ARTICLES

Robot Ipsa Loquitur

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Accidents are becoming automated. From self-driving cars to self-flying drones, robots are increasingly colliding with the world. One of the most pressing questions raised by these technologies—indeed, one of the great regulatory challenges of the coming era—is how the law should account for crashes involving these complex, automated systems. By now, many have weighed in. And, though responses vary, a tentative consensus has begun to emerge around the idea that tomorrow's robots will pose formidable challenges to today's negligence and design defect doctrines.

This Article challenges that view. In sharp contrast to the prevailing wisdom, it argues that widespread debates over the so-called vexing tort problems raised by robots have overlooked a crucial issue: inference. Fault, after all, need not be shown by pointing directly to a faulty line of code. Like all facts, it can be proven indirectly through circumstantial evidence. Indeed, as the ancient negligence rule of res ipsa loquitur makes plain, sometimes an accident can "speak for itself." Using the first robot accused of negligence as a case study, this Article shows how advanced data-logging technologies in modern machines provide richly-detailed records of accidents that, themselves, speak to the fault of the parties involved. In doing so, it offers the first wide-ranging account of how inference-based analysis can—and, in fact, already does—elegantly resolve liability determinations for otherwise confoundingly complex accidents. Having done so, it outlines steps that courts, practitioners, and policymakers can take to streamline fault determinations using an approach it calls robot ipsa loquitur. With trillion-dollar markets and millions of lives on the line, it argues that drastic calls by leading experts to upend conventional liability are ahistorical, contrary to tort law's fundamental goals, and unnecessary to protect the interests of accident victims. A simpler, more productive approach would let the robot speak for itself.

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INTRODUCTION

> There is going to be a moment in time when there's [an automated vehicle] crash and it's going to be undetermined who or what was at fault. That's where the difficulty begins.
>
> —David Strickland, Fourteenth Administrator of the National Highway Traffic Safety Administration[1]
>
> The inference of negligence [under res ipsa loquitur] may also arise where . . . the accident is more or less a mystery, with no particular cause indicated.
>
> —William Prosser, Reporter for the Second Restatement of Torts[2]

"[R]obots cannot be sued . . . ."[3] At least, that's according to Judge Higginbotham in *United States v. Athlone Industries, Inc.*[4] But if recent events

1. *David Strickland Quoted in* Bloomberg Business *on Where the Fault Lies in a Driverless Car Accident*, VENABLE LLP (Dec. 22, 2015), https://www.venable.com/about/news/2015/12/david-strickland-quoted-in-embloomberg-businessem [https://perma.cc/VR38-L9KY].
2. WILLIAM L. PROSSER, HANDBOOK OF THE LAW OF TORTS 204 (2d ed. 1955).
3. 746 F.2d 977, 979 (3d Cir. 1984).
4. *See id.* Even at the time, Judge Higginbotham, Jr. was well aware his quip didn't tell the entire story. In actuality, the judge meant that robots cannot be sued in personam. But, it follows from this

are any indication, one attorney did not get the memo.[5]

It all began on an unassuming San Francisco street in December 2017.[6] An automated vehicle deployed by GM's startup, Cruise, was plodding along at twelve miles per hour when it decided to switch lanes.[7] Midway through the maneuver, though, it changed course.[8] Noticing a minivan ahead of it slow down, the car opted to return to its original place.[9] Yet, in the process, it clipped a motorcyclist who had driven into the opening.[10] The impact caused the motorcyclist, Oscar Nilsson, to topple over and injure his shoulder.[11]

Police soon arrived to assess the scene. In their view, Nilsson shouldered the blame.[12] They filed a report faulting him "for attempting to overtake and pass another vehicle . . . under conditions that did not permit that movement in safety."[13] But Nilsson disagreed. And in January 2018, he filed suit.[14]

As far as accident claims go, Nilsson's was standard fare. As far as claims against vehicle operators go, however, it was utterly unique. Because Cruise's vehicle was in "autonomous mode" at the time of the collision, Nilsson didn't direct his negligence claim against the human in the driver's seat.[15] Instead, he leveled it against the car itself—accusing it of driving "in such a negligent manner that it veered into an adjacent lane of traffic without regard for a passing motorist."[16]

At first blush, there may appear little distance separating this event from other headline-grabbing "driverless accidents" that continue to overshadow it. Outlets

conclusion that in rem or quasi in rem actions are available against robots, precisely because robots are "objects" as opposed to legal "persons." *See generally* O'Brien v. Intuitive Surgical, Inc., No. 10 C 3005, 2011 WL 3040479, at *1–2 (N.D. Ill. July 25, 2011) (discussing in rem case brought against manufacturer of the "da Vinci surgical robot"); Mracek v. Bryn Mawr Hosp., 610 F. Supp. 2d 401 (E.D. Pa. 2009), *aff'd*, 363 F. App'x 925 (3d Cir. 2010) (same). In *Nilsson v. General Motors LLC*, No. 4:18-cv-00471-KAW (N.D. Cal. Jan. 22, 2018), detailed more in the paragraphs that follow, the boundaries of this distinction begin to blur—albeit only slightly. As Part I further explores, the automated vehicle's status as "autonomous" at the time of the accident does in fact press against conventional distinctions drawn between robots as objects and vehicle drivers as legal persons.

5. *See* Complaint at ¶¶ 16–17, Nilsson v. Gen. Motors LLC, No. 4:18-cv-00471-KAW (N.D. Cal. Jan. 22, 2018) [hereinafter *Nilsson* Complaint] (accusing an automated vehicle of driving itself negligently).

6. *See id.* at ¶ 5.

7. *See* CAL. DEP'T OF MOTOR VEHICLES, REPORT OF TRAFFIC ACCIDENT INVOLVING AN AUTONOMOUS VEHICLE #l70989746, at 2 (2017) [hereinafter CRUISE ACCIDENT REPORT] [https://perma.cc/HK43-TRV8].

8. *See id.*

9. *See id.*

10. *See id.*

11. *See Nilsson* Complaint, *supra* note 5, at ¶ 12.

12. *See* CRUISE ACCIDENT REPORT, *supra* note 7.

13. *See id.* (citing CAL. VEH. CODE § 21755(a) (West 2011)).

14. *See Nilsson* Complaint, *supra* note 5.

15. Of course, this claim, too, would likely have been directed against the company—albeit under a different theory such as vicarious liability.

16. *See Nilsson* Complaint, *supra* note 5, at ¶ 16. The suit was, of course, still aimed at the company responsible for deploying the vehicle—General Motors.

across the globe,[17] for instance, described recent collisions involving Uber and Tesla vehicles as the world's first "driverless," "self-driving," or "autonomous" fatalities.[18] But these crashes, as this Article demonstrates, fit such descriptions in only the narrowest of senses, given that the automated driving systems were not ultimately responsible for controlling the cars.[19]

The Cruise accident, by comparison, received just a fraction of the outsized media attention garnered by Uber and Tesla.[20] Yet, properly understood, it was a watershed moment. A robot[21] was formally accused of operating itself negligently—likely the first utterance of its kind to grace the pages of a U.S. court filing. It is an accusation that carries an air of epochal significance, announcing the arrival of robots of once-unimaginable capabilities at the courthouse doors.[22] Indeed, far from anomalous,

17. *See* Nick Bilton, *How the Media Screwed Up the Fatal Tesla Accident*, VANITY FAIR (July 7, 2016), https://www.vanityfair.com/news/2016/07/how-the-media-screwed-up-the-fatal-tesla-accident [https://perma.cc/7D26-C6GP] (noting that the victim Joshua Brown's "story has been picked up in thousands of outlets").

18. *See, e.g.*, Dee-Ann Durbin, *Fatal Tesla Crash Shows Limits of Self-Driving Technology*, SEATTLE TIMES (July 1, 2016, 11:56 AM), https://www.seattletimes.com/business/fatal-telsa-crash-shows-limits-of-self-driving-technology/ [https://perma.cc/8RJQ-RY4D]; Dana Hull et al., *The Uber Crash Is the Nightmare the Driverless World Feared but Expected*, BLOOMBERG (Mar. 19, 2018, 6:54 PM), https://www.bloomberg.com/news/articles/2018-03-19/uber-crash-is-nightmare-the-driverless-world-feared-but-expected [https://perma.cc/KA9R-N582]; Alice Klein, *Tesla Driver Dies in First Fatal Autonomous Car Crash in US*, NEW SCIENTIST (July 1, 2016), https://www.newscientist.com/article/2095740-tesla-driver-dies-in-first-fatal-autonomous-car-crash-in-us/ [https://perma.cc/FVG8-5NRG]; Michael Laris & Fai Siddiqui, *After Driverless Uber Hits and Kills Pedestrian, Probe Looks for Broader Safety Insights*, WASH. POST (Mar. 20, 2018), https://www.washingtonpost.com/local/trafficandcommuting/after-driverless-uber-hits-and-kills-pedestrian-probe-looks-for-broader-safety-insights/2018/03/20/2fe3af6e-2c5e-11e8-b0b0-f706877db618_story.html?utm_term=.1ce4e80c5f56; Timothy B. Lee, *Uber Self-Driving Car Hits and Kills Pedestrian*, ARS TECHNICA (Mar. 19, 2018, 4:15 PM), https://arstechnica.com/cars/2018/03/uber-self-driving-car-hits-and-kills-pedestrian/ [https://perma.cc/XZ2V-7FMB]; Olivia Solon, *Why Self-Driving Cars Aren't Safe Yet: Rain, Roadworks and Other Obstacles*, GUARDIAN (July 5, 2016), https://www.theguardian.com/technology/2016/jul/05/tesla-crash-self-driving-car-software-flaws [https://perma.cc/D44M-WP9C]; Bill Vlasic & Neal E. Boudette, *Self-Driving Tesla Was Involved in Fatal Crash, U.S. Says*, N.Y. TIMES (June 30, 2016), https://www.nytimes.com/2016/07/01/business/self-driving-tesla-fatal-crash-investigation.html.

19. *See infra* Section I.C.

20. The accident still attracted some modicum of attention. *See, e.g.*, Ethan Baron, *Blame Game: Self-Driving Car Crash Highlights Tricky Legal Question*, MERCURY NEWS (Jan. 23, 2018, 12:31 PM), https://www.mercurynews.com/2018/01/23/motorcyclist-hit-by-self-driving-car-in-s-f-sues-general-motors/ [https://perma.cc/CGT9-G3B2]; Peter Holley, *After Crash, Injured Motorcyclist Accuses Robot-Driven Vehicle of 'Negligent Driving,'* WASH. POST (Jan. 25, 2018, 2:33 PM), https://www.washingtonpost.com/news/innovations/wp/2018/01/25/after-crash-injured-motorcyclist-accuses-robot-driven-vehicle-of-negligent-driving/?utm_term=.64cc3ed8dee2.

21. As I and others have argued before, the term "robot" is "notoriously resistant to definition." Mark A. Lemley & Bryan Casey, *Remedies for Robots*, 86 U. CHI. L. REV. 1311, 1319 (2019) (discussing the fluctuating definitions of "robot" and "artificial intelligence"). *See generally* Bryan Casey, *Amoral Machines, Or: How Roboticists Can Learn to Stop Worrying and Love the Law*, 111 NW. U. L. REV. 231 (2017) (discussing the contested definitions of robots). In this Article, the term should be understood as including "any hardware or software system exhibiting intelligent behavior." Lemley & Casey, *supra*, at 1321.

22. *See* Arnold v. Reuther, 92 So. 2d 593, 596 (La. Ct. App. 1957) ("A human being, no matter how efficient, is not a mechanical robot and does not possess the ability of a radar machine to discover danger before it becomes manifest.").

current trends indicate that automated accidents will soon become ubiquitous parts of American life.[23] The Cruise crash may be among the leading examples of this trend, but it will be far from the last.

Seen through this lens, the moment is revolutionary. Precisely *how* revolutionary robot-driven accidents will be for our legal system is less clear, however. By now, many have weighed in on the topic—the academy's leading lights among them.[24] And, although opinions vary, a tentative consensus has emerged on at least one front. For most, conventional tort liability theories are essentially non-starters.[25] After all, both negligence and design defect liability require a showing of fault.[26] And in a world where robots of "confounding"[27] complexity roam, how could we possibly find the needle of fault in a haystack composed of millions of lines of software?[28]

Today, this question is widely regarded as among the "most significant source[s] of legal uncertainty"[29] in a global policy agenda spanning courts, legislatures,

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23. *See infra* notes 197–201 and accompanying text.

24. *See, e.g.*, Ryan Abbott, *The Reasonable Computer: Disrupting the Paradigm of Tort Liability*, 86 GEO. WASH. L. REV. 1 (2018); Kenneth S. Abraham & Robert L. Rabin, *Automated Vehicles and Manufacturer Responsibility for Accidents: A New Legal Regime for a New Era*, 105 VA. L. REV. 127 (2019); Jack B. Balkin, *The Path of Robotics Law*, 6 CALIF. L. REV. CIR. 45 (2015); Ryan Calo, *Robotics and the Lessons of Cyberlaw*, 103 CALIF. L. REV. 513, 515, 537 (2015); Bryan H. Choi, *Crashworthy Code*, 94 WASH. L. REV. 39, 46–47 (2019); Daniel A. Crane et al., *A Survey of Legal Issues Arising from the Deployment of Autonomous and Connected Vehicles*, 23 MICH. TELECOMM. & TECH. L. REV. 191, 193 (2017); Nora Freeman Engstrom, *When Cars Crash: The Automobile's Tort Legacy*, 52 WAKE FOREST L. REV. 293, 335–36 (2018); Mark A. Geistfeld, *A Roadmap for Autonomous Vehicles: State Tort Liability, Automobile Insurance, and Federal Safety Regulation*, 105 CALIF. L. REV. 1611 (2017); Donald G. Gifford, *Technological Triggers to Tort Revolutions: Steam Locomotives, Autonomous Vehicles, and Accident Compensation*, 11 J. TORT L. 71 (2018); Julie Goodrich, Driving Miss Daisy*: An Autonomous Chauffeur System*, 51 HOUS. L. REV. 265, 283–84 (2013); Kyle Graham, *Of Frightened Horses and Autonomous Vehicles: Tort Law and Its Assimilation of Innovations*, 52 SANTA CLARA L. REV. 1241 (2012); F. Patrick Hubbard, *"Sophisticated Robots": Balancing Liability, Regulation, and Innovation*, 66 FLA. L. REV. 1803, 1866–67 (2014); Bryant Walker Smith, *Proximity Driven Liability*, 102 GEO. L.J. 1777 (2014); David C. Vladeck, *Machines Without Principals: Liability Rules and Artificial Intelligence*, 89 WASH. L. REV. 117, 146–47 (2014); Jeffrey K. Gurney, Note, *Sue My Car Not Me: Products Liability and Accidents Involving Autonomous Vehicles*, 2013 U. ILL. J.L. TECH. & POL'Y 247, 271–77 (proposing strict liability for automated vehicle manufacturers); Andrzej Rapaczynski, *Driverless Cars and the Much Delayed Tort Law Revolution* (Columbia Law Sch. Law & Econ. Working Paper, Paper No. 540, 2016), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2764686. [https://perma.cc/3PYH-GNUX]; Omri Ben-Shahar, *Should Carmakers Be Liable When a Self-Driving Car Crashes?*, FORBES (Sept. 22, 2016, 11:36 AM), https://www.forbes.com/sites/omribenshahar/2016/09/22/should-carmakers-be-liable-when-a-self-driving-car-crashes/ [https://perma.cc/5TPJ-TXGF].

25. *But see* Lemley & Casey, *supra* note 21, at 1383 (offering a defense of "the idealized cost-internalization vision of negligence reflected in Learned Hand's formula" in the context of automated accidents, which is further elaborated in this Article).

26. *See infra* Section III.D (discussing why "strict" liability is a misnomer as applied to design defect doctrine).

27. *See, e.g.*, Abraham & Rabin, *supra* note 24, at 144 (discussing the "confounding effect of technological innovation[s]," such as automated vehicles, on conventional tort law).

28. *See infra* Part III; *see also infra* note 41 and text accompanying notes 41–47.

29. Geistfeld, *supra* note 24, at 1622. Crucially, "uncertainty" should be understood as distinct from "calculable risks," which can be accurately predicted and priced, unlike uncertainty. *See id.* at 1617 n.20.

regulators, practitioners, and titans of industry.[30] Its ultimate resolution will have far-reaching implications for markets measured in the trillions[31] and for lives measured in the millions.[32] With today's tort liability regimes seemingly headed the way of the horse and buggy,[33] widespread debates have emerged over how jurisprudence must account for this new era of robot-driven accidents.[34] The dialogue has elicited many nuanced and vitally important contributions—breathing fresh new life into longstanding contests over tort law's most fundamental goals of fairly allocating costs, promoting safety, and fostering innovation.[35]

But, urgent as these debates may be, they are also incomplete. Until now, the debates have given short shrift to a critical issue: inference. Fault[36] (or its absence) need not be proven by pointing directly to a faulty line of computer code.[37] Rather, like all facts, it can be shown through indirect evidence.[38] The tort rule known as res ipsa loquitur (res ipsa) is a particularly potent exemplar.[39] The Latinism means "the thing speaks for itself," referring to the idea

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30. *See, e.g.*, ANITA KIM ET AL., TECH. INNOVATION & POLICY DIV., DEP'T OF TRANSP., DOT-VNTSC-OSTR-16-03, REVIEW OF FEDERAL MOTOR VEHICLE SAFETY STANDARDS (FMVSS) FOR AUTOMATED VEHICLES: IDENTIFYING POTENTIAL BARRIERS AND CHALLENGES FOR THE CERTIFICATION OF AUTOMATED VEHICLES USING FMVSS (2016) (outlining federal administrative agencies' regulatory concerns regarding autonomous vehicles); Ass'n of Global Automakers, Comment Letter on the Development of Guidelines for the Deployment of Automated Vehicles to U.S. Dep't of Transportation 1–2 (May 9, 2016), https://www.regulations.gov/document?D=NHTSA-2016-0036-0051 [https://perma.cc/WGV6-W85P] (describing liability concerns of major industry players across globe); Jerry L. Mashaw & David L. Harfst, *From Command and Control to Collaboration and Deference: The Transformation of Auto Safety Regulation*, 34 YALE J. ON REG. 167, 269–71 (2017) (describing Congressional hearings on autonomous vehicles in which a diverse array of experts "repeatedly expressed concern that [the federal government] was creating . . . a 'policy vacuum' that states were rapidly filling with a 'patchwork' of inconsistent regulations"); Adam Thierer, *When the Trial Lawyers Come for the Robot Cars*, SLATE (June 10, 2016, 7:09 AM), http://www.slate.com/articles/technology/future_tense/2016/06/if_a_driverless_car_crashes_who_is_liable.html [https://perma.cc/38FP-K4UE].

31. Yes, that's trillion with a "t." *See, e.g.*, *First Look Inside Self-Driving Taxis as Waymo Prepares to Launch Unprecedented Service*, CBS NEWS (Oct. 12, 2018, 7:44 AM), https://www.cbsnews.com/news/first-look-inside-waymo-self-driving-taxis/ [https://perma.cc/93F7-AU93] (noting that "[a]nalysts predict self-driving revenue will hit a staggering $2.3 trillion by 2030").

32. *See, e.g.*, Global Health Observatory, *Number of Road Traffic Deaths*, WORLD HEALTH ORG., https://www.who.int/gho/road_safety/mortality/traffic_deaths_number/en/ [https://perma.cc/T8CV-U99H] (last visited Oct. 8, 2019) (reporting annual road traffic deaths in excess of 1.25 million globally).

33. *See* Engstrom, *supra* note 24, at 297 (arguing that "[o]ur traditional negligence system, designed for the Model T and premised on personal responsibility, will fit this new world [of robots] awkwardly").

34. *See infra* Part III; *see also supra* note 24 (providing a sample of the debate's leading participants).

35. *See supra* note 24; *infra* Part III; *infra* Section IV.C.4.

36. Or fault-based claims advanced under design defect theories. *See, e.g.*, RESTATEMENT (THIRD) OF TORTS: PRODUCTS LIABILITY § 3 (AM. LAW INST. 1998) (discussing fault-based claims advanced under design defect theories).

37. *See infra* Part III.

38. *See infra* Part IV.

39. See *infra* Section IV.A for a detailed discussion of res ipsa as applied to both negligence and design defect doctrine. Negligence per se is, of course, another liability rule that features significantly in accident law, as we'll see in section IV.C. *See infra* Section IV.C.

that the mere fact of an accident can, itself, permit the inference that a defendant was at fault.[40]

To date, scholars and practitioners have overlooked the extent to which inference-based analyses already play out in automated accidents.[41] This dearth of attention has been accompanied by an uncritical acceptance that new-age robots will simply prove too complex for age-old liabilities regimes.[42] The prevailing wisdom now treats this view as axiomatic, leading to a surge of proposals for "dramatic and unsettling"[43] regimes that often entail an outright "break with the tort system" or a sharp doctrinal turn toward strict products liability.[44] In this account, "[o]ur traditional negligence system, designed for the Model T and premised on personal responsibility, will fit this new world [of automated accidents] awkwardly."[45] Some have taken more measured approaches, asserting with little analysis or elaboration that tort law will somehow accommodate

40. *See infra* Section IV.A.

41. *See generally, e.g.*, Bryant Walker Smith, *Automated Driving and Product Liability*, 2017 MICH. ST. L. REV. 1, 52 (mentioning res ipsa's relevance to automated accidents once in passing); Abbott, *supra* note 24 (failing to mention res ipsa); Abraham & Rabin, *supra* note 24 (same); Balkin, *supra* note 24 (same); Calo, *supra* note 24, at 543–46 (briefly mentioning res ipsa analysis, but only as it relates to potential complications involving questions of agency and defendant's "exclusive control" over robot instrumentalities); Choi, *supra* note 24, at 52 n.54 (mentioning res ipsa only once in a footnote); Engstrom, *supra* note 24 (failing to mention res ipsa); Geistfeld, *supra* note 24, at 1636 n.85, 1638 n.94 (briefly mentioning res ipsa in only two footnotes); Gifford, *supra* note 24, at 134 n.366 (mentioning res ipsa only once in a footnote); Graham, *supra* note 24 (failing to mention res ipsa); Rapaczynski, *supra* note 24, at 9–10 (briefly discussing res ipsa's promise before advocating for a strict liability approach that seems to underappreciate the impact of autonomous fleet models on traditional vehicle ownership); Vladeck, *supra* note 24, at 129, 138–43 (discussing the merits of res ipsa analysis in automated accidents, only to abruptly dismiss the approach based on concerns that establishing liability "has been difficult," which the author asserts with little elaboration).

42. *See, e.g.*, Abraham & Rabin, *supra* note 24, at 142–44 (predicting that "the greatly heightened complexity and sophistication of the computerized control systems" will "confound[]" conventional analysis); Balkin, *supra* note 24, at 52 (predicting that robots may pose insurmountable challenges for conventional analysis that could require strict liability); Choi, *supra* note 24, at 44 (asserting that a "fundamental attribute of software—computational complexity—confounds the usual tort calculus" used to weigh the safety of "ordinary manufactured goods"); Engstrom, *supra* note 24, at 297 (arguing that "[o]ur traditional negligence system, designed for the Model T and premised on personal responsibility, will fit this new world [of robots] awkwardly"); Geistfeld, *supra* note 24, at 1612 (predicting robot algorithms will pose "vexing tort problems" under conventional analysis); Gifford, *supra* note 24, at 133 (arguing that "[p]roving factual causation is usually fairly easy in today's routine automobile accident, but once autonomous-vehicle-to-autonomous-vehicle accidents become the norm," their complexity will overwhelm investigators and jurors); Graham, *supra* note 24, at 1270 (expressing concerns over the "difficul[ty]" or impossibility of plaintiffs proving liability if forced to "engage in a searching review of the computer code that directs the movement of [robots]"); Vladeck, *supra* note 24, at 129–43, 129 n.39 (arguing that "common enterprise liability" may be necessary because robots will give rise to accidents where "something goes wrong and injury ensues and . . . it is impossible to determine" fault).

