ROBOT IPSA LOQUITUR

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ABSTRACT

Accidents are becoming automated. From self-driving cars to self-flying drones, robots are increasingly colliding with the world. And 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 such complex automated systems. By now, many have weighed in, including the field's luminaries. And, though responses vary, a tentative consensus has emerged on at least one front. Age-old liability regimes are essentially nonstarters. For negligence and design defect theories both require a showing of fault. And in a world where vexingly complex robots roam, how could one possibly find the needle of fault in a haystack comprised of millions of lines of computer code?

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 modern robots have overlooked a crucial issue: inference. Fault, after all, needn't 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. After showing that the purportedly novel challenges posed by robots are neither unprecedented, unresolvable, nor even unique to emerging technologies, the Article then takes a more practical turn. Drawing from a rich vein of precedent involving automated accidents, 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]

There is no absolute requirement that the plaintiff explain how the accident happened. Res ipsa loquitur *may apply where the cause of the injury is a mystery[.]*

—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 are any indication, one attorney didn't 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 12 miles per hour when it decided to change lanes.[7]

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[1] David Strickland, *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.

[2] HANDBOOK OF THE LAW OF TORTS 204 (2nd ed. 1955).

[3] United States v. Athlone Indus., Inc., 746 F.2d 977, 979 (3d Cir. 1984) (noting that a defective robot pitching machine couldn't be sued in personam).

[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 conclusion that in rem or quasi in rem actions are available against robots, precisely because they're "objects" as opposed to legal "persons." *See, e.g.,* O'Brien v. Intuitive Surgical, Inc., No. 10 C 3005, 2011 WL 304079, at *1 (N.D. Ill. Jul. 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, 402 (E.D. Pa. 2009) (same), aff'd, 363 F. App'x 925 (3d Cir. 2010). In Nilsson v. General Motors (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 robot as "objects" and vehicle drivers as legal "persons."

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

[6] *See id.* at ¶ 5.

[7] *See* REPORT OF TRAFFIC ACCIDENT INVOLVING AN AUTONOMOUS VEHICLE #l70989746, CAL. DEP'T OF MOTOR VEHICLES, https://www.dmv.ca.gov/portal/wcm/connect/1877d019-d5f0-4c46-b472-

Midway through the maneuver, though, it changed its mind.[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'd 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 of 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,[15] Nilsson didn't direct his negligence claim against the human in the driver's seat.[16] Instead, he levelled 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."[17]

At first blush, there may appear little distance separating this event from other headline-grabbing "driverless accidents" that continue to overshadow it. Outlets across the globe,[18] for instance, described recent collisions involving Uber and Tesla vehicles as the world's first "driverless," "self-driving," or "autonomous" fatalities.[19] But these crashes,

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78cfe289787d/GMCruise_120717.pdf?MOD=AJPERES [hereinafter CRUISE ACCIDENT REPORT].

[8] *See id.*

[9] *See id.*

[10] *See id.*

[11] *See* Complaint, Nilsson v. General Motors, *supra* note __ at ¶ 12.

[12] *See* CRUISE ACCIDENT REPORT, *supra* note __.

[13] *See* Calif. Vehicle Code § 21755(a).

[14] *See* Complaint, Nilsson v. General Motors, *supra* note __

[15] *See* CRUISE ACCIDENT REPORT, *supra* note __.

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

[17] *See* Complaint, Nilsson v. General Motors, *supra* note __ at ¶¶ 16–17. The suit was, of course, still aimed at the company responsible for deploying the vehicle, *i.e.* General Motors. *See generally id.*

[18] *See* Nick Bolton, *How the Media Screwed Up the Fatal Tesla Accident*, Vanity Fair (Jul. 7, 2016), https://www.vanityfair.com/news/2016/07/how-the-media-screwed-up-the-fatal-tesla-accident (noting that Brown's "story has been picked up in thousands of outlets").

[19] *See, e.g.,* Bill Vlasic & Neal E. Boudette, *Self-Driving Tesla Was Involved in Fatal Crash, U.S. Says*, N.Y. TIMES (Jun. 30, 2016), https://www.nytimes.com/2016/07/01/business/self-driving-tesla-fatal-crash-investigation.html; Olivia Solon, *Why Self-Driving Cars Aren't Safe Yet: Rain, Roadworks and Other Obstacles*, THE GUARDIAN (Jul. 5, 2016), https://www.theguardian.com/technology/2016/jul/05/tesla-crash-self-driving-

as this Article will demonstrate, fit such descriptions in only the narrowest of senses.[20]

