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THE BLACK BOX SOLUTION TO AUTONOMOUS LIABILITY

Imagine walking out your front door, newspaper and coffee in hand, ready to start the day. You open your car door, press the on button and proceed to work on today's crossword, sipping your coffee, as you are chauffeured to work by your autonomous vehicle. Imagine the significance of this ride. Imagine the productivity you gain—an extra hour for work? An extra hour of reflection? Imagine the benefits to your family—your elderly parents could achieve their desired independence, and you would not have to worry about your teenager crashing into a mailbox every time he or she pulls out of the driveway.

More importantly, imagine the potential to save lives. Autonomous vehicles may significantly lower the number of car accidents in the United States.[1] As human error has been found to be a contributing cause of over ninety percent of car accidents,[2] taking responsibility for driving out of the hands of the driver would significantly decrease the number of accidents that occur every year, and save thousands of lives.[3]

While the idea of a car that drives itself evokes images of science fiction, autonomous vehicles are no longer relegated to *Minority Report*[4] and *I, Robot*[5]—rather, they are being developed today by Google,[6] Toyota,[7] Nissan,[8] Audi[9] and Tesla.[10] There is no question that such

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1. NAT'L HIGHWAY TRAFFIC SAFETY ADMIN., U.S. DEP'T OF TRANSP., NO. 14-13, PRELIMINARY STATEMENT OF POLICY CONCERNING AUTOMATED VEHICLES 1 (2013), *available at* www.nhtsa.gov/staticfiles/rulemaking/pdf/Automated_Vehicles_Policy.pdf.

2. NAT'L HIGHWAY TRAFFIC SAFETY ADMIN., U.S. DEP'T OF TRANSP., DOT HS-805-085, TRI-LEVEL STUDY OF THE CAUSES OF TRAFFIC ACCIDENTS 28 (1979), *available at* http://ntl.bts.gov/lib/25000/25500/25515/DOT-HS-805-085.pdf.

3. In 2011, NHTSA estimates that there were 5,338,000 police-reported car accidents, resulting in over 32,367 deaths. NAT'L HIGHWAY TRAFFIC SAFETY ADMIN., U.S. DEP'T OF TRANSP., DOT HS-811-753, TRAFFIC SAFETY FACTS 2011 DATA 1 (2013), *available at* http://www-nrd.nhtsa.dot.gov/Pubs/811753.pdf. Given these figures, if autonomous vehicles were in use in 2011 and all accidents to which human error contributed did not occur, there would only have been 533,800 police-reported car accidents during the year. Assuming that no other factors influence fatalities in car accidents, 29,130 lives might have been saved through the use of autonomous vehicles in 2011.

Autonomous vehicles also have potential environmental benefits. According to the NHTSA, autonomous vehicles may conserve fuel by "automatically accelerat[ing] and brak[ing] with the flow of traffic" and "eliminating the traffic congestion that crashes cause every day on our roads." NHTSA, *supra* note 1, at 1 (2013). The NHTSA also foresees "corresponding reductions in greenhouse gas emissions." *Id.*

4. MINORITY REPORT (Twentieth Century Fox 2002).

5. I, ROBOT (Twentieth Century Fox 2004).

6. *See* John Markoff, *Google Cars Drive Themselves, In Traffic*, N.Y. TIMES, Oct. 9, 2010, at A1.

7. *See Toyota Sneak Previews Self-Drive Car Ahead of Tech Show*, BBC (Jan. 4, 2013), http://www.bbc.co.uk/news/technology-20910769 [hereinafter *Toyota Sneak Previews*].

vehicles will revolutionize industries—from transportation to insurance—and change travel forever.

Car functions fit into five categories: no-automation, function-specific automation, combined function automation, limited self-driving automation, and full self-driving automation.[11] No-automation is the type of driving experience that is currently the norm: the driver has full control of steering, speed, and other functionality. Function-specific automation, combined function automation, and limited self-driving automation are intermediary levels of automation, ranging from antilock braking systems to adaptive cruise control.[12] Full self-driving automation is the most advanced of these categories and is the type of functionality envisioned in an autonomous vehicle. These vehicles are "designed to perform all safety-critical driving functions and monitor roadway conditions for an entire trip."[13] Essentially, they replace the driver by guiding and operating themselves. This frees the user's time, creates opportunities for individuals with less mobility, and increases overall road safety. For all of the benefits, autonomous vehicles raise a number of issues that have yet to be tackled by legislators or legal scholars.

The first of these questions is a threshold question: To avoid barriers to manufacturing related to tort liability, what could manufacturers use to correctly determine who is liable in tort in the event of a car crash? This Note argues that the inclusion of a mechanism to monitor and record data about vehicle functioning, known as an Event Data Recorder ("EDR"), aboard autonomous vehicles is the solution. This technology is analogous to the Flight Data Recorders ("FDR"), colloquially known as a "black box," found on airplanes. An FDR records and transmits information about the airplane's functionality, as well as pilot error. By analyzing this information, investigators can easily determine whether the cause of a plane crash was human error or mechanical failure. The same would apply to autonomous vehicles. Manufacturers would be more secure about their

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8. *See* Alex Taylor III, *Nissan Goes Big on Self-Driving Cars*, CNN MONEY (Sept. 4, 2013), http://money.cnn.com/2013/09/04/autos/nissan-360-irvine.fortune/index.html.

9. *See* Tom Simonite, *Audi Shrinks the Autonomous Car*, MIT TECHNOLOGY REVIEW (Jan. 8, 2013), http://www.technologyreview.com/news/509676/audi-shrinks-the-autonomous-car/.

10. *See* m4tt, *Elon Musk in Talks with Google to Bring Driverless Tech to Tesla Cars*, THE VERGE (May 7, 2013, 11:07 AM), http://www.theverge.com/2013/5/7/4308288/elon-musk-talks-google-driverless-tech-tesla.

11. NHTSA, *supra* note 1, at 4–5.

12. *Id.*; *U.S. Department of Transportation Releases Policy on Automated Vehicle Development*, NHTSA (May 30, 2013), http://www.nhtsa.gov/About+NHTSA/Press+Releases/U.S.+Department+of+Transportation+Releases+Policy+on+Automated+Vehicle+Development.

13. NHTSA, *supra* note 1, at 5.

financial liability in tort claims, thus increasing their willingness to develop the new technology. However, issues related to the data recorded on EDRs will arise that may prevent manufacturers and users from adopting the technology. To provide comfort for users while protecting manufacturer interests, consumer privacy protections must secure and limit EDR data usage. Vehicle user ownership of the EDR data and a requirement of affirmative consent for any commercial use of data should be mandated.

This Note will explore the development of autonomous technology, barriers to manufacturing, a solution in the mandatory inclusion of EDRs aboard autonomous vehicles, and consumer protections that must be put in place to secure EDR data. Part I will provide a background of autonomous vehicles, including historical development and current legislation. Part II will discuss the issue of tort liability and how it may serve as a barrier to manufacturing of autonomous vehicles. Part III will argue that requiring EDRs on autonomous vehicles will ensure car manufacturers that liability will be assigned accurately, and the manufacturers will be responsible for only failures of their own products. Part IV asserts that consumer privacy protections must be implemented to prevent misuse of EDR data.

I. BACKGROUND OF AUTONOMOUS VEHICLES

A. Historical Development

As a result of the potential societal benefits from autonomous vehicles, the incentives for creating this technology have become apparent. Originally, the idea of self-driving vehicles arose from the national security interest in creating unmanned vehicles that could be used for military purposes.[14] In 2004, the Defense Advanced Research Projects Agency ("DARPA") created the Grand Challenge, which challenged inventors to create cars that could drive themselves 150 miles across the Mojave Desert.[15] While no cars completed the 2004 Grand Challenge,[16] DARPA extended another challenge in 2005.[17] During the 2005 Grand

14. *Grand Challenge Overview*, DARPA, http://archive.darpa.mil/grandchallenge04/overview.htm (last visited Jan. 8, 2014). "The purpose of the DARPA Grand Challenge 2004 is to leverage American ingenuity to accelerate the development of autonomous vehicle technologies that can be applied to military requirements." *Id.*

15. *The DARPA Grand Challenge: Ten Years Later*, DARPA (Mar. 13, 2014), http://www.darpa.mil/newsevents/releases/2014/03/13.aspx.

16. *Id.*

17. *Grand Challenge '05*, DARPA, http://archive.darpa.mil/grandchallenge05/ (last visited Jan. 8, 2014).

Challenge, five cars completed the 132-mile course over desert terrain,[18] with four of the cars completing the race in less than ten hours.[19] In 2007, DARPA held its last Grand Challenge, requiring cars to drive sixty miles "in an urban environment, complete with four-way stop signs, lanes that merge, and moving vehicle traffic."[20] Six teams successfully completed the final challenge.[21]

Google Inc. ("Google") became enamored with the prospect of creating self-driving cars. In 2005, one of their engineers, Sebastian Thrun, led the Stanford Racing Team to victory in DARPA's 2005 Grand Challenge.[22] Thrun and Larry Page, one of Google's co-founders, were early promoters of the potential of autonomous cars to "make highways safer and lower the nation's energy costs."[23] Over the next six years, Google continued investing in autonomous vehicle technology.

