courts look to precedent to determine if a duty exists.[15] Determining if the harm by an autonomous vehicle is a "reasonably foreseeable" result of the autonomous vehicle's conduct, at first glance would seem straightforward. Analyzing expert system based rules to evaluate if the autonomous vehicle had been improperly coded would be straightforward and objective. Courts, however, generally bar discovery due to possible trade secret claims protecting the algorithm.[16] For example, a Wisconsin state supreme court denied a claim due to trade secret protection when a defendant demanded the right to examine an algorithmic-based sentencing software that was used to sentence him.[17] Similarly, a federal court in Texas denied a right to examine claim and found trade secret protection even though the cybercrime software code sought was necessary to determine a Fourth Amendment violation.[18] Courts have denied access to trade secretes even in death penalty cases.[19] Therefore, courts would be unlikely grant access to trade secrets in autonomous vehicle liability cases.

B. Breach

Breach, the second element of negligence, requires that the defendant's actions fell below the standard of care prescribed by duty.[20] An autonomous vehicle would breach its duty of care if its software caused it to behave unreasonably. Therefore, courts must first assess reasonableness to determine a breach of the duty of care for autonomous vehicles.

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[13] *Id.*

[14] Theodore M. Benditt, *Liability for Failing to Rescue*, 1 Law and Phil. 391, 391-418 (1982).

[15] *See e.g., Caparo Industries plc v Dickman* [1990] 2 AC 605 (creating the tripartite test for establishing a duty of care).

[16] *See* Wisconsin v. Loomis, 371 Wis.2d 235, 243 (Wisc. 2016); *see e.g.*, Taylor R. Moore, *Trade Secrets & Algorithms as Barriers to Social Justice*, CDT (Aug. 2017), https://cdt.org/wp-content/uploads/2017/08/2017-07-31-Trade-Secret-Algorithms-as-Barriers-to-Social-Justice.pdf; Ben Rashkoich, *Government Accountability in the Age of Automation*, Yale L. Sch. Media Freedom & Info. Access Clinic (Apr. 9, 209), https://law.yale.edu/mfia/case-disclosed/government-accountability-age-automation.

[17] *See* State v. Loomis, 881 N.W.2d 749, 760-61 (Wis. 2016), *cert. denied*, 137 S. Ct. 2290 (2017)."[T]he term 'trade secret' means all forms and types of financial, business, scientific, technical, economic, or engineering information . . . if (A) the owner thereof has taken reasonable measures to keep such information secret; and (B) the information derives independent economic value, actual or potential, from not being generally known to, and not being readily ascertainable through proper means by, another person who can obtain economic value from the disclosure or use of the information . . . ."

[18] *See* United States v. Ocasio, No. 3:11-cr-02728-KC, slip op. at 1-2, 11-12 (W.D. Tex. May 28, 2013) (barring evidence due to trade secret although the information was necessary to determine whether a warrantless use of cybercrime software was a Fourth Amendment violation).

[19] *See* Petition for Review Filed by Defendant Michael Robinson at 4, Robinson v. Commonwealth, No. 25 WDM 2016 (Pa. Super. Ct. Mar. 7, 2016) (denying defendants access to trade secrets in a capital punishment case).

[20] David G. Owen, *The Five Elements of Negligence*, 35 HOFSTRA L. REV. 1671, 1676 (2007).

A. Reasonableness

Under the negligence standard, actors are only liable for harm when they fail to use "reasonable care," which is based on the behavior of a "reasonable person."[21] However, such a standard would be difficult, if not impossible, to apply to decisions of an autonomous vehicle's expert system. While a human actor can be compared to a theoretical reasonable person, creating a reasonable expert system or artificial intelligence standard would raise technological questions as to base programming and, ultimately, machine-learning.

The reasonable person standard implies that a mistake is possible and thus would not hold an actor accountable if a reasonable person would make the same mistake in the same situation. After all, reasonable people make mistakes. Autonomous vehicles, however, are created with the specific goal of eliminating human error all together. As machine learning advances with exponential growth, expert systems will increasingly make fewer mistakes and the standard of reasonableness will have to correspondingly increase.

