Hard Drive Crash

An Examination of Liability for Self-Driving Vehicles

by **Keri Grieman***

Abstract: This analysis considers the potential impacts of completely self-driving vehicles on vehicular liability. This begins with examining how such vehicles might be treated under an evolution of the current liability system, and the potential results of attributing liability to an operator, the vehicle itself, different manufacturers, and a government entity. Discussion then turns to how liability might be altered prospectively in order to incentivize outcomes beneficial to both consumers and creators from a public policy perspective. This includes a proposal of how such a proposal might be structured. Focal points include public policy, social acceptance, and potential incidental problems raised.

Keywords: Self-driving vehicles; self-driving cars; vehicular liability; autonomous vehicles; AVs; artificial intelligence; public policy; AV liability; self-driving vehicle liability

Recommended citation: Keri Grieman, Hard Drive Crash: An Examination of Liability for Self-Driving Vehicles, 9 (2018) JIPITEC 294 para 1.

A. Introduction

1 Preventative maintenance is a beneficial concept to many industries - the pre-emptive "repair" of areas that will become problematic in the future. It is, however, a concept that rarely impacts common law jurisdictions, where stare decisis rules the day. Law very seldom pro-actively regulates activities, particularly those of emerging technologies - one cannot regulate what does not exist. How could one have imagined the adaptation of privacy laws before everyone carried a recording device in their pocket? Moreover, regulating pre-emptively can serve to quash the very innovation they attempt to pave the way for.

2 Yet there are exceptions to this inability to predict change. Areas that subtly adjust the way that we interact with our world rather than radically altering them. These are changes that we can see coming and can conceivably prepare for without discarding the current system. The self-driving car is such an area: the modern world is already equipped with roads, stoplights, and fuel pumps. We are not attempting to regulate in a new dimension, no flying cars have yet emerged; but the imminent changes would benefit enormously from pre-emptive adaptation.

3 If frameworks of legal liability for self-driving or autonomous vehicles (AVs) are held off, the potential benefits of the AVs will be stifled. This is not to say that they will not come, merely that they may come agonizingly slowly, as shareholders limit the monetary risks they are willing to take. Nor is it suggested that the changes required are simple, but that they are necessary. It is important to balance proactivity with over-regulation, and the difficulty of post-ante regulation with administrative efficiency.

4 Vehicular liability must be written to incorporate AVs. A system that reflects the underlying differences between AVs and human drivers encourages beneficial change. In order to achieve this change as efficiently and cohesively as possible, AV legislation should be written proactively, rather than allowing the question of liability to bring change incrementally and with crippling uncertainty. Such a legislation system may be best complemented by the creation of an independent public insurance entity.

B. Assumptions

5 The central tenet of vehicular laws in many, if not all, common law countries is fault. Who is liable, when they are liable, and why. Rules of the road are written to reflect what one can and cannot do, resulting in fault when one fails to follow them. For this reason, analysis will focus on fully autonomous vehicles - those that do not require a human driver whatsoever, and taking those countries basing liability on fault as a starting point. There are recognized levels of autonomy within the industry: from an entirely human driven vehicle at 0, to an entirely human excluded one at 5.[1] Where a human driver is required or expected to maintain full or partial control of the vehicle, regular conceptions of liability are imperfect, but may be sufficient. Partially autonomous vehicle components can be turned off, as can components of full autonomy, such as self-parking.[2] Level four autonomous vehicles are indeed fully automated, but are not capable of covering every driving scenario,[3] and have already been rolled out in some areas - namely Las Vegas[4] and Singapore city centre,[5] although they are limited to a defined environment. While these vehicles can be used as independent taxis, it will be assumed that they can currently be run under transit-like liability, particularly given that their activity is currently confined to a defined area. The scope of this paper will primarily be concentrated on privately-owned vehicles. It will also be generally assumed that society is in favour of a system that allows for the compensation of victims in vehicular accidents. While no specific jurisdiction will be focused on, Canada provides a helpful, broad set of examples as it employs different insurance systems in each province and territory, but uniformly bases liability on fault.

6 Finally, exceptionally rigorous testing will be assumed. In order to be allowed to enter the market, relevant regulators should conduct stringent testing under a variety of conditions for all different manufacturers and models. Cars are heavy machinery, and their destructive potential should not be underestimated. While manufacturers will undoubtedly conduct in-depth testing themselves, an entity independent from the company needs to test the vehicles in question to ensure a sufficient level of safety and driving quality.

C. Technical Aspects

7 There are several typical elements that are used by AV manufacturers order to allow the car to function. These include a video camera mounted on or near the front windshield allowing for the detection of traffic lights and moving objects; a rotating sensor on the roof which scans the area in a large radius, creating a three-dimensional map; distance sensors on the bumpers to measure space between various obstacles; smart-navigation maps updating in real time to track accidents, speed limits, and car-to-car communication; and the artificial intelligence that commands the control centre.[6] These methods are, as yet, imperfect - sensors struggle with inclement weather, and the roof sensor aka LIDAR (light detection and ranging) faces problems with bright sunlight.[7] The technology in the marketplace has not

* Queen Mary University of London; The Canadian Internet Policy and Public Interest Clinic.

1 Hope Reese, 'Updated: Autonomous driving levels 0 to 5: Understanding the Differences' *TechRepublic* (20 Janaury 2016) <www.techrepublic.com/article/autonomous-driving-levels-0-to-5-understanding-the-differences/> accessed 12 January 2018.

2 ibid - breakdown of vehicular autonomy levels

0: The human driver is in complete control.

1: The human driver still holds the majority of control, but a specific function, such as accelerating, may be done by the vehicle.

2: "[A]t least one driver assistance system of both steering and acceleration/deceleration using information about the environment is automated, like cruise control and lane-centering." The driver may be incrementally separated from the operation of the vehicle, but must remain ready to re-take control in an instant.

3.'Safety-critical' functions are taken by the vehicle. While the driver must be able to intervene, they are not required to re-acquire control instantaneously.

4. The vehicle is able to perform all necessary functions, but not under all conditions.

5. The vehicle is able to perform all necessary functions under all conditions considered safe enough for a human to operate a vehicle.

3 Natasha Merat and others, 'Driver behaviour when resuming control from a highly automated vehicle' (Institute for Transport Studies, University of Leeds, 16 October 2014), 280.

4 Saqib Shah, 'Las Vegas' self-driving bus crashes in first hour of service' *Engadget UK* (11 November 2017) <www.engadget.com/2017/11/09/las-vegas-self-driving-shuttle-bus-crash/> accessed 12 January 2018.

5 Andrew J Hawkins, 'Singapore's self-driving cars can now be hailed with a smartphone' *The Verge* (22 September 2016) <www.theverge.com/2016/9/22/13019688/singapore-self-driving-car-nutonomy-grab-ride-hail-test> accessed 12 January 2018.

6 Muhammad Amat, Dr Clemens Schumayer, 'Self Driving Cars: Future has already begun' (Institute of Transport and Logistics, Vienna University of Economics and Business, 7 May 2015) <http://www.ioeb.at/fileadmin/ioeb/dateiliste/dokumente/Downloads___Links/WS_IV_-_Azmat_Schumayer_-_The_future_has_already_begun_.pdf> accessed 1 January 2018, 8.

7 ibid 5; A fatal crash occurred where a Tesla detected bright sunlight reflecting off a truck as a cloud rather than an obstacle. While the driver was supposed to be able to regain control, and the Autopilot feature was not intended to

yet reached level 5, though when it does, accidents are still to be expected. While it is possible and indeed likely that adaptations and new technologies will emerge, the aforementioned will serve as a minimum level of AV "competency" – that full AVs will have at least these levels of technology available to them.