In 2011, Google decided it had the capacity to put autonomous vehicles on public roadways and began lobbying for preemptive legislation to deal with the introduction of autonomous vehicles.[24] On June 4, 2011, Google lobbyist, David Goldwater, spoke before the Nevada Senate Committee on Finance in support of legislation allowing autonomous vehicles to operate on the public roadways of Nevada.[25] Goldwater's statements indicated the leaps and bounds Google had made in its autonomous technology since the Grand Challenge in 2005.[26] Instead of manufacturing its own cars, Google harnessed the existing technology in cars such as the Toyota Prius and Audi TT, and added the systems necessary to allow the cars to operate autonomously.[27] According to Goldwater, an autonomous vehicle "uses

18. K. Krasnow Waterman & Matthew T. Henshon, *Imagine the Ram-If-Ications: Assessing Liability for Robotics-Based Car Accidents*, SCITECH LAW., Spring 2009, at 14.

19. DARPA, *supra* note 17. The Stanford Racing Team won the $2 million prize with its time of six hours and fifty-three minutes. *Id.*

20. Waterman & Henshon, *supra* note 18, at 14.

21. *DARPA Urban Challenge*, ARCHIVE.DARPA.MIL, http://archive.darpa.mil/grandchallenge/index.asp (last visited Jan. 8, 2014).

22. Markoff, *supra* note 6. Sebastian Thrun was a "director of the Stanford Artificial Intelligence Laboratory, a Google engineer and the co-inventor of the Street View mapping service." *Id.*

23. *Id.*

24. John Markoff, *Google Lobbies Nevada to Allow Driverless Cars*, N.Y. TIMES, May 11, 2011, at A18; Amir Efrati, *Google's Driverless Car Draws Political Power*, WALL ST. J., Oct. 12, 2012, http://www.wsj.com/articles/SB10000872396390443493304578034822744854696.

25. Nev. S. Comm. on Fin., Minutes, 76th Sess., at 36 (June 4, 2011).

26. *Id.* at 36–37.

27. *Id.* Google's autonomous vehicles are driven by an extremely advanced system of GPS and sensors. In an aside attached to Adam Fisher's Popular Science article, *Inside Google's Quest to*

artificial intelligence, global positioning system, radar, lasers, cameras and internal sensors to create a three-dimensional view of the road."[28]

While Google may be the "pioneer of self-driving cars,"[29] other car companies are quickly getting into the business. Audi AG and Toyota Motor Corporation ("Toyota"), both companies whose vehicles Google is currently using to test its autonomous technology, are beginning to develop their own autonomous models.[30] Nissan Motor Co., Ltd. ("Nissan") is also planning to enter the autonomous vehicle market. Nissan's goal, according to its current Chief Executive Officer Carlos Ghosn, is to place an autonomous vehicle on the market by 2020.[31] Among the potential developers is Tesla Motors, Inc. ("Tesla"), an innovative car company known for its electric vehicles. Tesla Chief Executive Officer, Elon Musk, stated that his company plans to produce autonomous vehicles by 2016.[32]

B. Current Legislation

With the rise of competition and the creation of the new marketplace, companies interested in investing in autonomous vehicle technology are

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Popularize Self-Driving Cars, Graham Murdoch describes how Google's autonomous vehicles see the world:

> Once a driver activates the autonomous mode, the vehicle's drive-by-wire system transfers control of the brake, gas, and steering to an onboard computer. The vehicle's roof-mounted lidar (or light detection and ranging) unit probes 360 degrees with 64 laser beams, taking more than a million measurements per second. This data forms a high-resolution map (accurate to about 11 cm) of the car's surroundings. Prebuilt navigation maps indicate static infrastructure, such as telephone poles, crosswalks, and traffic lights, which enables software to quickly identify moving objects, like pedestrians and cyclists. These targets are clustered together and tracked so that algorithms can process the traffic situation and plot a path safely through it.

Adam Fisher, *Inside Google's Quest to Popularize Self-Driving Cars*, POPULAR SCI. (Sept. 18, 2013), http://www.popsci.com/cars/article/2013-09/google-self-driving-car. For more information on the specific technology used in autonomous vehicles, see Erico Guizzo, *How Google's Self-Driving Car Works*, IEEE SPECTRUM (Oct. 18, 2011), http://spectrum.ieee.org/automaton/robotics/artificial-intelligence/how-google-self-driving-car-works.

28. Nev. S. Comm. on Fin., *supra* note 25, at 36.

29. Markoff, *supra* note 6.

30. *See* Simonite, *supra* note 9; *Toyota Sneak Previews*, *supra* note 7.

31. *See* Press Release, Nissan Motor Corporation, Nissan Announces Unprecedented Autonomous Drive Benchmarks (Aug. 27, 2013), *available at* http://www.nissan-global.com/EN/NEWS/2013/_STORY/130828-02-e.html. Among Nissan's goals are to create a "revolutionary commercially-viable Autonomous Drive in multiple vehicles by the year 2020," and to provide "availability across the model range within two vehicle generations." *Id.*

32. Ellie Zolfagharifard, *Tesla Battles Google in Race to Get Driverless Cars on the Road*, DAILY MAIL, Jan. 7, 2014, http://www.dailymail.co.uk/sciencetech/article-2424312/Teslas-Elon-Musk-says-self-driving-cars-produced-2016.html.

lobbying for regulation of new issues that will arise as a result of autonomous vehicles. With the advent of these new vehicles, "technology is now advancing so quickly that it is in danger of outstripping existing law, some of which dates back to the era of horse-drawn carriages."[33] Cars operated by humans have extensive regulations and many of these will apply to autonomous vehicles. Autonomous vehicles, which are controlled by GPS and sensors as opposed to a human driver, will raise a myriad of new issues that may not be reconcilable with current regulations. Among these issues is tort liability—specifically, determining the party responsible for causing a vehicular accident. This Note will focus on providing and defending a method that may be used to establish liability in case of an accident.

According to Google lobbyist David Goldwater, "forward-looking" legislation may allow states to avoid the problem of "technology outpac[ing] the law."[34] If states are able to promulgate laws to deal with predictable legal issues, citizens and businesses will both have legal guidance in making decisions about the technology during the development process and when it is released.

Currently, Nevada, California, Florida, Michigan, and the District of Columbia have adopted regulations for autonomous vehicles.[35] Nevada was the first state to pass legislation on autonomous vehicles.[36] Its law went into effect on March 1, 2012, and the first autonomous vehicle driver's license was issued on May 8, 2012.[37] Nevada was followed by

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33. Markoff, *supra* note 24.

34. Nev. S. Comm. on Fin., *supra* note 25, at 36.

35. *See* CAL. VEH. CODE § 38750 (West 2012); D.C. CODE § 50-2352 (2012); FLA. STAT. ANN. § 319.145 (2012); NEV. ADMIN. CODE § 482A (2012).

36. *Google Gets License to Operate Driverless Cars in Nevada*, CNN (May 8, 2012), http://edition.cnn.com/2012/05/07/tech/nevada-driveless-car/; Paul A. Eisenstein, *Nevada First State to Authorize Driverless Cars*, NBC NEWS (Feb. 21, 2012), http://www.nbcnews.com/business/nevada-first-state-authorize-driverless-cars-157736; Tiffany Hsu, *Nevada Authorizes Driverless Cars (like the ones at Google)*, L.A. TIMES, June 24, 2011, http://latimesblogs.latimes.com/technology/2011/06/nevada-authorizes-driverless-cars-like-the-ones-at-google.html. It is not completely clear why Google approached Nevada first, but the author would speculate that it might have been a result of its lower insurance requirements. *See infra* note 49.

37. Mary Slosson, *Google Gets First Self-Driven Car License in Nevada*, REUTERS (May 8, 2012), http://www.reuters.com/article/2012/05/08/uk-usa-nevada-google-idUSLNE84701320120508.

Florida,[38] California, [39] and the District of Columbia.[40] Effective March 2014, Michigan also passed legislation.[41]

All four states and the District of Columbia have passed similar regulations in a number of areas. All have defined autonomous vehicles using similar language, such as "a vehicle capable of navigating . . . roadways and interpreting traffic-control devices without a driver actively operating any of the vehicle's control systems."[42] All have excluded the semi-autonomous technology that may currently be found in vehicles, such as "electronic blind spot assistance, crash avoidance, emergency braking, parking assistance, adaptive cruise control, lane keep assistance, lane departure warning, and traffic jam and queuing assistance," from the definition of autonomous vehicles.[43] They have also defined operators or drivers of autonomous vehicles similarly, either as the individual who "causes the autonomous vehicle to engage"[44] or the "human operator" of the autonomous vehicle.[45]

However, the regulations differ in a number of ways, including licensing requirements, insurance, and necessary safety devices. Nevada, unlike California, Florida, Washington D.C., and Michigan, has imposed

38. Ana M. Valdes, *Florida Embraces Self-Driving Cars, as Engineers and Lawmakers Prepare for the New Technology*, WPTV WEST PALM BEACH (May 7, 2012), http://www.wptv.com/dpp/news/state/florida-embraces-self-driving-cars-as-engineers-and-lawmakers-prepare-for-the-new-technology.

39. John Oram, *Governor Brown Signs California Driverless Car Law at Google HQ*, VR (Sept. 27, 2012), http://www.vrworld.com/news/2012/9/27/governor-brown-signs-california-driverless-car-law-at-google-hq-.aspx.