Reasonableness—the reasonable person standard—was created by courts to "assess what time and amount of care is reasonable," and defined as "the standard of proper behavior in terms of a mythical prudent person."[22] Next, courts must determine whether the expert system's choices and conduct that led to accidental injury were negligent. This would not likely depend so much on the programmer's personal efforts to be careful in coding the expert system, but courts, instead, would likely compare the autonomous vehicle's conduct to an external, objective standard. This objective standard would be measured by how average autonomous vehicle generally acts in the circumstances.[23] Such a standard could be based on manufacturing reporting on what autonomous vehicle's do in certain circumstances.

When considering "stranger-stranger interactions, such as drivers on the highway, custom establishes certain norms of behavior that define how people in those situations reasonably should act."[24] Autonomous vehicles would be expected to follow laws, like for example driving on the legal side of the road and following traffic laws, such as, staying far enough behind other vehicles to be able to stop to avoid a collision. Currently, there are no established norms of proper behavior for autonomous vehicles, and thus the law likely would ground the norm of reasonable behavior on society's customary expectations of how vehicles should act or respond in a given situation, to a principle of reason based on social utility. The lack of an established norm would prevent courts from having an initial reasonableness standard and may persuade them to use other approaches, such as the Hand Formula, instead.

[21] RESTATEMENT (SECOND) OF TORTS §302, cmt. a (1979).
[22] *Id.; see also* Henry T. Terry, *Negligence,* 29 HARV. L. REV. 40, 41 (1915) ("[N]egligence is doing what a reasonable and prudent man would not have done or not doing what such a man would have done.").
[23] *See* OLIVER WENDELL HOLMES, JR., THE COMMON LAW, 108-10 (1881).
[24] *Id.*

i. The Hand Formula

Judge Learned Hand applied this type of cost of investment in precaution, or "calculus-of-risk" approach, as an alternative to the reasonable person standard.[25] The $B \leq P \times L$[26] formula for negligence, described in United States v. Carroll Towing Co.,[27] often influences court opinions because "it provides a [practical,] economic model" in analyzing negligence.[28] If B (the cost of precautions that would reduce the expected harm) equals or is less than PL (the probability that an accident will occur multiplied by the magnitude of the resulting harm) then the defendant is liable for negligence because he should have taken the precautions as the least cost avoider. Using the Hand Formula in analyzing harm in the case of autonomous vehicles would likely balance interests. It would reward autonomous vehicles for according the interests of other vehicles and persons equal consideration to their own, which "tends to minimize waste, maximize society's scarce resources, and . . . advance the public good."[29] The Hand formula's analytic method "is properly determinative of negligence only when customs, expectations, property and other rights, and moral precepts fail to provide firm guidance on how people in particular situations should behave."[30]

Although this model promotes economic efficiency, courts may experience difficulty applying it to autonomous vehicle liability. The uncertain cost of precautions, *B*, that would reduce the expected harm is not easily calculated. Furthermore, the probability, *P*, that an accident would occur with autonomous vehicles is low when compared to human drivers. The magnitude of resulting harm, *L*, would not be clear as courts could either set the liability to the full extent of the harm or offset it with injuries avoided or lives saved. Stated differently, autonomous vehicles aim to eliminate human error. Autonomous vehicles will likely keep the accident number at a minimum, therefore the probability of harm, *P*, would be low. If the probability of harm, *P*, is low then P x L will almost never be $\geq$ B, and therefore the autonomous vehicle will rarely ever be liable. Therefore, the Hand formula may present practical problems in its application to autonomous vehicles.