D. Public Policy

8 The changes brought about by AVs will impact society in many ways, and not all of them will be positive. Challenges may be obscure - a decrease in car accidents has the potential to result in an even greater shortage of organs available for donation.[8] Impacts have been noted to range as far as the airline and hotel industries, predicting that as long-distance automobile transit becomes more convenient and comfortable, air travel will become less competitive.[9] More directly, automation will bring about the loss of work for many, including professional drivers. In 2014, it was reported that more than 4.4 million persons in the United States alone worked as drivers.[10] While it may in turn bring new jobs, the specifics of such work remain to be seen. In terms of hired driving services, some stakeholders are already making their investments – in 2015 then CEO of Uber, Travis Kalnick, stated the intention to replace human drivers with AVs.[11]Undoubtedly, there will be opposition to AVs for various reasons, and astute commentators note that unions for drivers will likely respond to the challenge to their profession by raising doubt about AV safety, and lobbying against them.[12] AVs are likely to face more opposition than most changes, given that humans appear to have an inherent distrust of non-human intelligence. While evidence-based algorithms are shown to be more accurate than humans, people lose confidence in the algorithm more quickly than humans, and continue to prefer the human even where the algorithm consistently outperforms the human.[13]

9 AVs are indisputably on their way. Both traditional and disruptive automakers are steering into the skid of AVs – even by 2012, Google's AV had completed over 300,000 miles of accident-free self-driving.[14] AVs are already in commercial use: AV trucks transport mining materials in the Australian outback, and self-driving tractors are already in the field.[15] Moreover, autopilot systems have been used by commercial jets for many years, aiding in maneuvering, navigation, and landing, lending "a significant amount of automated assistance," and allowing planes to land in conditions that were "previously difficult for human pilots."[16]

10 Accident reduction is a crucial potential benefit. While AVs are imperfect, they lack the failings endemic to human drivers: limited scope of vision; ability to be distracted; inability to focus on multiple areas at once; etc. Even more importantly, they lack the ability to be affected by the same level of choice as humans in terms of driving; namely, humans can and do drive when tired, ill, or impaired. Advocates of AV note that more than 90% of traffic collisions are caused by human error[17] - while AVs are imperfect,

replace human senses, it does demonstrate the problem for future vehicles and their sensors. Neal Boudette, 'Tesla's Self-Driving System Cleared in Deadly Crash' *New York Times* (New York, 19 January 2017) <www.nytimes.com/2017/01/19/business/tesla-model-s-autopilot-fatalcrash.html?_r=0> accessed 1 January 2018.

8 Ian Adams, Anne Hobson, 'Self-Driving Cars Will Make Organ Shortages Even Worse' *Future Tense* (30 December 2016) <www.slate.com/articles/technology/future_tense/2016/12/self_driving_cars_will_exacerbate_organ_shortages.html> accessed 1 January 2018.

9 Kevin LaRoche, Robert Love, 'Autonomous vehicles: Revolutionizing Our World" *Borden Ladner Gervais LLP* (2016) < blg.com/en/News-And-Publications/Documents/Autonomous-Vehicles2016.pdf> accessed 18 June 2017, citing 'Autonomous cars will make domestic flights run for the money: Audi' *Telematics Wire* (27 November 2015) <telematicswire.net/autonomouscars-will-make-domestic-flights-run-for-themoney-audi/> accessed 18 June 2017.

10 Mark Fahey, 'Driverless cars will kill the most jobs in select US states' *CNBC* (2 September 2016) <www.cnbc.com/2016/09/02/driverless-cars-will-kill-the-most-jobs-in-select-us-states.html> accessed 4 January 2017.

11 Stephen Edelstein, 'Uber CEO to Tesla: Sell me half a million autonomous electric cars in 2020' *Green Car Reports* (7 July 2015) <www.greencarreports.com news/1098997_uber-ceo-to-tesla-sell-me-halfa-million-autonomous-electric-cars-in-2020> accessed 18 June 2018.

12 Ratan Hudda and others, 'Self Driving Cars' (Fung Institute for Engineering Leadership, UC Berkeley College of Engineering, 29 May 2013) <https://ikhlaqsidhu.files.wordpress.com/2013/06/self_driving_cars.pdf> accessed 1 January 2018, 9.

13 Berkeley J Dietvorst, Joseph P Simmons, Cade Massey, 'Algorithm Aversion: People Erroneously Avoid Algorithms after Seeing Them Err' (July 2014) Journal of Experimental Psychology: General, forthcoming <https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2466040> accessed 2 January 2018.

14 ibid.

15 David Robson, 'The Truth About Driverless Vehicles' *BBC* (London, 13 October 2014) <www.bbc.com/future/story/20141013-convoys-of-huge-zombie-truck> accessed 30 December 2017.

16 Harry Surden, Mary-Anne Williams, 'Technological Opacity, Predictability, and Self-Driving Cars' (2016) *Cardozo Law Review* 38:121 <http://scholar.law.colorado.edu/articles/24> accessed 30 December 2018, citing Simon Wood, 'Flight Crew Reliance on Automation' Federal Aviation Administration Advanced Avionics Handbook (*UK Civil Aviation Authority*, 2009) <publicapps.caa.co.uk/docs/33/2004_10.PDF.157>

17 Emily Chung, 'Autonomous cars could save Canadians $65B a year' *CBC News* (Toronto, 21 January 2015) <www.cbc.ca/news/technology/autonomous-cars-could-save-canadians-

they will not eliminate these accidents immediately, but they have the potential to greatly reduce such accidents. Currently, the World Health Organization estimates that injuries caused by road traffic will become the worldwide fifth leading cause of death by 2030.[18] In the United States, automobile accidents are "the lead cause of death for people between the ages of 3 and 34," with a death every 30 seconds.[19] It is estimated that in the United States alone, AVs could save 300,000 lives per decade - 29,447 lives per year,[20] and as much as $190 billion USD per year in health costs.[21] However desirable these miraculous predictions, they depend on a minimum level of widespread adoption of AVs.[22]

11 Infrastructure efficiency and cost will be directly impacted. Worldwide, the cost of traffic congestion is estimated to reach $2,200 billion USD per year.[23] In northern North America, self-driving cars have been predicted to save $65 billion CAD by reducing traffic congestion, fuel costs, and "time wasted behind the wheel."[24] In reducing the need for car ownership, $5 billion CAD can be saved on congestion costs alone.[25] Google has already built the largest traffic jam surveillance network in the world by providing over 500 million smart phones with an operating system - the mapping function allows Google to track trends over time.[26] Independent researchers have modelled an algorithm that allows significant alleviation of traffic jams by multi-vehicle routing, and requires only 10% of vehicles on the road to follow the algorithm.[27] In other words, benefits of AVs need not reach a majority before they produce tangible infrastructure benefits - only a minimum point of saturation.

12 In terms of accessibility, AVs would open an entire world to those unable to drive themselves. Many individuals are, for reasons of age, physical ability, or current state, unable to drive. These individuals are dependent on either public transit, expensive private means of transport, such as taxis, or family and friends. It has been noted that allowing these individuals increased access to transportation has the potential to increase total vehicle transit by up to 11%.[28] While this obviously increases demand, it is cause for celebration as these individuals evidently do not have the freedom or capability to travel as much as their able-bodied counterparts.

13 Ecologically, there are also several benefits. Even with the current state of technology that is expected to improve, projections have placed the reduction of oil consumption and related greenhouse gas emissions at 2 to 4%.[29] These predictions were based on the use of technologies such as "adaptive cruise control, eco-navigation, and wireless communications."[30] The ease of incorporating AVs with other technologies has even greater potential, with "car to infrastructure communication"[31] - one "smart" parking system reduced time spent looking for spaces by 21%.[32] Additionally, AVs do not need to park in a space that is convenient or easily accessible – they can park underground or remotely, and the driver can summon the car when required. A traffic signal synchronization program saved "31.2 million hours of travel time, 38 million gallons of fuel and 337,000 metric tonnes of carbon dioxide per year."[33] Furthermore, most cars are unused for 95% of their lifespan, but AVs have the potential to reduce the amount of cars on the roads overall, as AVs can be farmed out for others when not in use by the owner.[34] Car sharing programs have led to less car ownership, and a reduction of emissions in cities,[35]

65b-a-year-1.2926795> accessed 1 January 2018; Berkeley J Dietvorst, Joseph P Simmons, Cade Massey, 'Algorithm Aversion: People Erroneously Avoid Algorithms after Seeing Them Err' (n 13) 6.

18 Ratan Hudda and others, 'Self Driving Cars' (n 12) 5-6.

19 ibid 0.

20 Adrienne Lafrance, 'Self-Driving Cars Could Save 300,000 Lives Per Decade in America' *The Atlantic* (29 September 2015) <www.theatlantic.com/technology/archive/2015/09/self-driving-cars-could-save-300000-lives-per-decade-in-america/407956/> accessed 1 January 2018.