40. D.C. CODE § 50-2352 (2012).

41. MICH. COMP. LAWS §§ 257.2b, 257.36, 257.44, 257.602b, 257.663, 257.665, 257.666, 257.817 (2013).

42. D.C. CODE § 50-2351 (2012). *See also* CAL. VEH. CODE § 38750 (West 2012) (defining autonomous vehicle as "any vehicle equipped with autonomous technology that has been integrated into that vehicle," and defining autonomous technology as "technology that has the capability to drive a vehicle without the active physical control or monitoring by a human operator"); FLA. STAT. ANN. § 316.003 (West 2012) (defining autonomous vehicle as "[a]ny vehicle equipped with autonomous technology. The term 'autonomous technology' means technology installed on a motor vehicle that has the capability to drive the vehicle on which the technology is installed without the active control or monitoring by a human operator."); MICH. COMP. LAWS §§ 257.2b (2013) (defining autonomous vehicle as "a motor vehicle on which automated technology has been installed, either by a manufacturer of automated technology or an upfitter that enables the motor vehicle to be operated without any control or monitoring by a human operator"); NEV. ADMIN. CODE § 482A.010 (2012) (defining autonomous vehicle as one "enabled with artificial intelligence and technology that allows the vehicle to carry out all the mechanical operations of driving without the active control or continuous monitoring of a natural person"). These definitions are also similar to the definition provided by the NHTSA. NHTSA, *supra* note 1.

43. NEV. ADMIN. CODE § 482A.010 (2012). *See also* CAL. VEH. CODE § 38750 (West 2012); D.C. CODE § 50-2351 (2012); FLA. STAT. ANN. § 316.003 (West 2012).

44. NEV. ADMIN. CODE § 482A.020 (2012). *See also* CAL. VEH. CODE § 38750 (West 2012); FLA. STAT. ANN. § 316.85 (West 2012).

45. D.C. CODE § 50-2351 (2012).

an additional license restriction on individuals interested in driving autonomous vehicles.[46] To operate an autonomous vehicle in Nevada, the user must get a "G endorsement" on his or her license, which limits the use of the vehicle to daytime driving.[47]

Insurance requirements also vary. While California and Florida require manufacturers of autonomous vehicles to obtain a $5 million insurance or surety bond prior to testing of autonomous vehicles,[48] Nevada requires manufacturers to maintain a significantly lower $500,000 insurance or surety bond.[49] Michigan requires insurance in line with normal state policies.[50] Washington D.C. has yet to set an insurance requirement.[51]

The required safety mechanisms also differ between states. While both Nevada and California share robust safety standards, the other states have not adopted such stringent standards. Among other requirements, Nevada and California require mechanisms for storing data before a collision occurs and alert systems that activate when there are issues with the autonomous technology.[52] Florida, Washington D.C., and Michigan have

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46. NEV. ADMIN. CODE § 482A.040 (2012). *Cf.* CAL. VEH. CODE § 38750 (West 2012) (requires "proper class of license for vehicle"); D.C. CODE § 50-2351 (2012) (requires valid driver's license); FLA. STAT. ANN. § 316.85 (West 2012) (requires valid driver's license); MICH. COMP. LAW § 257.665 (2013) (requires valid driver's license).

47. *See* NEV. ADMIN. CODE § 482A.040 (2012); *Restriction Codes and Descriptions*, NEV. DEP'T OF MOTOR VEHICLES, http://www.dmvnv.com/pdfforms/restriction_codes.pdf (stating that a G restriction limits drivers to "[d]aylight driving only," explaining that the "restriction is placed on the driver license of a person with visual acuity of 20/50 or worse in both eyes, who is required to wear a telescopic device while operating a motor vehicle or who holds a motorcycle driver instruction permit").

48. CAL. VEH. CODE § 38750 (West 2012); FLA. STAT. ANN. § 316.86 (West 2012).

49. NEV. ADMIN. CODE § 482A.210 (2012). The ability to set a lower insurance requirement might have influenced Google's decision to propose autonomous vehicle legislation in Nevada.

50. MICH. COMP. LAWS § 257.665 (2013).

51. This is indicated by the lack of mention of insurance requirements in the relevant D.C. Code sections. *See* D.C. CODE § 50-2351, 2352 (2012).

52. Nevada requires that an autonomous vehicle:

> (a) Has a separate mechanism in addition to, and separate from, any other mechanism required by law, to capture and store the autonomous technology sensor data for at least 30 seconds before a collision occurs between the autonomous vehicle and another vehicle, object or natural person while the vehicle is operating in autonomous mode. The autonomous technology sensor data must be captured and stored in a read-only format by the mechanism so that the data is retained until extracted from the mechanism by an external device capable of downloading and storing the data. . . .
>
> (b) Has a switch to engage and disengage the autonomous vehicle that is easily accessible to the operator of the autonomous vehicle and is not likely to distract the operator from focusing on the road while engaging or disengaging the autonomous vehicle.
>
> (c) Has a visual indicator inside the autonomous vehicle which indicates when the autonomous vehicle is engaged in autonomous mode.

adopted less stringent standards. Florida requires an alert system in the car to indicate trouble with the autonomous technology.[53] Similarly, Washington D.C. only requires that the vehicle "has a manual override feature that allows a driver to assume control of the autonomous vehicle at any time."[54] Michigan has the same requirement, but its legislature intends to revisit the issue of safety in early 2016.[55]

> (d) Has a system to safely alert the operator of the autonomous vehicle if a technology failure is detected while the autonomous vehicle is engaged in autonomous mode, and when such an alert is given, either:
>
> (1) Requires the operator to take control of the autonomous vehicle; or
>
> (2) If the operator is unable to take control of or is not physically present in the autonomous vehicle, is equipped with technology to cause the autonomous vehicle to safely move out of traffic and come to a stop . . . .

NEV. ADMIN. CODE §§ 482A.110, .190(2) (2012). California requires that:

> (A) The autonomous vehicle has a mechanism to engage and disengage the autonomous technology that is easily accessible to the operator.
>
> (B) The autonomous vehicle has a visual indicator inside the cabin to indicate when the autonomous technology is engaged.
>
> (C) The autonomous vehicle has a system to safely alert the operator if an autonomous technology failure is detected while the autonomous technology is engaged, and when an alert is given, the system shall do either of the following:
>
> (i) Require the operator to take control of the autonomous vehicle.
>
> (ii) If the operator does not or is unable to take control of the autonomous vehicle, the autonomous vehicle shall be capable of coming to a complete stop.
>
> (D) The autonomous vehicle shall allow the operator to take control in multiple manners, including, without limitation, through the use of the brake, the accelerator pedal, or the steering wheel, and it shall alert the operator that the autonomous technology has been disengaged . . . .
>
> (G) The autonomous vehicle has a separate mechanism, in addition to, and separate from, any other mechanism required by law, to capture and store the autonomous technology sensor data for at least 30 seconds before a collision occurs between the autonomous vehicle and another vehicle, object, or natural person while the vehicle is operating in autonomous mode. The autonomous technology sensor data shall be captured and stored in a read-only format by the mechanism so that the data is retained until extracted from the mechanism by an external device capable of downloading and storing the data. . . .

CAL. VEH. CODE § 38750 (West 2012).

53. Florida requires that an autonomous vehicle have:

> (a) Have a means to engage and disengage the autonomous technology which is easily accessible to the operator.
>
> (b) Have a means, inside the vehicle, to visually indicate when the vehicle is operating in autonomous mode.
>
> (c) Have a means to alert the operator of the vehicle if a technology failure affecting the ability of the vehicle to safely operate autonomously is detected while the vehicle is operating autonomously in order to indicate to the operator to take control of the vehicle.

FLA. STAT. ANN. § 319.145 (West 2012).

54. D.C. CODE § 50-2352 (2012).

55. MICH. COMP. LAWS § 257.665 (2013) ("No later than February 1, 2016, the state transportation department in consultation with the secretary of state and experts from various sizes of automobile manufacturing and automated technology manufacturing industries shall submit a report . . . recommending any additional legislative or regulatory action that may be necessary for the

II. ISSUES WITH TORT LIABILITY

A. Importance of Predetermining Manufacturer's Tort Costs in Autonomous Vehicles

When autonomous vehicles are released to the general public, previously unforeseen legal issues will arise, and car manufacturers will require those issues to be handled quickly.[56] Some of these issues, such as safety regulations,[57] cybersecurity,[58] insurance,[59] and the cost of tort liability[60] may be contemplated and dealt with before the release of these vehicles. Leading these issues is the cost of tort liability. Despite the fact that autonomous vehicles are designed to avoid crashes and keep the roads safe, accidents will inevitably occur and liability must be assessed. This poses a conundrum for car manufacturers: on the one hand, they want to develop autonomous vehicles, but on the other hand, "liability concerns might cause them to delay production and rollout."[61]

Car crashes result from a number of environmental, technological, and human-related factors. According to a study by the U.S. Department of Transportation, the top eight factors involved in fatal car crashes between 2004 and 2008 were traffic controls, speed and route type, road characteristics, weather impacts, traffic flow, crash characteristics, road classification, and persons.[62]

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continued safe testing of automated motor vehicles and automated technology installed in motor vehicles.").

56. Fisher, *supra* note 27 (The creator of Google's autonomous vehicle technology, David Hall, "described a PowerPoint presentation containing the automaker's [sic] analysis of self-driving-car technology. 'It was about 20 pages long,' he says, 'and the last 10 pages were "What's going to happen when we get sued?"' Detroit doesn't want to start making self-driving cars without legal clarity. And legal clarity will not arrive until self-driving cars test the law.").