C. Causation

The third element, causation, requires that the breach by the autonomous vehicle is the actual and proximate cause of the accident victim's injury. Causation compounds two distinct ideas: factual causation and proximate cause.[31] Factual causation, or cause-in-fact, concerns the question of

[25] *See Id.;* Richard A. Posner, A Theory of Negligence, I J. LEGAL STUD. 29(1972).
[26] *See* Posner, *supra* note 24 at 29. *B* (the cost of precautions that would reduce the expected harm) should be less than or equal to *P* (the probability that an accident will occur) multiplied by *L* (the magnitude of the resulting harm). These variables are then balanced against one another in a cost-benefit analysis.
[27] *See* United States v. Carroll Towing Co., 159 F.2d 169, 173 (2d Cir. 1947) (expressing the concept, in algebraic terms, as negligence being implied if $B < P \times L$, where B is the burden or cost of avoiding accidental loss, P is the increase in probability of loss if B is not undertaken, and L is the probable magnitude or cost of such loss).
[28] *See* Posner, *supra* note 24 at 29.
[29] Owen, *supra* note 19.
[30] Skeptics of social utility find little use for cost-benefit analysis, even in a default role. *See, e.g*., Richard W. Wright, *Hand, Posner, and the Myth of the "Hand Formula*," 4 THEORETICAL INQUIRIES L. 145 (2003).
[31] Owen, *supra* note 19.; *see also* Tory A. Weigand, *Tort Law—the Wrongful Demise of But for Causation*, 41 WESTERN NEW ENGLAND L. REV. 75, 75-76 https://digitalcommons.law.wne.edu/cgi/viewcontent.cgi?article=1812&context=lawreview.

"whether a cause-and-effect relationship between the defendant's wrong and the plaintiff s harm actually exists."[32] In contrast, proximate cause assumes the existence of actual causation and questions whether the relationship between the wrong and harm was sufficiently close.[33] Causation requires (i) cause in fact; (ii) proximate cause; and would (iii) cause issues when applied to autonomous vehicles.

i. Cause in Fact

"Negligence law allows an accident victim to recover damages only if the defendant was at least partially to blame for causing the accident." [34] The element of cause in fact (but-for or factual cause) thus may be described as the actual connection between a defendant's negligence and the plaintiff's harm.[35] This standard is usually met when the conduct was the factual cause of the harm. [36] The cause in fact requirement would thus limit autonomous vehicle accident liability to situations in which the autonomous vehicle itself was the factual cause of the accident.

ii. Proximate Cause

Proximate cause incorporates foreseeability into legal causation.[37] Proximate cause requires a reasonably close connection between a defendant's wrong and the plaintiff's injury.[38] The Third Restatement of Torts attempts to define the proximate cause requirement by limiting an actor's liability "to those harms that result from the risks that made the actor's conduct tortious."[39] The proximate cause doctrine serves to limit a tortfeasor's responsibility to the consequences of risks viewed fairly as arising from the wrong.

In an effort to distinguish it from factual cause, courts commonly refer to proximate causation as legal cause.[40] Although courts determine duty according to policy factors applicable to whole categories of actors in recurring situations, juries determine proximate cause according to fairness facts unique to every case.[41]

iii. Causation Applied to Autonomous Vehicles

Autonomous Vehicles present challenges with causation that may pose issues in the tort liability model. Although the cause in fact element would not present any new issues when applied to autonomous vehicles, proximate cause would. It may be difficult to know why an autonomous

[32] Owen, *supra* note 19 at 1674.
[33] Courts will often conflate these elements to mitigate the confusion. *See, e.g.*, Ulwick v. DeChristopher, 582 N.E.2d 954, 958 (Mass. 1991) ("'duty, breach of duty (or, the element of negligence), causation (actual and proximate) and damages'") (citations omitted).
[34] Under principles of comparative negligence, most states reduce a victim's damages proportionate to his or her own negligence that combined with the defendant's negligence to cause the accident, and many bar recoveries altogether if the accident was mostly (or in some states equally) the victim's fault. See DOBBS, supra note 13, § 201, at 503.
[35] *Id.*
[36] *Id.*
[37] *Id.*
[38] *Id.*
[39] RESTATEMENT (THIRD) OF TORTS: LIABILITY FOR PHYSICAL AND EMOTIONAL HARM §29 (1995).
[40] *See* RESTATEMENT (THIRD) OF TORTS: LIABILITY FOR PHYSICAL AND EMOTIONAL HARM §26 (1995).
[41] *See* Estate of Bordon v. Dep't. of Corr., 122 Wn.App. 227, 239, 95 P.3d 764 (2004).