21 ibid.

22 ibid.

23 Hongliang Guo and others, 'Routing Multiple Vehicles Cooperatively: Minimizing Road Network Breakdown Probability,' (2017) 1/2 *IEEE Transactions on Emerging Topics in Computational Intelligence.*

24 Vijay Gill and others, 'Automated Vehicles: The Coming of the Next Disruptive Technology' *The Conference Board of Canada* (21 January 2015) <www.conferenceboard.ca/e-library/abstract.aspx?did=6744> accessed 1 January 2018.

25 Emily Chung, 'Autonomous cars could save Canadians $65B a year' (n 18) 1.

26 Ratan Hudda and others, 'Self Driving Cars' (n 12).

27 Honglian Guo and others, 'Routing Multiple Vehicles Cooperatively' (n 23) 121.

28 Todd Litman, 'Autonomous Vehicle Implementation Predictions: Implications for Transport Planning' Victoria Transport Policy Institute (22 December 2017) <http://www.vtpi.org/avip.pdf> accessed 1 January 2018 13; citing Michael Sivak, Brandon Schoettle, 'Road Safety With Self-Driving Vehicles: General Limitations And Road Sharing With Conventional Vehicles, Sustainable Worldwide Transportation Program' *University of Michigan* (2015) <www.umich.edu/~umtriswt>.

29 Julia Pyper, 'Self-Driving cars Could Cut Greenhouse Gas Pollution' (15 September 2014) *Scientific American* <https://www.scientificamerican.com/article/self-driving-cars-could-cut-greenhouse-gas-pollution/> accessed 1 January 2018.

30 ibid.

31 Muhammad Amat, Dr Clemens Schumayer, 'Self Driving Cars: Future has already begun' (n 6) 13.

32 ibid.

33 ibid.

34 Ratan Hudda and others, 'Self Driving Cars' (n 12).

35 Darrell Etherington, 'Car sharing leads to reduced car ownership and emissions in cities, study finds' *Tech Crunch* (19 July 2016) <https://techcrunch.com/2016/07/19/car-

a benefit which is likely to increase as it cuts into the requirements for taxis and other chauffeuring needs. Finally, there is the simplest benefit of all: not having to drive.

14 Whilst the advantages are numerous, the technology remains vulnerable to smothering by the tyranny of the immediate - the defence of the bottom line in companies protecting themselves from liability, and legislation in taking a "wait and see" approach.

E. Liability

15 For all the many benefits of AVs, they are imperfect. Accidents will still happen, particularly in the early years. It is thus important to determine what party is potentially liable; specifically, who should pay for any damages incurred as well as compensation to the victim. While current liability systems will need to be tweaked to allow for integrated AI driving; i.e. for vehicles between levels 1 and 5, their setup still allows for and generally requires a human driver to take control. In aiming to fully achieve their full societal benefit, level 5 vehicles should have no interaction from the driver. This raises the obvious question as to who should be liable and how.

16 Informed commentators have suggested that parties potentially liable for AV accidents could include the user, the owner, the manufacturer, the manufacturer of AV components, or a government entity. Methods such as product liability have the potential to cause difficulties both in the expense incurred through the legal process in determining liability, and in determining how and why an AV made the "decision" that it did; class action suits are too cumbersome for something as ordinary as auto accidents. What mechanism, therefore, should be used to allocate liability? As will be examined, negligence under our current conception of the notion, has the potential to prove problematic in allocation of liability.

I. Potential Liability Allocated to the Operator

17 Given that one of the potential benefits of AVs is increased car-sharing, it is possible that the user and owner may be different individuals. The user might simply be someone who has independently hired the car through, say, a taxi service app. The owner is the person who has technical ownership of the AV. For the purposes of legal application, one can treat the user, owner, or general occupant as one entity, as they run into the same potential concerns. For the sake of discussion, these entities can be refined into one, the "operator" – the definition of which should rely on the individual determining the destination.

18 In a liability context, the operator is the entity who is most closely aligned with current fault attribution. While each country differs slightly in their application of the law, vehicular liability generally relies on the individual who has control of the vehicle. In Canada, for example, section 214 of the Canadian Criminal Code states that to operate "means, in respect of a motor vehicle, to drive the vehicle."[36] Crimes such as operating under the influence rely on this definition of operation, and on the concept of "the care or control of a motor vehicle... whether it is in motion or not."[37] "Care and control" has included situations such as a passenger grabbing the steering wheel,[38] sitting in the driver's seat "braking and steering an inoperable vehicle,"[39] or using the steering wheel while being towed, as noted by Osler PJ in *R v Morton*:[40]

> *when, though the means of propulsion is under the control of the driver of a towing vehicle, there is a person in charge of the towed vehicle who is manipulating the steering wheel and brakes and exercising a significant measure of control over the direction and movement of that vehicle, I consider that person can be said to be operating or driving the motor vehicle.*

19 In other words, determining liability of an operator has centred around their intent and ability to influence the movement of a vehicle through functions in the province of a driver. Many jurisdictions are willing to find drivers liable for driving under the influence of intoxicants even if they were not in the driver's seat, nor piloting the car, but were in the car and had access to the keys. The capacity to direct the car, whether or not in current use, has been used to determine care and control, and thus liability. This approach does not make sense for AVs. The intent of a fully autonomous vehicle is that the occupant will not have control, and thus will not be able to direct the specific movements of the vehicle. The occupant may have the ability to direct the car generally - they are, after all, determining the end destination of the AV. However, "care and control" does not make this distinction.

sharing-leads-to-reduced-car-ownership-and-emissions-in-cities-study-finds/> accessed 1 January 2018.

36 'An Act respecting the criminal law' (RSC 1985) c C-46, 'Canadian Criminal Code' section 214.

37 ibid section 2(a).

38 R v Belanger, [1970] 10 CRNS 373 (SCC).

39 R v Flemming [1980], 43 NSR (2d) 249 (NS Co Ct), cited in R v Danji, [2005] ONCJ 70, 16 18 MVR (5th) 1.

40 R v Morton [1970], 12 CRNS 76 (BCPC).

20 An operator of an AV is analogous to the passenger of a bus. They have an ultimate destination in mind. They are capable of influencing the vehicle's path by asking the driver to stop, potentially by pushing a button or pulling a cord. If the bus were to be in an accident, however, even if the bus is inarguably at fault, the bus passenger is in no way responsible for that accident or the damages resulting from it. Operators of an AV have no less a duty of care to the occupants of other vehicle than an ordinary human driver does, but attempting to extend liability does not, from a logical standpoint, make sense. The duty of care may include not interfering with drivers, or distracting them, but should not overextend to include the "but for" test – i.e. "but for" the occupant choosing to use the AV, the accident would not have occurred. This is simply too broad to be functional.

21 In the case of an accident between an AV and a human driver, the legal result would depend on which vehicle were at fault. If the AV were at fault, the previous issue arises: the occupant is unlikely to have acted negligently or unreasonably. If the human driver were at fault, all current laws are easily applicable. If fault is mixed, the court can apportion damage based on contribution to the harm, as is common in many areas of law, but the AV portion should not fall on the operator.

22 There are cases where traditional conceptions of liability should apply, namely where the operator had previous knowledge of a potential issue with the AV. AVs have the potential to learn, and better their "driving". This is a desirable feature of AVs - not only can AVs learn from their own behaviour, but potentially the behaviour of other vehicles capable of communicating with them. Such a system is likely to function on an update system, similar to updates on a computer or smart phone. This could result in a situation where an operator, or an owner, were confronted with a notice warning them of a defect with the car's programming, or a potential update. If the operator were to ignore this warning and continue to use the vehicle, they can and should be found liable for an accident resulting from the lapse in update. This may be an extreme outlier scenario but serves to sufficiently include the operator's negligence.

23 Additionally, if an individual - whether owner, user, operator, or unrelated party - were found to have tampered with any programming impacting the AV's ability to function safely, this could produce a range of liability. This range should run from negligence to attempted murder, depending on what happened and how, such as if it was intended to affect another operator. This does limit the operator's freedom to adjust their vehicle's programming as they would like, but such a step is crucial to the uniformity and thus predictability of AVs - a necessary requirement for ensuring the safety potential of the vehicle.