57. NHTSA, *supra* note 1, at 7 (2013).

58. *Id.*

59. *See* Robert W. Peterson, *New Technology—Old Law: Autonomous Vehicles and California's Insurance Framework*, 52 SANTA CLARA L. REV. 1341, 1355–62 (2012) (describing potential insurance regimes for autonomous vehicles).

60. *See* Kyle Graham, *Of Frightened Horses and Autonomous Vehicles: Tort Law and Its Assimilation of Innovations*, 52 SANTA CLARA L. REV. 1241, 1246 (2012); Waterman & Henshon, *supra* note 18, at 16; Stephen P. Wood et al., *The Potential Regulatory Challenges of Increasingly Autonomous Motor Vehicles*, 52 SANTA CLARA L. REV. 1423 (2012).

61. Rachel Boehm, *Autonomous Cars Raise Liability Concerns; Some Want Federal, Not State, Approach*, BLOOMBERG LAW DAILY REP. FOR EXECS, Feb. 4, 2013, *available at* http://www.bloomberglaw.com/search/results/4b7af553cba03cdd965a4e3331a076bf/document/X69552P4000000?search32=C9P6UQR5E9FN6PB1E9HMGNRKCLP6QFB1ELQ6URJFDLNNASP0EPIMGQB3DHIJMER2DTNMOPB1DPFN6PB1E9HMGNRKCLP6QFAE9TA2GF32DPGLUOR1EHIMERRIF4UI4SJ5E1NN4T127OKJMEREDTFMIRBGBTO6GSJ1EDIN6F9H7CTN6UBEDTN7IRBJ7KOG.

62. JENNY GUORINO & AMRUT CHAMPANERI, BUREAU OF TRANSP. STATISTICS, FACTORS INVOLVED IN FATAL VEHICLE CRASHES (2010), *available at* http://www.rita.dot.gov/bts/sites/rita.dot.

Many of the environmental factors such as traffic controls, road characteristics, weather impacts, traffic flow, crash characteristics, and road classification are congruent across all vehicles, regardless of whether they are autonomous or not, and current methods of assessing those factors remain adequate for autonomous vehicles. However, due to the advanced technology in autonomous vehicles, it may be difficult to separate autonomous system malfunctions from driver negligence. Current methods of differentiating human error from malfunctioning vehicles may not be sufficient to deal with autonomous vehicle crashes.

The numerous social benefits and cutting-edge technology of autonomous vehicles create an attractive, but expensive, investment for many companies. The safety and efficiency benefits of autonomous vehicles[63] may positively impact the company's brand. The special functionality of the vehicles will attract early technology adopters and those interested in mobility for the disabled community, environmental efficiency, and safety. Still, companies may be hesitant to invest in the development of the technology because of the high cost of research and development, coupled with the potentially high cost of tort liability—or damages in case of crashes.[64]

Put simply, companies are more likely to invest in technology if they believe that the technology will produce high returns. The simplest calculation of a return on investment is to subtract the cost of an

gov.bts/files/publications/bts_technical_report/september_2010/pdf/entire.pdf. Traffic controls are defined as "any type of signage or signal with the goal of influencing traffic flow (e.g., stop, yield, or warning signs)." *Id.* at 3. Speed and route type refer to the speeds and type of route that cars are traveling on at the time of their accidents. "[A] large proportion of fatal crashes, regardless of size, occurred on a state highway. With regard to speed limits, the greatest percentage of fatal crashes occurred in a 55 mile-per-hour (mph) zone." *Id.* Road characteristics account for "roadway alignment, roadway profile, and pavement type." *Id.* at 4. Weather impacts "depict[] the relationship between weather and roadway surface conditions." *Id.* at 4. Traffic flow depicts the movement of cars at the time of the accident. *Id.* at 3. Crash characteristics "relates to the crash's relation to the roadway and the first harmful event which occurred." *Id.* at 2. Road classification determines whether crashes occurred on national highways or on other roadways. *Id.* at 4–5. Persons "relates to the relationship between the number of persons involved in a fatal crash and fatality counts." *Id.* at 2. It should be noted that malfunctioning vehicles are not included among the top factors causing car accidents in 2004 to 2008.

63. *See supra* note 3.

64. Furthermore, experts in general robotics hypothesize that concerns about liability might cause a negative impact on American society. "M. Ryan Calo, a fellow at the Stanford Law School's Center for Internet and Society and Co-Chair of the Artificial Intelligence and Robotics Committee of the ABA, cautions that the uncertainty about liability in the field of robotics could discourage innovation and cause the United States to fall behind other countries in a vital area of technological development." Dana M. Mele, *The Quasi-Autonomous Car as an Assistive Device for Blind Drivers: Overcoming Liability and Regulatory Barriers*, 28 SYRACUSE J. SCI. & TECH. L. 26, 40–41 (2013) (citing M. Ryan Calo, *Open Robotics*, 70 MD. L. REV. 571, 576 (2011)).

investment from its gains and divide that amount by the cost.[65] When determining whether to make an investment in the development of autonomous vehicles, a company must calculate the potential sale price of the car, the cost of developing and manufacturing autonomous vehicles, and the potential cost of damages in case of a crash. If one of these factors, such as the potential cost of damages, becomes unexpectedly high, the return on investment will decrease. The cost of damages could increase because of the inability of crash investigators to separate system malfunction from driver negligence. In that instance, the return might be too low to invest in the technology.

Even though Google did not create its own autonomous vehicle and only added autonomous systems to existing cars, it reportedly spent $150,000 on each autonomous vehicle.[66] For car manufacturers, the cost of developing autonomous vehicles may be even higher. Whereas Google was only concerned with the autonomous technology, a car manufacturer must combine cutting-edge technology with user friendly and aesthetically pleasing features.[67]

In 2011, during the period Toyota was beginning to develop semi-autonomous features in its cars, Toyota spent more than any other company in the world on research and development.[68] It spent nearly $10 billion on research, amounting to 4.2% of its sales.[69] While Toyota is generally a leader in promoting new technology in its vehicles, such as the advent of its successful hybrids, few others are financially able to take the risk of developing autonomous vehicles when the return on investment is unknown.

The immense amounts of capital at stake amplify the interest in ensuring a reasonable cost of tort liability for manufacturers. Establishing

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65. *Return on Investment—ROI*, INVESTOPEDIA, http://www.investopedia.com/terms/r/returnoninvestment.asp (last visited Oct. 11, 2013).

66. Alisa Priddle & Chris Woodyard, *Google Discloses Cost of Its Driverless Car Tests*, USA TODAY, June 14, 2012, http://content.usatoday.com/communities/driveon/post/2012/06/google-discloses-costs-of-its-driverless-car-tests/1#.Us7txmRDszA.

67. *See Toyota Design*, TOYOTA, http://www.toyota-global.com/showroom/toyota_design/ (last visited Oct. 11, 2013). Toyota's design philosophy focuses on creating cars that are stylish, and appeal to customers on both emotional and rational levels through their color palette, harmonious design, and functionality. *Id. See also Innovation*, AUDI, http://www.audiusa.com/innovation (last visited Oct. 11, 2013). Audi's goals are to "defy convention and push performance to the limits. Engineer lighter, efficient vehicles. Innovate intelligent technology that anticipates drivers' needs." and its aesthetic concerns involve developing "silhouettes that defy trends and the wind." *Id.* This language clearly indicates an interest in cutting-edge technology and style.

68. *Focus: R&D Spending*, THE ECONOMIST GRAPHIC DETAIL (Oct. 30, 2012, 17:22 PM), http://www.economist.com/blogs/graphicdetail/2012/10/focus-7.

69. *Id.*

a reliable system for determining tort liability would ensure that manufacturers are liable only to the extent that their technologies malfunction and cause a crash. With a reliable system in place, companies would be able to decide whether to invest in autonomous vehicles. This would "allow more technologies to come to the market faster."[70]

B. Tort Liability in Autonomous Vehicles

Manufacturers of autonomous vehicles fear that "[w]hen the bells and whistles do not sound as they should . . . an increasing amount of liability for injuries is likely to bypass drivers and alight on the sellers and manufacturers of the vehicle."[71] This fear may be warranted, as an autonomous vehicle is a new product with which users have no prior experience. As a result, users may be quick to blame the new technology for any accidents that may occur, regardless of the actual cause.

Existing vehicle regulations require constant vigilance by drivers. A driver is in control of his vehicle and is responsible for any damage done by the vehicle. An autonomous vehicle, however, is designed to take control out of the hands of the driver. There has been great debate over whether a driver should be liable for the damage caused by a vehicle driving autonomously. A number of theories have been raised to address this issue, including holding the driver liable for the car's actions through a theory of vicarious liability[72] and identifying categories of crashes for

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70. Waterman & Henshon, *supra* note 18, at 16.

71. Peterson, *supra* note 59, at 1342. "This would attach . . . major liability to sellers and manufacturers of the vehicle." *Id.* at 1355.

72. One of the most creative theories posited regarding liability for autonomous vehicles is to hold the driver liable for the car's actions through the theory of vicarious liability, a theory generally reserved for employer-employee relationships. The employer is vicariously liable for the actions of his employee done within the scope of the employee's employment.