vehicle decided to change lanes, for example. It is possible that an autonomous vehicles decision was based on programming, or a newly learned behavior that was based on historical experiences, or instruction from a third-party. If an autonomous vehicle has the capability to learn and evolve its behavior based on mapping, history, experience, and real-time situational observations it will be challenging to determine what the proximate cause was for those decisions. Autonomous vehicles may even learn from observing the behavior of other autonomous vehicles with Vehicle to Vehicle communication. This further complicates determining the foreseeability of its actions. Policymakers should therefore impose regulations on the programming of autonomous vehicles so that their thought process is transparent, saved in memory, and subject to discovery. If the decision-making of autonomous vehicles is not transparent, the causation requirement will make it nearly impossible to find liability under a negligence theory.

Autonomous vehicle accidents may break the chain of causation and prevent courts from finding liability when a new act intervening between the wrongful act of the defendant and the harm suffered by the plaintiff occurs.[42] Expert-system, artificial intelligence-based autonomous vehicles will inevitably make unforeseeable decisions, however, allowing manufacturers, designers, users, and programmers to avoid liability in this manner would disincentivize them from improving system safety. The proximate cause requirement may also relieve manufacturers from liability when another actor intervenes. For example, the autonomous vehicle may be hacked or have bugs in its code that cause it to act in a way that is considered unforeseeable like, as mentioned above, hitting a person or damaging property. Regulators can address this issue by mandating an automatic shutdown and failsafe alert in the event of a hacking. An owner may also break the chain of causation if, for example, he breaches a service contract for maintenance of the autonomous vehicle or failed to download an update which contained a patch to a vulnerability. Regulators may also prevent this possibility by requiring that owners regularly maintain and update their autonomous vehicles. This maintenance can include security patches, charging the battery, and possibly even upgrading the random-access memory (RAM) or defragmenting the hard drive.

Ultimately, courts will have difficulty applying a negligence theory to autonomous vehicles due to the reasonableness and standard of care requirements. Instead of courts, policymakers could act and create a standardized duty of care for autonomous vehicles. Nonetheless, difficulty in creating a reasonableness standard, taking into consideration if the expert system based logic is flawed, would present difficult challenges. Regulators could use Asimov's three laws of robotics as guidance for programming the reasonable care framework:[43] (1) a robot may not injure a human being, or, through inaction, allow a human being to come to harm; (2) a robot must obey the orders given it by human beings except where such orders would conflict with the First Law; (3) a robot must protect its own existence as long as such protection does not conflict with the First or Second Law.[44]Using these laws as guidance to construct a regulatory framework may prohibit autonomous vehicles from engaging in tortious activities harmful to human life and property.

[42] RESTATEMENT (SECOND) OF TORTS, § 431 (1977).
[43] F. Patrick Hubbard, *Sophisticate Robots: Balancing Liability, Regulation, and Innovation*, p.6, https://www.dropbox.com/s/wck4vjtwsu2q26q/Hubbard%20-%20Sophisticated%20Robots%20%28Final%29.doc?dl=0.
[44] ISAAC ASIMOV, ROBOT VISIONS 8 (1990); *see also* ISAAC ASIMOV, THE NAKED SUN 31-33 (1957).

D. Damage

The fourth element of a negligence claim requires damages, consisting of destruction to the plaintiff's person or property, including pain and suffering.[45] Tort law aims to compensate victims for any injuries or losses suffered by the unreasonable acts of another, as well as discouraging the defendant from repeating the violation in the future. This element will likely not present any new challenges with the introduction of autonomous vehicles because any actionable autonomous vehicle accident would inherently involve damage to a person or property.

2. Strict, Vicarious, and Joint Liability

Autonomous vehicle liability could also turn on other common law causes of action. If (A) courts do not consider autonomous vehicles as actors, they could impose (B) strict liability on other parties.

A. Autonomous Vehicles as Actors

It is seductive to regard autonomous vehicles as legal actors when the actions of the expert system cause an accident. At this time, however, personal jurisdiction over autonomous vehicles does not exist, because courts have not determined that autonomous vehicles have legal personhood. Courts would be unlikely to accept autonomous vehicles with no property or income as potentially liable actors in a tort claim. Therefore, liability must be posed upon some other party involved in an autonomous vehicle accident.