24 Despite these minor exceptions, conceptions of liability surrounding the vehicle's operator must be updated to reflect the reality that the operator does not, and should not, affect the "decision making" of the vehicle. This is the societally desirable outcome - removing the operator from the second-to-second decision making process is what allows the AV to drive in a way that avoids human failings. In the same way that a taxi passenger has made a responsible decision and thus should not be charged with driving under the influence, neither should an AV operator be at the mercy of decisions which are not their own.

II. Potential Liability Allocated to the AV Itself

25 The AV itself is not a logical successor to the human driver in terms of liability, although it may at first glance appear to be so. The entity that best fits current conceptions of liability in terms of "driving" and "care and control" of the vehicle is the artificial intelligence entity that enables the AV. For simplicity's sake, the AI and the AV will be treated as a singular entity given their inseparability for the purpose in question.

26 Determining whether the AV has made a "wrong" decision may require extensive evaluation of the way in which it makes decisions. It may require a comprehensive understanding of how decisions were made, and what information was available. Requiring the AV to take on responsibility for actions taken implies a level of responsibility. However, there are two problems with this: first, from a functional standpoint, the AV has no assets except, potentially, itself. In an accident, the victim is to be compensated for damage to the vehicle, injury, etc. However, without delving into an analysis of robo-slavery, it is clear that an AV does not own anything, whether or not it owns itself. Accordingly, whether or not the AV owns itself, depriving the owner of the AV is detrimental to the owner, rather than the AV.[41] Second, the AV's decision making originally depends on how it was programmed. While it may "learn", its key input is given before it ever hits the road

41 Interestingly, a robot has been already been 'arrested' for its actions. A robot in Switzerland was created by a group of artists and given a bitcoin budget per week to randomly purchase from the dark web, with the intention of displaying the items purchased. The robot was confiscated along with its purchases, which included a passport and ecstasy tablets, but was returned three months later with all purchases except the Ecstasy. Arjun Kharpal, 'Robot with $100 bitcoin buys drugs, gets arrested' *CBC Tech Transformers* (Ottawa, 22 April 2015) <www.cnbc.com/2015/04/21/robot-with-100-bitcoin-buys-drugs-gets-arrested.html> accessed 1 January 2018.

- it does not inherently "choose" to do something wrong, it follows directions that it has been given. This is not the sort of "guilty mind" or mens rea envisioned by current legal regimes. Moreover, this approach to liability would assume that the AV both can and does "think" like a human, and thus could be assessed to the same standards. Even the ways that the AV "learns", or what it "learns" about, are initiated by its programming, and are not inherently based on human thought patterns. The AV's "decisions" are not the same as human ones. This evokes the question of whether the party that originally programmed the AV should be liable for what the AV is programmed to do.

III. Potential Liability Allocated to the Manufacturer - parts

27 Manufacturing can be separated into two parts: the main manufacturer or assembler, and parts manufacturers. Consider first the parts themselves. Continuing to treat parts manufacturers under traditional common law liability understandings does not seem particularly problematic - main manufacturers maintain the duty to check parts they buy to a reasonable standard, and the parts manufacturers maintains the duty to manufacture them to the standard promised. Individual parts currently account for relatively few accidents, and there is no reason to believe the relatively low rate of product liability suits or issues would increase. While machinery for AVs may be more complicated, even vehicles that are not fully autonomous are improving at tasks like diagnosing parts or physical issues with vehicles. While product liability suits are slow and costly, the relatively small-scale requirements for individual faulty parts means that this is likely still a functional way to address the problem without a systemic overhaul.

IV. Potential Liability Allocated to the Manufacturer - programming

28 First, some definitional clarification. It has been suggested that Google is likely to license a developed version of its AV software to car manufacturers, allowing for a prospective licensing industry alongside the AV market.[42] However, given that Google has a successful AV of its own, and major automotive manufacturers are creating their own AVs, discussion will focus around manufacturers as having produced and programmed their own AVs.

29 In the current state of the market, most manufacturers selling vehicles that have AV features state that the driver must be able to take control at all times, and that any autonomous features are not in fact self-driving; thus by using the vehicle, the "driver" confirms that they will always be "driving", even if the car is able to function in any way on its own. This appears to be an attempt to potentially contract out of liability in favour of having the driver agree to assume it. Whether or not this will hold up to substantial legal challenges remains to be seen, either in tort liability or contractual restrictions, but it nonetheless appears to be the current method attempted. The current state of the liability union is divided - automotive companies and Google have lobbied governments to absolve them of liability - to negative effect in California, but positive effect in Nevada.[43] Volvo has already made public its willingness to accept full liability, whereas Tesla has stated that it will accept liability only for design failure.[44]

30 Whether liability should fall on major manufacturers through the decisions made by their agents in programming an AV, and on the subsequent decisions of the AVs acting on that programming, opens an obvious chain of questioning. While removed from the immediacy of the road, programing largely fits the conception of "control" over the vehicle - how it is driven, when and where it stops, how to react to changes in the environment. Programmers for manufacturers, acting in their professional capacity, could be treated as creating liability for the manufacturer in embedding their decisions, even if it is an initial step in a machine learning process. This is compounded by the "black box" problem - it is often difficult for artificial intelligence to "explain" why it did what it did - the AV in question might have weighed many factors, and learned from many sources, which ultimately resulted in a particular action. Elon Musk, co-founder, CEO and Product Architect at Tesla, used the following analogy:

> *Point of views on autonomous cars are much like being stuck in an elevator in a building. Does the Otis [Elevator Company] take responsibility for all elevators around the world, no they don't.*[45]

31 This presents an interesting point. Programming the way something works has not previously resulted in major liability. Nor has it prevented society from doing away with elevator attendants, or in the case of cars, drivers. However, not only do the number of

42 Ratan Hudda and others, 'Self Driving Cars' (n 12).

43 Ratan Hudda and others, 'Self Driving Cars' (n 12) 6.

44 Danielle Muoio, 'Elon Musk: Tesla not liable for driverless car crashes unless it's design related' *Business Insider* (Sydney, 20 October 2016) <www.businessinsider.com.au/elon-musk-tesla-liable-driverless-car-crashes-2016-10> accessed 1 January 2018.

45 ibid.

elevator accidents pale in comparison to the number of car accidents - even proportionately - the elevator deals with a pre-set course with no obstacles or other players, programmed or otherwise. Cars must deal with a great deal more and put more lives at risk than just those inside of it, and there is an inherent level of "decision making" involved.

32 Priorities for the AV are set in advance. This often brings to mind philosophical debates such as the trolley problem, wherein one must choose whether to divert a trolley hitting three people instead of hitting one person. However, problems like this do not address what AVs are, or are intended to do: AVs are not intended to make a choice of the amount of humans tied to the train track to kill. They are intended to stop the trolley. Treating AV "decisions" as identical to human ones ignores the reality that AVs can work with far more input than humans can: 360 degrees of vision, multiple heights and layers of sensors, and a lack of distractions. If AVs can communicate with one another, and there are enough to do so, they could provide information in real time; for example, "up-coming pothole" and "group of joggers on road shoulder" are not particularly difficult messages to transmit. This translates into larger concepts as well, such as "human-sized entity darting into traffic". The world is not tied to two tracks and no breaks, and reducing the decisions to be made to such a scenario fetters our understanding of what could be.

33 Statutorily pinning liability on manufacturers forces them to prioritize liability. This does not mean that manufacturers would place it as a first priority - human life is likely to forever hold the primary spot, if only because cases of deaths may kill public favour of AVs. But it does inevitably affect priorities as a whole. Damage to property is certainly preferable to damage to humans, yet focusing on liability may shift this emphasis. It is entirely possible to be both in the right legally, yet making the wrong decision. While measures such as the strict liability approach of capping the amount of damages to be paid may be reasonable stopgaps, they present their own domino issues - potentially neither covering the full amount of damages, nor removing the incentive to de-prioritize physical damage in favour of safety.