"Agency is the fiduciary relationship that arises when one person (a 'principal') manifests assent to another person (an 'agent') that the agent shall act on the principal's behalf and subject to the principal's control, and the agent manifests assent or otherwise consents so to act." RESTATEMENT (THIRD) OF AGENCY § 1.01 (2006). In the proposed relationship between the driver and the autonomous vehicle, the vehicle would be the driver's agent. As such, the driver would be vicariously responsible for the actions of the vehicle. "An employer is subject to liability for torts committed by employees while acting within the scope of their employment." RESTATEMENT (THIRD) OF AGENCY § 2.04 (2006) (doctrinal definition of vicarious liability). In the proposed relationship, the autonomous vehicle, as agent, would act as employee for the driver. The driver, as employer, would be liable for the actions of the autonomous vehicle.

Although it seems farfetched:

> An autonomous automobile is very much like a driver hired by the owner. It is doing the owner's bidding, and if the car violates the rules of the road and causes an injury, perhaps the owner or the one instructing the automobile should be liable as they would be for a similar injury caused by the conduct of an agent.

which the driver or the manufacturer would be liable to different degrees.[73] Regardless of the regime ultimately chosen, product or design defect of an autonomous vehicle must be separated from driver negligence.

To assure manufacturers that they would only be responsible for failures on behalf of their product and encourage the production of autonomous vehicles, there must be a way to determine driver negligence or rather, rule out vehicle malfunction.[74] There are two situations in which the driver should be responsible for negligence: vehicle maintenance and emergency situations. First, even though the driver is not actively driving the car, the driver is still responsible for the care of the vehicle. As with "tires and brakes, owners have a responsibility for maintenance" of the autonomous vehicle.[75] For an autonomous vehicle to function properly, it must be maintained and monitored. "Once an owner is or should be aware that the automobile is not acting as it should, the owner may be negligent in continuing to drive the car until the issue is adequately addressed."[76] Second, the driver may also be responsible for taking over the car in

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Peterson, *supra* note 59, at 1359. This would create a paradigm shift in liability; the inanimate autonomous vehicle would itself be liable for its own actions and the owner of the vehicle would be vicariously liable.

While car manufacturers might favor this proposal, as they would avoid essentially all liability, vicarious liability would greatly deter buyers from purchasing an autonomous vehicle. "[T]he efficiency of vicarious liability turns on a number of factors, which include . . . the ability of the principal to observe the loss-avoidance behavior of the agent . . . ." Alan O. Sykes, *The Economics of Vicarious Liability*, 93 YALE L.J. 1231, 1232 (1984). A rational person would not hire a complete stranger to do his bidding without some knowledge of the stranger's behavior. The same would apply to a car; without knowing how the car would function (i.e., avoid loss), a driver would not want to take on all responsibility for the car's autonomous actions.

73. The theory examines different driving scenarios (the Distracted Driver, the Diminished Capabilities Driver, the Disabled Driver, and the Attentive Driver), and argues that tort liability should depend "on the nature of the driver and the ability of that person to prevent the accident [in an autonomous vehicle]." Jeffrey K. Gurney, Note, *Sue My Car Not Me: Products Liability and Accidents Involving Autonomous Vehicles*, 2013 U. ILL. J.L. TECH. & POL'Y 101, *available at* http://works.bepress.com/jeffrey_gurney/1/.

74. As with any negligence claim, a plaintiff must establish the defendant had a duty to the plaintiff, the defendant breached that duty, the breach caused the injury, and damages for the injury. Mele, *supra* note 64, at 42 (citing Michael D. Scott, *Tort Liability for Vendors of Insecure Software: Has the Time Finally Come?*, 67 MD. L. REV. 425, 441 (2008)). As with all vehicles, the driver of a car owes a duty to care for the vehicle itself, and could breach the duty by failing to respond to maintenance signals in the car. If this causes an injury, then the driver will be held liable for his negligence. However, it may be difficult to determine whether the driver's negligence was the sole cause of a crash, if the vehicle's systems were malfunctioning, or if there was some interplay between the two that resulted in the crash. It is likely that contributory negligence would play a large part in determining the cost of tort liability.

75. Peterson, *supra* note 59, at 1358.

76. *Id.*

emergency situations, especially in early autonomous vehicles.[77] If the driver is unable to do so or does so poorly for some reason, this may constitute negligence as well.

To assure manufacturers that they will not be unfairly held liable for negligence of drivers, steps must be taken to ensure that crash investigators are able to accurately determine the cause of an accident. The difficulty in separating the fault of the manufacturer from the fault of the driver lies in the difficulty of assessing the cause of an accident. With existing cars, investigators have the experience necessary to determine whether a crash occurred due to vehicle malfunction or driver error. With autonomous vehicles, investigators do not have this experience and it is unclear how fault would be determined. This ambiguity may raise the cost of tort liability, deterring manufacturers from developing and marketing autonomous vehicles. To assure manufacturers that tort liability costs will be reasonable, a solution must be implemented to ensure that liability is reliably determined.

III. A SOLUTION FOR ASSESSING TORT LIABILITY: THE EVENT DATA RECORDER

A. Analogies to Existing Technology

When new technology arises, new legal issues "may be resolved by reference to analogies that rely on similarities in form."[78] Currently, there are autonomous technologies available in the marketplace, such as the Roomba, cruise missiles, elevators, and autopilot in airplanes. Of these technologies, only autopilot appears to provide a way to separate driver negligence from product liability which may be applied to autonomous vehicles.

The Roomba is a robotic vacuum that navigates itself around obstacles in a given area, vacuuming with the promise to clean "more thoroughly" than a human being.[79] "The computer algorithms that control them are simple, but they appear to make rational decisions as the [sic] scoot around

77. "'The first generations [of autonomous cars] are going to require a driver to intervene at certain points,' [said] Clifford Nass, codirector of Stanford University's Center for Automotive Research. . . ." Will Knight, *Driverless Cars Are Further Away Than You Think*, MIT TECH. REV. (Oct. 22, 2013), http://www.technologyreview.com/featuredstory/520431/driverless-cars-are-further-away-than-you-think/.

78. Graham, *supra* note 60, at 1242.

79. *Why Roomba*, IROBOT, http://store.irobot.com/family/index.jsp?categoryId=2501652&s=A-ProductAge (last visited Jan. 9, 2014).

the floor avoiding objects and entertaining your cat."[80] Although extremely helpful with chores around the home, the Roomba is unlike autonomous vehicles. While it uses technology similar to the sensors on autonomous vehicles to navigate, the Roomba has not caused damage that has required the manufacturer to separate product liability from negligence on part of the machine's owner. This provides no suggestion for how to deal with the issue in autonomous vehicles.

Cruise missiles are more similar to autonomous vehicles.[81] Reminiscent of the technology used in autonomous vehicles, a cruise missile, after being launched, is able to maneuver around terrain features using GPS and other navigational systems.[82] Furthermore, a cruise missile also generally operates independent of human control from the inception of its path to its final destination.[83] Despite these similarities, there is a practical difficulty in basing a tort liability regime off of a cruise missile. The purpose of a cruise missile is to destroy and annihilate its target. Therefore, there has generally been no need to separate user negligence from product defect.

Elevators create a particularly interesting analogy to autonomous vehicles. An elevator is one of the few completely autonomous devices used regularly today by ordinary consumers. Using mechanical inputs, elevators operate independently to transport users from one floor to another. Elevators, especially at their inception, were prone to mechanical failures that caused accidents, sometimes resulting in loss of human life.[84] Over time, "improved technology coupled with increased insurance and

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80. Neil M. Richards & William D. Smart, How Should the Law Think About Robots? 6 (May 10, 2013) (unpublished comment) (*available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2263363).

81. Drones do not pose a good analogy to autonomous vehicles for a number of reasons. Even though they seem as though they are completely autonomous, current drones, such as Predators and Reapers, are not autonomous—they are manned by pilots from thousands of miles away. Ryan Gallagher, *Military Moves Closer to Truly Autonomous Drones*, SLATE (Jan. 16, 2013), www.slate.com/blogs/future-tense/2013/01/16/taranis-newron-militaries-moving-closer-to-truly-autonomous-drones.html. Unlike autonomous vehicles, they lack the ability to identify changes in their immediate environment and react by themselves. Furthermore, issues of liability are moot, as, if the drone completes its mission successfully, it and its target will be completely annihilated.

82. Eliot A. Cohen, *Five Myths About Cruise Missiles*, WASH. POST, Sept. 12, 2013, at A3 ("A cruise missile uses one or more guidance systems, including GPS, inertial navigation (following a programmed route on the basis of internally stored data), terrain-matching radar (detecting and recognizing landmarks as it flies over them) or digital scene matching (same idea, but using imagery rather than radar)."); Richards & Smart, *supra* note 80, at 7.

83. *See* Cohen, *supra* note 82, at A2 (once a cruise missile has been fired, "crews of missile-firing destroyers do not welcome back Tomahawks that have decided to return to base").

84. "[E]levator accidents were one of the most common causes of multiple deaths in the early twentieth century." Waterman & Henshon, *supra* note 18, at 16 (citing James A. Robertson, *How Umbrella Policies Started Part 2: The First Umbrella Forms*, INT'L RISK MGMT INST. (Apr. 2000), www.irmi.com/Expert/Articles/2000/Robertson04.aspx).

more stringent regulation permitted the move away from human operator oversight."[85] Elevators do not require the sophisticated technology that autonomous vehicles do, because they do not need to adapt to changing environmental stimuli. Unlike autonomous cars, elevators only operate on one axis (up and down), as opposed to two.[86] The adoption of the same industry-wide standards by state legislatures has made elevators much safer and has standardized features across the product.[87] While these standards may be instructional for future autonomous vehicles, elevators do not provide a helpful method by which to separate user negligence from product defect that could be applied to autonomous vehicles.