43. Abraham & Rabin, *supra* note 24, at 171.

44. *Id.*; *see* Calo, *supra* note 24, at 535 (asserting that "plaintiffs injured by the products they buy can generally avail themselves of strict liability"). For a detailed discussion of these proposal, see *infra* Parts II–III.

45. Engstrom, *supra* note 24, at 297. Many scholars share this general sentiment. *See infra* Part III.

automated accidents.[46] The prevailing wisdom, however, now insists that any viable solutions exist outside of convention.[47]

This Article challenges that view. In doing so, it relies not on distant speculation, but on contemporary evidence.[48] Indeed, with all the focus on the future of technologies like automated vehicles, it's easy to lose sight of the facts and figures that emerge each day. But the world has actually witnessed scores of accidents involving fully automated systems, including driverless vehicles.[49] Contrary to the impression conveyed by the literature, conventional analysis—relying on inferences about the fault of the automated systems involved—has successfully dealt with all of them.[50]

The key, as this Article demonstrates, lies in the advanced data-logging technologies on board these emerging technologies.[51] To navigate autonomously, robots must constantly sense their surrounding environments.[52] As a natural byproduct, they create richly detailed, multisensory records of the events that transpire around them.[53] Thanks to these robust data-logging capabilities, authorities can reconstruct automated accidents with a degree of granularity simply unimaginable in conventional contexts.[54] Rather than getting bogged down in algorithmic esoterica, they can look for the inference of negligence[55] in the machine's own meticulous account.[56] The robot, in other words, speaks for itself.

Embracing a liability rule we might call "robot ipsa loquitur" doesn't magically resolve all of our concerns surrounding the emerging technologies. It does, however, supply a number of helpful insights and conceptual tools drawn from past precedents.[57] Accordingly, after showing that the "most vexing tort

46. *See, e.g.*, Ryan Calo, *Is the Law Ready for Driverless Cars?*, COMM. ACM, May 2018, at 34, 34 (remarking, "I am reasonably convinced U.S. common law is going to adapt to driverless cars just fine," with little elaboration).

47. *See infra* Part III.

48. See *infra* Sections III.A and IV.B for a detailed discussion of the contemporary evidence. This evidence includes more than eighty "closed-loop" automated accidents that have been reported in California. *See Report of Traffic Collision Involving an Autonomous Vehicle*, STATE OF CAL. DMV [hereinafter *Cal. Report of Traffic Collisions Involving an Autonomous Vehicle*], https://www.dmv.ca.gov/portal/dmv/detail/vr/autonomous/autonomousveh_ol316 [https://perma.cc/923Q-ARYF] (last visited Oct. 8, 2019). See also *infra* Section II.A for a discussion of "closed-loop" and "open-loop" automated systems.

49. *See infra* Sections II.B, III.A, IV.B.

50. *See infra* Sections II.B, III.A, IV.B.

51. *See infra* Section IV.B.

52. *See, e.g.*, Cade Metz, *How Driverless Cars See the World Around Them*, N.Y. TIMES (Mar. 19, 2018), https://www.nytimes.com/2018/03/19/technology/how-driverless-cars-work.html (describing how automated vehicles sense their environments). For illustrations of these technologies, see *infra* Appendix A.

53. *See id.*

54. *See infra* Section IV.B.

55. As section IV.C.1 demonstrates, this inference extends to either the presence *or* absence of negligence, and it can be attributed to any number of parties. *See infra* Section IV.C.1.

56. *See infra* Section IV.B.

57. As shown in sections II.B, III.A, and IV.B, these precedents include successful fault determinations for genuinely "driverless" accidents. *See infra* Sections II.B, III.A, and IV.B.

problems"[58] anticipated by the literature are neither unprecedented, unresolvable, nor even unique to modern robots,[59] this Article takes a more pragmatic turn. Drawing from a rich vein of precedent involving automated accidents, it outlines steps that courts, professionals, and policymakers can take to streamline fault determinations for accidents while simultaneously promoting tort law's most foundational goals.[60] With so much riding on the successful deployment of robotics technologies,[61] these steps offer a promising alternative to the increasing number of drastic—often contradictory—calls for the legal system to abandon centuries of convention.[62] As this Article shows, a simpler, more productive approach would let robots speak for themselves.

This Article arrives at a time when the need for a detailed, evidence-based approach to resolving liability for automated accidents is fiercely urgent. With significant legislation in Congress,[63] state regulations in tumult,[64] and increasingly vocal concerns by citizens, politicians, government organizations, and industry leaders alike,[65] it's now safe to describe liability for robot-driven accidents as among the great regulatory challenges of the coming era.[66] Though the automotive industry may be among the leading sectors, a long line of similarly ambitious applications are also emerging. Press releases announcing autonomous drones,[67] agricultural robots,[68] automated micromobility devices,[69] self-flying cars,[70] delivery bots,[71]

58. *See* Geistfeld, *supra* note 24, at 1612, 1622 (describing the "vexing tort obligations to design these vehicles in a reasonably safe manner and to warn about the inherent risk of crash").

59. *See infra* Sections II.B–III.D.

60. *See infra* Section IV.C.

61. *See supra* notes 31–32 and accompanying text.

62. See *infra* Part III for an overview of these calls to abandon convention. See *infra* Part IV for a description of the solution.

63. *See* Aarian Marshall, *Congress Races to Pass a Self-Driving Car Law by Year's End*, WIRED (Dec. 5, 2018, 8:29 PM), https://www.wired.com/story/av-start-act-senate-congress-new-language-self-driving/ [https://perma.cc/NF8T-N9BK].

64. *See, e.g.*, Huu Nguyen, *Artificial Intelligence Law Is Here, Part One*, ABOVE THE LAW (July 26, 2018, 2:22 PM), https://abovethelaw.com/legal-innovation-center/2018/07/26/artificial-intelligence-law-is-here-part-one/?rf=1 [https://perma.cc/B3YT-YEB9] (noting that "twenty-three states have enacted autonomous vehicle (AV) legislation to account for liabilities of self-driving cars").

65. *See supra* notes 30–32 and accompanying text.

66. Numerous others have expressed substantially similar sentiment. *See infra* Part III.

67. *See, e.g.*, Farhad Manjoo, *The Autonomous Selfie Drone Is Here. Is Society Ready for It?*, N.Y. TIMES (Feb. 13, 2018), https://www.nytimes.com/interactive/2018/02/13/technology/skydio-autonomous-drones.html.

68. *See, e.g.*, Steve Lohr, *Robotic Milkers and an Automated Greenhouse: Inside a High-Tech Small Farm*, N.Y. TIMES (Jan. 13, 2019), https://www.nytimes.com/2019/01/13/technology/farm-technology-milkers-robots.html.

69. *See, e.g.*, Larry Hardesty, *Driverless-Vehicle Options Now Include Scooters*, MIT NEWS (Nov. 7, 2016), http://news.mit.edu/2016/driverless-scooters-1107 [https://perma.cc/5884-KTYA].

70. *See, e.g.*, Andrew Ross Sorkin, *Larry Page's Flying Taxis, Now Exiting Stealth Mode*, N.Y. TIMES (Mar. 12, 2018), https://www.nytimes.com/2018/03/12/business/dealbook/flying-taxis-larry-page.html.

71. *See, e.g.*, Elle Hunt, *'It's like a Robot Playground': The Cities Welcoming Self-Driving Delivery Droids*, GUARDIAN (May 1, 2018, 5:12 AM), https://www.theguardian.com/cities/2018/may/01/what-the-hell-is-that-self-driving-delivery-robots-hit-london [https://perma.cc/XJG9-35LF].

self-sailing ships,[72] intelligent medical devices,[73] homecare bots,[74] and automated warehouse applications[75] are now daily fixtures of the news. Robots entering these underexamined domains will raise similarly vexing questions of liability.[76] Fortunately, as discussed in the following Parts, the insights provided by robot ipsa loquitur generalize well to these diverse contexts.[77] Indeed, as surprising as Nilsson's negligence claim against the Cruise vehicle may have been to many experts,[78] this Article demonstrates that it actually offers a "virtuous"[79] solution—not only for robot-driven cars, but also for a coming world where robots roam our skies, sidewalks, seas, and even our homes.[80]

The Article proceeds in four parts. Part I juxtaposes two collisions involving automated vehicles, showing why a little-known incident resulting in a vehicle accused of negligence heralds a coming era of *truly* automated accidents. Part II discusses the "revolutionary" implications of these accidents, arguing that they'll upend current notions of legal *responsibility* but not necessarily legal *liability*—despite what many scholars have claimed. Part III delves further into this argument, demonstrating that the features scholars now cite as destined to "revolutionize" accident liability are neither novel to robots nor likely to confound conventional analysis. Part IV then lays out the Article's core contribution, arguing for an inference-based approach to allocating fault that relies on the unique capacity of modern robots to speak to the negligence of parties involved in accidents.

I. A TALE OF TWO ROBOTS

The year 2018 produced a lawsuit of sci-fi proportions.[81] A robot—in this instance, a driverless car—was formally accused of negligence,[82] likely the first

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72. *See, e.g.*, Jack Stewart, *Rolls-Royce Wants to Fill the Seas with Self-Sailing Ships*, WIRED (Oct. 15, 2018, 9:00 AM), https://www.wired.com/story/rolls-royce-autonomous-ship/ [https://perma.cc/5RYE-EQ2E].

73. *See, e.g.*, Hannah Devlin, *The Robots Helping NHS Surgeons Perform Better, Faster – and for Longer*, GUARDIAN (July 4, 2018, 6:00 AM), https://www.theguardian.com/society/2018/jul/04/robots-nhs-surgeons-keyhole-surgery-versius [https://perma.cc/D8XA-SUAM].

74. *See, e.g.*, *id.*

75. *See, e.g.*, Mick Mountz, *Kiva the Disrupter*, HARV. BUS. REV. (Dec. 2012), https://hbr.org/2012/12/kiva-the-disrupter [https://perma.cc/VV4G-5TFB].

76. Indeed, they may actually do so before automated vehicles. To paraphrase a recent *Wall Street Journal* headline, your ice cream may ride in a self-driving car before you do. *See* Christopher Mims, *Why Your Ice Cream Will Ride in a Self-Driving Car Before You Do*, WALL. ST. J. (Jan. 5, 2019, 12:03 AM), https://www.wsj.com/articles/why-your-ice-cream-will-ride-in-a-self-driving-car-before-you-do-11546664589?mod=hp_lead_pos9.

77. *See infra* Part IV.

78. *See infra* Part III (describing that the prevailing wisdom holds that claims would arrive under products liability theories).

79. This phrase is an homage to Mark Lemley's seminal piece. *See* Mark A. Lemley, *The Surprising Virtues of Treating Trade Secrets as IP Rights*, 61 STAN. L. REV. 311 (2008).

80. *See supra* notes 67–76 and accompanying text.

81. *See Nilsson* Complaint, *supra* note 5, at ¶¶ 16–17; *see also supra* notes 5–16 and accompanying text.

82. *See Nilsson* Complaint, *supra* note 5, at ¶¶ 16–17 (accusing a self-driving vehicle of driving itself negligently).

such accusation to breach the courthouse doors.[83] More titillating still, it was in earnest. The suit was no mere publicity stunt (nor an elaborate attempt to troll the Third Circuit's Judge Higginbotham, Jr.).[84] Rather, the circumstances giving rise to the controversy gave the plaintiff genuine cause to advance a legal theory grounded in negligence.[85]

Viewed in this light, the moment is historic. But, oddly, hardly a soul took notice.[86] Understanding why requires first rewinding the tape two years prior to another historic accident involving an automated vehicle. What follows is a tale of two robots. The first centers on a "driverless accident," much in need of the scare quotes surrounding the phrase. As we'll see in section I.A, much of the preliminary coverage of this accident described it as a first-of-its-kind moment involving an automated driving system. But, in the end, the accident turned out to be much more human-driven than initially appeared. Section I.B then turns to our second story centering on a driverless accident of a far more authentic variety. With this comparative case study as a backdrop, we can then meaningfully assess the legal implications of *truly* automated accidents in the remainder of this Article.

A. THE FIRST "DRIVERLESS FATALITY"[87]

In 2016, one of the 37,461 fatal accidents on U.S. roadways occurred in a car that was driving itself.[88] The vehicle was a Tesla Model S, belonging to Ohio resident Joshua Brown.[89] Brown was returning from Walt Disney World in Florida with his Tesla in "Autopilot"[90] mode when he collided with the broad side of a semitruck.[91]

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83. This claim is, admittedly, difficult to confirm. But I was unable to locate any evidence to the contrary. For other confirmatory accounts, see, for example, Holley, *supra* note 20 (describing accusation as "one of the first" and offering no evidence of others), and Melissa Locker, *Can a Self-Driving Car Be Negligent? A Motorcyclist Allegedly Injured by One Says Yes*, FAST COMPANY (Jan. 25, 2018), https://www.fastcompany.com/40521720/can-a-self-driving-car-be-negligent-a-motorcyclist-allegedly-injured-by-one-says-yes [https://perma.cc/ZVL9-UEY9] (same).

84. *See supra* note 4 and accompanying text (contextualizing Judge Higginbotham, Jr.'s quip that "robots cannot be sued").

85. *See infra* Sections I.B–C. There are, of course, a few oddities surrounding the claim. An important one is Nilsson's decision to file in federal court, as opposed to state court, which typically occurs with common law tort claims.

86. *See supra* note 20 and accompanying text.

87. As discussed below, not only was it not the first "driverless" fatality, it also was not even the first fatality involving Tesla's Autopilot system.

88. *See* Press Release, Nat'l Highway Traffic Safety Admin., USDOT Releases 2016 Fatal Traffic Crash Data (Oct. 6, 2017), https://www.nhtsa.gov/press-releases/usdot-releases-2016-fatal-traffic-crash-data [https://perma.cc/9NSR-XAQW] (outlining 2016 traffic fatality statistics); Rachel Abrams & Annalyn Kurtz, *Joshua Brown, Who Died in Self-Driving Accident, Tested Limits of His Tesla*, N.Y. TIMES (July 1, 2016), https://www.nytimes.com/2016/07/02/business/joshua-brown-technology-enthusiast-tested-the-limits-of-his-tesla.html.

89. Abrams & Kurtz, *supra* note 88.

90. *A Tragic Loss*, TESLA (June 30, 2016), https://www.tesla.com/blog/tragic-loss [https://perma.cc/KT37-475S] (offering a more detailed description of Tesla's "Autopilot" technology).

91. Abrams & Kurtz, *supra* note 88.

The impact killed him instantly.[92] Initial media reports described Brown as traveling at dangerous speeds on a divided highway when a tractor trailer made a left turn in front of him.[93] Normally, Autopilot is designed to automatically brake in moments like this.[94] But, in Brown's case, the truck's white trailer was backlit by both a bright sky and an overhanging highway sign—resulting in a "rare" event that evaded the detection capabilities of the Tesla's camera, radar, and ultrasonic sensing systems.[95] Consequently, Brown hit the truck without so much as braking, "with the bottom of the trailer impacting the windshield."[96]

The cacophony of media coverage that followed Brown's tragic death was deafening,[97] with thousands of outlets across the world running the story.[98] Many described it as the world's first "driverless" or "autonomous" fatality.[99] Others argued it "raised significant concerns for . . . the future of driverless cars."[100] A front-page story by the *New York Times*, for example, quoted experts remarking that the crash represented a "wake-up call" for the industry, one that cautioned us all to "reassess" driverless vehicles.[101]

As more information came to light, however, those initial media pronouncements appeared increasingly misplaced. Among the first dominos to fall was the truck driver's own account. According to Frank Baressi—the sixty-two-year-old driving the truck—Brown had been travelling at reckless speeds before the collision.[102] Baressi's original recollection "implied . . . Brown was driving faster than 85 mph,"[103] with numerous outlets quoting him as saying, "[Brown] went so fast through my trailer I didn't see him."[104] But Baressi's account didn't end there.

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92. Jordan Golson, *Read the Florida Highway Patrol's Full Investigation into the Fatal Tesla Crash*, VERGE (Feb. 1, 2017, 1:13 PM), https://www.theverge.com/2017/2/1/14458662/tesla-autopilot-crash-accident-florida-fatal-highway-patrol-report [https://perma.cc/7TYG-AFKU].

93. *Id.*; *see also infra* notes 103–04 and accompanying text (describing initial reports of Brown's speed).

94. *See* OFFICE OF DEFECTS INVESTIGATIONS, NAT'L HIGHWAY TRAFFIC SAFETY ADMIN., U.S. DEP'T OF TRANSP., INVESTIGATION PE16-007, at 1, 12 (2017) [hereinafter ODI TESLA INVESTIGATION 16007], https://static.nhtsa.gov/odi/inv/2016/INCLA-PE16007-7876.PDF [https://perma.cc/WJ2G-J4AS] (noting that the AEB technology included Forward Collision Warning (FCW), Dynamic Brake Support (DBS), and Crash Imminent Braking (CIB) capabilities but was "not designed to reliably perform in all crash modes, including crossing path collisions").

95. *See A Tragic Loss*, *supra* note 90 (describing the crash as "rare"); Metz, *supra* note 52 (describing the difference in these sensing systems).

96. *See A Tragic Loss*, *supra* note 90.

97. *See* Bilton, *supra* note 17 (noting that Brown's "story has been picked up in thousands of outlets").

98. *Id.*

99. *Id.* (describing numerous media claims). As we'll see in section I.C, the accident was not "driverless" in any meaningful sense. *See infra* Section I.C.

100. *Id.*

101. *See* Vlasic & Boudett, *supra* note 18.

102. *See infra* notes 103–04 and accompanying text.

103. Fred Lambert, *Tesla Autopilot Crash: Images of the Fatal Accident's Aftermath Emerge [Video]*, ELECTREK (July 1, 2016, 4:39 PM), https://electrek.co/2016/07/01/images-aftermath-fatal-tesla-autopilot-crash-video/ [https://perma.cc/L8BJ-DVBX].

104. Sam Levin & Nicky Woolf, *Tesla Driver Killed While Using Autopilot Was Watching Harry Potter, Witness Says*, GUARDIAN (July 1, 2016, 1:43 PM), https://www.theguardian.com/technology/

The truck driver had also accused Brown of "playing Harry Potter on the [Tesla's] TV screen" at the time of the crash.[105] The claim quickly went viral (exactly how Baressi squared this observation with his prior one—that "[he] didn't see [Brown]"—remains somewhat unclear).[106]

In the normal course of events, investigations into claims like Baressi's are, by nature, limited. With no survivor to tell the driver's side of the story, reconstructing the circumstances of the crash requires no shortage of guesswork. Brown's fatal collision, however, represented a marked departure from this historic norm. Thanks to the advanced data-logging technologies embedded in the Tesla Model S,[107] Brown's story actually survived his passing.[108] Without relying on cross-examinations, eyewitness testimony, fact-finding powers of juries, or fraught battles of experts, investigators from no fewer than three government agencies recreated the events leading up to Brown's collision using the vehicle's own meticulous telematics records.[109] And when they did, the truck driver's account fell to pieces.

Brown's Tesla, as it turns out, had been travelling at the more modest speed of seventy-four miles per hour[110]—nine miles over the posted speed limit of sixty-five, but hardly a speed putting him at risk of a reckless driving citation.[111] Further, investigators found no evidence to corroborate Baressi's claim that Brown had been watching Harry Potter.[112] Instead, authorities deemed Baressi himself blameworthy.[113] And they cited the trucker "for failing to give right of way during a left turn."[114]

When the investigation turned to Brown's own conduct, the Tesla's telematic records proved equally insightful. The car's data log revealed that in "a 37-minute period of the trip when Brown was required to have his hands on the wheel, he apparently did so for just 25 seconds."[115] During this time, visual and audio

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2016/jul/01/tesla-driver-killed-autopilot-self-driving-car-harry-potter [https://perma.cc/35BF-VRSV]. *See, e.g.*, *id.*; Will Oremus, *The Tesla Autopilot Crash Victim Was Apparently Watching a Movie When He Died*, SLATE (July 1, 2016, 7:43 PM), https://slate.com/business/2016/07/tesla-autopilot-crash-victim-joshua-brown-was-watching-a-movie-when-he-died.html [https://perma.cc/K7JF-TBRJ].

105. Levin & Woolf, *supra* note 104.

106. *Id.* Baressi alleged that he somehow "heard" the movie playing—even over the noise of the accident. *See id.*

107. For a detailed description of these technologies, see *infra* Section IV.B.

108. *See* Golson, *supra* note 92 (discussing reports by NHTSA and the Florida Highway Patrol regarding the accident).

109. *See id.* (describing analysis by NHTSA and the Florida Highway Patrol); *see also* Neal E. Boudette & Bill Vlasic, *Tesla Self-Driving System Faulted by Safety Agency in Crash*, N.Y. TIMES (Sept. 12, 2017), https://www.nytimes.com/2017/09/12/business/self-driving-cars.html (describing the National Transportation Safety Board's analysis).

110. *See* Golson, *supra* note 92.

111. *See* Lambert, *supra* note 103 (noting that Baressi's original account clocked Brown as traveling in excess of eighty-five miles per hour).

112. Golson, *supra* note 92.

113. *Id.*

114. *Id.*

115. David Shepardson, *Tesla Driver in Fatal 'Autopilot' Crash Got Numerous Warnings: U.S. Government*, REUTERS (June 19, 2017, 5:36 PM), https://www.reuters.com/article/us-tesla-crash/tesla-driver-in-fatal-autopilot-crash-got-numerous-warnings-u-s-government-idUSKBN19A2XC [https://perma.cc/3DHK-7AME].

warnings prompting Brown to keep his hands on the wheel went off seven times, to no avail.[116] According to one investigative report, Brown had seven seconds to react before impact after Baressi failed to give him the right of way.[117] But Brown "took no braking, steering or other actions to avoid the collision."[118]

With these facts in hand, it became increasingly apparent that the media's original descriptor of the event as a "driverless accident" was a misnomer. Given that human factors played a decisive causal role in the tragic outcome, any clear distinction between Brown's accident and the hundreds of other human-driven fatalities which occurred that same day began to fade from view.[119] In addition, driving this dramatic twist in the narrative was the Tesla vehicle's unique ability to speak for itself.[120]

B. THE FIRST ROBOT ACCUSED OF NEGLIGENCE

It would take just two years after Brown's tragic accident for the world to witness a "driverless accident" fitting of the description.[121] The vehicle at the center of the tale was a Chevy Bolt belonging to Cruise, an automated vehicle outfit owned by General Motors.[122] Though the accident failed to garner the same level of media attention that Brown's did, a data-generated "disengagement report" filed in its aftermath allows us to recreate the event in similar detail.[123]

According to the report, Cruise's vehicle was "operating in fully autonomous mode" in the center lane of San Francisco's Oak Street, a one-way road that is three lanes wide.[124] Travelling at twelve miles per hour in heavy traffic, the car identified a space between two vehicles in the lane to its left and began to merge.[125] Meanwhile, a motorcyclist by the name of Oscar Nilsson "was filtering up [Oak Street] at about 17 miles per hour," behind the Cruise vehicle.[126] Nilsson was "lane splitting," a practice common in California that allows motorcyclists to "pass[] other vehicles proceeding in the same direction within the same lane"

116. *Id.*

117. Golson, *supra* note 92.

118. Shepardson, *supra* note 115.

119. *See* Bilton, *supra* note 17 (noting that "[t]hroughout that day, hundreds of other people were killed or seriously injured in their cars across the country").