34 Consider a situation wherein an AV is suddenly faced with an obstacle it can either hit lightly, causing no injury, or stop immediately and cause the human car speeding behind it to injure either the AV and the speeding car's occupants. In a case where liability is not in question, and human safety is the highest priority, the AV hits the obstacle - damaging the AV, but neither set of passengers. If liability is a priority, the AV avoids liability by coming to a stop as the human driver would be in the wrong through speeding, and being unable to make a safe stop without hitting the AV. However, this is not the societally desirable outcome: car parts are replaceable, human health is not. It is quite possible to be correct in law but not in morality, and the concern for liability means the prioritization of cost and correctness over better outcomes. Mandating liability means incentivizing the wrong priorities. As for the trolley problem, we want the AV to stop the trolley, even if it means breaking said trolley.

35 While instances such as negligent or malevolent programming should still be considered, from a public policy perspective, governments should encourage manufacturers to take safety of all parties as the highest consideration. As AVs reach a point of saturation, these priorities will have an increasing impact and importance. Statutorily mandated liability on manufacturers does not make vehicles safer in and of themselves - it reinforces the priority of doing the legally correct action, rather than the socially beneficial one. Allocation of liability for non-human damage simply does not produce the best incentivized outcome for social priorities.

36 Furthermore, if liability is focused on manufacturers, risk is concentrated onto a concerningly small number of entities, who will simply increase product prices to cover the risk at an even greater rate considering the unknown cost to the manufacturer themselves. The current system of liability and spreading liability cost, transfers the price to a later point in the transaction, but allows for greater predictability and a greater sharing of the smaller, more predictable cost.

V. Potential Liability Allocated to a Government Entity

37 Ultimately, insurance will still be necessary for AVs. There will be accidents, and thus accident victims. An insurance infrastructure will ensure compensation for these victims and help to establish the viability of AVs as an institution. As previously discussed, naming one or a combination of the previous actors and stakeholders presents many problems. Liability needs to be apportioned without a concept of "blame" - damage has occurred, and the damage needs to be fixed or compensated for. A strict liability regime is a functional way to accomplish this and legislating it pre-emptively for level five AVs has the significant benefit of predictability.

38 AV manufacturers are understandably concerned with the extent to which they will be liable, and in what ways. Companies have been easing slowly into full automation by using automated features, being careful to mandate that the driver must still be in control - thus avoiding liability. A "wait and see"

approach to legislation means that manufacturers are understandably hesitant to be the first to throw their hat into the ring with commercial, fully automated vehicles. It also means that smaller companies are struck from the automation race completely, as they lack the war chest to fund costly litigation when an accident occurs. Providing assurances allows manufacturers to bring an actual product to market - the societally desirable, completely hands-off, AVs.

39 How, then, should this system be structured? Ideally, at least initially, as a government-run, AV-mandated single-pool insurance entity through which all AVs must be insured. First, such an entity has the initial benefit of actually providing insurance rather than waiting for the private sector to enter the market. Second, time and profiteering can be avoided by circumventing the private insurance sector. Third, it allows for a specialized entity to deal with the information created by accidents; specifically, assessing it, and passing it along to the necessary parties, such as the manufacturer, when there is a clear problem with the AV system. Fourth, it allows for the reduction of administrative work - no time and effort is spent resolving damages between AV insurance providers; rather the costs are simply paid and the accident can be analyzed from a systemic perspective, i.e. could the AV have made a better "decision"? While non-AV insurance providers will still have dealings between themselves, they too benefit from a single-system for AVs, such as a standardized system that specializes in how AVs function, and can thus concentrate on, for example, provision of crash footage in the case of a combined AV/human accident. This is not to say that AVs should suddenly become liable for all accidents they are involved in, but rather those where a human driver would similarly be found at fault.

1. Avoiding the private insurance sector

40 Single pool compensation has been employed in other areas to good effect. One example is New Zealand's ACC, a crown-corporation accidental injury insurance board. The fund is paid into by everyone in New Zealand who "works and owns a business," and through levies on vehicle licensing payment and car fuel filling.[46] The levies provide a fund that pays out in cases involving accidental injury. This coverage applies to everyone in New Zealand, regardless of age or employment status, and even includes visitors to New Zealand.[47] While there are various incentives implemented, such as a slight discount on levies for companies with excellent workplace injury rates, the overall structure is a no-fault, community approach to accidents.

41 Outside of accident insurance, single-pool or single-payer insurance has been most visible in the healthcare sector. The United States is a noted hold-out against such a system, and spends "more than twice as much on health care as the average of other developed nations, all of which boast universal coverage ... [while] more than 41 million Americans have no health insurance [and] [m]any more are underinsured."[48] In 2003 experts estimated[49] that converting the United States would "save at least $200 billion [USD] annually (more than enough to cover all of the uninsured) by eliminating the high overhead and profits of the private, investor-owned insurance industry and reducing spending for marketing and satellite services."[50] From a purely logical perspective, this makes sense - an industry run for profit is intended to *make* a profit, and must do so by either over-charging or under-providing. It is not intended to be a zero-sum game that provides the greatest amount of care at the lowest cost, it is intended to create a gap between what is paid by the insured, and what is paid to the provider. Without this gap, there is no profit. In addition to this, money is spent on advertising for the insurance company, fighting claims both from providers and the insured, and "avoiding unprofitable patients."[51] While it is often argued that a private insurance market allows individuals to suit coverage to suit their needs, this inherently provides a problem for "unprofitable patients."[52]

42 Returning to automotive insurance, Canada provides an interesting comparison as some provinces have mandated government insurance, whilst others have not. British Columbia, Manitoba, and Saskatchewan all have a "one-stop shop" approach to insurance, but differ in their exact coverage, and Quebec drivers all have personal injury insured through the government, while private insurers cover the rest.[53] Direct cost comparisons are difficult, as the provinces have different challenges; for example, more extreme weather in central Canada, and a

46 Accidental Compensation Corporation 'What we do' (2018) <https://www.acc.co.nz/about-us/who-we-are/what-we-do/> accessed 1 January 2018.

47 ibid.

48 S Woolhandler and others, 'Proposal of the Physicians' Working Group for Single-Payer National Insurance' (1 August 2003) *Journal of the American Medical Association* 290/6 798

49 ie, before both the roll-out and subsequent roll-in of 'Obamacare'.

50 S Woolhandler and others, 'Proposal of the Physicians' Working Group for Single-Payer National Insurance' (n 48).

51 ibid.

52 ibid.

53 Karen Aho, 'When the government sells car insurance' *Nasdaq* (25 March 2013) <http://www.nasdaq.com/article/when-the-government-sells-car-insurance-cm230568> accessed 12 January 2018.

greater amount of drivers in British Columbia, Ontario, and Quebec. However, one study compared the same city - one which straddled a government insurance and a private insured province - and found that those with government coverage paid less.[54] Additionally, net income from public insurance, at least in British Columbia, goes into reserves, rather than exiting the system as a shareholder dividend.[55] It has also been suggested that high costs are the reason for the difference in percentage of uninsured. For example, in 2002 Ontario (the province with the highest average insurance rates) had an estimated 10-20% of drivers uninsured, whereas British Columbia had 0.26% uninsured drivers.[56]

43 These arguments are not intended to frame the free market as inherently negative or bad. What this system aims to accomplish is to set aside, at least temporarily, the profit of the insurance sector to pave the way for the AV sector, for the simple reason that AVs offer more direct societal benefits.

2. No-fault

44 No-fault insurance is not a new concept to the automotive world. Policy-holders and passengers are reimbursed for accidents and damage through their own insurer, rather than tort insurance, where fault is assigned to a party. No-fault insurance usually only covers up to a particular sum and precludes individuals from pursuing the other party in court. Unfortunately, it does not typically mean the absence of attribution of fault, rather that the insurance company or companies will determine between them which party is at fault, and potentially increase that party's future insurance rates.[57] Fault can be attributed by percentage, wherein both parties may see future increases in rates.[58]

45 As previously discussed, the attribution of actual fault is difficult in scenarios solely involving AVs, given the difficulty of deconstructing the decision-making process. What the future of AVs require is to give up the concept of fault in actuality rather than in name. This is not an easy thing to do - not only are the rules of the road set up to determine fault, but humans like blame, and we do not trust intelligences we don't understand. This is true even if the non-human intelligence is demonstrably better at the task at hand.[59] In essence, giving up fault is a leap of faith: it requires letting go of the idea of an "intuitive and automatic" desire to conceive of blame.[60] It is, however, a necessary step to improvement - the move to acknowledgement of an undesirable consequence rather than the attribution of the individual entity responsible. There will be a period of time where fault will still be apportioned, for example, where accidents have occurred between AVs and human drivers. This is necessary in order to allow for incremental integration of AVs, rather than wholesale substitution. However, AVs will inherently make fault determination between AV and non-AVs easier to determine, as AVs can provide their own surveillance footage.