B. Strict Liability

Strict liability does not require a finding of intent or negligence.[46] In the case of strict liability, the defendant pays for the injury his conduct causes the plaintiff, regardless of whether the defendant was negligent.[47] An advantage of a strict liability model is the reduction of court administrative costs because the judgement is certain. Defendant would pay for conduct resulting in injury, encouraging settlement. Either this process or the resulting settlement would essentially work as a form of insurance. When a company is strictly liable it spreads risks to all the consumers who purchase the product. The internalization of liability will ensure that the costs are spread to reflect all the harms the products cause, rather than merely costs due to negligence.[48] If autonomous vehicles were to follow a strict liability model, manufacturers of unsafe vehicles would face higher costs.

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[45] RESTATEMENT (SECOND) OF TORTS, § 652 (1977).

[46] Steven Shavell, *The Mistaken Restriction of Strict Liability to Uncommon Activities*, 10 THE J. OF LEGAL ANALYSIS 1, 4 (2019).

[47] *See e.g.*, Rylands v. Fletcher, L.R. 3 H.L. 330 (1868); Ploof v. Putnam, 81 Vt. 471 (1908); Vincent v. Lake Erie Transp. Co., 109 Minn. 456 (1910); Bolton v. Stone, 1 K.B. 201 (1950).

[48] Absent any liability, the costs of any harms from autonomous vehicles would be completely externalized from the company. In other words, owners and victims of accidents would face all of the costs of harm while the company would face none. This externalization of harm would lead the companies to underinvest in safety features. Instead, internalizing this cost would lead companies to adopt stronger safety features and share the costs with the owners through higher prices.

Strict liability is generally confined to product liability or ultrahazardous activity. Autonomous vehicles could be examined under product liability as they are not considered ultrahazardous. A strict liability theory could depend on (1) product liability, (2) vicarious liability, or (3) joint and several liability.

1. Product Liability

One form of strict liability is product liability.[49] Product liability not only focuses on liability from injury due to use of a product but also considers whether the product was defective or unexpectedly dangerous and whether the manufacturer gave notice and warned the consumer of potential safety risks.[50] "A defective product is a product that causes damage or injury to a person as a result of some defect in the product itself, its labeling, or its intended use."[51] Product liability prioritizes consumer interests and incentivizes manufacturers to prevent product defects. Focusing on the least cost avoider, courts reason that manufacturers are better positioned than consumers to reduce product defects.[52] To bring a claim of a manufacturing defect, a plaintiff must prove that a product was unsafe, even when manufactured according to design.[53] In the case of an autonomous vehicle, for example, a manufacturer could face liability if the type of plastic used in production was brittle, causing the plastic to shatter upon impact. To bring a claim of a design defect, a plaintiff would have to prove that the design of the autonomous vehicle is unsafe, so that the entire fleet is unreasonably dangerous.

In a product liability claim, a defect must have existed at the time it left the manufacturers possession and be the cause of the injury. This introduces challenging issues. If, for example, a third-party provided downloadable updates for the expert system with a glitch that caused an injury, the third-party, and not the manufacturer, would assume liability for the accident.

Another requirement is that the manufacturer must reasonably anticipate misuse.[54] A plaintiff may also make a claim of insufficient warnings.[55] The contract of adhesion signed when purchasing an autonomous vehicle, however, would likely disclaim liabilities of foreseeable misuse and provide sufficient instructions and warnings.[56] In addition, if the misuse was not foreseeable, the manufacturer would not be held liable.[57] If an expert system learns behavior and it autonomously performs an illegal act, a manufacturer could argue that it should not be liable for an unanticipated harm. An expert system's coding by design learns from the environment. Thus, such a harm could be considered a design defect. The owner's actions, however, in placing the autonomous vehicle in an environment to learn behavior leading to a tortious act would break the manufacturer's chain of causation and prevent a product liability finding.