120. For illustrations of this accident reconstruction, see *infra* Appendix A.

121. As we will see section IV.B, it wasn't the first accident involving a fully automated vehicle, but it was the first to breach the courthouse doors. *See infra* Section IV.B.

122. *See* David R. Baker, *Cruise Reports Its First Injury Involving Self-Driving Car*, S.F. CHRON. (Dec. 20, 2017, 2:01 PM), https://www.sfchronicle.com/news/article/Cruise-reports-its-first-injury-involving-12445072.php.

123. *See Cruisin' for a Bruisin': Deconstructing the First 'Level 4/5' AV-Motorcycle Accident*, HAV STORY (Feb. 1, 2018), http://havstory.com/havstories/2018/2/1/deconstructing-the-first-true-cav-motorcycle-accident [https://perma.cc/M82S-VBVK].

124. *Id.*

125. *Id.*

126. *Id.*

by driving on dividing lines.[127]

Nilsson's motorcycle was between the center and the right lanes when the Cruise vehicle started merging leftward.[128] As it did, Nilsson accelerated into the vacated space; but in the midst of the Cruise vehicle's maneuver, a minivan in front of it suddenly decelerated.[129] "Sensing that its gap was closing, the Cruise [vehicle] stopped making its lane change and returned fully to the center lane."[130] In the process, the car sideswiped Nilsson. The motorcyclist "wobbled[] and fell over," injuring his shoulder and neck on impact.[131]

The San Francisco Police Department (SFPD) soon arrived on the scene. As is standard, an officer obtained statements from Nilsson and Cruise's "safety driver"[132] before filing a report.[133] The SFPD faulted Nilsson "for attempting to overtake and pass another vehicle on the right under conditions that did not permit that movement in safety in violation of [California Vehicle Code section] 21755(a)."[134] Under the code section, "[t]he driver of a vehicle may overtake and pass another vehicle upon the right only under conditions permitting that movement in safety."[135]

Nilsson, however, disagreed. He sued Cruise. But rather than advancing a products liability claim against the company, Nilsson instead opted for a theory based in negligence. The motorcyclist claimed that Cruise's vehicle "drove in such a negligent manner that it veered into an adjacent lane of traffic without regard for a passing motorist, striking [him] and knocking him to the ground,"[136] and that, "[a]s a result of such negligent driving, [he] sustained serious injuries of body and mind and incurred expenses for medical care and attendance."[137]

Surveying the literature, it's no overstatement to characterize Nilsson's legal strategy as unanticipated.[138] To date, an overwhelming consensus within the field has characterized products liability theories against automated vehicles as all but foreordained.[139] Nilsson's attorney apparently did not get the memo. Rather than

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127. *Lane Splitting General Guidelines*, STATE OF CAL. DMV, https://www.dmv.ca.gov/portal/dmv/detail/about/lane_splitting [https://perma.cc/HY4N-ATTV] (last visited Nov. 28, 2019).

128. CRUISE ACCIDENT REPORT, *supra* note 7, at 2.

129. *Id.*

130. *Id.*

131. *Id.*

132. This term refers to the individual responsible for controlling the vehicle in the event that a driver's intervention is required.

133. *See* CRUISE ACCIDENT REPORT, *supra* note 7.

134. *Id.* at 2.

135. CAL. VEH. CODE § 21755(a). The code section also adds "[i]n no event shall that movement be made by driving off the paved or main-traveled portion of the roadway." *Id.*

136. *Nilsson* Complaint, *supra* note 5, at ¶ 16.

137. *Id.* at ¶ 17.

138. *See generally, e.g.*, Abraham & Rabin, *supra* note 24 (predicting or presuming that such claims would proceed under products liability theories, absent the adoption of a new policy or liability regime); Calo, *supra* note 24 (same); Choi, *supra* note 24 (same); Crane et al., *supra* note 24 (same); Geistfeld, *supra* note 24 (same); Walker Smith, *supra* note 41 (presuming products liability will predominate, with *de minimis* consideration given to negligence).

139. *See supra* note 138.

abiding by the conventional wisdom, he opted to ground the claim in negligence.[140] And with it, the U.S. legal system witnessed what is likely the first such utterance to grace the pages of a court filing.[141] A robot was formally accused of operating itself negligently—a tort allegation once exclusively reserved for human operators.[142]

If only for the sheer shock value, the accusation would seem to be a newsworthy event, yet hardly anyone took notice. The sci-fi-esque filing was lost in the midst of more dramatic "driverless accidents," including Joshua Brown's fatal collision. But as we'll see in the next section, this accident—unlike Brown's—represents a genuinely historic moment for driverless technology, for society, and, of course, for the law.

C. UNTANGLING THE TALES

At first blush, there may appear to be little distance separating the two tales set forth above. After all, both the Tesla and Cruise accidents involved automated systems tasked with driving under dynamic conditions, and both turned on questions of whether their respective designs should have safeguarded against the resultant crashes. Yet, beyond those convergent starting points, the legal implications diverge radically.

Despite the media frenzy surrounding Brown's death, the description of his accident as "autonomous" or "driverless" is actually a misnomer.[143] As the Tesla owner's manual, multiple disclaimers, and the company's CEO have repeatedly stressed, Autopilot is not a driverless system.[144] Rather, when drivers activate Autopilot, they must acknowledge that it "'is an assist[ive] feature that requires you to keep your hands on the steering wheel at all times,' and that 'you need to maintain control and responsibility for your vehicle' while using it."[145] Thus, in the aftermath of Brown's death, Tesla stressed that Autopilot "is not perfect and still requires the driver to remain alert."[146] And shortly after the company's response, a preliminary report by the National Highway Traffic Safety Administration (NHTSA) mostly agreed with the position.[147] The agency described Tesla's Autopilot as an

140. *See Nilsson* Complaint, *supra* note 5, at ¶¶ 16–17.

141. *See supra* note 22 and accompanying text.

142. The use of a negligence claim, however, doesn't change that the entity ultimately responsible was still Cruise, not the vehicle itself. As detailed in *supra* note 4, the relevant legal analysis still turns on holding persons or, in this instance, corporations liable.

143. In fact, as explained in section II.A, if ever there's been an automobile accident presenting no possibility of intervention by a human in the driver's seat, it occurred long before the Tesla crash. *See infra* Section II.A.

144. *See* Golson, *supra* note 92 (describing these warnings and disclaimers).

145. *See A Tragic Loss*, *supra* note 90.

146. *Id.*

147. *See* Golson, *supra* note 92 (stating that "NHTSA looked into the crash and found that the system had worked appropriately" under its specified design parameters, which required drivers to continually monitor the traffic environment).

"Advanced Driver Assistance System," not a *truly* driverless technology.[148] Brown, not Autopilot, was the ultimate arbiter.

Thus, from a doctrinal standpoint, little about the Tesla crash can be considered novel. Even with Autopilot active, responsibility for controlling the vehicle and preventing the ensuing accident remained with Brown. And when he failed to use Autopilot as intended (despite as many as six contrary warnings), he foreclosed manufacturer liability under traditional "failure to warn" theories that center on violations of consumers' minimum safety expectations.[149] The same foreclosure of liability occurs with respect to the myriad other warnings people disregard on a daily basis. It happens when we ignore the *memento mori* featuring prominently on cigarette packaging,[150] or when we consume risky foods such as herbal products. In fact, it even happens when driving conventional cars. When, for instance, we activate assistive systems such as cruise control or advanced lane keeping, the legal complexion looks markedly similar.[151]

That is not to suggest there are no doctrinal novelties arising from technologies like Autopilot.[152] Just ask the National Transportation Safety Board (NTSB), which offered a scathing rebuke of both Tesla's and NHTSA's defense of Autopilot in 2017.[153] According to the agency's chairman Robert L. Sumwalt, "[t]he combined effects of human error and the *lack of sufficient system controls* resulted in a fatal collision that should not have happened."[154] The NTSB acknowledged that Autopilot had functioned as intended, but its system nonetheless "lacked [sufficient] safeguards to prevent drivers from using it improperly."[155]

The larger point here is that the legal novelties relevant to this inquiry turn almost exclusively on what M.C. Elish provocatively terms "moral crumple zones."[156] That is, the "mismatches between control and responsibility" that can emerge in AI systems that rely on human oversight.[157] Elish writes:

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148. ODI TESLA INVESTIGATION 16007, *supra* note 94, at 1 (noting "[t]he Autopilot system is an Advanced Driver Assistance System (ADAS) that requires the continual and full attention of the driver to monitor the traffic environment and be prepared to take action to avoid crashes").

149. *See* Izzarelli v. R.J. Reynolds Tobacco Co., 136 A.3d 1232, 1249 (Conn. 2016) (describing this foreclosure).

150. *See id.*

151. The same is true when pilots activate autopilot technologies. *See* Brouse v. United States, 83 F. Supp. 373, 374 (N.D. Ohio 1949) (ruling that pilot of a plane operating autopilot technologies had an obligation "to keep a proper and constant lookout").

152. After all, "[w]arnings are not . . . a substitute for the provision of a reasonably safe design." RESTATEMENT (THIRD) OF TORTS: PRODUCTS LIABILITY § 2 cmt. l (AM. LAW INST. 1998).

153. *See* Boudette & Vlasic, *supra* note 109.

154. *Id.* (emphasis added) (internal quotation marks omitted).

155. *Id.* Tesla, notably, went on to implement additional safeguards in the aftermath of the report's release via mass software updates. *Id.*

156. M.C. Elish, Moral Crumple Zones: Cautionary Tales in Human-Robot Interaction 3 (Mar. 14, 2016) (unpublished manuscript), http://robots.law.miami.edu/2016/wp-content/uploads/2015/07/Elish_cautionary-tales_prelim_draft.pdf [https://perma.cc/7PM9-Y5X7].

157. *Id.*

> Just as the crumple zone in a car is designed to absorb the force of impact in a crash, the human in a highly complex and automated system may become simply a component—accidentally or intentionally—that bears the brunt of the moral and legal responsibilities when the overall system malfunctions.[158]

Legal inquiries into moral crumple zones ask whether a nominally assistive system actually delegated too much (or too little) responsibility to a human operator.[159] We might, for example, ask similar questions if cruise control routinely induced drivers into taking their attention off the road.

In this respect, NTSB's response to Brown's fatality certainly brought to the fore novel legal concerns regarding the limits of human attention and long-term supervision. But, at bottom, the agency was concerned with whether Tesla should have designed its system to encourage better oversight by human drivers, not better driving by automated ones. Seen in this light, the difference between Autopilot and a host of operator-assistive technologies is one of distinction and not of kind. Vital though these doctrinal inquiries may be, they're a far cry from the ones that have enraptured the legal field since the Defense Advanced Research Project Agency's (DARPA) 2004 "Grand Challenge" announced the possibility—if only a distant one—of truly automated accidents.[160] That's precisely where our second tale involving the Cruise vehicle arrives on the scene.

Cruise's automated system also required constant vigilance on the part of the safety driver on board. Unlike Brown's accident, however, the Cruise accident occurred under conditions that triggered neither a prior warning nor a request for driver intervention.[161] That, in turn, meant that the human sitting in the driver's seat at the time of the collision had about as much of a role to play in the intervening events as a railway passenger does in a train crash. Consequently, the relevant legal inquiry no longer turned on the assistive capabilities of the system. Rather, the system was operating under truly automated conditions—thereby breaking from a long line of precedent involving "driver-assistance systems."[162]

It's exactly this type of scenario that practitioners, policymakers, and sci-fi nerds had long anticipated. And, in fitting sci-fi fashion, the accident was also accompanied by an accusation of Asimovian[163] proportions—one that few

158. *Id.* at 3–4.

159. *See id.* at 1. But even this question does not always result in defect liability. Abraham and Rabin, for example, give the example of a failure of automakers to embed speed governors in their vehicles, despite understanding that users will reliably abuse them by speeding. *See* Abraham & Rabin, *supra* note 24, at 136 n.23.

160. *See* Cadie Thompson, *These Images Show How Far Self-Driving Cars Have Come in a Few Short Years*, BUS. INSIDER (Oct. 22, 2015, 4:08 PM), https://www.businessinsider.com/the-first-self-driving-cars-that-competed-in-darpa-grand-challenge-2015-10 [https://perma.cc/82EA-X3CE] (describing DARPA's Grand Challenge competition); Balkin, *supra* note 24, at 52 (discussing "why lawyers care about" the doctrinal challenges of robots).

161. *See* CRUISE ACCIDENT REPORT, *supra* note 7, at 2 (describing how accident occurred without the driver's intervention).

162. *See* Geistfeld, *supra* note 24, at 1624, 1629 (describing the moment as "a legal discontinuity").

163. Asimov is the science fiction author of *I, Robot* and other works responsible for popularizing the modern conception of robots.

experts had anticipated. Seen through this lens, it's a revolutionary moment. Indeed, far from anomalous, current trends indicate that accidents involving fully automated robots like this one will soon become ubiquitous parts of American life.[164]

Yet, whether these revolutionary technologies will also revolutionize our current conventions surrounding accident liability—as many experts appear to argue—is far less clear. In the next Parts, we will see why claims about the "revolutionary" liability ramifications of robots are mostly overstated, and why age-old liability theories like the one advanced by Nilsson are actually well suited to address the thorny liability challenges likely to arise in a coming era where robots roam.

II. A TALE OF TWO ROBOT REVOLUTIONS

Just a few years ago, robot-driven accidents represented a decidedly esoteric topic. Now, they're fodder for front-page news and for policy debates rising to the highest levels of government.[165] The sheer speed of advancement has been breathtaking, but it has also led these technologies to come of age in a veritable "policy vacuum."[166] From this vacuum, a tale of impending revolution has recently emerged.[167] Robots able to drive cars or fly drones—so the tale goes—will revolutionize industries, economies, and entire societies.[168] Given the revolutionary changes they pose to everyday life, it's only natural to argue that equally revolutionary changes to conventional accident liability await on the road ahead.[169]

This Part attempts to show why these claims are overstated. In doing so, it again tells a two-fold tale—juxtaposing the revolutionary ramifications robots pose for legal *responsibility* with the ramifications they pose for legal *liability*. As we'll see, "driverless," "pilotless," and "autonomous" systems will almost certainly upend current conventions around legal responsibility for a vehicle's operation, with our notion of control shifting away from the humans who happen to be riding in the driver's seat and back to manufacturers. But the claim that robots will also upend the legal liability regimes we use to assess and allocate fault for accidents is far less certain. Section II.A supplies the technological underpinnings of emerging robotics technologies and their interactions with tort law, demonstrating why current frameworks based on "levels" of autonomy actually produce more analytic confusion than clarity. Section II.B then uses a framework based on closed- versus open-loop systems to show why robots that revolutionize

164. *See infra* Section II.B.

165. *See supra* Part I.

166. *See* Mashaw & Harfst, *supra* note 30, at 269 (describing this "policy vacuum").

167. *See, e.g.*, Abraham & Rabin, *supra* note 24, at 128 ("We are on the verge of another new era, requiring yet another revision to the legal regime. This time, it is our system of transportation that will be revolutionized."); Calo, *supra* note 24, at 515 (describing robotics as "the next transformative technology"); Gifford, *supra* note 24, at 105 (describing robots as the next revolutionary technology).

168. *See infra* Section II.B.

169. For a survey of the dozens of leading scholars who have advanced this claim, see *infra* Part III.

current notions of legal responsibility will not, inexorably, revolutionize legal liability in the process.

A. WHY "LOOPS," NOT "LEVELS," MATTER FOR ROBOT RESPONSIBILITY

Part I demonstrated that the transition from driver assistance systems to fully automated systems will cause a break from years of tort precedent that has presumed human drivers are responsible for operation of vehicles. Yet, whether this transition will also cause a "revolutionary" break from tort convention writ large—as many have argued[170]—is another matter altogether. The tort questions presented by automated accidents are numerous, and the challenges real. But, as this section shows, fully automated robots are actually not as revolutionary as many suggest. Understanding this counterintuitive truth first requires establishing a basic conceptual understanding of the technology underneath the proverbial hood. Although the relevant literature provides a description that needn't be revisited in detail,[171] certain confusions (which, in turn, beget further confusion) nevertheless loom large. Accordingly, it's worth clarifying a few key terms, such as "artificial intelligence," system "loops," and "levels" of automation.

First, "artificial intelligence" (AI), a term notoriously resistant to definition. It refers roughly to a suite of technologies that attempt to automate the complex behaviors we refer to as exhibiting "intelligence."[172] Notionally, as the level of machine intelligence increases, intervention by humans decreases. Ultimately, AI systems aim to create discrete operating states in which machines can perform tasks by purely automated means.

Although automation exists on a spectrum, its immediate legal consequences are better understood as binary. Automating a complex task can produce a system with a discrete operating state involving neither a need (nor expectation) of appropriate[173] human intervention—referred to as "human-out-of-the-loop"[174] or "closed-loop." Or, automating a complex task can produce a system that still envisages some degree of human intervention—referred to as "human-in-the-loop"[175] or "open-loop." Critically, a liability loop needn't encompass an entire operating domain to be considered "closed."[176] Automatic emergency braking (AEB) systems, for instance, are closed-loop technologies that constantly scan for impending collisions, without ever actually taking over control of the larger

170. *See infra* Part III.

171. For a detailed overview of artificial intelligence and its key technological constituents, see, for example, Lemley & Casey, *supra* note 21, at 1319–26.

172. *See generally* PEDRO DOMINGOS, THE MASTER ALGORITHM: HOW THE QUEST FOR THE ULTIMATE LEARNING MACHINE WILL REMAKE OUR WORLD (2015) (discussing the definitions of "artificial intelligence" and "intelligence" respectively).

173. The term "appropriate" here refers to questions of the type raised by the NTSB in response to Brown's fatalities. *See supra* Section I.C.

174. *See* Marc C. Canellas et al., Framing Human-Automation Regulation: A New Modus Operandi From Cognitive Engineering 16–20 (Mar. 23, 2017) (unpublished manuscript) [https://perma.cc/3DZW-BL3J].

175. *See id.*

176. *See infra* notes 178–90 and accompanying text.

driving task. Nor must a given loop be particularly "intelligent." In fact, as we'll see below, automated loops don't actually need to involve software at all.

Unfortunately, efforts to elucidate the sometimes-subtle distinctions between closed- and open-loop AI systems can create more confusion than clarity. In September 2016, for example, NHTSA adopted the Society of Automotive Engineers' (SAE) six-tiered description of automated vehicles, describing each level as follows:

- At Level 0, or "No Automation," the "full-time performance by the *human driver* of all aspects of the *dynamic driving task*, even when enhanced by warning or intervention systems."
- At Level 1, or "Driver Assistance," the "*driving mode*-specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*."
- At Level 2, or "Partial Automation," the "*driving mode*-specific execution by one or more driver assistance systems of both steering and acceleration/deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*."
- At Level 3, or "Conditional Automation," the "*driving mode*-specific performance by an *automated driving system* of all aspects of the *dynamic driving task* with the expectation that the *human driver* will respond appropriately to a *request to intervene*."
- At Level 4, or "High Automation," the "*driving mode*-specific performance by an *automated driving system* of all aspects of the *dynamic driving task*, even if a *human driver* does not respond appropriately to a *request to intervene*."
- At Level 5, or "Full Automation," the "full-time performance by an *automated driving system* of all aspects of the *dynamic driving task* under all roadway and environmental conditions that can be managed by a *human driver*."[177]

Relying on this framing, numerous scholars have zeroed in on the jump between SAE Level 3 (Conditional Automation) and Level 4 (High Automation) as representing a crucial break with conventional tort doctrine.[178] In their

177. SOC'Y OF AUTOMOTIVE ENG'RS, TAXONOMY AND DEFINITIONS FOR TERMS RELATED TO ON-ROAD MOTOR VEHICLE AUTOMATED DRIVING SYSTEMS 2 tbl.1 (2014).

178. *See, e.g.*, Abraham & Rabin, *supra* note 24, at 131 (describing the jump from Level 3 to 4 vehicles as representing a crucial legal juncture); Crane et al., *supra* note 24, at 202 (defining an "autonomous vehicle" as "a vehicle equipped with NHTSA level 3 or 4 technology"); Geistfeld, *supra* note 24, at 1629 (describing the moment that "automated driving technologies fully take over the dynamic driving task" as "a legal discontinuity").

accounts, the jump from assistive driving systems to unassistive ones represents a meaningful departure from existing precedent, given that automated systems are fully in control when the vehicle is under Level 4 conditions.[179] But, this view misapprehends the technology. Despite what the SAE's categories imply, automating the dynamic driving task is not an all-or-nothing proposition. Rather, the scope of legal concern is circumscribed by the relevant loop involved in—or alleged to have caused—an injurious event.

Autopilot, for example, is an SAE Level 3 system. When, in Brown's case, the system collided with a semitruck, its loop was "open." Because human intervention was both expected *and* legally appropriate, Brown retained an obligation to respond under the circumstances. But, if Brown's Autopilot system had suddenly accelerated into the same tractor trailer due to software error (as recently occurred in *In re Toyota*),[180] the legal complexion would have changed dramatically. Whether the system was nominally referred to as "partially," "conditionally," "highly," or "fully" autonomous would be irrelevant. Without an opportunity to appropriately intervene, the system's loop would be closed. And the robot (or mere subcomponent) would, by implication, be functionally "automated." Indeed, if there has ever been a truly "driverless accident," it happened long before Joshua Brown's crash. Automated loops don't require "deep neural networks"[181] to be considered closed; in fact, they don't require software at all. Unoccupied vehicles that plummet down hills after their parking brakes disengage are no more or less "driverless" (or "automated") than SAE Level 5 ones.[182]

Seen through this framing, the focus on "levels" as opposed to "loops" is, at best, a distraction. The proper inquiry simply asks whether a system is closed or open at the crucial juncture of a harmful event. The answer can be established with a pair of questions: (1) Was a specific automation loop active when an event with legal repercussions occurred? (2) If so, did it—or *should* it have—precluded any expectation that a human would respond appropriately to a request to intervene? If the answer to either question is "no," then the case for conventional operator responsibility and liability is straightforward. In the automotive context, for example, this type of scenario would fit into existing precedent involving assistive systems.[183] Once a system no longer assists in a specific operational task, but instead completely automates it, questions of outside involvement become irrelevant. As is self-evident from the "closed-loop" terminology, the possibility of human intervention is closed.

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179. Abraham & Rabin, *supra* note 24, at 131; Crane et al., *supra* note 24, at 202; Geistfeld, *supra* note 24, at 1629.

180. *See In re* Toyota Motor Corp. Unintended Acceleration Mktg., Sales Practices, & Prods. Liab. Litig., 978 F. Supp. 2d 1053, 1100–01 (C.D. Cal. 2013). This case and others like it are explored in far greater detail later in this Article. *See infra* Section III.A.2.

181. *See generally* Jürgen Schmidhuber, *Deep Learning in Neural Networks: An Overview*, 61 NEURAL NETWORKS 85 (2015) (providing a brief overview of "neural networks" and how they work).

182. *See infra* Section IV.A (describing res ipsa cases involving unoccupied vehicles).

183. *See, e.g.*, ODI TESLA INVESTIGATION 16007, *supra* note 94, at 5–6 (describing NHTSA's legal analysis of autopilot using a traditional products liability approach).