46 Moreover, as Reed et al. point out, common law is not unfamiliar with strict liability for inherently dangerous activities, such as the keeping of dangerous animals, or ownership and use of aircraft.[61] These difficulties have not quashed either activity but serve to account for the dangers inherent to them. Strict liability tends to invoke the opposite conception of no-fault, as it incurs fault no matter how careful or reasonable the activities of the individual in question - "the person responsible is required to indemnify the remainder of society."[62] However, the result and acknowledgement are the same: accidents do occur, and must be accounted for, no matter the reasonability of the actors in question.

3. Structure

47 Even given a singular pool insurance provider, there are many potential iterations of how insurance may be structured. It is not unreasonable to leave the consumer with a regular insurance cost that covers damage - there is no indication that the cost involved will be higher than a human driver, particularly

54 ibid.

55 Lucy Lazarony, 'Public vs. private auto insurance' *Bankrate* (22 July 2002) <https://www.bankrate.com/auto/public-vs-private-auto-insurance/> accessed 12 January 2018.

56 ibid.

57 'No-Fault Insurance: What it Really Means to You' *Insurance Hotline* (11 November 2011) <https://www.insurancehotline.com/no-fault-insurance-what-it-really-means-to-you/> accessed 1 January 2018.

58 ibid.

59 Berkeley J Dietvorst, Joseph P Simmons, Cade Massey, 'Algorithm Aversion: People Erroneously Avoid Algorithms after Seeing Them Err' (n 13). Rather than debating what truly constitutes intelligence, non-human intelligence should be understood here as the computation behind the AV's decision making.

60 Janice Nadler, Mary-Hunter McDonnell 'Moral Character, Motive, and the Psychology of Blame' (2012) 97/255 *Cornell Law Review* <https://scholarship.law.cornell.edu/cgi/viewcontent.cgi?referer=https://www.google.ca/&httpsredir=1&article=3290&context=clr> accessed 11 January 2018 257

61 Chris Reed, Elizabeth Kennedy, Sara Noguiera Silva 'Responsibility, Autonomy and Accountability: legal liability for machine learning' (Third Annual Symposium for the Microsoft Cloud Computing Research Centre, 8-9 September 2016) <https://ssrn.com/abstract=2853462> accessed 11 January 2018, 5.

62 ibid.

given that Google cars drove 1.3 million miles in seven years before causing an accident.[63] Reed et al. suggest that the identifiable party to insure is, pragmatically, the keeper of the vehicle, and that this allocation follows the precedent of aircraft owners, where it has invoked no serious problems.[64] This has the additional benefit of not disrupting the current vehicular liability requirements, as vehicles must already be insured by their owners.[65] The amount to be paid for insurance can initially reflect the average rates for their human driver counterparts, but should not involve typical factoring characteristics such as the driving record, where the owner lives, driving experience, age, gender, or vehicle type. The aim of the AV is to make these irrelevant, and to exclude bias when pricing the coverage.[66] It should also provide an initial overhead for damage coverage as the potential damage-reduction possibilities of the AV bear fruit.

48 However, there should be another sector of contribution to the singular fund - a per-car entry cost from the manufacturer. While the initial amount will be arbitrary, what the amount should eventually reflect is injury and related costs compensation for AV accidents. This amount will require buffering before a minimum level of saturation for AVs, as if there is only one AV on the road which causes an accident worth an accident pay-out of three million dollars, this is unreasonably punitive. However, as more and more AVs are put onto the road, the injury pay-out amounts should be split between their manufacturers on, for example, a year-to-year determination basis. This means that when manufacturer A causes an accident that produces injury, that cost is split communally amongst all manufacturers.

49 This should not be seen as a shift or allocation of blame, nor changing the insuring party. It is analogous to collecting levies from, for example, blank CD sales. Rather than requiring the time or public resources to go after individual problematic activity, it is the acknowledgment that an undesirable result occurs, and is made possible by the manufacturer. The levy is neither a punishment, nor an allocation of liability, but a recognition that the end result is enabled by the party in question. For the music industry, this is the assumption that blank CDs are used to enable industry-undesirable sharing. For AVs, this is the assumption that no matter how well-designed AVs are, accidents will, at least initially, occur and cause injury. In both cases, costs are ultimately borne by consumers, whether or not the purchase in question actually enabled an undesirable result. The industry simply passes costs along to its purchasers. While damage may be sufficiently and reasonably covered through traditional insurance by AV owners, the levy serves both a social purpose, of acknowledging the enabling of these types of accidents, and a monetary one, through compensation for injury caused. Even if manufacturers are not held liable, it is beneficial that the consequences of design be acknowledged. While collecting societies may have acquired a negative reputation, the levy in itself is not necessarily a negative way to address this problem - particularly where manufacturers have both the motivation and the capability of reducing this amount by decreasing injury.

50 This may seem an arbitrary approach that punishes manufacturers who produce vehicles that do not cause injury. However, it incentivizes manufacturers in societally beneficial ways. First, it places injury reduction as the ultimate cost-saving priority to manufacturers; specifically, they can reduce costs by placing it at the top of the decision-making process for the car, rather than avoiding liability. Second, it promotes co-operation and standardization between companies. Every manufacturer gains when they collectively reduce injury costs. Standardized reactions from AVs not only allow for predictability for human drivers who share the road with AVs but foster better interaction between different manufacturers. It also encourages car to car communication - rather than building an intra-company network of communication, manufacturers are incentivized to communicate cross-brand. The success of one company is the success of all companies. Third, it reduces the potential for manufacturers to hold monopolies over AVs. Requiring an entry cost to enter the market would mean that a company must be of a certain worth to even attempt to compete. When fiscal giants like technology companies and traditional auto manufacturers are involved, this is likely to be an unassailable moat. Placing the cost per-car means that the success of then-current market players reduces the potential

63 Alex Davies, 'Google's Self-Driving Car Caused Its First Crash' *Get Wired Magazine* (29 February 2016) <www.wired.com/2016/02/googles-self-driving-car-may-caused-first-crash/> 2 January 2018.

64 Chris Reed, Elizabeth Kennedy, Sara Noguiera Silva 'Responsibility, Autonomy and Accountability: legal liability for machine learning' (n 61) 29.

65 ibid, and further noting that "This approach is supported by the Draft Report with recommendations to the Commission on Civil Law Rules on Robotics" (2015/2103(INL), European Parliament Committee on Legal Affairs 31 May 2016) paras 29-31.

66 These are commonly factored in features of auto insurance - 'Compare car insurance quotes to get the lowest rates in Saskatchewan' (*LowestRates.ca*) <www.lowestrates.ca/insurance/auto/saskatchewan> citing David Marshall, 'Fair Benefits Fairly Delivered: A Review of the Auto Insurance System in Ontario' (*Ontario Ministry of Finance,* 2017) < www.fin.gov.on.ca/en/autoinsurance/fair-benefits.html> accessed 1 January 2018; 'Compare Auto Insurance Quotes in Ontario' (LowestRates.ca) <www.lowestrates.ca/insurance/auto/ontario> accessed 1 January 2018.

cost per entry for new manufacturers, lowering the entry to effective competition. Fourth, it means that companies can fold in the one-time cost per car into the purchase price, rather than being liable in perpetuity for an unpredictable cost. Fifth, it does not remove the benefits of branding from individual companies as car buyers "frequently cite safety as the most important factor in selecting a car."[67] There is no reason to believe that this would change and is in fact likely to be reinforced as drivers hand control over to an AV. Overall, there should still be the potential for pursuing a particular company in extreme cases, such as egregious negligence. For example, if it can be demonstrated that a company had knowledge of a dangerous vulnerability and ignored it - such as a design flaw that made any crash likely to ignite the vehicle - they should bear the full cost for that oversight. While this may seem like an unclear standard, the law has dealt with such standards before, given that tort law is built on the concept of a "reasonable person".