Autopilot systems on airplanes[88] provide the closest analogy to autonomous vehicles. Autopilot, originally known as a "gyroscopic stabilizer apparatus," controls the three flight axes of an aircraft (yaw, pitch, and roll), and "offset[s] movement in the aircraft through the air, opening or closing valves to change wing or rudder angles."[89] Unlike an autonomous vehicle, however, "autopilot does not attempt to adapt to changing environment, but rather continues on its current heading, at the same altitude."[90] In contrast to autopilot, where a pilot provides continued input during flight, autonomous vehicles receive nearly no input from the driver during use. The autonomous system must perform many functions "continuously and asynchronously" leading to difficulty in testing and proving the system's abilities.[91] This greatly impacts the potential for analogizing liability from an airplane crash to an autonomous vehicle crash, because the autopilot is not responsible for adapting to changing

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85. Waterman & Henshon, *supra* note 18, at 16.

86. *Id.*

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> Though elevators are state regulated, nearly all states have adopted the same industry standards. Neither state legislators nor state safety officials attempt to craft the rules for autonomous elevator construction and maintenance. Instead, they cite two detailed sets of standards created by professional associations: ASCE Code 21 (the American Society of Civil Engineers Code 21 for people movers operated by cables) and ASME Code A17 (the American Society of Mechanical Engineers Safety Code for Elevators and Escalators).

Id.

88. This is similar to self-parking features on recent cars, but there have been no adjustments to vehicle liability, perhaps as there is a very short period of time during which the feature is in control of the vehicle.

89. Waterman & Henshon, *supra* note 18, at 14 (citing *Lawrence Sperry: Autopilot Inventor and Aviation Innovator*, HISTORYNET, http://www.historynet.com/lawrence-sperry-autopilot-inventor-and-aviation-innovator.htm (last visited Nov. 1, 2013)).

90. Waterman & Henshon, *supra* note 18, at 14.

91. NIDHI KALRA ET AL., CAL.DEP'T TRANSP., UCB-ITS-PRR-2009-28, LIABILITY AND REGULATION OF AUTONOMOUS VEHICLE TECHNOLOGIES 8 (2009), *available at* http://www.path.berkeley.edu/PATH/Publications/PDF/PRR/2009/PRR-2009-28.pdf.

environmental stimuli. Accordingly, the human pilot must be in control of the airplane at all times, and adjusting to any changes in the environment.[92]

Although not a perfect analogy, autopilot shares an important similarity with autonomous vehicles: the need to separate user error from system error. To address this problem, airplanes are federally required to carry Flight Data Recorders ("FDRs") onboard.[93] These FDRs are used to collect and retain information about the time, altitude, airspeed, vertical acceleration, heading time of each radio transmission either to or from air traffic control, pitch attitude, roll attitude, longitudinal acceleration, control column or pitch control surface position, and thrust of each engine.[94] The collection of this information tells investigators the story of the airplane's operations and functionality, as well as pilot error. Through this information, investigators are able to determine the cause of the crash, whether by human error, technological failure, or outside cause.[95] Collecting such data in autonomous vehicles would be equally useful in determining the cause of autonomous vehicle crashes.

B. *Implementation of Event Data Recorders in Autonomous Vehicles*

To reasonably assign liability to manufacturer or driver in an autonomous vehicle crash, autonomous vehicles should be required to carry Event Data Recorders ("EDRs"), similar to the FDRs required on airplanes. This abides by the NHTSA's recommendation that "[s]elf-

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92. Also, "most airplane accidents involve departures or landings, which are generally not when autopilots are in use . . . Although there are a handful of reported cases where autopilots played a role in the accident, in most cases the autopilot plays a lesser role than human oversight." Waterman & Henshon, *supra* note 18, at 14 (citations omitted).

The vehicular analogy to autopilot would be engaging cruise control in a car. While the car is maintaining the same speed, the driver is responsible for guiding it along the road.

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> No person may operate a U.S. civil registered, multiengine, turbine-powered airplane or rotorcraft having a passenger seating configuration, excluding any pilot seats of 10 or more that has been manufactured after October 11, 1991, unless it is equipped with one or more approved flight recorders that utilize a digital method of recording and storing data and a method of readily retrieving that data from the storage medium, that are capable of recording the data specified in appendix E to this part, for an airplane, or appendix F to this part, for a rotorcraft, of this part within the range, accuracy, and recording interval specified, and that are capable of retaining no less than 8 hours of aircraft operation.

14 C.F.R. § 91.609(c) (2010).

94. *See Flight Data Recorder Rule Change*, BOEING AERO MAG., at 6, http://www.boeing.com/commercial/aeromagazine/aero_02/textonly/s01txt.html (last visited Apr. 5, 2015).

95. *Id.* at 1. "The data collected in the FDR system can help investigators determine whether an accident was caused by pilot error, by an external event (such as windshear), or by an airplane system problem."

driving test vehicles should record data from the vehicle's sensors, including sensors monitoring and diagnosing the performance of the automated vehicle technologies, in the event of a crash, or other significant loss of vehicle control."[96] An EDR would be well equipped to record the information suggested (data from the vehicle's sensors and engagement of automated technology) by the NHTSA. Although the NHTSA's recommendation was only extended to "test vehicles," the same idea could be applied to all autonomous vehicles to provide a simple solution for determining liability in autonomous vehicle crashes.

The idea of an EDR, used in vehicles, is based on the concept of an FDR, used on airplanes. An FDR is required on all "registered, multiengine, turbine-powered airplane or rotorcraft having a passenger seating configuration, excluding any pilot seats of 10 or more that has been manufactured after October 11, 1991."[97] The regulation has been in effect since 1988 and continues to require FDRs on airplanes.[98] FDRs are invaluable to plane crash investigators. The FDR "records the many different operating functions of a plane all at once, such as the time, altitude, airspeed and direction the plane is heading."[99] These functions, along with other actions "such as the movement of individual flaps on the wings, auto-pilot and fuel gauge," allow crash investigators to reconstruct a flight "so that they can visualise [sic] how a plane was handling shortly before a crash."[100]

Access to the same types of information for an autonomous vehicle crash would be equally useful. Investigators could determine, using actual data recorded in the vehicle, the exact functioning of the autonomous vehicle leading up to time of the crash. This type of information was so useful that the NHTSA has considered requiring EDRs on all light

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96. NHTSA, *supra* note 1, at 14.

97. 14 C.F.R. § 91.609(c) (2010).

98.

> The FAA issued Amendment Nos. 23-35, 25-65, 27-22, 29-25, 91-204, 121-197, 125-10, and 135-26 June 30, 1988 (53 FR 26134; July 11, 1988), to require digital flight data recorders and cockpit voice recorders to be installed in a broad range of airplanes and rotorcraft operated by air carriers and commuter airlines, as well as in selected aircraft operated in general aviation. Compliance is required by October 11, 1991. The amendments respond to legislation that required the FAA to amend its FR and CVR requirements in accordance with recommendations from the National Transportation Safety Board. The intent of the amendments was to provide more information to accident investigators in determining the causes of accidents and the measures needed to correct the causes.

56 FED. REG. 51,618 (1991).

99. *What Is a Black Box?*, NAT'L GEOGRAPHIC CHANNEL, http://natgeotv.com.au/tv/air-crash-investigation/what-is-a-black-box.aspx (last visited Jan. 9, 2014).

100. *Id.*

vehicles (e.g., passenger vehicles). In 2006, the NHTSA set standards for EDRs in cars that voluntarily chose to include them.[101] The NHTSA described an EDR as "a device or function in a vehicle that records the vehicle's dynamic, time-series data during the time period just prior to a crash event (e.g., vehicle speed vs. time) or during a crash event (e.g., delta-V vs. time), intended for retrieval after the crash event."[102]

1. EDRs in Current Vehicles

Although the NHTSA considered mandating the installation of EDRs in light vehicles in 2006, it decided not to do so because sixty-four of new vehicles were voluntarily being equipped with such devices.[103] In December 2012, the NHTSA revisited the issue and published a Notice of Proposed Rulemaking for Federal Motor Vehicle Safety Standards and Event Data Recorders in the Federal Register ("Notice").[104] This Notice suggested "a new safety standard mandating the installation of EDRs in most light vehicles manufactured on or after September 1, 2014."[105] The NHTSA published findings that the mandate would not be particularly expensive, averaging $20.00 per vehicle.[106] By its calculations, if most light vehicles were to be equipped with EDRs, the "estimated total incremental costs associated with this proposal would be $26.4 million

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101. 49 C.F.R. §§ 563.6–.11 (2006).

102. Event Data Recorders, 71 Fed. Reg. 50,998, 51,001 (Aug. 28, 2006) (to be codified at 49 C.F.R. pt. 563).

103. *Id.* at 50999.