As noted above, the legal system has previously encountered accidents involving closed-loop systems. Precedents range from absentmindedly parked cars to complex software componentry responsible for "sudden acceleration" defects.[184] This long line of precedent, in turn, means that the only genuine novelty posed by modern robots is the size of the automated loops they're capable of closing. Unlike the "good old-fashioned artificial intelligence" (GOFAI) systems of recent years,[185] emerging robots can automate more complex tasks than their technological antecedents.[186]

As the next section will show, size matters. In fact, advances in AI that dramatically increase the capabilities of closed-loop robots will almost certainly revolutionize conventional notions of *responsibility* for accidents. Whether merely increasing the size of loops will also revolutionize accident *liability* is far less certain, however. That, then, is the question explored by the next section, which traces the history of industry advances aimed at increasing the size of closed loops within automated systems. In doing so, this section argues that the rapidly advancing automating capabilities we're seeing today will upend conventional notions of how we hold humans riding in vehicles responsible for accidents but will not necessarily upend conventional notions of how we assign and allocate fault.

B. WHY CLOSING LOOPS REVOLUTIONIZES RESPONSIBILITY, BUT NOT NECESSARILY LIABILITY

As recently as five years ago, talk of removing humans from the vehicle driving loop entirely—as was the case in the Cruise accident—might not have sat well with many automakers.[187] Even for companies in hot pursuit of driverless capabilities, the end goal looked less like Cruise's vision of automation and more like Tesla's. Instead of closed-loop systems, companies were aiming for an open-loop design paradigm, which the industry called incremental autonomy.[188] Under this philosophy, the "dynamic driving task" would not be handed over to robots entirely. Instead, incremental advancements in technologies such as "adaptive cruise control, lane keeping assist, [and] pedestrian recognition" would iteratively improve over time, allowing machines to take over more and more of the driving task.[189] Whenever intervention was required, though, robots would still need to hand off control to human drivers, thereby obliging humans to serve as ever-vigilant backups.[190]

184. *See infra* Section IV.A; *see also In re Toyota*, 978 F. Supp. 2d at 1100.

185. For a fuller description of GOFAI systems, see Lemley & Casey, *supra* note 21, at 1322–23.

186. *See, e.g.*, *id.*; Abbott, *supra* note 24, at 23 (observing that computers are less and less "just inert tools directed by individuals").

187. *See* Alex Davies, *The Sneaky Way Automakers Are Getting Us to Accept Self-Driving Cars*, WIRED (May 30, 2014, 6:30 AM), https://www.wired.com/2014/05/automakers-self-driving-cars/ (describing how many leading automakers had adopted an incremental approach that was "the opposite of what Google call[ed] its 'moonshot' approach").

188. *See id.*

189. *See id.*

190. *See* Alex Davies, *The Very Human Problem Blocking the Path to Self-Driving Cars*, WIRED (Jan. 1, 2017, 7:00 AM), https://www.wired.com/2017/01/human-problem-blocking-path-self-driving-cars/.

This iterative vision has mostly faded, however. The reason is straightforward: although an incremental approach sounds great on paper, an increasingly robust body of evidence has shown that "humans are for the most part horrible backups."[191] Studies have demonstrated that human operators are particularly ill-suited to long-term supervision tasks and tend to develop a false sense of confidence when automating technologies function for long periods without issue.[192] Confidence, in turn, begets complacency; operators' "attention wanders, and they often begin to doze."[193] It's this phenomenon that got Tesla into hot water with the NTSB in the aftermath of Joshua Brown's fatal collision.[194] Now that the evidence against incremental autonomy is all but incontrovertible, most companies are trying to skip it entirely by racing straight for closed-loop robots.[195]

As this industry-wide ambition approaches reality, its consequences for tort law are likely to be profound. Today, the majority of vehicular accidents are driven by human negligence: recent estimates put the figure at as high as 94% attributable to human error, verses less than 3% attributable to manufacturer error.[196] But all signs now suggest "we are apt to leave the current world of auto accidents [in which] the vast majority . . . are caused by human error . . . for a world that is flipped 180 degrees."[197] This coming inversion appears poised to extend far beyond the automotive realm—with self-flying drones,[198] self-sailing ships,[199] self-navigating delivery robots,[200] self-operating agricultural machines,[201] and countless other sophisticated automated applications also adopting closed-loop designs.

The immediate legal implications of this coming era are uncontroversial. A consensus holds that closing the loop on operational tasks will revolutionize legal responsibility, shifting conventional notions of control away from the humans who happen to be inside (or nearby) robots back to the manufacturers themselves.[202] As section II.A showed, this is consistent with a long line of tort

191. *See id.*

192. *See* Letter from Robert W. Peterson, Professor of Law, Santa Clara Univ., to Cal. Dep't of Motor Vehicles 10 (Feb. 23, 2016), https://orfe.princeton.edu/~alaink/SmartDrivingCars/Papers/RPeterson_CA_DMV%20_RegsComments032316.pdf [https://perma.cc/9BBF-AV8W].

193. *See id.*

194. Boudette & Vlasic, *supra* note 109 (describing the NTSB's critique of Autopilot).

195. *See* Davies, *supra* note 190.

196. *See* Engstrom, *supra* note 24, at 296 & n.16 (citing NAT'L HIGHWAY TRAFFIC SAFETY ADMIN., U.S. DEP'T OF TRANSP., FEDERAL AUTOMATED VEHICLES POLICY: ACCELERATING THE NEXT REVOLUTION IN ROADWAY SAFETY 5 (2016), https://www.transportation.gov/sites/dot.gov/files/docs/AV%20policy%20guidance%20PDF.pdf [https://perma.cc/QZW4-2EAJ], and NAT'L HIGHWAY TRAFFIC SAFETY ADMIN., U.S. DEP'T OF TRANSP., NATIONAL MOTOR VEHICLE CRASH CAUSATION SURVEY: REPORT TO CONGRESS 25–26 (2008), https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/811059 [https://perma.cc/2WM8-36GA]).

197. *See id.* at 296 (emphasis omitted).

198. *See* Manjoo, *supra* note 67.

199. *See* Stewart, *supra* note 72.

200. *See* Hunt, *supra* note 71.

201. *See* Lohr, *supra* note 68.

202. *See, e.g.*, Geistfeld, *supra* note 24, at 1619 (observing that scholars have reached "'the shared conclusion' that elimination of a human driver will shift responsibility onto manufacturers").

precedent, not to mention common sense.[203] And lest there be any lingering doubts, numerous industry leaders and state statutes have gone so far as to affirmatively recognize the consequences of this shift.[204]

Reaching a resolution on the question of legal responsibility for control of an automated system is just the beginning, however. Liability, after all, doesn't flow axiomatically from responsibility. Accidents occur for many reasons—some of which we hold operators liable for and some of which we don't. Thus, any sense of comfort brought by reaching this "shared conclusion"[205] is fleeting. Having settled the preliminary question of who should be legally *responsible* for a vehicle operating under closed-loop conditions, a subsidiary question of far greater import follows: how should accident *liability*[206] function in this world flipped 180 degrees?

Today, this open question of liability for closed-loop robots is viewed as among the "most significant source[s] of legal uncertainty"[207] in a global policy agenda spanning courts, legislatures, regulators, and titans of industry.[208] How we answer it will have lasting consequences for markets measured in the trillions[209] and for lives that number in the millions.[210] As we'll see in Part III, many have now weighed in on the topic—the field's leading lights among them.[211] And, though responses vary widely,[212] experts are almost unanimous on one front: they view conventional accident claims as likely to become unworkable.[213] Conventional negligence and products liability, after all, both require a showing of fault. And when it comes to the vastly complex technological constituents that

203. As the University of Chicago's Omri Ben-Shahar observes, "[t]here will be no drivers to blame, and the only remaining culprit would be the technology." Ben-Shahar, *supra* note 24.

204. *See, e.g.*, MICH. COMP. LAWS. § 257.665(5) (stipulating that "[w]hen engaged, an automated driving system allowing for operation without a human operator shall be considered the driver or operator of a vehicle for purposes of determining conformance to any applicable traffic or motor vehicle laws"); Kirsten Korosec, *Volvo CEO: We Will Accept All Liability When Our Cars Are in Autonomous Mode*, FORTUNE (Oct. 7, 2015), http://fortune.com/2015/10/07/volvo-liability-self-driving-cars/ [https://perma.cc/G93T-74EQ].

205. *See* Geistfeld, *supra* note 24, at 1619 (internal quotation marks omitted).

206. By "liability" here, I refer to the question of who (or what) bears the costs when an injurious accident occurs.

207. *See* Geistfeld, *supra* note 24, at 1622 (noting that the "most significant source of legal uncertainty stems from the manufacturer's potential liabilities for crashes caused by a fully [automated] system").

208. *See supra* note 30 and accompanying text.

209. *See, e.g.*, CBS NEWS, *supra* note 31 (noting that "[a]nalysts predict self-driving revenue will hit a staggering $2.3 trillion by 2030").

210. *See, e.g.*, Global Health Observatory, *supra* note 32 (reporting annual road traffic deaths in excess of 1.25 million globally in 2013). The number of U.S. accidents reliably tops six million a year, resulting in tens of thousands killed, millions more injured, and hundreds of billions of dollars in economic losses. *See* NAT'L HIGHWAY TRAFFIC SAFETY ADMIN., U.S. DEP'T OF TRANSP., TRAFFIC SAFETY FACTS: 2015 DATA 1–3 & tbl.1 (2017), https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812412 [https://perma.cc/8EWW-4USS].

211. *See infra* Part III; *see also supra* note 24.

212. *See supra* note 42; *infra* Part III.

213. *See supra* note 42; *infra* Part III.

make up modern robots, finding the needle of fault in a haystack comprised of millions of lines of computer code is seen as uniquely "vexing."[214]

With conventional tort liability seemingly headed the way of the horse and buggy—and technological advances proceeding at a breathtaking clip—robotics applications like automated vehicles have come of age in a veritable "policy vacuum."[215] From this vacuum, a second tale of "revolution" has recently emerged.[216] It begins in much the same way as the first: robots capable of previously unimaginable feats—such as driving a car or flying a drone—represent a technological paradigm shift. It's therefore only natural to conclude that these robots will require a legal paradigm shift.[217] In this account, "[o]ur traditional negligence system, designed for the Model T and premised on personal responsibility, will fit this new world awkwardly."[218] Some have taken more measured approaches, insisting that conventional analysis will somehow accommodate the "vexing tort problems"[219] posed by robots without offering much in the way of elaboration.[220] But, the prevailing view appears to hold that tort is "on the verge of another new era, requiring yet another revision to the legal regime."[221]

As the next Part will show, however, this tale of revolutionary liability doesn't follow as inexorably as some have indicated. Rather, many of the features scholars now cite as evidence of robots' revolutionary legal properties are neither novel, unresolvable under conventional legal analysis, nor even unique to emerging robotics technologies. What's more, upon closer inspection, it appears that age-old negligence theories actually fit this coming world of robot-driven accidents far less awkwardly than many suggest.

III. A NEW LEGAL REGIME FOR A NEW ERA?

As we saw in the preceding Part, the prevailing wisdom now holds that the proliferation of "revolutionary" robotics technologies will spur a liability revolution of similar magnitude.[222] Although disagreements exist over exactly how it will unfold, a growing consensus has converged on the view that tomorrow's software-driven robots will simply prove too "vexing" for conventional analysis.[223]

214. The adjective "vexing," as we'll see below, is sometimes exchanged for "confounding," "awkward," or other synonyms. *See infra* Part III.

215. *See* Mashaw & Harfst, *supra* note 30, at 269 (describing this "policy vacuum").

216. *See, e.g.*, Abraham & Rabin, *supra* note 24, at 128 ("We are on the verge of another new era, requiring yet another revision to the legal regime. This time, it is our system of transportation that will be revolutionized."); Calo, *supra* note 24, at 515 (describing robotics as "the next transformative technology"); Gifford, *supra* note 24, at 72 (describing both robots and autonomous vehicles as part of a "looming technological revolution").

217. For a detailed description of these claims, see *infra* Part III.

218. Engstrom, *supra* note 24, at 297. Though this specific quote comes from Stanford Law School's Nora Engstrom, the general sentiment is shared by many. *See infra* Part III.

219. Geistfeld, *supra* note 24, at 1612.

220. *See, e.g.*, Calo, *supra* note 46 (expressing confidence that "U.S. common law is going to adapt to driverless cars just fine," without further discussion).

221. *See* Abraham & Rabin, *supra* note 24, at 128.

222. *See supra* Section II.B.

223. *See infra* Sections III.A–III.D.

This Part challenges that view. Despite the wonder and wizardry of modern robots, the doctrinal problems they pose are actually not as vexing as many have indicated. Indeed, upon closer inspection, those who dismiss the viability of conventional analysis actually appear to be missing a crucial point. Tort law doesn't require that plaintiffs pinpoint direct evidence of accident fault in a faulty line of software. Instead, the legal rule of res ipsa loquitur allows plaintiffs to show fault through inference—even in accidents involving confoundingly complex machines.[224]

Before delving into this crucial doctrine, however, it's worth first engaging with the current scholarship. The following sections examine four predominant claims about the unique legal challenges posed by emerging robotics. Each section (1) describes the conventional claim, then (2) responds to it, showing why the features cited as demanding a departure from conventional analysis may not be quite as intractable as the literature currently suggests. Section III.A examines proposals in favor of stricter liability regimes. Section III.B examines similarly constituted proposals that instead favor safe harbor for automated vehicle manufacturers. Section III.C examines some concerns over legal roadblocks that software systems may encounter under conventional tort analysis. Finally, Section III.D examines several lingering misconceptions about products liability doctrine that remain prevalent in the literature.

A. ARE STRICTER REGIMES NECESSARY STRICTLY FOR SIMPLICITY?

1. The Claim: Eliminating Fault Is Necessary for Simplicity's Sake

As robots capable of driving, flying, and deftly navigating our sidewalks have moved from "moonshot" experiments to commercial realities,[225] a growing number of scholars have begun to argue that their proliferation will pose insurmountable challenges for existing accident law. The culprit, in this view, is complexity.[226] According to these scholars, age-old approaches for allocating liability will become infeasible or impossible in a world dominated by sophisticated robots.[227] The most developed of these arguments comes from the University of Virginia's Kenneth Abraham and Stanford University's Robert Rabin.[228] These scholars claim that "the greatly heightened complexity and sophistication of the computerized control systems in highly automated vehicles . . . would impose overwhelming stress on the premises of conventional [tort] analysis."[229] In their telling, legal "contests over blameworthiness will be replaced by examination of . . . esoteric, algorithm-based design differences" that will prove "needlessly contentious and costly" for courts, administrators, and accident victims.[230]

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224. *See infra* Part IV.

225. *See supra* Section II.B.

226. *See supra* note 42.

227. *See id.*

228. *See* Abraham & Rabin, *supra* note 24. For a more comprehensive list of the scholars who subscribe to this view, see *supra* note 42.

229. *See* Abraham & Rabin, *supra* note 24, at 143–44.

230. *See id.*

The solution proposed by these experts? "[B]reak with the tort system" altogether by imposing "strict,"[231] "no-fault,"[232] or "common enterprise"[233] liability on robot manufacturers—in this instance, automakers.[234] The primary appeal here is simplicity. Proponents argue that regimes that disregard fault would "better fit[] the new world of [automated] accidents than our current negligence and product-defect liability system."[235] Although the transition may seem "dramatic and unsettling,"[236] the scholars argue that "substantial efficiencies . . . could be achieved by eliminating hotly contested issues of reasonable technological expectations."[237] In their view, doing away with conventional fault-based analysis would reduce administrative burdens, shift costs onto parties better situated to handle them, and protect accident victims from becoming entangled in protracted disputes over blameworthiness that would otherwise arise under traditional approaches.[238]

2. The Response: Conventional Analysis Already Tames Complexity and There's Nothing Magical About Robots

In Arthur C. Clarke's arresting turn of phrase, "[a]ny sufficiently advanced technology is indistinguishable from magic."[239] With all the hype and mystique surrounding emerging robotics technologies, it's easy to see the staggering sophistication of their deep neural networks[240] and "black box" algorithms[241] as akin to black magic. It's little wonder, then, that numerous experts now insist that the sheer technological complexity of new-age robots will prove to be uniquely "confounding" for age-old tort liability.[242] The reality, however, is that there's nothing new about the prospect of profoundly complex systems getting into accidents. In fact, history is riddled with almost verbatim claims dating back to the

231. *See, e.g.*, *id.* at 171 (proposing abandonment of fault-based analysis); Gurney, *supra* note 24, at 271–77 (same).

232. *See, e.g.*, Abraham & Rabin, *supra* note 24, at 134 n.13.

233. *See, e.g.*, Vladeck, *supra* note 24, at 129 n.39, 146–47 (same); *see also* Engstrom, *supra* note 24, at 296 (remarking that autonomous vehicles will "bring[] enterprise liability principles, long foreign to automobile accident litigation, finally to the fore").

234. Each regime envisages an "elimination of the fault concept in compensating accident victims for their losses." C. L. Gaylord, *Fault, No Fault or Strict Liability?*, 58 AM. BAR ASS'N J. 589, 589 (1972) (describing subtle differences between regimes).

235. *See* Abraham & Rabin, *supra* note 24, at 171.

236. *See id.*

237. *See id.* at 144.

238. *See id.* at 142–44 (describing the various benefits purportedly offered by strict liability).

239. ARTHUR C. CLARKE, PROFILES OF THE FUTURE: AN INQUIRY INTO THE LIMITS OF THE POSSIBLE 21 n.1 (Harper & Row, Publishers, Inc. rev. ed. 1973) (1958) (internal quotation marks omitted).

240. *See generally* Schmidhuber, *supra* note 181 (describing this technology).

241. *See generally* Andrew D. Selbst & Solon Barocas, *The Intuitive Appeal of Explainable Machines*, 87 FORDHAM L. REV. 1085 (2018) (discussing the inscrutability of "black box" algorithms); Will Knight, *The Dark Secret at the Heart of AI*, MIT TECH. REV. (Apr. 11, 2017), https://www.technologyreview.com/s/604087/the-dark-secret-at-the-heart-of-ai/ (asserting that "[y]ou can't just look inside a deep neural network to see how it works" and arguing that "[n]o one really knows how the most advanced algorithms do what they do").

242. Abraham & Rabin, *supra* note 24, at 144; *see also supra* note 42.

introduction of the automobile—when practitioners routinely insisted that vexingly complicated "devil wagons" and their drivers should be subject to strict liability.[243] The claims are as unfounded today as they were then.

To start, it's unclear how "the greatly heightened complexity"[244] of modern robots would impose any more "stress on the premises of conventional [tort] analysis"[245] than is already the case with human drivers. As Raj Rajkumar notes: "Driving is the most complex activity that most adults engage in on a regular basis."[246] Crucially, it's an activity accomplished by algorithms that are universally recognized as utter "black boxes."[247] Tom Vanderbilt's description is a particularly apt one:

> [Drivers] are endlessly having to make snap decisions in fragments of moments, about whether it is safe to turn in front of an oncoming car, about the right speed to travel on a curve, about how soon we should apply the brakes when we see a cluster of brake lights in the distance. We make these decisions not with some kind of mathematical probability in the back of our heads—I have a 97.5 percent chance of passing this car successfully—but with a complicated set of human tools. These could be cobbled from the most primeval instincts lurking in the ancient brain, the experience from a lifetime of driving, or something we heard yesterday on the television news.[248]

Today, our understanding of how humans navigate the sprawling maze "of uncharted, little-understood dynamics" we call "traffic" remains woefully imperfect.[249] Theoretically, this imperfect understanding could give rise to an endless procession of costly and contentious suits. With each scientific advancement, experts could be summoned—time and again—to battle over "reasonable"

243. Richard M. Nixon, Note, *Changing Rules of Liability in Automobile Accident Litigation*, 3 L. & CONTEMP. PROBS. 476, 476–77 (1936). *See, e.g.*, Xenophon P. Huddy, *The Motor Car's Status*, 15 YALE L.J. 83, 83–86 (1905) (insisting, despite protestation to the contrary, that "[a] motor vehicle is not a machine of danger when controlled by an intelligent prudent driver"); Nixon, *supra*, at 476–77 (noting "the insistent contention of counsel in the early cases that the absolute liability of the keeper of vicious dogs or evilly-disposed mules should be imposed upon the drivers of 'devil wagons'" (footnote omitted)). We've seen similar claims to technological "exceptionalism" arise in other contexts, such as "data exceptionalism," only to be resoundingly rebuffed. *See generally, e.g.*, Andrew Keane Woods, *Against Data Exceptionalism*, 68 STAN. L. REV. 729 (2016) (challenging those who claimed data posed unique doctrinal challenges for conventional analysis).

244. *See supra* note 229 and accompanying text.

245. *See id.*

246. *See* Alison Snyder & Kaveh Waddell, *A Car That's Better Without a Driver*, AXIOS (Sept. 21, 2018), https://www.axios.com/autonomous-driving-is-hard-2e597891-e0d1-4b64-8c18-8b98b5fefb95.html [https://perma.cc/CGS4-Q39M] (internal quotation marks omitted) (quoting the preeminent Carnegie Mellon University professor).

247. Indeed, these mental algorithms are even more complex than the deepest of neural nets. *See, e.g.*, *Prying Open the Black Box of the Brain*, NAT'L SCI. FOUND. (June 12, 2013), https://www.nsf.gov/discoveries/disc_summ.jsp?cntn_id=128239 [https://perma.cc/AW4C-CP3E] (surveying literature that reveals the brain as "the most complex biological structure on Earth").

248. TOM VANDERBILT, TRAFFIC: WHY WE DRIVE THE WAY WE DO (AND WHAT IT SAYS ABOUT US) 245–46 (2008).

249. *See id.* at 6.

human reaction times, attentiveness, or multitasking capabilities. But, although the possibility of these esoteric contests is—at least in theory—ever-present, they rarely eventuate in practice. The reason for this is simple: despite the impression conveyed by Abraham, Rabin, and numerous other luminaries, the law doesn't need to understand how the algorithms in our brains work to make sense of our behavior. Rather, it simplifies the baffling complexity of what we call reasonably safe driving through behavioral heuristics that include traffic codes, roadway signage, driver tests, minimum age requirements, safety standards, coercive auto insurance, and liability rules of thumb.[250] There is no reason why similar heuristics can't be applied to the algorithm-based design differences of robots (more on this in Part IV).[251] Indeed, there seems as much reason to fear that the law will be confounded by tomorrow's "neural networks" as it is today by the neuronal firing of human brains—which is to say, none at all.

The same logic, of course, applies to vehicle manufacturing. Cars rolling off modern assembly lines constitute a maddeningly complicated amalgamation of hardware, software, and advanced materials.[252] They're comprised of roughly 150 million lines of code,[253] over 100 "programmable computing elements,"[254] "numerous different types of electronic signaling and interconnect[ed] buses," and thousands of intricate, interlocking parts.[255] Beyond sheer design sophistication, the organizational intricacy of their supply chains is also astounding. They require that manufacturers piece together parts from multi-tiered logistics chains spanning companies, industries, and jurisdictional boundaries.[256] Once again, any marginal design decision along this manufacturing continuum could, in theory, be scrutinized *ad infinitum*—giving rise to what Abraham and Rabin describe as "hotly contested issues of reasonable technological expectations."[257] In actuality, however, the law simplifies the conceptual complexity of reasonably safe manufacturing using highly-developed heuristics that include licensing requirements, manufacturing regulations, professional state-of-the-art standards, industry best practices, and tort and insurance conventions.[258] What's more, when the circumstances giving rise to an accident become too perplexing even for these modes of

250. *See* H. LAURENCE ROSS, SETTLED OUT OF COURT: THE SOCIAL PROCESS OF INSURANCE CLAIMS ADJUSTMENT 21 (1980). This extends to rules found in both negligence and products liability.