51 It is possible that many of these incentives could be achieved by allowing the insurance fund, or other parties, to pursue manufacturers for negligence. Even co-operation could be encouraged by allowing manufacturers to be pursued as a single entity. However, this places a greater burden on either the consumer or insurance entity to undergo the necessary litigation, or at least legwork, to show the manufacturer's negligence. One of the problems unique to machine learning is that the decision-making process of artificial intelligence can be particularly opaque - consumers may find it difficult if not impossible to understand "black box" decision-making.[68] It may be that the consumer attempts to recover before having proper knowledge of whether the AV was in fact negligent. Additionally, litigation puts further strain on the court system. Allowing for the levy to provide these incentives - except in extreme cases - means that there is a strict liability approach to a no-fault problem, namely, the acknowledgment of blameless enablement, but the ultimate injury caused.

4. Implementation:

52 When allowing manufacturers to side-step strict liability, it is naturally important to hold high standards to entry. This is not to say that the entry requirements should have monetary value, as previously mentioned, but should include such areas as rigorous testing. Strict requirements can reasonably be placed on manufactures as the AV is still a multi-tonne machine that will be piloted amongst unarmored pedestrians. The possibility for co-ordination is also a positive one between manufacturer and government, since co-ordination such as car to infrastructure, or car to transit, have the potential to benefit both parties. Car to infrastructure communication, such as traffic lights, or road closures, have the ability to make the AV more efficient, and to alleviate strains on infrastructure such as traffic jams. Even more crucially, requiring predictable procedures for emergency vehicles could result in reduced emergency response times, as AVs part like the Red Sea as required.

53 Car to transit communication can not only help avoid collision, but also allows for better co-ordination in timing, particularly when AVs are used to fill a gap in transportation rather than replace an individually owned vehicle. Implementation should also allow communication between the government insurer and manufacturers - where damage is tracked to a particular problem, the government entity has the ability to convey this to the manufacturer, and the power to demand a solution. It is unlikely to reach this level, as manufacturers are incentivized to better their vehicles regardless, but it nonetheless allows for a two-factor system of tracking issues with the AVs.

54 A further requirement could also be standardized signaling to third parties. One particularly prescient analysis notes that while AVs are technically more predictable than their human counterparts, this does not mean that they are more predictable to third parties – i.e., those who have not programmed them.[69] Pedestrians have indications as to whether a human driver has noticed them. This can include eye contact, a hand-wave, or, in extreme cases, a rude gesture. This sort of communication has not yet been indicated by AV manufacturers, but could grow to be included in the "price to entry" in order to qualify to enter the market. This could be as simple as unique blinking indicators in the pedestrian's direction, or as complex as screens on various parts of the car, but overall serves to show that there needs to be a consistent dialogue between the regulator and manufacturers.

F. Public Policy Part Two

55 What a public policy approach to AVs aims to achieve is incentivizing better questions. Rather than demanding manufacturers wait on the answer to "how liable will the company be?", a proactive

67 Ratan Hudda and others, 'Self Driving Cars' (n 12) 7.

68 Chris Reed, Elizabeth Kennedy, Sara Noguiera Silva 'Responsibility, Autonomy and Accountability: legal liability for machine learning' (n 61) 13-14.

69 Harry Surden, Mary-Anne Williams, 'Technological Opacity, Predictability, and Self-Driving Cars' (n 16).

public policy approach, such as the one described, forces companies to instead ask "what is the best possible way to reduce injury?".

56 Many billions have been put into researching and developing fully autonomous vehicles, not to mention the many stages of partial-autonomy along the way. The industry growth rate is currently 16% and is expected to be over $1 trillion by 2025.[70] One policy benefit of the proposal thus far discussed is that rather than stockpiling capital against the eventuality of a lawsuit, companies can focus on putting funds towards other areas such as increasing fuel efficiency, reducing vehicle cost, and improving accessibility. This has the potential for positive economic impact since research and development is encouraged, rather than stifled or put on hold to wait for potential legal impacts. While there is still an indeterminate amount of time to wait before manufacturers are ready to put consumer-model AVs on the road, the reluctance to assume responsibility is palpable as all consumer available automated features require that there be a licensed human in the driver seat in order to take control the instant it becomes necessary - and preferably even before.

57 This paper's proposal encourages the introduction of AVs, while interfering minimally with the current regime of road rules and liability. It does not require the scrapping of an entirely workable system, and simultaneously allows for the incremental introduction of AVs on the road with a majority of human drivers. While current automated features on cars do still require a human driver, it is unnecessary to allow for a change in liability where the human driver must still be able to step in.

58 A Public Prosecution Service of Canada working group has produced a report on the Future of Automated Vehicles in Canada.[71] While the report is naturally focused on implementation of semi and full AVs in Canada specifically, it provides a helpful list on "The Role of Governments":

- Regulate vehicle safety;
- Harmonize standards [between countries];
- Encourage innovation;
- Protect privacy of individual vehicle users;
- Educate the public;
- Build data expertise and capacity;
- Develop and enforce traffic laws;
- Oversee insurance and liability;
- Ensure a safe and smooth transition;
- Build and upgrade transportation infrastructure.[72]

59 While many of these areas have been discussed in this paper, it is a helpful reminder that a government's role is not simply to mandate legal change from a removed perspective, but to aid transition in a variety of areas and elements. Insurance and liability are naturally important, but if laws are not enforced, or the public remain unconvinced, then the potential benefits will not be realized in full.

60 Public policy is an important tool to achieve social acceptance. Transparency and clarity of legislation will be key to sufficient initial confidence in consumers to start building positive interaction – personal experience being the ultimate key to social acceptance, both by the individual themselves and word of mouth. If the policy is to achieve the aforementioned benefits of AVs, it must have the public on board. Changes inherently bring opposition, but this has not stopped legislating in favour of change in the past; for example, high occupancy vehicle lanes encourage car-sharing, tax incentives for electric and hybrid vehicles incentivize greener purchases, and seat-belt and airbags have forced societal change directly.[73]

61 Testing and safety are priority concerns. Social acceptance will never be achieved unless there is a belief in the safety of AVs. Consumers have good reasons to be skeptical of the automotive industry, and safety records in particular, especially given the Ford Pinto's transmission problems, Firestone tire blowouts, the Takata airbag recall, and the Volkswagen emission scandal, which all suggest that profit may have been prioritized over safety. AVs cannot afford this type of profit post-mortem. Testing must be particularly stringent, and indeed better than the average driver to overcome the concerns over non-human drivers. The adoption of the aforementioned levy approach is beneficial as consumers could not only avoid liability, but it would ensure that companies are serious enough about the vehicle's safety capacity passengers to "put their money where their mouth is" in terms of human safety.

70 Muhammad Amat, Dr Clemens Schumayer, 'Self Driving Cars: Future has already begun' (n 6) 18.

71 Public Prosecution Services of Canada 'The Future of Automated Vehicles in Canada' (29 January 2018) <https://comt.ca/reports/autovehicle2018.pdf> accessed 23 June 2018.

72 ibid 14.

73 Ratan Hudda and others, 'Self Driving Cars' (n 12).

62 Two potential ways to foster social acceptance are publicizing existing uses and creating pilot programs. The public already interacts with AI transportation, such as Masdar and Heathrow airport shuttles, the Milan driverless metro, and driverless trucks in Australian and Chilean mines.[74] A simple step is to make the public more aware that these transportation methods are already in use, safely, efficiently, and successfully. Pilot programs to provide AVs to impoverished communities or those underserved by current transit initiatives can be a way to allow for optional adoption and demonstrable benefit, though particular care should be taken to show that this is not a testing ground. Initiatives for the visually impaired, for example, would demonstrate that unlike AI levels below five, fully autonomous AVs make car travel accessible to all. Both publicization and pilot programs have significant potential in terms of building positive personal experiences, promoting both personal acceptance and word of mouth recognition.

63 Social acceptance of AVs through public policy methods faces unique challenges. Seatbelt adoption, for example, used a variety of methods in the United States: policies and mandates such as laws regarding use; incentives and rewards based on use; signs politely reminding seatbelt use; and feedback on community performance.[75] These methods are not easily transportable to AV adoption. While laws regarding use are naturally important in terms of regulation, AVs present unique challenges; for example, although wearing a seatbelt or not is a distinct choice, it is still possible to drive without one. If one is in an AV, the choice is not whether or not to drive, since by the time an individual has made the choice to use an AV, they have accepted the overarching function of the AV, rather than deciding whether or not to wear a seatbelt while still using the car in a way they are familiar. The role of public policy in the case of AVs is to remove uncertainties which might disincentivize use, rather than attempt to force a particular choice. Public policy should not be focused on forcing the adoption of AVs, but on removing the barriers to those in the position to adopt their use, such as uncertainties like liability. No car owner wants to be unsure of whether or not they will be liable for an accident over which they had no control, even if they were aware that the probability of an accident occurring was much lower.