104. Federal Motor Vehicle Safety Standards, 77 Fed. Reg. 74,144 (proposed Dec. 13, 2012) (to be codified at 49 C.F.R. pt. 571). In its proposal, the NHTSA outlined the benefits of accepting the proposal:

> The benefits of this proposal would be to expand and, therefore, enhance the utilization of the recorded information and lead to further improvements in the safety of current vehicles as well as future ones . . . . It is important to have EDR data relating to the crash experiences of vehicles with these advanced safety systems so that the agency can, at the earliest possible time, gather enough information about emerging advanced technologies to conduct reliable analyses and make policy judgments. Additionally, the agency's experience in handling unintended acceleration and pedal entrapment allegations has demonstrated that EDR data from a particular vehicle model can have significant value to both the agency and the vehicle's manufacturer to identify and address safety concerns associate with possible defects in the design or performance of the vehicle. To serve this purpose for all light vehicles required to have frontal air bags, EDR data must be available for all such vehicles.

Id. at 74,146.

105. *Id.* at 74,144 ("The EDRs in those vehicles would be required by the new standard to meet the data elements, data capture and format, data retrieval, and data crash survivability requirements of the existing regulation. This proposal would not modify any of the requirements or specifications in the regulation for EDRs voluntarily installed between September 1, 2012 and September 1, 2014.").

106. *Id.* at 74,146.

(2010 dollars), which reflects the need for technology improvements, as well as assembly costs, compliance costs, and paperwork maintenance costs."[107] The total costs of the proposed rule, including the burden on private citizens and corporations, would be $314.2 million annually.[108] It also noted that ninety-two percent of new light vehicles in 2012 are voluntarily equipped with EDRs, and only 1.32 million vehicles would need to install an EDR.[109]

More than 1000 comments were collected regarding the Notice.[110] These comments were from a number of interested private individuals,[111] professional organizations, and interest groups.[112] The comments from individuals present a number of privacy concerns[113] and business groups convey their fear of "significant and unnecessary burdens upon both

107. *Id.*

108. *Id.* at 74,155. The NHTSA further expounded:

> In determining the costs of this proposed rule under the [Paperwork Reduction Act ("PRA")], we estimate that there are approximately 15.71 million applicable vehicles produced annually, 14.39 million of which are already voluntarily equipped with EDRs. The cost to install an EDR meeting the requirements of this proposed rule is $20 per vehicle if a vehicle does not have an EDR. The costs of this proposed rule under the PRA include the costs of installing compliant EDRs on all applicable vehicles, even those that are currently equipped with EDRs. Accordingly, the annual total costs of this proposed rule under the PRA would be $314.20 million.

Id.

109. *Id.* at 74,145.

110. *Federal Motor Vehicle Safety Standards Event Data Recorders*, REGULATIONS.GOV, http://www.regulations.gov/#!docketBrowser;rpp=100;so=DESC;sb=docId;po=0;dct=PS;D=NHTSA-2012-0177 (last visited Dec. 27, 2014).

111. *See, e.g.*, *Brandy Johnson—Comments*, REGULATIONS.GOV, http://www.regulations.gov/#!documentDetail;D=NHTSA-2012-0177-1037 (last visited Jan. 12, 2014); *Douglas Wilkinson—Comments*, REGULATIONS.GOV, http://www.regulations.gov/#!documentDetail;D=NHTSA-2012-0177-1034 (last visited Jan. 12, 2014).

112. Interest and business groups such as the Insurance Institute for Highway Safety, Chrysler Group LLC, the Electronic Privacy Information Center, and the Electronic Frontier Foundation all attached documents with their commentary. *See Chrysler Group LLC—Comments*, REGULATIONS.GOV, http://www.regulations.gov/#!documentDetail;D=NHTSA-2012-0177-1010 (last visited Jan. 12, 2014); *Electronic Frontier Foundation—Comments*, REGULATIONS.GOV, http://www.regulations.gov/#!documentDetail;D=NHTSA-2012-0177-0977 (last visited Jan. 12, 2014); *Electronic Privacy Information Center—Comments*, REGULATIONS.GOV, http://www.regulations.gov/#!documentDetail;D=NHTSA-2012-0177-1006 (last visited Jan. 12, 2014); *Insurance Institute for Highway Safety—Comments*, REGULATIONS.GOV, http://www.regulations.gov/#!documentDetail;D=NHTSA-2012-0177-1016 (last visited Jan. 12, 2014). These comments contain specific concerns about the data collected, potential secondary uses, and fear of overreach by the federal government.

113. *See Insurance Institute for Highway Safety—Comments*, regulations.gov, http://www.regulations.gov/#!documentDetail;D=NHTSA-2012-0177-1016 (last visited Jan. 12, 2014); *Electronic Privacy Information Center—Comments*, regulations.gov, http://www.regulations.gov/#!documentDetail;D=NHTSA-2012-0177-1006 (last visited Jan. 12, 2014); *Electronic Frontier Foundation—Comments*, regulations.gov, http://www.regulations.gov/#!documentDetail;D=NHTSA-2012-0177-0977 (last visited Jan. 12, 2014). These comments contain specific concerns about the data collected, potential secondary uses, and fear of overreach by the federal government.

vehicle manufacturers and the agency."[114] Although the comments have been collected, the proposed regulation has not been adopted and codified in the Code of Federal Regulations.

In March 2012, Congress considered a bill that would mandate EDRs in current vehicles.[115] Although the Senate passed the bill, the House of Representatives did not.[116] The bill would have mandated EDRs in all "new passenger motor vehicles" and established ownership of the data by the owners or lessees of the vehicle.[117]

2. Advantages and Disadvantages of EDRs in Current Vehicles

There have been numerous discussions regarding EDRs in current vehicles. Proponents of EDRs in light vehicles argue that the benefits outweigh the costs: installing EDRs in current vehicles helps crash investigators determine the cause of an accident and helps car manufacturers to develop safer vehicles.[118] These uses are beneficial to society. In the event of a car crash, investigators would be able to accurately pinpoint—or rule out—potential causes. This would decrease and resolve disputes about liability. The development of safer vehicles has great potential to save lives and economic resources. Although the $314 million burden placed on government, individuals, and corporations is hefty, it may be an efficient decision considering the long-term benefits of EDRs in light vehicles.

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114. *See, e.g.*, *Chrysler Group LLC—Comments*, REGULATIONS.GOV, http://www.regulations.gov/#!documentDetail;D=NHTSA-2012-0177-1010 (last visited Jan. 12, 2014).

115. S. 1813, 112th Cong. (2012); H.R. 2374, 112th Cong. (2012).

116. Based on S. 1813's legislative history, it is unclear whether the bill was discussed on the floor of the House of Representatives. The Senate engrossed S. 1813 on March 14, 2012, but there was no further action on it. *112 S. 1813 MAP-21*, PROQUEST CONGRESSIONAL, http://congressional.proquest.com (search "112S 1813") (last visited Apr. 5, 2015). 112 H.R. 2374 was introduced and referred to the House Subcommittee on Commerce, Manufacturing, and Trade on June 24, 2011, but no further action was taken. *Bill Summary & Status: 112th Congress (2011-2012) H.R. 2374*, CONGRESS.GOV (search "112 H.R. 2374) (last visited Apr. 5, 2015).

117. S. 1813, 112th Cong. (2013).

118. Federal Motor Vehicle Safety Standards; Event Data Recorders, 77 Fed. Reg. 74,144, 74,145 (proposed Dec. 13, 2012).

> EDR data are used to improve crash and defect investigation and crash data collection quality to assist safety researchers, vehicle manufacturers, and the agency to understand vehicle crashes better and more precisely. Additionally, vehicle manufacturers are able to utilize EDR data in improving vehicle designs and developing more effective vehicle safety countermeasures. EDR data can also be used by Advanced Automatic Crash Notification (AACN) systems to aid emergency response teams in assessing the severity of a crash and estimating the probability of serious injury before they reach the site of the crash.

Id.

Opponents of EDRs in light vehicles have successfully argued against EDRs on three grounds: car prices, redundancy, and privacy. First, the National Motorists Association ("NMA")[119] argues that implementing EDRs in vehicles will unnecessarily raise car prices as car manufacturers pass on the cost of adding the instrument to vehicles on to the unwilling purchaser.[120] Second, these groups argue that car owners should not be coerced to use EDRs in judicial or enforcement hearings in the interest of fairness.[121] Finally, the NMA argues that it is unnecessary for the entire population to adopt the instrument because many cars are already equipped with EDRs.[122] Therefore, it would be redundant to force unwilling car owners to add EDRs.

Other groups, such as the American Civil Liberties Union ("ACLU"), have spoken out opposing EDRs for their potential to infringe on individual privacy. The NHTSA in its proposed regulation acknowledged the potential privacy concerns of EDRs: "who owns it, who has access to it and under what circumstances, and what are the purposes for which it may be used" remain open questions.[123] In its consideration of the EDR mandate, the ACLU proposed that the data on EDRs belong to the owner of the vehicle.[124] Without ownership by the car owner, law enforcement or other parties would be able to access the data without the consent of the car owner or a search warrant.[125] This would give the government and other entities unlimited access to the data as well as the ability to track and store all of a vehicle's movements, locations, and other information regarding the vehicle's actions.

Lastly, opponents may argue that EDRs have limited usefulness when investigating a crash.[126] As EDRs do not possess the ability to track driver

119. The National Motorists Association is a special interest group formed in 1982 to combat the 55 mph National Maximum Speed Limit. They have since taken on a number of other issues related to driving, explaining that "we want to drive what we want to drive, go where we want to go and in the process not be unwitting cannon fodder for self-serving government programs, over-bearing police departments or greedy courts." *About Us*, NAT'L MOTORISTS ASS'N, http://www.motorists.org/about/ (last visited Feb. 2, 2015).