251. These could include performance metrics, data auditing, simulation or real-world safety testing, and piloting. *See, e.g.*, Erik Coelingh & Jonas Nilsson, *Creating Driving Tests for Self-Driving Cars*, IEEE SPECTRUM (Feb. 27, 2018, 4:48 PM), https://spectrum.ieee.org/transportation/self-driving/creating-driving-tests-for-selfdriving-cars [https://perma.cc/TPP3-K3HC]. In fact, it is precisely the type of proposal advanced by Mark Geistfeld. *See also infra* Section III.B.1.

252. *See infra* notes 253–61 and accompanying text.

253. *See* Ondrej Burkacky et al., *Rethinking Car Software and Electronics Architecture*, MCKINSEY & CO. (Feb. 2018), https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/rethinking-car-software-and-electronics-architecture [https://perma.cc/3XKG-4A8Z].

254. Bob O'Donnell, *The Digital Car*, TECHSPOT (May 23, 2017, 10:04 AM), https://www.techspot.com/news/69430-digital-car.html [https://perma.cc/T7J2-GKZ9].

255. *See id.*

256. *See* Burkacky et al., *supra* note 253.

257. *See* Abraham & Rabin, *supra* note 24, at 144.

258. *See* ROSS, *supra* note 250, at 21 (describing this legal machinery).

analysis, plaintiffs have another tool in their kit. Rather than advancing a theory of negligence per se,[259] or showing direct evidence of fault,[260] they can instead rely on the doctrine of res ipsa loquitur to prove negligence or a design defect through inference.[261]

A recent string of legal actions against the automaker Toyota demonstrates how this process works.[262] They arose after multiple plaintiffs accused Toyota's vehicles of inexplicably accelerating due to a software error.[263] The plaintiffs alleged that the vehicle's software had caused their cars to suddenly accelerate, leading to injuries and deaths.[264] Yet, even after extensive investigations, the plaintiffs failed to pinpoint the precise cause of the error in the code.[265] Jurors involved in the multidistrict litigation, however, ruled in the plaintiffs' favor.[266] Applying the rule of res ipsa, they found that the circumstantial evidence surrounding the event permitted the inference of Toyota's fault.[267] Similar theories have succeeded in cases involving other vehicle software defects.[268] In addition,

259. *See id.* (describing how statutory violations proceeding under negligence per se theories resolve many accidents).

260. Under either negligence or products liability theories.

261. For a full-throated description of res ipsa, see *infra* Section IV.A.

262. *See, e.g.*, *In re* Toyota Motor Corp. Unintended Acceleration Mktg., Sales Practices, & Prods. Liab. Litig., 978 F. Supp. 2d 1053, 1100–01 (C.D. Cal. 2013).

263. *See, e.g.*, *id.* at 1064.

264. *See, e.g.*, *id.* at 1100–01.

265. *See, e.g.*, *id.*

266. *See* Vladeck, *supra* note 24, at 143 (noting that "an Oklahoma jury, applying the doctrine of res ipsa loquitur, awarded the plaintiffs $3 million. . . . even though the plaintiffs could not isolate the cause of sudden acceleration" (footnote omitted)); *see also Toyota Loses First Acceleration Lawsuit, Must Pay $3 Million*, AUTOMOTIVE NEWS (Oct. 24, 2013, 1:00 AM), http://www.autonews.com/article/20131024/OEM11/131029935#axzz2r8ypeVIJ [https://perma.cc/9SYS-HY4K]. Before the settlement, the court stated:

> Toyota's Motion for Summary Judgment is premised on the uncontroverted fact that Plaintiff has been unable to identify a precise software design or manufacturing defect and point to physical or otherwise traceable evidence that the defect actually caused the Camry throttle to open from an idle position to a much wider angle without analog input from the driver via the accelerator pedal. To a lesser extent, it is also premised upon the fact that Plaintiff cannot prove the actual failure of Toyota's fail-safe mechanisms in the Camry on the day of the collision. As explained more fully below, Plaintiff's burden at the summary judgment stage is not so onerous.
>
> Essentially, Toyota asks the Court to conclude that the only reasonable inference that may be drawn from the volumes of evidence proffered by the parties is that Mrs. St. John mistakenly applied the accelerator pedal instead of the brake pedal. The Court cannot so conclude. As Plaintiff points out, and as detailed by the Court more fully below, Mrs. St. John's testimony, together with other evidence, much of it expert evidence, support inferences from which a reasonable jury could conclude that the Camry continued to accelerate and failed to slow or stop despite her application of the brakes.

In re Toyota, 978 F. Supp. 2d at 1100–01.

267. *See* Vladeck, *supra* note 24, at 143 (noting Oklahoma jurors awarded the plaintiffs $3 million in damages after applying res ipsa and that the settlement led the automaker to settle upwards of 400 related cases that were pending against it).

268. *See, e.g.*, Buck v. Ford Motor Co., 526 F. App'x 603, 605, 607 (6th Cir. 2013) (applying res ipsa to claims involving sudden acceleration); Estate of Knoster v. Ford Motor Co., 200 F. App'x 106, 114

outside of the automotive realm, plaintiffs have advanced inference-based claims against the software systems controlling commercial or military airplanes,[269] passenger trains,[270] escalators,[271] surgical robots,[272] and assembly plants.[273]

As Part IV further explores, these precedents show great promise for plaintiffs seeking to show fault without getting bogged down in "examination[s] of esoteric alleged engineering failures."[274] Yet, not only do proponents of stricter liability regimes overlook res ipsa's applicability to automated accidents,[275] but they also exhibit another oversight. After all, the claim that these accidents will present unique tort problems is an empirical one. Given that the world has already witnessed scores of crashes involving closed-loop vehicles,[276] one would think that evidence of this claim would have already begun to emerge in practice. A close examination of the facts, however, suggests the opposite.

For example, consider California. The state saw 120 accidents involving automated vehicles between January 2014 and September 2018.[277] As we'll see in Part IV, eighty-six of these accidents involved closed-loop vehicles, meaning that the robot itself was in control when the accident occurred.[278] Crucially, of these eighty-six accidents, none gave rise to significant contests over fault.[279] In fact,

(3d Cir. 2006) (finding that the Restatement of Products Liability preserved the possibility that "common experience" could lead to a res ipsa inference that a product would not have failed absent a defect).

269. *See, e.g.*, Stoddard v. Ling-Temco-Vought, Inc., 513 F. Supp. 314, 321 (C.D. Cal. 1980) (applying res ipsa to structural and electronic modification of military airplane); Nelson v. Am. Airlines, Inc., 70 Cal. Rptr. 33, 35–36 (Ct. App. 1968) (applying res ipsa to commercial airplane's autopilot).

270. *See* Jennifer Steinhauer, *At Least 18 Killed as Trains Collide in Los Angeles*, N.Y. TIMES (Sept. 12, 2008), https://www.nytimes.com/2008/09/13/us/13crash.html (describing collision that did not specifically invoke res ipsa but about which it was said: "Obviously two trains are not supposed to be at the same place at the same time").

271. *See* Barretta v. Otis Elevator Co., 677 A.2d 979 (Conn. App. Ct. 1996) (applying res ipsa to claim involving defective escalator).

272. *Family Gets $7.5 Million in Death After Spleen Removal*, MCNABOLA & ASSOCIATES, LLC (Feb. 21, 2012), https://www.personalinjurylawchicago.com/blog/2012/february/family-gets-7-5-million-in-death-after-spleen-re/ [https://perma.cc/A693-NTG5] (describing $7.5 million award for res ipsa case involving surgical robotics device).

273. *See* Plaintiff's Brief in Opposition to FANUC America Corporation's Motion to Dismiss Pursuant to Rule 12(b)(6), Holbrook v. Prodomax Automation Ltd., No. 1:17-cv-00219 (W.D. Mich. June 23, 2017), 2017 WL 6553473 (involving a res ipsa case against manufacturer of robot that killed worker).

274. *See* Abraham & Rabin, *supra* note 24, at 143.

275. *See supra* note 41. As a throwaway line, however, Abraham and Rabin mention in a footnote that "in some instances technological change might be expected to lower the difficulty of identifying the causes of accidents (e.g., by black box-type feedback on what happened)." *See* Abraham & Rabin, *supra* note 24, at 143 n.38.

276. For a detailed discussion of eighty-six accidents in California involving closed-loop vehicles, see *infra* Section IV.B.

277. *See Cal. Report of Traffic Collisions Involving an Autonomous Vehicle*, *supra* note 48 (documenting every accident involving an automated vehicle reported in the state thus far).

278. *See infra* Section IV.B.

279. *See* Kia Kokalitcheva, *People Cause Most California Autonomous Vehicle Accidents*, AXIOS (Aug. 29, 2018), https://www.axios.com/california-people-cause-most-autonomous-vehicle-accidents-dc962265-c9bb-4b00-ae97-50427f6bc936.html [https://perma.cc/MU56-5V22] (surveying every reported accident in 2018 and finding successful fault determination in each one). Even the Cruise accident discussed in Part I

none even went to trial.[280] Authorities successfully resolved questions of blame and compensation in each case—a ratio far exceeding that of conventional accidents.[281]

How, one might wonder, could authorities be so certain of their conclusions, despite lacking access to the automated vehicles' underlying software? The key, as Part IV details, lies in the data-logging technologies embedded in these robots.[282] Just as was true in the Tesla and Cruise accidents described in Part I, the automated vehicles contained advanced telematics systems that recorded the events surrounding the accident.[283] Although the vehicles' underlying software may have been utterly inscrutable, their observable behavior—and the behavior of those around them—was logged with remarkable clarity.[284] Thanks to these detailed records, investigators didn't need to cross-examine witnesses or resort to fraught battles of experts, as many seem to fear. Instead, they used the robots' own meticulous accounts to make fault determinations—ones that looked to the conduct, not the software, of the parties involved. This approach is a far cry from what prior scholarship summarily labels "confounding."[285]

Another brittle assumption underlying calls for stricter liability regimes emerges from this mounting number of fault determinations. As it turns out, fault in the overwhelming majority of crashes resided with human, not robot, operators.[286] This trend also bodes ominously for scholars calling to abandon fault-based analysis. In a world where fault regularly resided with closed-loop robots, calls to disregard the negligence of humans would be more defensible. But, in a world where the overwhelming majority of accidents stem from human error,

involved a straightforward determination of fault—an outcome that likely influenced Nilsson's swift settlement after filing the complaint. *See supra* Section I.B.

280. It is impossible to prove a negative, but there is no existing report of such an action.

281. In California, for example, roughly 30,000 accidents were contested in 2015 (and this figure doesn't include claims of less than $25,000 made in small claims courts which the state doesn't track). JUDICIAL COUNCIL OF CAL., 2016 COURT STATISTICS REPORT: STATEWIDE CASELOAD TRENDS 2005–2006 THROUGH 2014–2015, at 40 figs.5 & 9 (2016), http://www.courts.ca.gov/documents/2016-Court-Statistics-Report.pdf [https://perma.cc/JBT6-2XCT].

282. *See infra* Section IV.B.

283. *See infra* Section IV.B–C for a detailed discussion of these telematics technologies.

284. *See infra* Appendix A (illustrating the clarity with which these data logs record surrounding events).

285. *See, e.g.*, Abraham & Rabin, *supra* note 24, at 144 (discussing the "confounding effect of technological innovation[s]," such as automated vehicles, on conventional tort law).

286. *See* Kokalitcheva, *supra* note 279 (surveying every reported accident in 2018 and finding successful fault determination in each one); *Cal. Report of Traffic Collisions Involving an Autonomous Vehicle*, *supra* note 48 (finding that, according to the most recent reports, fault resided with the closed-loop system in two of the eighty-six accidents); *see, e.g.*, CAL. DEP'T OF MOTOR VEHICLES, REPORT OF TRAFFIC COLLISION INVOLVING AN AUTONOMOUS VEHICLE: ZOOX OCTOBER 12, 2019 (2019), https://www.dmv.ca.gov/portal/wcm/connect/329536a2-9d8b-4448-8fb3-2459ab9f997e/Zoox_101219.pdf?MOD=AJPERES&CVID= [https://perma.cc/4D6J-Z64D] (detailing a vehicle in fully-automated mode that was rear-ended while moving forward cautiously at a stop sign); CAL. DEP'T OF MOTOR VEHICLES, REPORT OF TRAFFIC COLLISION INVOLVING AN AUTONOMOUS VEHICLE: GM CRUISE MAY 2, 2019 (2019), https://www.dmv.ca.gov/portal/wcm/connect/74cad504-4db8-445c-bab2-5004f9910c60/GMCruise_050219.pdf?MOD=AJPERES&CVID= [https://perma.cc/37N4-ZZQU] (detailing a vehicle in fully-automated mode that was rear-ended while waiting at a stoplight).

stricter liability regimes would routinely impose the costs of behavior we currently call "negligent" on parties exhibiting no evidence of it. This type of outcome would be suboptimal from the dual vantage points of fostering life-saving technologies and fairly allocating costs, as section IV.C further details.

But it gets worse. Even supposing that this trendline reversed, it's also unlikely that the beneficiaries of the "substantial efficiencies"[287] purportedly offered by strict liability are the same ones that proponents of the regime appear to have in mind. Those scholars calling for the regime often paint a vision of downstream customers becoming hopelessly embroiled in litigation over technologies that they neither control nor understand.[288] But these concerns misapprehend the rapidly changing industry dynamics. Fears that complex legal contests would overburden consumers may make sense if the legal system allowed robot manufacturers to disclaim responsibility for their closed-loop systems. As we saw in Part II, however, this question is all but settled. Aside from edge cases involving negligent maintenance or aftermarket modification,[289] responsibility for the operation of closed-loop robots will almost certainly reside with their manufacturers[290]—meaning that downstream consumers will interact with insurance, not tort, liability systems in the event of an accident.

The closest contemporary analogs to the types of insurance models expected to prevail in this coming era are already standard fare in ridesharing fleets.[291] Much like conventional cab providers, companies such as Uber and Lyft directly insure passengers who purchase their services, instead of requiring that the drivers carry individual policies.[292] Passengers injured during a trip receive up to $1 million in insurance coverage automatically.[293] Similar practices have been codified into automated vehicle legislation in states throughout the United States. Michigan, for example, requires that each automaker assume liability and insure every car in its fleet when driverless systems are at fault.[294]

The conclusion that follows from this shift toward fleet-level insurance, as Part IV further details, is a straightforward one. The potential burdens of litigating

287. *See supra* note 237 and accompanying text.

288. *See supra* Section III.A.1.

289. Depending on the circumstances, scenarios like these could break the chain of liability that would otherwise reach back to manufacturers.

290. *See supra* Section II.B.

291. John Cusano & Michael Costonis, *Driverless Cars Will Change Auto Insurance. Here's How Insurers Can Adapt*, HARV. BUS. REV. (Dec. 5, 2017), https://hbr.org/2017/12/driverless-cars-will-change-auto-insurance-heres-how-insurers-can-adapt (describing future insurance models).

292. *See What You Need to Know About Uber's $1 Million Insurance Plan*, HG.ORG, https://www.hg.org/legal-articles/what-you-need-to-know-about-uber-s-1-million-insurance-plan-37714 [https://perma.cc/BY9N-5QVN] (last visited Oct. 17, 2019); KPMG, MARKETPLACE OF CHANGE: AUTOMOBILE INSURANCE IN THE ERA OF AUTONOMOUS VEHICLES (2015), https://assets.kpmg.com/content/dam/kpmg/pdf/2016/06/id-market-place-of-change-automobile-insurance-in-the-era-of-autonomous-vehicles.pdf [https://perma.cc/UCQ7-BHLT].

293. *See What You Need to Know About Uber's $1 Million Insurance Plan*, *supra* note 292.

294. *See* MICH. COMP. LAWS § 257.665b(4) (2016); Yuki Noguchi, *Self-Driving Cars Raise Questions About Who Carries Insurance*, NPR (Apr. 3, 2017, 4:23 AM), https://www.npr.org/sections/alltechconsidered/2017/04/03/522222975/self-driving-cars-raise-questions-about-who-carries-insurance [https://perma.cc/UVQ6-GQ8H].

automated accidents won't fall on the customers riding inside them, as many scholars seem to fear.[295] Rather, these individuals will be insured by owners of the vehicle service—meaning it will be the prerogative of those highly resourced, sophisticated, and incentive-aligned companies to sort out any thorny questions of fault, indemnity, or joint liability that might arise down the road. (Even if, as Part IV argues, these questions are only likely to arise in rare circumstances).[296]

B. IS A LIABILITY "SAFE HARBOR" PREFERABLE UPON REACHING THE RIGHT SAFETY THRESHOLD?

1. The Claim: Safe Harbor Liability Is (Again) Necessary for Simplicity's Sake

Another leading proposal—this time by New York University's Mark Geistfeld—begins from the same starting point as Abraham and Rabin, but promptly parts ways. Geistfeld shares Abraham and Rabin's sense that conventional accident analysis would impose "vexing tort obligations to design . . . vehicles in a reasonably safe manner and to warn [consumers] about the inherent risk of crash."[297] But rather than turning to strict liability, the scholar argues that tort should instead adopt a new standard granting manufacturers a kind of liability safe harbor after attaining a certain safety threshold.[298] According to Geistfeld, evidence of reaching this threshold could be established using "aggregate driving data" from fleets of automated vehicles.[299] In his estimate, showing that an "autonomous vehicle performs at least twice as safely as conventional vehicles" would suffice—thereby "eliminating defective design as a potential source of manufacturer liability."[300]

2. The Response: Granting Blanket Safe Harbor Is Fatally Flawed

Insofar as Geistfeld's proposal serves as a recognition that indirect evidence can illuminate questions of liability,[301] it's surely a step in the right direction. Indeed, the premise underlying his argument—namely, that no line-by-line software audit is necessary to allocate legal liability—is spot on. But from that laudable starting point, his proposal takes several puzzling turns.

Not only does Geistfeld fail to define the metrics he would use to establish automated vehicles as doubly "safe" relative to their conventional counterparts (a notoriously fraught undertaking),[302] but he also fails to adequately justify why

295. Some accident victims will, of course, still be third parties.

296. *See infra* Section IV.C.1 (arguing that only a small subset of accidents will pose challenges for conventional tort).

297. *See* Geistfeld, *supra* note 24, at 1622.

298. *See id.* I use "safe harbor" here to refer to blanket immunity from liability upon meeting certain predetermined criteria.

299. *Id.*

300. *See id.* at 1692.

301. Here, "indirect evidence" refers to the high-level safety statistics Geistfeld proposes as an alternative to scrutinizing the source code of the vehicle's software.

302. *See, e.g.*, Zachary C. Lipton & Jacob Steinhardt, *Troubling Trends in Machine Learning Scholarship* 5 (July 27, 2018) (unpublished manuscript), https://arxiv.org/pdf/1807.03341.pdf [https://perma.cc/T6H7-ZM8X] (describing troubling tendencies to make inapposite comparisons between human and machine performance capabilities).

a multiplier of two "would necessarily satisfy the manufacturer's tort obligation."[303] After all, there's nothing special about the number two—as opposed to, say, three or even three hundred—as a matter of either product safety or tort precedent. In addition, there's no reason why humans should set the baseline. As Ryan Abbott notes: "Once computers become safer than people and practical to substitute, computers should set the baseline for the new standard of care."[304] Tort has never compared modern safety standards to those of obsolete predecessors. By the same token, we might imagine early nineteenth century tort theorists proposing a liability safe harbor for horseless carriage manufacturers that produced vehicles twice as safe as the horse and buggy. And, given that some modern estimates put the fatality rate of buggies at as high as seven times that of modern automobiles, such a threshold would long ago have granted automakers blanket immunity.[305]

Viewed in this light, the fatal flaw at the heart of Geistfeld's proposal becomes readily apparent. Today, roughly 40,000 individuals perish in U.S. automotive accidents annually[306] (and that's just one of the many high-stakes sectors robots are entering).[307] Halving this figure would constitute an enormous societal achievement, but we do not want manufacturers to start tapping the brakes after dropping the number to a still tragic 20,000 deaths. Just as is true of Abraham and Rabin's proposal, some amount of litigation may conceivably be avoided by granting manufacturers safe harbor. As we will see in section IV.B, however, this purported benefit would come at the cost of promoting tort's most fundamental policy goals.

C. WILL THE LAW BE SOFT ON ROBOT SOFTWARE?

1. The Claim: Hardware Crashes and Software Crashes Are on a Doctrinal Collision Course

The centrality of software to modern robots has also rekindled interest in tort's application to computer code that causes injury.[308] Some scholars now speculate that the software-centric nature of emerging technologies could lead plaintiffs to

303. Geistfeld, *supra* note 24, at 1651. Geistfeld arrives at the number by offering a stylized example in which the "minimum expected cost of more extensive testing" of automated vehicles "equals the maximum expected safety benefit." *Id.* at 1653. But the example ignores that additional safety testing doesn't preclude manufacturers from deploying automated vehicles. His example, in other words, turns on a false tradeoff. It's possible for automated vehicles deployed in the realm world to both: (1) outperform conventional vehicles safety levels by 100% or more, and (2) continue to benefit from ongoing performance testing and improvements.

304. *See* Abbott, *supra* note 24, at 5.

305. *See* Eric Morris, *From Horse Power to Horsepower*, ACCESS, Spring 2007, at 6 (describing data from Chicago showing "that in 1916 there were 16.9 horse-related fatalities for each 10,000 horse-drawn vehicles . . . [which] is nearly seven times the city's fatality rate per auto in 1997").

306. *See, e.g.*, Press Release, Nat'l Highway Traffic Safety Admin., *supra* note 88 (noting a 5.6% increase from the previous calendar year).

307. *See supra* notes 67–76 and accompanying text.

308. *See* Choi, *supra* note 24, at 39 (noting robots "have rekindled interest in understanding how tort law will apply when software errors lead to loss of life or limb").

encounter novel doctrinal roadblocks.[309] One leading article by Ohio State University's Bryan Choi describes the problem thusly: "As the software industry ventures from purely cyber systems toward cyber-physical systems such as [robots], anticipation has been building that the rules for cyber-physical liability" may shake the foundations of tort.[310] According to Choi, "Traditional software does not kill, at least not without opportunity for human intervention. But when code controls physical systems directly, code crashes will cause physical crashes."[311] And this technological paradigm shift, so the account goes, may require a legal paradigm shift too.[312]

The core challenge, in this view, comes from the code itself. In general, courts have refused to subject software defects to products liability.[313] The justifications are somewhat varied. Courts have done so because the software in question was seen as a "service,"[314] or alternatively as representing "intangible thoughts, ideas, [or] expressive content."[315] In other circumstances, courts have precluded tort liability due to the economic loss doctrine (specifically "because there [was] no physical injury at stake"[316]) or because the case at hand was better suited to a breach of warranty claim.[317]

Whatever the precise legal rationale may be, though, the underlying concern remains the same. Despite some precedent to the contrary,[318] many scholars now worry that conventional products liability theories may not be available to plaintiffs involved in software-driven accidents.[319] And, in such a world, scholars fear

309. *See, e.g.*, Nora Freeman Engstrom, *3-D Printing and Product Liability: Identifying the Obstacles*, 162 U. PA. L. REV. ONLINE 35, 38, 40 n.29 (2013) (noting that "there are strong arguments that code does not qualify" as a product under current products liability doctrine, but speculating in a footnote that res ipsa might overcome this challenge); Wendy Wagner & Lisa Loftus-Otway, *A Study of the Non-Interventionist Model for Regulating Automated Vehicles: A Case Study of Texas Technology*, 1 J.L. & TECH. TEX. 1, 30 (2017) (citing 68 AM. JUR. 3d *Proof of Facts* § 333 (2015)) (arguing "plaintiffs are likely to face considerable difficulty in proving that software was negligently coded"); Calo, *supra* note 24, at 533–37 (noting possible liability breakdown due to intangibility doctrine); Graham, *supra* note 24, at 1270 (expressing concerns that robot software will present formidable hurdles for injured plaintiffs).