G. Challenges – Legal and Technical

64 There are many challenges to be faced in introducing AVs. There are uncountable minor changes that must be introduced - everything from regulations requiring hands on the wheel, to how vehicles are fueled. There are much more impactful challenges to be faced, however. Manufacturers must be discouraged from attempting to allow their car to game the system and offering consumers a vehicle that disadvantages either other AVs or human drivers.

65 Where AVs can communicate between themselves and infrastructure, the ability of third parties to hack the system for their own potential malicious ends is a concern, particularly in a nexus with personal privacy. Personal privacy has already become a crucial battle in the 21st century, and AVs will accelerate the race between laws protecting privacy of data, and companies using that data for their own means. AV data can not only identify a person and their current whereabouts, but likely a great deal of telling information about their habits, friends, and lifestyle. Beyond hacking, connections between vehicles and with infrastructure and the manufacturer could still be used to collect and transmit personal data. Unless forced to do so, manufacturers are unlikely to allow consumers to opt out of data transmission since a great deal of the data will likely be used for positive means, such as optimizing function and driving patterns. However, there is still the danger that information released could identify an individual. Collection has significant benefits, and the problem must be addressed by controlling use and disclosure. This is done through data protection law. The question remains whether existing data protection law is sufficient. While some jurisdictions have unified their approach to data protection, such as the European Union's General Data Protection Regulation, there is no global unity on issues such as what constitutes personal data; who can use what, and how; what protection should be in place; or how to properly anonymize that data. Common data protection issues and proffered solutions can be seen in other areas such as medical data; data is crucial for research, but there is a significant threat to privacy if data is insufficiently anonymized or used in ways that were not foreseen at collection. Addressing such issues for AVs might follow practices similar to medical data collection or may be found to require a customized regime that can be updated faster than traditional data protection law.

74 Alain L Kornhauser, 'Smart Driving Cars: Where Are We Going? Why Are We Going? Where Are We Now? What Is In It for Whom? How Might We Get There? Where Might We End Up?' (2013) (Princeton University TransAction Conference, 18 April 2013) <http://orfe.princeton.edu/~alaink/Presentations/ITE_SmartDrivingCars/TransAction2013_SmartDrivingCars_041113.pdf> accessed 22 June 2018 24.

75 E Scott Geller, Timothy D Ludwig, 'A conceptual framework for developing and evaluating behavior change interventions for injury control' (Health Education Research, 1990) DOI: 10.1093/her/5.2.125.

66 While the system suggested should, on the whole, be able to integrate with current systems, there may be unforeseen challenges. For example, it has been suggested that both the Geneva and Vienna Conventions may not allow for a vehicle that does not permit a human driver to resume control.[76] Individual jurisdictions, not to mention countries, may have legislation or precedents that negatively impact, or currently do not allow for, the integration of AVs.

67 Functionally, AVs still have hurdles to overcome. They are expensive, perhaps prohibitively so as, the extra equipment that allows the AV to drive itself are not cheap, and their cost is in addition to the vehicle itself. Extensive testing is also expensive and is a cost that is likely to remain. AVs still struggle with weather, and while testing is being carried out to overcome this,[77] accidents have occurred on the basis of weather conditions.[78] Additionally, the lack of opacity is a barrier to trust. While AVs have much to offer, it is a legitimate complaint that the "decisions" made by AVs can be difficult to understand, particularly from a lay-person's perspective. This lack of clarity can carry through to lawsuits and will challenge the technical expertise of those who may be ill-equipped to evaluate such decisions.

68 Even with the suggested changes, there are will be systemic issues to be addressed. While co-operation between companies in terms of life-saving measures, predictability, and integration is positive, it inherently raises concerns about competition and collusion. Companies may be motivated to, for example, find a system that works well enough between them and keep to it, rather than striving for better, safer, or more efficient advancements.

H. Conclusion

69 There is a world of potential to be unlocked by AVs. On a purely ethical basis, it would be very difficult to ignore their lifesaving potential. Beyond this, there are countless other, if lesser, benefits. A car is an expensive investment that sits unused an estimated 95% of its life.[79] Currently, 40% of fuel is used finding a parking space in urban areas.[80] Time, energy, and stress are expended on commutes that could be spent in better, or at least more relaxing, ways. Even better use of land is a possibility, as concepts such as a "park and ride" for airports need no longer take up space.[81]

70 AVs have the potential to remove every human failing from the province of transportation. This has an impact beyond human choices, such as driving while intoxicated or tired. Vehicles can see further than human eyes and communicate on many more levels. A car that needs no human driver can avoid a traditional vehicle's security liabilities - with no need for human eyes, there is no need for a vulnerable glass portal at the front of the car. AVs have the potential to become metaphorical tanks, as they need not account for a driver's ability to see from various angles.

71 Current liability conceptions are deeply problematic for AVs. Not only are they uncertain in terms of introducing AVs, but the current jurisprudence provides no promising answers as to where liability may fall. Pinning liability on parties who have no control, or on parties who will make it a primary priority over more important concerns, is likely have the effect of chilling the market before it can really begin. Ignoring liability questions and assuming that the market will develop and flourish when left alone is optimistic at best, and at worst enables a monopolistic and limited-benefits system.

72 It is important that public policies regarding AVs are scalable. It needs to be capable of addressing a slow trickle of AVs as they enter the market, and an increasing majority as they become more affordable and marketable. The regime needs to ensure that victims are not left out in the cold, and manufacturers not incentivized to prioritize fiscal vulnerability ahead of human safety.

73 It is crucial that we incentivize better questions - how to achieve a perfect no-injury record, rather than where liability should fall on a scale of priorities. How to improve access for individuals with mobility issues, rather than how to inch forward without invoking liability. Regulation should aim to encourage one particular future: where accidents are unusual, and vehicular deaths non-existent. But this needs to start somewhere and needs law reform action to put the wheels in motion.

74 Ultimately, liability conceptions need to evolve in order to fully realize the potential benefits of AVs on a societal level. This is best achieved by letting

76 Jonathan Margolis, 'Self-driving cars still face multiple roadblocks' *Financial Times* (New York, 11 January 2017) <www.ft.com/content/f9847198-d40b-11e6-b06b-680c49b4b4c0> accessed 2 January 2018.

77 snow - Ford Media, 'Ford's Industry first autonomous vehicle tests in snow' (YouTube, 11 January 2016) <www.youtube.com/watch?v=vShi-xx6ze8> accessed 2 January 2018.

78 Neal Boudette, 'Tesla's Self-Driving System Cleared in Deadly Crash' (n 7).

79 Muhammad Amat, Dr Clemens Schumayer, 'Self Driving Cars: Future has already begun' (n 6) 11.

80 ibid.

81 ibid 18.

go of traditional liability conceptions and blame. There needs to be strict liability as damage needs to be reimbursed, and no-one should face financial hardship for decisions beyond their control. This strict liability needs to be placed without fault. Attempting to place fault and blame results in inevitable time, money, and litigation spent, when such energies are better focused on remedying the problem, compensating the victim, and improving the AVs. It also sidesteps the problem of incentivizing avoidance of liability rather than the prevention of harm. Compulsory insurance is already required in most if not all countries currently developing AVs, and this insurance setup can and should be expanded to cover AV accidents. Doing so from a single pool allows for streamlined claims, a direct dialogue between claim evaluators and manufacturers, and co-operation regarding AV issues. Such a system could be realized through an independent government entity and augmented by a manufacturer levy.

75 "May you live in exciting times" is often cited to be a curse. Yet these are indeed exciting times – we are at a crossroads of design, manufacturing, and vision. We have the unique opportunity to foresee innovation, and to level the field in preparation of its arrival. We have a distinct moment to celebrate one of humanity's greatest qualities, the prerequisite of all innovation: drive. Let's put the pedal to the metal.