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[49] LexisHub, *Fundamentals of Product Liability Law*, LEXISNEXIS (May 28, 2008), https://www.lexisnexis.com/legalnewsroom/lexis-hub/b/commentary/posts/fundamentals-of-product-liability-law.
[50] *Id.*
[51] *Id.*
[52] *Id.*
[53] *Id.*
[54] *Id.*
[55] *Id.*
[56] *Id.*
[57] *Id.*

One regulatory cure to this problem could be architectural.[58] The autonomous vehicle could be programmed to send reports back to the manufacturer, a private third-party, or a government entity, so as to monitor its learning and ensure safety compliance. This regulatory solution could help track the learned behavior and possibly provide the expert system with an algorithmic training solution.

Autonomous vehicle manufacturers may also provide training as part of the purchase of a vehicle. This could help reduce the manufacturers liability. In a Minnesota case, a pilot did not complete training before crashing a plane.[59] There, the state supreme court did not find the airplane manufacturer liable.[60] The court noted that "[a]n airplane manufacturer's duty to warn does not include a duty to provide training to pilots who purchase an airplane from the manufacturer."[61] Similarly, manufacturer's duties would not extend to the vehicle training that owners would be required to undertake.

Similar to the causality issues described above in the negligence discussion, there may also be issues in this model because other actors, such as hackers or the owners, can break the chain of proximate causation. These issues will make it likely that current strict product liability models will not be easily applied to autonomous vehicles. A vicarious liability solution could avoid these issues.

2. Vicarious Liability

Under the respondent superior doctrine, vicarious liability imposes liability on one person for a tortious act committed by another.[64] When an owner tells the car to do something, the autonomous vehicle is essentially acting on the owner's behalf. The owner could therefore assume liability for the vehicle's actions. This would appropriately deter the owner from negligently failing to train his vehicle correctly and reduce injuries from not training vehicles. It is much easier for the owner to train his car than for a victim to protect herself in the event of an accident so this also shifts harm to the least cost avoider.

As a matter of policy, courts can redress more harms under an agency theory than under the conclusion that autonomous vehicles are independent actors. A vicarious liability model will ensure compensation for loss rather than imposing liability on financially incapable parties like autonomous vehicles. This type of liability scheme would incentivize users to employ the use of autonomous vehicles when the benefits will outweigh the potential social costs. Imposing vicarious

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[58] Lessig, supra note 2.
[59] Glorvigen v. Cirrus Design Corp., 816 N.W.2d 572 (Minn. 2012).
[60] *Id.*
[61] *Id.*; *but see* Walsh v. Pagra Air Taxi, Inc., 282 N.W.2d 567, 570–71 (Minn.1979) (holding that an airport base operator was liable for breach of a tort duty the operator assumed through its operating agreement with a city).
[62] LexisHub, *supra* note 44.
[63] *Id.*
[64] Alan O. Sykes, *The Boundaries of Vicarious Liability: An Economic Analysis of the Scope of Employment Rule and Related Doctrines*, 101 HARV. L. REV. 563, 563 (1987) (adapting a theoretical framework to analyze the liability of a vehicle owner for the tort of someone who borrows the vehicle); *see also* Harold J. Laski, *The Basis for Vicarious Liability*, 26 YALE L.J. 105, 107 (1916).

liability for users, however, raises an issue because the high costs of tort cases may discourage consumers from purchasing autonomous vehicles.

In an attempt to deter harmful conduct and efficiently allocate costs, the current tort system requires tortfeasors to remedy the harms of their actions by imposing penalties in hopes of making the victim whole.[65] If we chose a strict liability regime and designate liability completely to manufacturers of autonomous vehicles, we may over-deter manufacturers from creation and improvement of autonomous vehicles. These costs can be proportionally defrayed to users/owners of AV by holding them partially liable. A shared liability model could allocate costs between both the manufacturers and the owners.

Shared liability could also present an answer to other difficult issues. For example, if an owner sends his friend home in his autonomous vehicle but it injures a third-party walking across the street while en route, liability could potentially fall upon both the owner and the friend who benefitted from this action. Courts must analyze each case to evaluate who were the principals benefitting from the vehicle's actions. An autonomous vehicle making independent decisions essentially acts as an agent of the user. An agency theory would further avoid the proximate cause issues inherent to autonomous vehicles.