310. *See* Choi, *supra* note 24, at 43 (emphasis omitted) (footnote omitted).

311. *See id.* (footnote omitted).

312. *See supra* note 309; *infra* notes 314–16 and accompanying text.

313. *See* Wagner & Loftus-Otway, *supra* note 309, at 30 (noting that "[c]ourts across the country have generally refused to subject software defects to strict liability in products liability law"); *see also infra* notes 314–16.

314. *See* Choi, *supra* note 24, at 65–71 (surveying cases in which software was viewed as a "service").

315. Sanders v. Acclaim Entm't, Inc., 188 F. Supp. 2d 1264, 1277–79 (D. Colo. 2002); *see also* Engstrom, *supra* note 309, at 38–39 (surveying cases in which software was viewed as an intangible product that "can't give rise to product liability actions").

316. *See* Choi, *supra* note 24, at 42.

317. *See, e.g.*, *In re* All Am. Semiconductor, Inc., 490 B.R. 418, 434–35 (Bankr. S.D. Fla. 2013) (involving a defective software case proceeding under breach of warranty theory); *see also* Motorola Mobility, Inc. v. Myriad Fr. SAS, 850 F. Supp. 2d 878, 885 (N.D. Ill. 2012) (same).

318. *See, e.g.*, Singh v. Edwards Lifesciences Corp., 210 P.3d 337, 339–40, 345 (Wash. Ct. App. 2009) (allowing liability theory to proceed).

319. *See supra* notes 309–13 and accompanying text.

that the burden of proof facing plaintiffs would be considerable, if not insurmountable.[320] They argue that precluding products liability would render "plaintiffs . . . likely to face considerable difficulty in proving that software was negligently coded."[321] For "even when the plaintiff allege[d] an eligible injury, it [would] remain[] exceedingly difficult to prove whether the software caused the injury, and whether that cause was due to some defect intrinsic to the software."[322] Plaintiffs, according to this view, would need to "engage in a searching review of the computer code that directs the movement of [robots]."[323] And just as Abraham, Rabin, and Geistfeld argue, experts adopting this position insist such an undertaking would be "difficult[] and expensive," if not impossible.[324]

2. The Response: Faulty Software Has Killed Before and Establishing Fault Did Not Require Pinpointing a Faulty Line of Software

The reality, however, is that the concerns expressed above are overstated. First, as we saw in section II.A, contemporary vehicles already contain hundreds of electronic control units running millions of lines of code.[325] Yet, the law spends little time fretting over the code's inherent "intangibility" or status as a "service." Instead, courts consider the embedded software to be part and parcel of a product (such as a vehicle) or a product's components (which are themselves discrete products).[326] Even when the software directly determines the performance of these products, tort liability does not hinge on the directness of its connection to actual hardware. Were it otherwise, "a conventional motor vehicle that perform[ed] according to engineering plans that were developed or otherwise embodied in a computer program would also be exempt" on similar grounds.[327] No matter the industry, product manufacturers are duty-bound to ensure their products operate in a reasonably safe manner, including when it is software that determines the performance of these products.[328] In dozens of cases centering on software-driven injuries spanning diverse industrial contexts, this duty has not been "negated by the economic loss rule [n]or contractual provisions that disclaim the manufacturer's liability."[329]

The existence of this long line of cases—discussed in greater detail in Part IV—highlights another deficiency in the concerns raised by the scholars above. Despite numerous claims made in the literature that "[t]raditional software does

320. *See supra* note 42.

321. Wagner & Loftus-Otway, *supra* note 309, at 30.

322. Choi, *supra* note 24, at 42 (emphasis omitted).

323. Graham, *supra* note 24, at 1270.

324. *Id.*; *supra* note 309; *supra* note 24.

325. *See supra* Section II.A.

326. *See* Geistfeld, *supra* note 24, at 1631 (describing the legal system's regard for software as part of a broader product).

327. *Id.*

328. *See* RESTATEMENT (THIRD) OF TORTS: PHYSICAL AND EMOTIONAL HARM § 7(a) (AM. LAW. INST. 2010) ("An actor ordinarily has a duty to exercise reasonable care when the actor's conduct creates a risk of physical harm.").

329. Geistfeld, *supra* note 24, at 1631; *see also supra* notes 266–73.

not kill, at least not without opportunity for human intervention,"[330] the reality is that software actually *has* killed and maimed many times before, going decades back.[331] And, crucially, those software-driven injuries included instances "without opportunity for human intervention."[332] Closed-loop software has injured in aviation, elevators, assembly plants, medical settings, and numerous other contexts.[333] In fact, as the "sudden acceleration" cases discussed in section III.A show, it has even killed or maimed outside of the automotive realm.[334]

The problems with the view outlined above do not end there. As section II.A also makes clear, assertions about the "exceedingly difficult"[335] burden of proving fault without conventional products liability theories are also dubious. *In re Toyota*, for example, shows that demonstrating fault caused by faulty software does not require that plaintiffs "engage in a searching review of the computer code that directs the movement of [robots]."[336] Rather, thanks to res ipsa loquitur, plaintiffs involved in automated accidents can rely on inference to establish fault, even when they lack direct insight into the system's underlying code.[337] And that permissibility of inference, in turn, suggests plaintiffs will not face nearly as insurmountable an evidentiary burden as some now suggest.[338]

D. WILL A NATURAL SHIFT TO "STRICT" PRODUCTS LIABILITY RESOLVE NEGLIGENCE'S VEXING ISSUE OF BLAME?

1. The Claim: Shifting to "Strict" Products Liability Obviates Negligence's Need to Show Blame

Although the proposals surveyed so far have envisaged radical departures from existing accident law, not all do. Beyond the group of scholars calling for an outright "break with . . . tort"[339] lies another group whose outlook is less dire. In this view, the vexing challenges inherent in robotics accidents will not require a page-one rewrite of conventional liability. Rather, patience will cure tort's impending ails.[340]

According to this account, a natural transition to "strict products liability" will resolve the thorny challenges complex robots would otherwise pose for negligence analysis.[341] Tort theorists of this view tend to spin out the following

330. Choi, *supra* note 24, at 43.
331. *See infra* Section IV.A.
332. Choi, *supra* note 24, at 43; *see supra* notes 266–73.
333. *See supra* notes 266–73.
334. *See, e.g.*, *supra* notes 269–72 and accompanying text.
335. Choi, *supra* note 24, at 42.
336. *See* Graham, *supra* note 24, at 1270.
337. *See infra* Section IV.A.
338. *See id.*
339. *See* Abraham & Rabin, *supra* note 24, at 171; *see also supra* Sections III.A–B.
340. *See infra* notes 341–44 and accompanying text.
341. *See, e.g.*, Michelle Sellwood, Comment, *The Road to Autonomy*, 54 SAN DIEGO L. REV. 829, 850–51 (2017) (asserting that a product liability regime will hold manufacturers "strictly liable for every choice the autonomous vehicle makes, regardless of fault" (emphasis omitted)); Abbott, *supra* note 24, at 4–5 (asserting that products liability entails strict liability, whereas negligence entails a distinct reasonableness standard); Calo, *supra* note 24, at 535 (writing that "plaintiffs injured by the products

syllogism: (1) closed-loop machines will shift accident liability from human operators to product manufacturers; (2) plaintiffs injured by these products can ground their claims in "strict products liability" doctrine; and, consequently, (3) tort will naturally hold robot manufacturers strictly liable for accidents.[342] The University of Washington's Ryan Calo, one of the field's preeminent voices, puts it thusly: "Under existing doctrine, plaintiffs injured by the products they buy can generally avail themselves of strict liability. They do not need to show negligence."[343]

What follows from this syllogism, of course, is an elegant solution to the vexing challenges raised by scholars like Abraham, Rabin, and Geistfeld. With one fell swoop, the change heralded by a shift toward strict products liability analysis would cut through their concerns. Robots, this account goes, would not require us to reinvent the liability wheel. For, unlike negligence, "strict products liability" obviates the need to show fault. That, in turn, means liability for automated accidents will shift toward analytic approaches better suited to the "current competency of judges" simply because they will involve products.[344]

2. The Response: "Strict" Products Liability Is a Zombie Regime

The view set forth above is, in some sense, understandable. After all, the notion that products liability constitutes a "strict" standard continues to pervade the legal field.[345] Mark Geistfeld's textbook, for example, defines "strict products liability" as "[a] tort that makes a product seller of a defective product liable to a right holder for physical harms proximately caused by the defect."[346]

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they buy can generally avail themselves of strict liability"). Unfortunately, the list of student note authors who have repeated this error is long. *See, e.g.*, Jessica S. Brodsky, Note, *Autonomous Vehicle Regulation: How an Uncertain Legal Landscape May Hit the Brakes on Self-Driving Cars*, 31 BERKELEY TECH. L.J. 851, 865 (2016) (implying that products liability is a strict regime); Carrie Schroll, Note, *Splitting the Bill: Creating a National Car Insurance Fund to Pay for Accidents in Autonomous Vehicles*, 109 NW. U. L. REV. 803, 820–21 (2015) (arguing that "society already accepts that car manufacturers can be held strictly liable for defects in their products"). Sometimes, of course, the word "strict" is used to convey the more nuanced claim that downstream distributors or sellers of manufactured products can be held liable for defects, despite lacking involvement in the manufacturing process. Other times, it's used to make the nuanced argument that the evidentiary burden of overcoming negligence per se can approach "strict" liability. *See, e.g.*, Escola v. Coca Cola Bottling Co., 150 P.2d 436, 440–41 (Cal. 1944) (Traynor, J., concurring) (noting a manufacturer's difficulty in overcoming "the negligence rule [which] approaches the rule of strict liability"). But neither of these nuanced claims underlies the arguments set forth above.

342. *See, e.g.*, Calo, *supra* note 24.

343. *Id.* at 535 (footnote omitted).

344. *See* Schroll, *supra* note 341, at 820–21.

345. *See, e.g.*, David G. Owen, *Defectiveness Restated: Exploding the "Strict" Products Liability Myth*, 1996 U. ILL. L. REV. 743, 745 (noting that "courts still purport to apply a general rule of 'strict' liability in tort for defective products, and . . . some academics still proclaim the virtues of such a rule"); *see also* Peter M. Gerhart, *The Death of Strict Liability*, 56 BUFF. L. REV. 245, 245 (2008) ("It is axiomatic that the field of non-intentional torts is divided into two domains: negligence liability and strict liability."). Gerhart notes that although he "[does] not deal directly with products liability law . . . much of [his] analysis is applicable to products liability law as well." *Id.* at 250 (footnote omitted).

346. MARK A. GEISTFELD, TORT LAW: THE ESSENTIALS 406 (2008).

But, even though the notion of "strict" products liability continues to "occup[y] the core of modern products liability doctrine,"[347] the description is actually a misnomer.[348] To merit the adjective "strict," a liability regime must do one of two things. It must either hold defendants accountable for conduct that negligence would regard as a reasonable response to a foreseeable risk, or it must hold defendants accountable for conduct even in the absence of intent.[349] Modern products liability, of course, does neither.

Some early rulings saw it as a genuinely "strict" standard,[350] but that has long since changed. Products liability tests in force in the majority of states turn on principles of reasonableness, foreseeability, and causation that are congruent with findings of fault in negligence.[351] The Third Restatement, for example, "treats [products liability] as equivalent to negligence,"[352] specifying that predicating liability on the question of whether "the foreseeable risks of harm could have been reduced by a reasonable alternative design is based on the commonsense notion that liability . . . should attach only when harm is reasonably preventable."[353] Whether plaintiffs rely on a theory of design defect, failure to warn, or information defect, the tort inquiry is—at bottom—resolved in the same manner.[354] Where manufacturers have fulfilled their obligation to adequately warn consumers, the various tests function essentially as "[different] labels for the

347. *See* Owen, *supra* note 345, at 743.

348. *See* Gerhart, *supra* note 345, at 246 (noting that "strict liability as a doctrinal or analytical category of accident law is dying, and should be absorbed within negligence liability").

349. *See* John C.P. Goldberg & Benjamin C. Zipursky, *The Strict Liability in Fault and the Fault in Strict Liability*, 85 FORDHAM L. REV. 743, 745 (2016) ("According to prevailing academic usage, strict liability is liability *without wrongdoing*. A defendant subject to strict liability must pay damages irrespective of whether she has met, or failed to meet, an applicable standard of conduct. Action that causes harm is all that is required.").

350. *See, e.g.*, Escola v. Coca Cola Bottling Co., 150 P.2d 436, 440 (Cal. 1944) (Traynor, J., concurring); *see also* RESTATEMENT (SECOND) OF TORTS § 402A(1) (AM. LAW INST. 1965) (noting that a manufacturer who "sells any product in a defective condition unreasonably dangerous to the user or consumer" is strictly liable); Owen, *supra* note 345, at 744 (observing that "courts and legislatures across the land embraced . . . the bold new doctrine that [proclaimed] 'strict' liability in tort for harm caused by defective products").

351. *See* Mark A. Geistfeld, *The Regulatory Sweet Spot for Autonomous Vehicles*, 53 WAKE FOREST L. REV. 337, 364 (2018) ("This tort question is clearly resolved by a majority of states in the same manner, requiring that AV manufacturers test the vehicle until the costs of more extensive testing exceed the safety benefits.").

352. Richard L. Cupp Jr. & Danielle Polage, *The Rhetoric of Strict Products Liability Versus Negligence: An Empirical Analysis*, 77 N.Y.U. L. REV. 874, 880 (2002) (footnote omitted). *See* RESTATEMENT (THIRD) OF TORTS: PRODUCTS LIABILITY § 2 cmt. d (AM. LAW INST. 1998) ("Assessment of a product design in most instances requires a comparison between an alternative design and the product design that caused the injury, undertaken from the viewpoint of a reasonable person. That approach is also used in administering the traditional reasonableness standard in negligence. The policy reasons that support use of a reasonable-person perspective in connection with the general negligence standard also support its use in the products liability context." (citation omitted)).

353. RESTATEMENT (THIRD) OF TORTS: PRODUCTS LIABILITY § 2 cmt. f.

354. This excludes manufacturing defect theories, which are rare but in fact "strict" in the true sense of the standard.

same liability rule"—one that turns on a cost-benefit analysis resembling negligence.[355]

To call this "strict" liability is an exercise in confusion. By introducing tests of foreseeability and reasonableness, products liability long ago departed from any semblance of strictness. As Peter Gerhart quips:

> [By the same token,] we might as well refer to "strict negligence liability" and define "strict services liability" as a tort that makes a service seller liable for the sale of defective services. As long as liability is tied to a defect that must be proven, the word "strict" is surplus; it does no analytical work and cannot signify liability without fault.[356]

Nowadays, the claim that negligence and products liability theories are substantively similar in application is not new.[357] It's not even controversial.[358] Yet, mystifyingly, no matter how many times scholars conclusively kill "strict products liability," like a zombie it lives on. And, unfortunately, it continues to survive in the contemporary literature—causing significant analytic confusion even among leading experts.[359]

As we saw above, numerous scholars view products liability's apparent "strictness" as offering a natural solution to the vexing questions of fault that might otherwise arise under conventional negligence analysis.[360] But, in actuality, the regime is no panacea. Simply shifting away from negligence toward products liability regimes will not allow plaintiffs to "avail themselves of strict liability," as some claim.[361] Rather, plaintiffs will still need to show fault—even when their injuries are caused by profoundly complex products.[362] Res ipsa theories are actually particularly well suited to this type of analysis.[363] In fact, as the next Part shows, negligence *and* products liability rules that invoke it have already proven remarkably effective at showing fault for automated accidents.

IV. ROBOT IPSA LOQUITUR: AN OLD LEGAL REGIME FOR A NEW ERA

The preceding Parts suggest that emerging robotics applications are neither doctrinally revolutionary nor even conceptually novel and that alternative regimes proposed by leading experts fail to offer satisfying solutions. Simply pointing out these analytic defects does not resolve the real liability challenges

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355. Geistfeld, *supra* note 24, at 1643.

356. PETER M. GERHART, TORT LAW AND SOCIAL MORALITY 195 (2010).

357. *See, e.g.*, Crane et al., *supra* note 24, at 260 (describing the two standards as similar); *see also supra* notes 351–53.

358. *See, e.g.*, James A. Henderson, Jr. & Aaron D. Twerski, *Achieving Consensus on Defective Product Design*, 83 CORNELL L. REV. 867 (1998) (showing consensus); Crane et al., *supra* note 24 (same); Cupp & Polage, *supra* note 352 (same); Gerhart, *supra* note 345 (same).

359. *See supra* Section III.D.1.

360. *See supra* note 341.

361. *See* Calo, *supra* note 24, at 535.

362. *See supra* Sections III.B, III.C.

363. *See infra* Part IV.

posed by the technologies, though. So, what should we do? This Part argues that the solution to the vexing complexity of robots is actually a simple one: when combined with the advanced telematics technologies embedded in modern applications, the age-old liability rule of res ipsa actually provides a potent tool for resolving questions of fault. Thanks to the "event data recording" systems on board modern robots, the system's own account of an accident often contains ample evidence to make a determination of fault, without necessarily requiring direct access to the software underneath the hood.[364] The robot, in other words, speaks for itself.

Having now toured the literature, it appears we've come full circle—to the first robot accused of negligence. Surprising though the accusation may have been, the following sections will show why doctrinal claims based on res ipsa-style negligence theories—combined with the "event data recorders" (EDRs) onboard modern robots—actually offer a surprisingly virtuous solution to one of the great regulatory challenges of the coming era. Section IV.A describes the rule of res ipsa, as well as its application to modern suits involving liability for automated accidents. Section IV.B shows how informal versions of res ipsa relying on accident reconstructions have already shown promise in scores of accidents involving automated vehicles and makes the case for an analytic approach we might call "robot ipsa loquitur." Finally, section IV.C concludes the Article by outlining a path to establishing robot ipsa loquitur as a formal liability rule, arguing that this new take on an age-old regime offers a superior solution to those currently on offer in the literature.

A. SPEAKING OF NEGLIGENCE

When deciding questions of liability for modern accidents, courts focus on the precautions not taken.[365] A crash's mere occurrence, as we saw in section II.C, is not sufficient. Some accidents are unavoidable; others occur without the fault of anyone, except perhaps the plaintiffs' own. Accordingly, plaintiffs must prove that a defendant's conduct was unreasonable. To do so, plaintiffs must establish, by a preponderance of evidence, that a defendant's untaken precaution "would have yielded greater benefits in accident reduction than its cost."[366]

Not all allegations of liability, however, require a direct showing of fault. Like any fact, where direct proof is impossible or infeasible to produce, plaintiffs can instead rely on inference.[367] In many cases, plaintiffs invoke inference without any specific reference to formal tort doctrine.[368] If, for example, "a man is found with his throat cut and the defendant was the last person seen with him, the

364. *See supra* Section III.B.

365. Courts emphasize the failure to take precautions under both negligence and products liability theories.

366. Meiring de Villiers, *Virus Ex Machina Res Ipsa Loquitur*, 2003 STAN. TECH. L. REV. 1, 2. As section III.D showed, this is true under negligence or products liability theories.

367. *See generally* William L. Prosser, *Res Ipsa Loquitor in California*, 37 CALIF. L. REV. 183 (1949) (describing liability rule allowing plaintiffs to rely on inference).

368. *See id.* at 189.

defendant's footprints are found leading away from the scene of the crime, and the defendant is found in possession of a bloodstained knife together with the deceased's watch and wallet," we simply call it "circumstantial evidence."[369] But, when the relevant circumstantial evidence stems directly from an allegedly tortious accident, "we speak of it as a case of res ipsa loquitur."[370]

The Latinism, of course, means nothing more than "the thing itself speaks."[371] It entered the legal canon through Chief Baron Pollock in the 19th century case, *Byrne v. Boadle*.[372] That case centered on a hapless pedestrian injured by a flour barrel that inexplicably fell from the defendant's warehouse.[373] The defendant argued that a lack of direct evidence precluded liability. But Pollock, the presiding judge, disagreed, writing: "There are certain cases of which it may be said res ipsa loquitur . . . . [T]he mere fact of the accident having occurred is evidence of negligence . . . ."[374]

Today, virtually every state recognizes res ipsa,[375] though its particulars vary by jurisdiction. The elements drawn from the Third Restatement provide a rough formulation of the multistate rule. According to it, res ipsa may be inferred if "the incident that harmed the plaintiff . . . was of a kind that ordinarily occurs as a result of product defect" and "was not, in the particular case, solely the result of causes other than product defect existing at the time of sale or distribution."[376]

From these simple elements, plaintiffs can advance claims involving otherwise confounding factual circumstances. Res ipsa has resolved vexing questions of responsibility, foreseeability, and contributory or joint liability in cases that bear striking similarities to modern automated accidents.[377] Early cases invoking the doctrine, for example, frequently involved street railway cars[378] and overturned stagecoaches.[379] In fact, surprising though it may seem, the negligence rule has even resolved liability questions involving *literally* driverless vehicles. Instances of unoccupied cars plummeting down hills are more common than one might imagine. And when a parked car inexplicably begins barreling down a hill, it is hardly a stretch to analogize the circumstantial evidence to barrels inexplicably falling from warehouses.[380]

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369. *Id.*

370. Griffen v. Manice, 59 N.E. 925, 927 (N.Y. 1901).

371. Prosser, *supra* note 367, at 184 (internal quotation marks omitted).

372. *See* David Kaye, *Probability Theory Meets Res Ipsa Loquitur*, 77 MICH. L. REV. 1456, 1458 (1979) (noting that the phrase "appears to have been introduced into the law of torts by Chief Baron Pollock" in *Byrne v. Boadle*).

373. *See* Byrne v. Boadle, 159 Eng. Rep. 299, 299 (UK 1863).

374. *Id.* at 300.

375. *But see, e.g.*, Watson v. Ford Motor Co., 699 S.E.2d 169, 179 (S.C. 2010) (noting that South Carolina does not recognize the rule of res ipsa).

376. RESTATEMENT (THIRD) OF TORTS: PRODUCTS LIABILITY § 3 (AM. LAW INST. 1998).

377. *See supra* Section III.A.2.

378. *See, e.g.*, Wyatt v. Pac. Elec. Ry. Co., 103 P. 892, 174 (Cal. 1909).

379. *See, e.g.*, Bush v. Barnett, 31 P. 2, 3 (Cal. 1892); Boyce v. Cal. Stage Co., 25 Cal. 460, 468 (1864); Fairchild v. Cal. Stage Co., 13 Cal. 599, 604 (1859).

380. *See* Prosser, *supra* note 367, at 196 & n.76 (listing res ipsa cases involving a "parked car which starts down a hill").

Of course, res ispa is hardly limited to accidents involving nineteenth and twentieth century technologies. As section II.A's discussion of *In re Toyota* reveals, the negligence rule has also shown great promise in cases involving modern automated products.[381] But the "sudden acceleration" case against Toyota, as we also saw, is just one exemplar. Analogous theories have been advanced against other automakers.[382] Beyond these automotive cases, res ipsa is also commonly invoked in other contexts. It has been advanced in suits involving commercial or military airplanes,[383] passenger trains,[384] elevators,[385] surgical robots,[386] and even "escaped" assembly line bots.[387]

Though the circumstances giving rise to these accidents vary widely, each exhibits a common theme. Where a line-by-line analysis of the software underneath a machine's proverbial hood would prove impossible or infeasible, the regime has demonstrated an elegant ability to nevertheless prove fault. So long as there is a reasonable and logical inference that the defendant's negligence or design defect caused an injury, the mere description of the event can serve as sufficient evidence of the defendant's causal negligence.[388] Indeed, as the next section will show, res ipsa analysis has even demonstrated its usefulness in contemporary accidents involving automated vehicles.