120. *Black Boxes Fact Sheet*, NAT'L MOTORISTS ASS'N, http://www.motorists.org/black-boxes/black-box-fact-sheet.pdf.

121. *Id.*

122. *Id.*

123. Federal Motor Vehicle Safety Standards; Event Data Recorders, 77 Fed. Reg. 74,144, 74,146 (proposed Dec. 13, 2012).

124. Jay Stanley, *A Look at the Issues Raised by 'Black Boxes' in Cars*, ACLU (Dec. 10, 2012, 12:20 PM), https://www.aclu.org/blog/technology-and-liberty/black-boxes-cars-may-set-important-precedents.

125. *Id.*

126. Thomas Michael Kowalick, *Real-World Perceptions of Emerging Event Data Recorder (EDR) Technologies*, NHTSA, 5 (finding that college-age motorists perceive that "EDRs may provide

error, they do not reveal whether the driver was distracted. These distractions might include falling asleep at the wheel or texting while driving. As human error accounts for the majority of accidents, EDRs may not be able to explain why most current vehicles crash and have a very limited use.

C. The Impact of EDRs in Autonomous Vehicles

Arguments for and against mandating EDRs in autonomous vehicles are similar to those in current vehicles. However, an EDR in an autonomous vehicle is more useful than an EDR in a human operated vehicle. For reasons discussed below, EDRs should be required in autonomous vehicles.

In autonomous vehicles, the data recording would be especially helpful in untangling the issue of driver negligence from product defect or system failure. Unlike drivers in traditional vehicles, the driver in an autonomous vehicle is actively not paying attention to driving. With human error generally removed as a potential cause for accidents, the data from an autonomous vehicle's EDR would provide a better picture of the functioning vehicle than of one from a traditional vehicle. The EDR's data would, therefore, assure autonomous vehicle manufacturers that they would not be liable for drivers' negligence. Instead, manufactures would only be liable for the malfunctioning systems. This would encourage manufacturers to produce autonomous vehicles because they would be able to accurately estimate the costs of liability involved with autonomous vehicles. Bearing in mind the social benefits of autonomous vehicles, the lower price to market entrance by manufacturers would be favorable.

Given the complex systems involved in autonomous vehicles,[127] it is especially important to distinguish system error from driver negligence. Even with the highly sophisticated technology, it is likely that there will be unforeseen errors in an autonomous vehicle's programming or machinery. When combined with inexperienced drivers, it may be difficult to distinguish between a system malfunction and negligence in the event of a crash. With the installation of the EDR, the data stored on the device would provide information about the source of the crash if it were caused by the vehicle's autonomous or other technology. This would efficiently determine—or rule out—whether the cause of the crash was a malfunction

only a part of a complex crash scenario. . . EDR data may have little or no immediate value to victims of crashes. . . .").

127. *See* NIDHI KALRA ET AL., *supra* note 91.

of autonomous vehicle technology, reassuring manufacturers that they would be liable for a crash only if their technology malfunctioned.

The cost of installing EDRs in autonomous vehicles would be comparable to the cost of installing them in current vehicles—roughly $20 per vehicle, and adding up to around $314 million annually.[128] As a result of anticipated social benefits, autonomous vehicles would actually create savings for the American government. Google anticipates a 90% drop in car crashes and a 90% reduction in commute times, which would save the United States roughly $400 billion per year.[129] Based on these statistics, the American government would save more than $500 billion by installing EDRs, far outweighing the $314 million price tag to install them. Thus, if autonomous vehicles were released and reached their anticipated social benefits, America would benefit economically.

IV. PRIVACY CONCERNS REGARDING EDRS IN AUTONOMOUS VEHICLES

Given the valid concerns of many leading civil rights organizations regarding privacy and EDRs, it is imperative to consider the protections that should be put into place to create an environment that benefits both corporations and consumers. Both producers and consumers of autonomous vehicles stand to gain from the release of these vehicles on to the market. To support both parties, a balance must be struck between protecting the interests of the producers by limiting potential liability costs with the use of EDRs and protecting the privacy of consumers who are using these vehicles.

As mentioned above, the ACLU has taken a strong stance against the adoption of EDRs without restrictions on use of data collected by the devices.[130] Among the ACLU's concerns is that the data provided by the EDR may not belong solely to the car's owner.[131] This concern arises in the many circumstances in which personal data is used for commercial purposes—for example, Google and Facebook are both known for utilizing information gathered from consumers using their services to

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128. 71 Fed. Reg. 74144, 74155 (proposed Dec. 13, 2013).

129. Chunka Mui, *Fasten Your Seatbelts: Google's Driverless Car Is Worth Trillions (Part 1)*, FORBES (Jan. 22, 2013, 10:12 AM), http://www.forbes.com/sites/chunkamui/2013/01/22/fasten-your-seatbelts-googles-driverless-car-is-worth-trillions/. For a discussion of the potential lost revenues as a result of the autonomous vehicle, see Chunka Mui, *Google's Trillion-Dollar Driverless Car—Part 2: The Ripple Effects*, FORBES (Jan. 24, 2013, 9:36 AM), http://www.forbes.com/sites/chunkamui/2013/01/24/googles-trillion-dollar-driverless-car-part-2-the-ripple-effects/.

130. Stanley, *supra* note 124.

131. *Id.*

tailor advertisements toward specific individuals.[132] This equates to an exchange of private information for use of these electronic services.[133]

One could imagine a similar fate for autonomous vehicles. For instance, imagine:

> On a future road trip, your robot car decides to take a new route, driving you past a Krispy Kreme Doughnut shop. A pop-up window opens on your car's display and asks if you'd like to stop at the store. "Don't mind if I do," you think to yourself. You press "yes" on the touchscreen, and the autonomous car pulls up to the shop.[134]

Vehicle manufacturers could easily sell the data collected from individuals to commercial retailers and tailor ads specific to individual vehicle owners. Even more disconcertingly, manufacturers might also provide the vehicle's location information to law enforcement officials without the requirement of a warrant.[135] To avoid such exchanges of data, there are a number of safeguards and restrictions that could protect consumers.

In the language of the Senate and House of Representative bills regarding EDRs, proposals were included that would give full ownership of the data on an EDR to the owner of the vehicle.[136] This would be a safe starting point to ensure that the personal data is not used without the vehicle owner's permission.

Consumer protection should not end with ownership rights. Even if vehicle owners own EDR data, there are still concerns regarding the transfer of the data from owner to the vehicle manufacturer via contract. In the past, implied contract provisions have been suggested as ways of preventing disclosure of personal information.[137] If new regulations prohibited the use of commercial data without informed consent by vehicle owners, the data mining of private information that has occurred in various online services may not be used

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132. NEIL RICHARDS, INTELLECTUAL PRIVACY 3–10, 128–32, 182 (2015).

133. Joseph W. Jerome, *Buying and Selling Privacy: Big Data's Different Burdens and Benefits*, 66 STAN. L. REV. ONLINE 47, 48 (2013) (citing Joe Mullin, *How Much Do Google and Facebook Profit from Your Data?*, ARS TECHNICA (Oct. 9, 2012, 6:38 AM PDT), http://arstechnica.com/tech-policy/2012/10/how-much-do-google-and-facebook-profit-from-your-data/).

134. Patrick Lin, *What If Your Autonomous Vehicle Keeps Routing You Past Krispy Kreme?*, THE ATLANTIC (Jan. 22, 2014), http://www.theatlantic.com/technology/archive/2014/01/what-if-your-autonomous-car-keeps-routing-you-past-krispy-kreme/283221/.

135. Stanley, *supra* note 124.

136. S. 1813, 112th Cong. (2012); H.R. 2374, 112th Cong. (2012). S. 1813 would also give ownership of the data to a vehicle's lessee.

137. JON L. MILLS, PRIVACY: THE LOST RIGHT 297–99 (2008).

If regulations create a legal standard that commercial use of EDR data is prohibited without informed consent by vehicle owners, it is possible to ensure that the data mining of private information that has occurred through use of various online services will not occur with EDRs. Consumer protection should also extend to the encryption and anonymity of the data that must be transmitted to a network for the autonomous vehicle to function. Transmitted personal information should not be traceable to the vehicle of origin, and the data involved must be encrypted.[138]

Due to potential high returns on their investments, the burden of adding EDRs to autonomous vehicles is comparatively low. As a result, autonomous vehicle producers should not be dissuaded from the decision to manufacture and market autonomous vehicles. At the same time, these safeguards will protect consumers' privacy while maintaining the benefits of autonomous vehicles for society. By implementing these regulations, an efficient equilibrium for producers, consumers, and society may be defined.

V. CONCLUSION

Autonomous vehicles have the potential to create immense positive change, but they come with a high price tag. The high cost is driven in part by the uncertainty regarding the cost of liability in case of car crashes. To effectively separate driver negligence from product or design defect, EDRs should be required in all autonomous vehicles. As EDR data may be used against consumers' interests, implantation of EDRs necessitates a balancing of both producer and consumer interests. To protect consumer privacy, regulations regarding data ownership and use must be put in place. With these regulations in place, consumers would be protected and society could reap the tremendous benefits associated with autonomous vehicles.

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138. Dorothy J. Glancy, *Privacy in Autonomous Vehicles*, 52 SANTA CLARA L. REV. 1171, 1238 (2012).

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