Autonomous vehicles can be analogized to vicarious liability models applied to keepers of wild or dangerous animals.[66] Positive law already provides for a finding of liability absent fault for keepers of a wild or dangerous animals.[67] The dangerous characteristics and propensities of certain animals make the owner strictly liable for any harm they cause.[68] Also, an owner of a domestic animal could be vicariously liable without fault if the owner must have known or had reason to know of a dangerous propensity that was not a typical characteristic of similar animals.[69] This type of vicarious liability could similarly apply to owners of autonomous vehicles. For example, a user of an autonomous vehicle that is still in beta stages of testing and has previously shown bugs in its behavior should be liable because the user had reason to know about a propensity of dangerous behavior. Further, owners must train their autonomous vehicles to effectively operate and should be held strictly liable when they fail to do so. This analogy may be useful for analyzing future tort cases involving autonomous vehicles because of its inherent unpredictability.

3. Joint and Several Liability

If two or more defendants are found liable for an indivisible injury, defendants are held jointly and severally liable.[70] This means that each defendant is liable for the entire damage award regardless of the individual degree of fault. In the case of autonomous vehicles, both the owner and the manufacturer could be held liable. The manufacturer in this case may be held liable for an entire damage award even if the manufacturer is only fractionally liable. This would ensure that manufacturers take the steps needed to reduce accidents. It would be much cheaper for a

[65] *See e.g.*, RICHARD A. POSNER AND WILLIAM A. LANDES, THE ECONOMIC STRUCTURE OF TORT LAW (1987); RICHARD A. POSNER, TORT LAW: CASES AND ECONOMIC ANALYSIS. LITTLE BROWN AND COMPANY (1982).
[66] RESTATEMENT (SECOND) OF TORTS, § 522.
[67] *Id.*
[68] *Id.*
[69] *Id.*
[70] William L. Prosser, *Joint Torts and Several Liability*, 25 CALIF. L. REV. 413 (1937).

manufacturer ex ante to design safer vehicles than for pedestrians to try to protect themselves in a world of dangerous vehicles.

4. Hybrid: Vicarious with Joint and Several Liability

When combined with vicarious liability, joint and several liability would properly allocate costs to both the users and manufacturers who could have prevented the harm. Autonomous vehicle manufacturers, parts manufacturers, and third-party warranty vendors would bear some liability due to their ability to create and maintain the autonomous vehicle and expert-system, artificial intelligence-based algorithms, but owners would also bear some liability due to their responsibility to train their vehicles. Hybrid liability puts the burden on the least cost avoider, the manufacturers and owners; ensures that there are less injuries, and; deters manufacturers from designing unsafe vehicles and owners from failing to train their cars.

Joint and several liability would also prevent the market for autonomous vehicles from failing due to adverse selection.[71] If manufacturers held all the liability for autonomous vehicles they would increase the price of the vehicles to pay for their potential liability. Manufacturers, however, would be unable to differentiate between buyers who would train their vehicles properly and those who would not. This would cause manufacturers to charge all buyers one price that might be desirable to buyers who do not expect to incur training costs but not to those who would incur them. The buyer's market for cars would then increasingly shift towards those who would not properly train their cars and the price of the cars would increase until there was no market left at all. By imposing some liability on the buyers, this adverse selection problem could be effectively avoided.

Conclusion

Traditionally, tort law serves to constrain the behavior of individuals by internalizing the costs of their harms. This paper concludes that autonomous vehicles can effectively be regulated under a hybrid, vicarious with joint and several liability, model for owners, autonomous vehicle manufacturers, parts manufacturers, and third-party warranty vendors.

This hybrid liability model also efficiently allocates the costs of accidents. Injured parties would recover damages, manufacturers would not be solely burdened with the costs and owners would be incentivized to properly train their vehicles. This system would, therefore, not only ensure that victims are compensated for their harms but also lead to a reduction of harms occurring in the first place.

[71] "Adverse selection describes circumstances in which either buyers or sellers have information that the other group does not have." Prateek Agarwal, *Adverse Selection*, INTELLIGENT ECONOMIST (Nov. 29, 2019), https://www.intelligenteconomist.com/adverse-selection/. In this situation, buyers know whether they will train their autonomous vehicles or not but sellers do not.