B. A SOLUTION HIDING IN PLAIN SIGHT

As discussed in Part III, the prevailing wisdom now treats the inherently "confounding" nature of fault-finding in automated accidents as axiomatic. Yet, not only do these claims overlook the viability of inference-based analysis (as we saw in Part III), they also overlook the contemporary evidence. Though scarcely acknowledged in the literature, the world has actually witnessed scores of vehicular accidents involving closed-loop robots.[389] Rather than confounding the

381. *See supra* Section II.A.

382. *See, e.g.*, Buck v. Ford Motor Co., 526 F. App'x 603, 605 (6th Cir. 2013) (using res ipsa doctrine in claim involving sudden acceleration).

383. *See, e.g.*, Stoddard v. Ling-Temco-Vought, Inc., 513 F. Supp. 314, 321 (C.D. Cal. 1980) (applying res ipsa to structural and electronic modification of military airplane); Nelson v. Am. Airlines, Inc., 70 Cal. Rptr. 33, 35–36 (Ct. App. 1968) (applying res ipsa to commercial airplane's autopilot).

384. *See* Steinhauer, *supra* note 270 (describing collision that did not specifically invoke res ipsa but about which it was said: "Obviously two trains are not supposed to be at the same place at the same time.").

385. *See* Barretta v. Otis Elevator Co., 677 A.2d 979, 980 (Conn. App. Ct. 1996) (applying res ipsa to claim involving defective escalator).

386. *See Family Gets $7.5 Million in Death After Spleen Removal*, *supra* note 272 (describing $7.5 million award for res ipsa case involving surgical robotics device).

387. Plaintiff's Brief in Opposition to FANUC America Corporation's Motion to Dismiss Pursuant to Rule 12(b)(6), Holbrook v. Prodomax Automation Ltd., No. 1:17-cv-00219 (W.D. Mich. June 23, 2017), 2017 WL 6553473 (involving a res ipsa case against manufacturer of robot that killed worker).

388. *See, e.g.*, Fowler v. Seaton, 394 P.2d 697, 700 (Cal. 1964) (citing WILLIAM L. PROSSER, HANDBOOK ON THE LAW OF TORTS 204 (2d ed. 1955)).

389. *See Cal. Report of Traffic Collisions Involving an Autonomous Vehicle*, *supra* note 48 (listing more than 120 accidents reported in California, 86 of which involved closed-loop robots).

question of fault, the overwhelming weight of the evidence indicates that the involvement of robots more often simplifies it.[390]

Consider California. Since 2014, state law has mandated that autonomous vehicle manufacturers file public reports in the event of an accident.[391] Consequently, we know that the state witnessed at least 120 accidents involving autonomous vehicles between 2014 and September 2018.[392] Eighty-six of these accidents involved vehicles in "autonomous mode," meaning that the liability loop was effectively closed at the time of the accident.[393] (As section II.A shows, this closing of the loop is true regardless of whether the system was nominally referred to as Level 2, 3, or 4). Taking the literature's claims regarding the vexing complexity of these accidents at face value, we might already expect there to be a considerable amount of litigation stemming from these accidents.[394] But, in actuality, blame and compensation have been successfully allocated in each instance.[395] And, as we saw in section III.A, fault for almost every accident has resided with a human (not robot) driver.[396]

The successful resolution of so many fault determinations, however, leaves a simple question: How could authorities be so confident in their conclusions? After all, none had direct access to the robot's underlying software. Complicating matters further, even if authorities did have access, they would still have to overcome the notion that relevant software is likely an algorithmic "black box."[397] The answer to this puzzle lies in the telematics technologies on board modern robots. Thanks to a host of advanced data-logging systems embedded in the automated vehicles—usually lumped together under the catchall EDR—investigators tasked with reconstructing accidents are actually able to recreate detailed, moment-by-moment accounts of accidents.[398]

EDR technologies are not novel to modern accident analysis,[399] but when used in conjunction with modern robotics applications, they offer investigators unique

390. *See id.* (allocating fault in every accident).

391. *Testing of Autonomous Vehicles with a Driver*, STATE OF CAL. DMV, https://www.dmv.ca.gov/portal/dmv/detail/vr/autonomous/testing [https://perma.cc/5CL2-EDAW] ("Under the testing regulations, manufacturers are required to provide DMV with a Report of Traffic Collision Involving an Autonomous Vehicle . . . ."); *see also* CAL. CODE REGS. tit. 13, § 227.48 (2014) (requiring manufacturers authorized to test autonomous vehicles on public roads to submit reports summarizing the circumstances surrounding any collision "result[ing] in the damage of property or in bodily injury or death").

392. *See Cal. Report of Traffic Collisions Involving an Autonomous Vehicle*, *supra* note 48.

393. *See id.*

394. *See supra* note 42. This is likely the case, particularly given that potential plaintiffs were deemed to be at fault in the overwhelming majority of accidents, as Part III showed.

395. *See* Kokalitcheva, *supra* note 279 (describing these successful allocations of fault).

396. *See id.* (noting that "[h]umans continue to be the cause of most accidents").

397. *See* Selbst & Barocas, *supra* note 241, at 1089–90 (describing the "opaque" nature of algorithms, which can be "black boxes").

398. *See* Kristen Hall-Geisler, *The Importance of Black Boxes in an Autonomous Automotive Future*, TECH CRUNCH (May 13, 2016, 6:08 PM), https://techcrunch.com/2016/05/13/the-importance-of-black-boxes-in-an-autonomous-automotive-future/ [https://perma.cc/497U-DV2B] (describing the rise of EDRs).

399. *See* Jaclyn Trop, *A Black Box for Car Crashes*, N.Y. TIMES (July 21, 2013), https://www.nytimes.com/2013/07/22/business/black-boxes-in-cars-a-question-of-privacy.html (describing narrow

insights into the kinds of inference-based fault determinations typical of res ipsa claims. The key difference between the EDRs found in conventional vehicles and those found in robots is technical in nature. To navigate the world autonomously, robots must first sense their surrounding environments.[400] As a natural byproduct, they collect richly detailed, multisensory records of the events leading up to accidents.[401] Consequently, authorities can simply examine the evidence captured by the vehicle's componentry, navigational technologies, and multisensory camera, LIDAR, ultrasonic, and radar sensors—without necessarily having to resort to the fact-finding powers of juries, extensive discovery efforts, unreliable witness testimonies, or fraught battles of experts.[402] Based on these detailed re-creations, authorities have thus far used inference-based evidence to assign accident fault with a degree of precision simply unimaginable in conventional contexts.[403] Authorities do not need to comb through millions of lines of source code in search of direct evidence. Instead, it's as easy as letting the robot's account of the accident speak for itself.[404]

To be clear, no fault assignments involving automated vehicles have yet occurred under the formal auspices of res ipsa. As we saw in section IV.A, however, it's not necessary to throw around Latinisms to invoke inferential evidence. Without displaying a "learned tongue,"[405] authorities ranging from federal agencies to local police have, nonetheless, relied on accident reconstructions to resolve what might have otherwise been "confounding" algorithmic roadblocks.[406] Instead of scouring the vehicles' software in search of direct evidence of faulty code, they simply looked for evidence of fault in the events leading up to the accident.[407] Where the relevant evidence spoke of human negligence, robot fault was presumptively absent.[408]

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uses of telematics technologies to determine braking and positioning of vehicles involved in conventional accidents).

400. *See* Hall-Geisler, *supra* note 398 (describing how the proliferation of sensing technologies vastly increases the capabilities of EDRs). For illustrations of these sensing technologies in action, see *infra* Appendix A.

401. *See* Hall-Geisler, *supra* note 398; *infra* Appendix A.

402. *See* Metz, *supra* note 52 (describing these sensing capabilities); *see also infra* Appendix A (illustrating the descriptive capabilities of these data).

403. *See* Kokalitcheva, *supra* note 279.

404. Note that manufacturers will have every reason to keep assiduous records, given that the current evidence suggests the vast majority of recordings will prove exculpatory.

405. Prosser, *supra* note 367, at 183 (using this phrase to refer to the Latin language).

406. *See* Hall-Geisler, *supra* note 398; Kokalitcheva, *supra* note 279 (describing many successful fault determinations in California alone).

407. *See* Hall-Geisler, *supra* note 398.

408. *Cf. Cal. Report of Traffic Collisions Involving an Autonomous Vehicle*, *supra* note 48 (finding that, according to the most recent reports, fault resided with the closed-loop system in two of the eighty-six accidents); *see, e.g.*, CAL. DEP'T OF MOTOR VEHICLES, REPORT OF TRAFFIC COLLISION INVOLVING AN AUTONOMOUS VEHICLE: ZOOX OCTOBER 12, 2019, *supra* note 286 (finding that fault lay with a human driver who rear-ended a vehicle in fully-automated mode that was moving forward cautiously at a stop sign); CAL. DEP'T OF MOTOR VEHICLES, REPORT OF TRAFFIC COLLISION INVOLVING AN AUTONOMOUS VEHICLE: GM CRUISE MAY 2, 2019, *supra* note 286 (finding fault lay with a human driver who rear-ended a vehicle in fully-automated mode that was waiting at a stoplight).

Conversely, where the evidence did not speak of human negligence, the presumption of fault shifted to the robot.

Though the world has now witnessed scores of these accidents ranging from the deadly, to the mundane, to the utterly strange,[409] each has displayed this unique ability to turn the "vexing" tort inquiry dreaded by many scholars on its head. This may seem somewhat counterintuitive given that modern robots are routinely described as utterly inscrutable algorithmic "black boxes."[410] If we liken the opacity of the software running on autonomous vehicles to the opacity of the warehouse in the canonical case of *Byrne v. Boadle*,[411] however, the applicability of inference-based analysis becomes immediately apparent. Just as is true in human-driven accidents, investigators do not need to locate direct evidence of fault in the source code running on the robot's proverbial "brain."[412] Instead, they can look to the events surrounding the accident to infer whether the robot's code was faulty or not. Indeed, it seems a solution to the "vexing" tort challenges of automated accidents may have been hiding in plain sight all along. A "revolutionary" new liability regime is not required,[413] because robot ipsa loquitur—the robot speaks for itself.

C. LETTING ROBOTS SPEAK FOR THEMSELVES

Above, we saw that inference-based[414] analysis provides a potent tool for establishing fault in complex machine-driven accidents, and informal versions of a liability rule we might call robot ipsa loquitur (robot ipsa) have already proven effective in scores of automated accidents. But, merely demonstrating the utility of the rule is no guarantee of its adoption; advancing robot ipsa as a formal legal theory will require addressing doctrinal concerns surrounding its scope, implementation, and policy implications.

The following sections explore these concerns in a level of detail that may seem surprising given the nascent state of emerging robotics technologies. As we saw in Part III, however, much of the discussion surrounding liability for automated accidents has occurred at a theoretical level, with less attention paid to hard-nosed technical, doctrinal, or policy details than may have been optimal. To drive the discussion forward, it is necessary to go beyond theory. Contemporary evidence, high-stakes policy tradeoffs, and possible doctrinal pitfalls must be identified and analyzed. The following sections explore these concerns, detailing: (1) the practical applications of robot ipsa in automated accidents, (2) the existing legal ambiguities surrounding robot responsibility, (3) the limits of human behavior as a legal metaphor, and (4) the policy implications of adopting negligence regimes in comparison to the alternative regimes proposed thus far.

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409. People, for example, have hit and climbed on top of vehicles. *See* Kokalitcheva, *supra* note 279 (noting several such attacks).

410. *See, e.g.*, Selbst & Barocas, *supra* note 241 (surveying these descriptions).

411. 159 Eng. Rep. 299 (UK 1863).

412. *See supra* Section III.A.

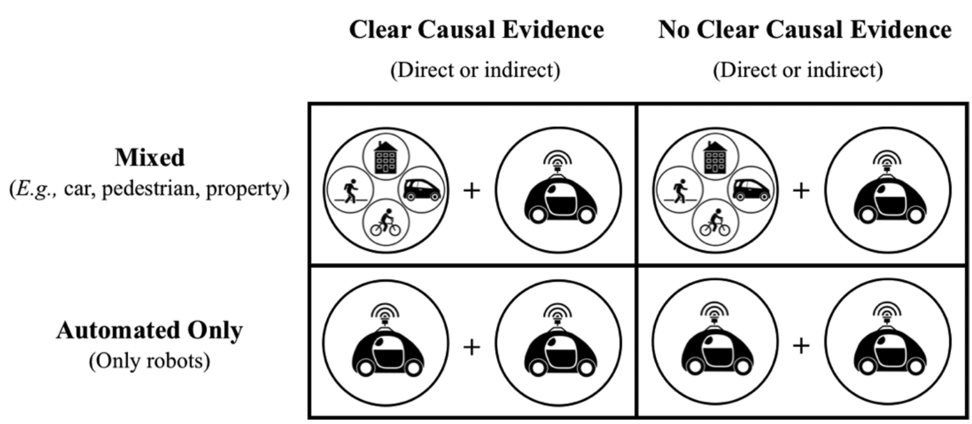
413. *See supra* Section II.B and Part III.

414. In accidents with direct evidence of human negligence, the "inference" referred to here involves the robot's presumptive lack of negligence or defectiveness.

1. Artificial Negligence

As a first step toward formalizing robot ipsa, it's prudent to map out the universe of possible automated accidents, as well as res ipsa's doctrinal relevance to each. Closed-loop robots involved in accidents give rise to four distinct scenarios. At the outset, they introduce the possibility of two accident types: (1) "mixed accidents" between robot actors and non-robot actors (such as pedestrians, cyclists, property) and (2) accidents that exclusively involve robot actors. Then, beyond these two core accident scenarios, we can anticipate a further bifurcation, with the relevant circumstances of the accident either: (3) providing clear causal evidence[415] or (4) not providing this evidence.

As we saw in Part III, many scholars now fear that "[o]ur traditional negligence system, designed for the Model T and premised on personal responsibility, will fit



this new world awkwardly."[416] But walking through how robot ipsa would actually play out in each instance helps to shrink these fears down to size.

To start, as section IV.B demonstrated, conventional analysis is already well-equipped to handle automated accidents exhibiting clear evidence of negligence or a design defect (the entire left-hand side of the taxonomy above). Embedded data-logging technologies will provide moment-by-moment records of accidents. And if the law likens the opaque algorithms found in robots to the warehouse found in *Byrne v. Boadle*,[417] then these detailed logs should shed considerable light on the question of fault—whether it ultimately comes in the form of direct

415. As the taxonomy shows, this could also include direct evidence or evidence of negligence per se. Then the notion of "inference" would shift to the lack of negligence (or defectiveness) on behalf of the parties exhibiting no evidence.

416. Engstrom, *supra* note 24, at 297. *See supra* Part III.

417. Byrne v. Boadle, 159 Eng. Rep. 299 (UK 1863).

evidence, indirect evidence, or evidence of negligence per se.[418] What's more, all signs suggest these records will only increase in granularity over time, with advances in sensory system capabilities, robot-to-robot communications, and other "smart" technologies likely allowing investigators to consult the perspectives of multiple machine accounts simultaneously.[419]

Once a machine-driven accident reconstruction is complete, current trends suggest that the ensuing analysis should be straightforward. The inquiry will begin (and often end) by looking at direct evidence of negligence on behalf of any non-robot actor. Where this evidence does not exist, its absence will give rise to the inference that the robot's causal role in the accident "was of a kind that ordinarily occurs as a result of product defect" or negligence.[420] Here, more than a century of tort and insurance precedent will help guide these investigative conclusions, even for automated accidents that require complex inquiries into component failures, industry standards, maintenance issues, insurance allocations, comparative negligence, or joint- and several-liability.[421] Moreover, as incremental advances in safety technologies enter into automated fleets over time, they will introduce new considerations that help to inform and update contemporary assessments—just as occurs today.[422]

Having thus dispatched with what the current evidence indicates will be the overwhelming majority of accidents using robot ipsa, what remains is the right-hand side of our taxonomy. That is, the category of accidents without a clear causal inference. Here, traditional res ipsa again appears to be up to the task. For the rule is not only useful in accidents where plaintiffs lack strong causal evidence. As we saw in section IV.A, it is also useful where the cause of an accident is an outright "mystery."[423] In these instances, res ipsa transforms from a mere liability rule to an information-forcing one.[424] When non-robot actors (for example, conventional drivers, cyclists, pedestrians, or even property) are harmed by a closed-loop robot, and there is no evidence that the plaintiff's own negligence was solely responsible, res ipsa will allow plaintiffs to make a prima facie case

418. *See supra* Section IV.B.

419. *See, e.g.*, Notice of Proposed Rulemaking: Fact Sheet on Vehicle-to-Vehicle Communication Technology, NAT'L HIGHWAY TRAFFIC SAFETY ADMIN. (2016), https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/v2v_fact_sheet_101414_v2a.pdf [https://perma.cc/AZ8N-JTHX]; John R. Quain, *Cars Will Talk to One Another. Exactly How Is Less Certain.*, N.Y. TIMES (Mar. 9, 2017), https://www.nytimes.com/2017/03/09/business/cars-v2v-dsrc-communication.html. For a seminal work discussing the new role of machine evidence in modern law, see generally Andrea Roth, *Machine Testimony*, 126 YALE L.J. 1972 (2017).

420. RESTATEMENT (THIRD) OF TORTS: PRODUCTS LIABILITY § 3(a) (AM. LAW INST. 1998).

421. *See* Abraham & Rabin, *supra* note 24, at 142 (noting the complex "issues that arise out of such situations have been addressed and resolved—albeit not in a single voice").

422. *See* Daniel J. Fagnant & Kara Kockelman, *Preparing a Nation for Autonomous Vehicles: Opportunities, Barriers and Policy Recommendations*, 77 TRANSP. RES. PART A 167, 177 (2015) (noting that new technologies "such as parking assist and adaptive cruise control[] will likely provide initial test cases that will guide how fully autonomous technologies will be held liable").

423. *See* Fowler v. Seaton, 394 P.2d 697, 700 (Cal. 1964) (noting that "[r]es ipsa loquitur may apply where the cause of the injury is a mystery").

424. *See id.*

against manufacturers. Having done so, manufacturers will then have an opportunity to produce exculpatory evidence rebuffing the inference. When they cannot, juries can simply let the liability burden fall upon these sophisticated, well-resourced parties—the parties almost certainly best placed to handle that burden. And that outcome, in turn, means robot ipsa is amply capable of handling the first of the two scenarios in the right-hand column of the taxonomy.[425]

Finally, with three out of the four conceivable scenarios dispatched using conventional analysis, we are left with one remaining: those accidents between two or more robots *with no clear causal inference of fault by any party*. It is not at all apparent what this scenario would look like. If, for example, an automated vehicle hits another one that's stopped at a light, or collides with one while trying to change lanes, conventional causal inference would almost certainly prove up to the task. Notably, none of the scholars who have expressed fears of this kind of scenario actually offer a concrete example of what one would look like in practice.

Setting aside this lack of clarity, what *is* clear is that any such scenario would likely represent a rarified category of accidents—even in a world where millions of robots dominated. Though the category represents a full fourth of our taxonomy, the size of the fraction should not be mistaken as implying a commensurate number of crashes. To fall into the quadrant, an automated accident with two EDRs running during the time of the event would nonetheless have to escape analysis under existing licensing and maintenance standards, traffic and legal codes, manufacturing regulations, organization standards, industry best practices, and tort and insurance conventions, among other considerations.[426] Having defied all odds to get there, the circumstances giving rise to it would almost certainly raise the kinds of thorny questions of fault, foreseeability, and causality that have worried many scholars.[427]

Although this small (perhaps infinitesimally small) subset of accidents will certainly pose its share of challenges for conventional tort law, those challenges are not actually the same as those typically raised by scholars advocating for new liability regimes. First, as section III.A demonstrated, the burden of litigating these types of "vexing" events wouldn't actually fall on hapless accident victims despite what numerous scholars have suggested. Rather, victims injured in automated vehicles will operate in the orbit of insurance liability, just as taxi and ride-sharing customers do today.[428] Second, this shift away from individual insurance

425. In the majority of states, res ipsa provides for a permissible inference of negligence against the defendant. *See* KENNETH S. ABRAHAM, THE FORMS AND FUNCTIONS OF TORT LAW 108–11 (Thomson Reuters/Foundation Press 4th ed. 2012) (describing varying applications). But in a few states, the rule actually creates a rebuttable presumption. *See id.* As the number of automated accidents grows with time, promoting consistency on this front may become more economically and socially salient from the dual perspectives of administrative and commercial costs.

426. *See supra* Section III.A.

427. *See supra* Part III.

428. *See supra* Section III.A.

policies and toward fleetwide insurance models[429] will, in turn, mean that the burden of litigating this rare category of accident will fall on the parties best situated to handle that burden. If, for instance, manufacturers want to spend resources hashing out esoteric, algorithm-based design differences by holding other manufactures jointly, severally, or comparatively liable for accidents, it will be their prerogative to do so—free of any concerns that this kind of undertaking might adversely affect individual victims. Even here, this type of outcome is unlikely. Indeed, as in the vehicle component manufacturing industry and the car insurance industry,[430] the inefficiencies of pursuing formal legal actions against other manufacturers will likely drive certain industry sectors to devise parallel systems to allocate liability and compensation more efficiently.

2. Artificial Operators

Having explored the practical applications of robot ipsa as it would apply to each conceivable automated accident scenario, we can now address some of the more granular doctrinal concerns the approach might raise. To start, robot ipsa, like any other negligence or design defect theory, will require that plaintiffs identify someone (or something) as a defendant. As William Prosser notes, "It is never enough for the plaintiff to prove merely that he has been injured by the negligence of someone unidentified."[431] Rather, even when "the facts cry loudly of someone's negligence, it is still the plaintiff's task to fix that negligence upon the defendant."[432]

It is commonly said that plaintiffs must show that an "instrumentality" which caused an accident was under the defendant's "exclusive control."[433] But, as Prosser observed long ago, this description "is misleading and pernicious."[434] There are, after all, "a great many situations in which the defendant's responsibility is apparent even though the 'instrumentality' is in the control of another."[435] A driver operating a car may be in control of it. But, if the axle suddenly breaks, "the conclusion is that only the defendant who supplied the [car] was negligent."[436] A better articulation comes from the Second Restatement, which asks whether intervention by outside parties (parties other than the defendant) has

429. For a detailed description of why this is a durable trend that will not revert back to the individual coercive insurance model, see generally JERRY ALBRIGHT ET AL., KPMG, THE CHAOTIC MIDDLE: THE AUTONOMOUS VEHICLE AND DISRUPTION IN AUTOMOBILE INSURANCE (2017), https://institutes.kpmg.us/content/dam/institutes/en/manufacturing/pdfs/2017/chaotic-middle-autonomous-vehicle-paper.pdf [https://perma.cc/U5Y8-8C5F].

430. *See generally* ROSS, *supra* note 250 (describing the motivations of insurance companies to negotiate and settle claims between providers).

431. *See* Prosser, *supra* note 367, at 196.

432. *Id*. at 197.

433. *See, e.g*., Calo, *supra* note 24, at 543 (noting that "for a plaintiff successfully to invoke res ipsa, she must show that the defendant had 'exclusive control' over the instrumentality of her injury").

434. *See* Prosser, *supra* note 367, at 199.

435. *Id*.

436. *Id*. at 200.

been "sufficiently eliminated by the evidence."[437]

Nowadays, producing this kind of evidence for human-driven accidents is, in most cases, a formality.[438] Conventional analysis presumes that responsibility lies with the "driver," "operator," or, in some circumstances, "owner" of a vehicle.[439] As Part II showed, closing the loop on these driving, operating, or ownership tasks will shift the nexus of legal responsibility to robot manufacturers. But, although there's little controversy surrounding this shift in theory, ensuring that it occurs in practice is actually less straightforward. Many state and federal laws, for example, have codified an explicit notion of human control over vehicles by defining vehicle "drivers" and "operators" as flesh and blood.[440] Others simply leave the definition ambiguous, having been "written decades ago [by] authors [who] likely never considered the possibility that a car might not have a human driver at all."[441] In 2015, Google's automated vehicle outfit sought clarification on precisely this issue in a letter to the NHTSA.[442] As Jerry Mashaw and David Harfst note, "many [NHTSA] standards require that a vehicle device or basic feature be located near 'the driver' or 'the driver's seating position.'"[443] Google, meanwhile, was set on developing a vehicle "entirely controlled by artificial intelligence . . . such that no driver was needed, or indeed, wanted."[444] Accordingly, Google requested clarification regarding the ambiguity, asking that the agency consider its vehicle a driver for purposes of regulation.

NHTSA's answer to this seemingly straightforward request offered cause for both optimism and pessimism. The agency acknowledged the internal logic of Google's position, but nonetheless lamented: "'[I]t can take substantial periods of time to develop rulemaking proposals and final rules,' and that such proceedings are 'ill-suited as first-line regulatory mechanisms to address rapidly-evolving vehicle technologies.'"[445] As such, the agency recommended that Google instead

437. RESTATEMENT (SECOND) OF TORTS § 328D(1)(b) (AM. LAW INST. 1965); *see supra* note 420. As is often true of tort law, "the evidence need not be conclusive, but should eliminate intervening causes with a greater than 50 percent likelihood." Villiers, *supra* note 366, at 13.

438. *See infra* notes 439–44 and accompanying text.

439. *See* JAMES M. ANDERSON ET AL., AUTONOMOUS VEHICLE TECHNOLOGY: A GUIDE FOR POLICYMAKERS 115 (2014) (stating that, at the present time, "we commonly speak of crashes as being caused by one or more at-fault drivers" (emphasis omitted)).

440. *See infra* notes 443–45 and accompanying text.

441. Timothy B. Lee, *Congress Debates Allowing Tens of Thousands of Cars with No Steering Wheel*, ARS TECHNICA (Mar. 16, 2018, 10:15 AM), https://arstechnica.com/cars/2018/03/congress-debates-allowing-tens-of-thousands-of-cars-with-no-steering-wheel/ [https://perma.cc/8QRF-QGTE].

442. Mashaw & Harfst, *supra* note 30, at 268 (citing Letter from Paul A. Hemmersbaugh, Chief Counsel, Nat'l Highway Traffic Safety Admin., to Chris Urmson, Dir., Self-Driving Car Project, Google, Inc. (Feb. 4, 2016), https://isearch.nhtsa.gov/files/Google%20–%20compiled%20response%20to%2012%20Nov%20%2015%20interp%20request%20–%204%20Feb%2016%20final.htm [https://perma.cc/5JUH-YMMQ]).

443. *Id.*

444. *Id.*

445. *Id.* at 268–69 (citing Letter from Paul A. Hemmersbaugh, Chief Counsel, Nat'l Highway Traffic Safety Admin., to Chris Urmson, Dir., Self-Driving Car Project, Google, Inc. (Feb. 4, 2016), https://isearch.nhtsa.gov/files/Google%20–%20compiled%20response%20to%2012%20Nov%20%2015%20interp%20request%20–%204%20Feb%2016%20final.htm [https://perma.cc/5JUH-YMMQ]).

petition for an outright exemption from the federal regulatory requirements so that the company could continue to advance its AV technology apace.[446]

Thankfully, now that this potential legal roadblock has been identified, a massive typological overhaul is underway across the nation to redress it.[447] Numerous states have clarified that machine operators needn't necessarily be flesh and blood.[448] But those who believe that this transition will occur absent explicit legal clarification need only look to the legal literature circa 1900. The replacement of the horse and buggy by automobiles raised similar typological challenges regarding "drivers," "operators," or "owners" of carriages.[449] And precisely how the legal system would resolve those ambiguities was far from obvious then, despite how clear the outcome may seem in hindsight. Plaintiffs advancing robot ipsa theories should therefore be sensitive to this doctrinal ambiguity.

3. Artificial Analogies

Although analogizing between people and robots is appropriate in some contexts, it is not necessarily appropriate in *all* contexts. Accordingly, plaintiffs advancing robot ipsa claims must also be cautious of drawing direct analogies between robot drivers and human drivers. Here, a fatal accident involving an automated vehicle deployed by Uber provides a tragic, albeit vitally important, example. In February 2018, a vehicle owned by the tech giant struck and killed Elaine Herzberg.[450] The accident occurred at night, after the vehicle's sensory system failed to detect her crossing a three-lane street. In an unusual turn of events, Uber immediately released dashcam footage of the accident.[451] And with this footage in hand, authorities effectively exonerated the tech company.[452] Despite its low quality, the video showed Herzberg stepping suddenly into the well-lit roadway from the shadowy median.[453] From this footage, the police chief determined that fault for the accident lay not with Uber, but with Herzberg.[454] In the chief's telling, Herzberg "came from the shadows right into the roadway,"[455]

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446. *See id.* at 269.

447. *See id.* at 267–71 (describing the overhaul).

448. *See, e.g.*, Mark A. Lemley & Bryan Casey, *You Might Be a Robot*, 105 CORNELL L. REV. (forthcoming 2020) (manuscript at 35), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3327602 [https://perma.cc/8KC5-5QEN] (discussing efforts by California and Nevada to address these legal ambiguities).

449. *See generally* Huddy, *supra* note 243 (describing these typological problems).

450. *See* Timothy B. Lee, *Police Chief Said Uber Victim "Came from the Shadows"—Don't Believe It*, ARS TECHNICA (Mar. 23, 2018, 9:06 AM), https://arstechnica.com/cars/2018/03/police-chief-said-uber-victim-came-from-the-shadows-dont-believe-it/ [https://perma.cc/S8LC-RMVL].

451. *See id.*

452. *See id.*

453. *See id.*

454. *See id.* ("Herzberg 'came from the shadows right into the roadway,' Tempe police chief Sylvia Moir [said].").

455. *See id.* (internal quotation marks omitted).

and in her estimation, no human could have reacted in time.[456]

Unfortunately, the chief's determination failed to account for the combination of sensory inputs—including LIDAR, ultrasonic, and radar systems that do not all rely on the visible light spectrum—which Uber uses to navigate its autonomous vehicles.[457] With no physical occlusions in their way, these sensory systems are capable of spotting objects even in pitch black[458]—a feat that human perception is simply incapable of rivaling. In light of this fact, the police chief's analogy to human driving behavior was inapposite. Herzberg's seeming emergence "from the shadows" was no excuse.[459] Rather, the vehicle's sensory system experienced a catastrophic error and did not detect that Herzberg was a pedestrian. Fortunately, investigators quickly realized the error in their analogy, eventually pointing the finger of blame squarely at Uber.[460]

But the incident nonetheless provides a cautionary tale; for some robot behaviors, direct comparisons to human behavior simply do not make sense. Indeed, on occasions like this one, the standards we apply to robots may need to be different than those that would apply to humans.[461] Practitioners, courts, legislators, and regulators considering the application of robot ipsa must therefore be careful to ensure that the inferences we ascribe to robots correspond to their actual capabilities, and not simply to those of humans.

4. Artificial Solutions

Having explored the more granular doctrinal concerns of robot ipsa, we can now zoom out to the broader implications of its adoption. As a policy matter, the choice of which liability regime should govern an emerging technology or sector is never one that should be made lightly. When it comes to robots, this truism is especially important. As we saw above, vast markets and immense numbers of lives hang in the balance.[462] Against this backdrop, the advantages of robot ipsa appear to be at least threefold. The approach: (1) offers superior incentives for promoting social welfare, (2) better generalizes to diverse industries and contexts than proposals currently offered, and (3) provides a pragmatic solution that neither requires "dramatic and unsettling"[463] legal changes, nor precludes industries

456. *See* Carolyn Said, *Exclusive: Tempe Police Chief Says Early Probe Shows No Fault by Uber*, S. F. CHRONICLE (Mar. 26, 2018, 8:56 AM), https://www.sfchronicle.com/business/article/Exclusive-Tempe-police-chief-says-early-probe-12765481.php [https://perma.cc/GMN6-BX2X].

457. For an illustration of these systems, see *infra* Appendix A.

458. *See* Lee, *supra* note 450.

459. *See id.*

460. *See* Timothy B. Lee, *NTSB: Uber's Sensors Worked; Its Software Utterly Failed in Fatal Crash*, ARS TECHNICA (May 24, 2018, 11:10 AM), https://arstechnica.com/cars/2018/05/emergency-brakes-were-disabled-by-ubers-self-driving-software-ntsb-says/ [https://perma.cc/P86D-SSKZ] (describing NTSB's characterization of the event as a failure on the part of Uber's software).

461. In this instance, assuming that robots rely on lighting conditions to navigate in the same way that humans do is simply inaccurate.

462. *See supra* notes 30–32 and accompanying text.

463. *See* Abraham & Rabin, *supra* note 24, at 171.

from devising parallel allocative systems that promote fairness and efficiency among manufacturers.

First, the available evidence indicates that robot ipsa would better promote the tort system's fundamental goals of "inducing firms to improve product safety, causing prices of products to reflect their risks, and providing compensation to injured consumers."[464] As we saw above, human negligence has caused the vast majority of accidents involving automated vehicles so far. Yet, under stricter liability regimes, the costs of these accidents would shift to manufacturers in the event of an accident between conventional and automated vehicles. When, for instance, a human driver runs a red light, swerves across three lanes of traffic, and then collides with a closed-loop automated vehicle—an event that recently occurred in Arizona[465]—the law would automatically impose the costs on the automated vehicle manufacturers. Accidents like these occurring on a large enough scale could place an enormous commercial burden on manufacturers, and would require them to raise the price of their (potentially safer) services for downstream consumers,[466] allow unsafe drivers to externalize the costs of behavior we currently consider negligent,[467] and potentially disincentivize additional spending on safety.[468] As Mark Lemley and I recently discussed:

> Without the addition of a contributory negligence defense (which functions a lot like plain old B<PL from a fault perspective), innovators would end up disproportionately bearing costs, human drivers wouldn't be priced off the roads as quickly as they should, and companies would also be apt to spend less on safety from a competitive perspective, since no amount of investment could get them off the liability hook when people, themselves, created the hazards.[469]

Meanwhile, safe harbor liability would produce a different, albeit similarly troubling, set of incentives (as discussed in section III.B).

Second, robot ipsa provides a more generalizable solution than the ones currently offered. Proposals by Abraham, Rabin, and Geistfeld, for example, seek to address the vexing tort problems posed by automated vehicles using legal mechanisms applicable only to the automotive sector.[470] But, as we saw above, the same

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464. *See* A. Mitchell Polinsky & Steven Shavell, *The Uneasy Case for Product Liability*, 123 HARV. L. REV. 1437, 1440 (2010).

465. *See* Bree Burkitt, *Police: Driver Cited for Running Red Light in Chandler Crash with Waymo Self-Driving Van*, AZ CENTRAL (May 5, 2018, 2:10 PM), https://www.azcentral.com/story/news/local/chandler-breaking/2018/05/05/driver-cited-crash-waymo-self-driving-van/583815002/.

466. *See generally* Richard Craswell, *Passing on the Costs of Legal Rules: Efficiency and Distribution in Buyer-Seller Relationships*, 43 STAN. L. REV. 361 (1991) (describing how redistributing costs through liability can be undone through price increases by manufacturers).

467. *See* Louis Kaplow & Steven Shavell, *Economic Analysis of Law*, in 3 HANDBOOK OF PUBLIC ECONOMICS 1661, 1667–82 (Alan J. Auerbach & Martin Feldstein eds., 2002) (describing incentives in determining liability for accidents).

468. *See id.*

469. Lemley & Casey, *supra* note 21, at 1383.

470. Abraham and Rabin, for example, propose a liability regime that would apply exclusively to automated vehicles and not to automated systems broadly. *See generally* Abraham & Rabin, *supra* note

vexingly complex technological constituents in autonomous vehicles are rapidly entering a wide variety of aerial, naval, and ground-based robots that will also get into accidents. Given this reality, regimes tailor-made for vehicles will offer only a superficial solution to the deeper doctrinal problems likely to arise down the road. Thanks to robot ipsa's ability to elegantly resolve these challenges using mechanisms relevant to *all* emerging robotics technologies, the approach would be capable of spanning diverse industries and contexts.

Finally, unlike many of the regimes surveyed in Part III, robot ipsa does not require massive legislative overhauls, reliance on federal preemption, large-scale regulatory revamps, or ahistorical breaks with centuries of legal precedent. Rather, it offers a simple, uncontroversial, and pragmatic solution that is grounded in existing doctrine. Even more promising, if manufacturers, industries, regulators, or insurers do ultimately decide to devise their own parallel regimes for allocating liability costs, robot ipsa will not stand in their way. Indeed, all signs suggest that industry-wide movements in this direction are already underway—with insurance liability likely to shift away from individual, coercive models toward, for example, fleetwide models that companies build into their pricing structure, for instance. Not only would robot ipsa allow this trend to continue, it would also do so without jeopardizing the interests of accident victims or imposing additional costs on deployments of life-saving—potentially world-changing—technologies.

CONCLUSION

Those who argue that emerging robotics applications will pose vexing tort problems for conventional analysis are wrong. Closed-loop robots capable of driving, flying, and sailing themselves will, no doubt, present numerous social, economic, and legal challenges. But, as this Article has demonstrated, accidents involving these technologies will neither necessitate a wholesale "break with the tort system" nor a sharp doctrinal turn toward "strict products liability."[471] The legal system has successfully dealt with complex, software-driven accidents many times before using age-old approaches. And, thanks to the sophisticated data recording technologies embedded in modern robots, these longstanding liability regimes offer an especially elegant solution to the purportedly "confounding" challenges raised by automated accidents.[472]

If this Article's assessment is accepted, it implies that serious consideration should be given to theories that rely on inference-based analysis for assigning negligence or design defect liability in automated accidents—an approach it calls robot ipsa loquitur. Of course, decades from now, the stark policy differences between these age-old liability regimes and other proposed alternatives may become less consequential. Robots might, for example, become so safe as to

24 (setting forth this proposal). Similarly, Geistfeld's proposal relies on "aggregate driving data" that, again, is only applicable to automakers. *See generally* Geistfeld, *supra* note 24 (same).

471. *See supra* note 44 and accompanying text; *see also supra* Part III.

472. *See supra* Part III.

eliminate the most pressing allocative concerns raised by automatically imposing liability on the manufacturers of life-saving technologies. But, in the meantime, attempting to do away with the "commonsense notion that liability . . . should attach only when harm is reasonably preventable"[473] would be contrary to tort law's fundamental goals and unnecessary to protect the interests of accident victims. A more pragmatic and productive solution would let the robot speak for itself.

473. *See* RESTATEMENT (THIRD) OF TORTS: PRODUCTS LIABILITY § 2 cmt. f (AM. LAW INST. 1998).

APPENDIX A: ILLUSTRATIONS OF ROBOTS SENSING THE WORLD

This Appendix offers illustrations of the sensing and telematics technologies on board emerging robots and includes accident reconstructions produced by NHTSA in the aftermath of Joshua Brown's fatal collision.

Figure 1: Examples of Robot Sensory Inputs
(a) Multisensory Inputs at Intersection[474]

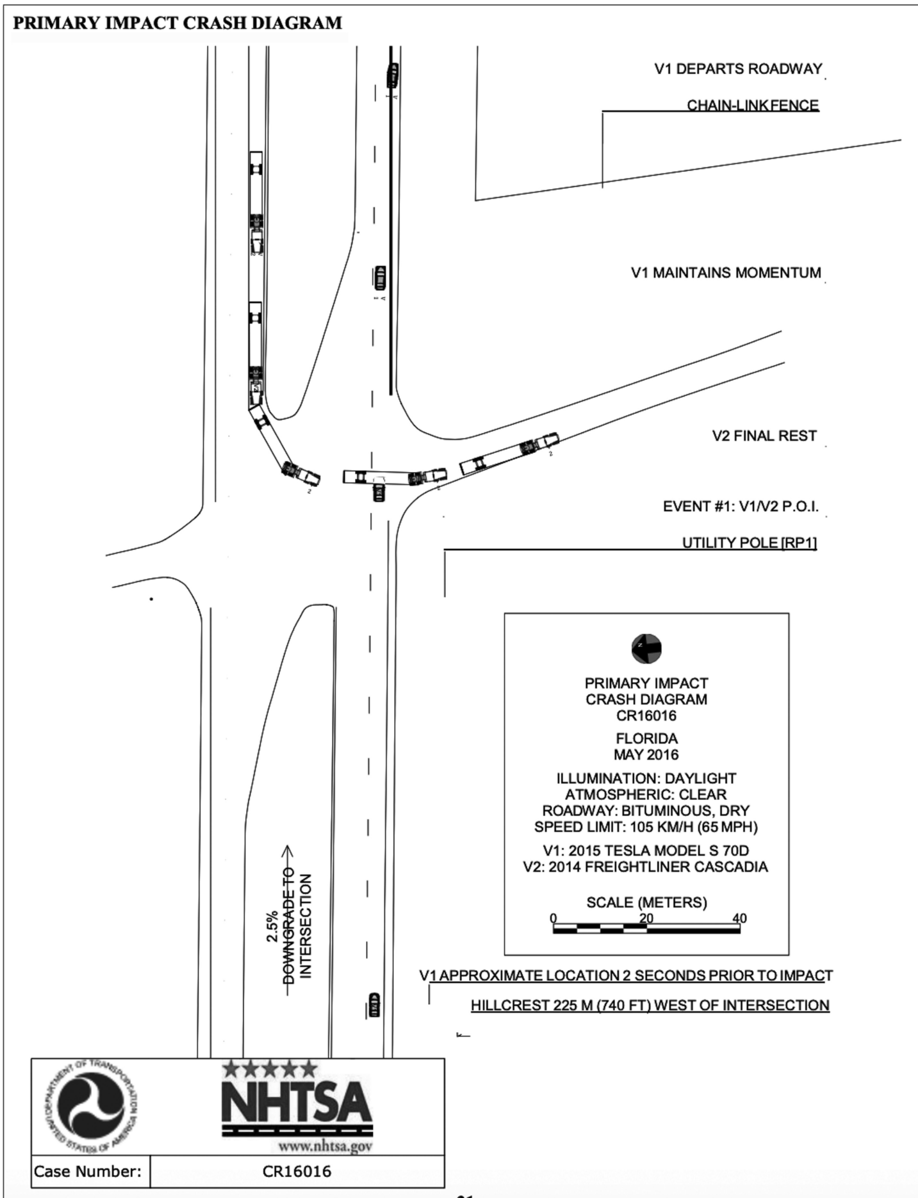
(b) LIDAR Sensing Pedestrians and Bikers[475]

Examples of Robot Sensory Inputs

474. *See* Oliver Cameron, *An Introduction to LIDAR: The Key Self-Driving Car Sensor*, VOYAGE (May 9, 2017), https://news.voyage.auto/an-introduction-to-lidar-the-key-self-driving-car-sensor-a7e405590cff [https://perma.cc/LN9G-NLQW].

475. *Id*.

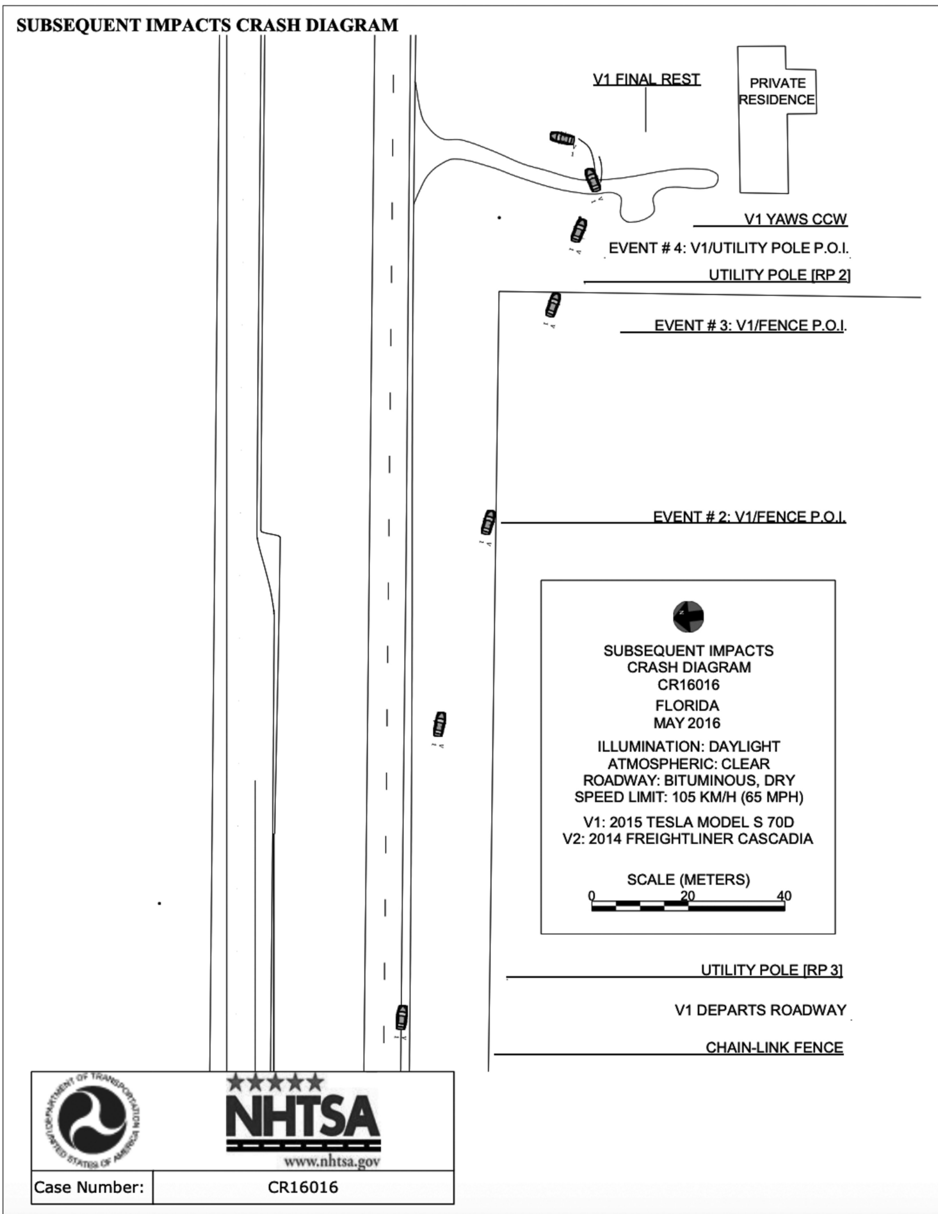
Figure 2: NHTSA Accident Reconstruction, Joshua Brown (1 of 2)
(a) Reconstruction Based on Sensory Input Data Taken by Tesla Autopilot System[476]



476. NAT'L HIGHWAY TRAFFIC SAFETY ADMIN., U.S. DEP'T OF TRANSP., SPECIAL CRASH INVESTIGATIONS: ON-SITE AUTOMATED DRIVER ASSISTANCE SYSTEM CRASH INVESTIGATION OF THE 2015 TESLA MODEL S 70D 31(2018), https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812481 [https://perma.cc/8KYQ-GCN3].

Figure 3: NHTSA Accident Reconstruction, Joshua Brown (2 of 2)

(a) Further Reconstruction Based on Sensory Input Data Taken by Tesla Autopilot System[477]



477. *Id*. at 32.