The Cruise accident, by comparison, received just a tiny fraction of the outsized media attention garnered by Uber and Tesla.[21] Yet, properly understood, it was a watershed moment. A robot[22] was formally accused of operating itself negligently—likely the first such utterance to grace the pages of a U.S. court filing.[23] It's an accusation that carries an air of epochal significance, announcing the arrival of robots of once-unimaginable

car-software-flaws; Dee-Ann Durbin, *Fatal Tesla Crash Shows Limits of Self-Driving Technology*, SEATTLE TIMES (Jul.1, 2016), https://www.seattletimes.com/business/fatal-telsa-crash-shows-limits-of-self-driving-technology/; Alice Klein, *Tesla Driver Dies in First Fatal Autonomous Car Crash in US*, NEW SCIENTIST (Jul. 1, 2016), https://www.newscientist.com/article/2095740-tesla-driver-dies-in-first-fatal-autonomous-car-crash-in-us/; Timothy B. Lee, *Uber Self-Driving Car Hits and Kills Pedestrian*, ARS TECHNICA (Mar. 19, 2018), https://arstechnica.com/cars/2018/03/uber-self-driving-car-hits-and-kills-pedestrian/; Dana Hull et al., *The Uber Crash Is the Nightmare the Driverless World Feared But Expected*, BLOOMBERG (Mar. 19, 2018), https://www.bloomberg.com/news/articles/2018-03-19/uber-crash-is-nightmare-the-driverless-world-feared-but-expected; 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.

[20] *See* Part I.C *infra*.

[21] To be sure, the accident 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), https://www.mercurynews.com/2018/01/23/motorcyclist-hit-by-self-driving-car-in-s-f-sues-general-motors/; Peter Holley, *After Crash, Injured Motorcyclist Accuses Robot-Driven Vehicle of 'Negligent Driving'*, Wash. Post (Jan. 25, 2018), https://www.washingtonpost.com/news/innovations/wp/2018/01/25/after-crash-injured-motorcyclist-accuses-robot-driven-vehicle-of-negligent-driving/?utm_term=.64cc3ed8dee2. But nothing resembling that of Uber and Tesla.

[22] As I (and many others) have argued before, the term "robot" is "notoriously resistant to definition." 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); Mark A. Lemley & Bryan Casey, *Remedies for Robots*, U. CHI. L. REV. (forthcoming 2019) (discussing the fluctuating definitions of "robot" and "artificial intelligence"). In this Article, the term should be understood as including "any hardware or software system exhibiting intelligent behavior," *see* Lemley & Casey, *supra* note __ (manuscript at 12).

[23] Arnold v. Reuther, 92 So. 2d 593, 596 (La. Ct. App. 1957).

capabilities at the courthouse doors. Indeed, far from anomalous, current trends indicate that automated accidents will soon become ubiquitous parts of American life.[24] The Cruise crash may be among the leading examples of the trend. But it will be far from the last.

Seen through this lens, the moment is clearly revolutionary. But precisely *how* revolutionary robot-driven accidents will be for our legal system is less clear. By now, many have weighed in on the topic—the academy's leading lights among them.[25] And, while opinions vary, a tentative consensus has emerged on at least one front. Negligence theories of the kind advanced by Nilsson are, essentially, nonstarters.[26] For negligence requires a showing of fault (as does products liability's "design

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[24] *See infra* notes __ – __ and accompanying text.

[25] *See, e.g.,* Kenneth Abraham & Robert Rabin, *Automated Vehicles and Manufacturer Responsibility for Accidents: A New Legal Regime for a New Era*, 105 VA. L. REV. (forthcoming 2019); Mark A. Geistfeld, *A Roadmap for Autonomous Vehicles: State Tort Liability, Automobile Insurance, and Federal Safety Regulation*, 105 CALIF. L. REV. 1611 (2018); Bryant Walker Smith, *Proximity Driven Liability*, 102 GEO. L. J. 1777 (2014); Ryan Calo, *Robotics and the Lessons of Cyberlaw*, 103 CALIF. L. REV. 513, 514–15 (2015); Donald Gifford, *Technological Triggers to Tort Revolutions: Steam Locomotives, Autonomous Vehicles, and Accident Compensation*, 11 J. TORT LAW ___ (forthcoming 2019); David C. Vladeck, *Machines without Principals: Liability Rules and Artificial Intelligence*, 89 WASH. L. REV. 117, 146-47 (2014); Bryan Choi, *Crashworthy Code*, WASH. L. REV. (forthcoming 2019); Nora Freeman Engstrom, *When Cars Crash: The Automobile's Tort Legacy*, 52 WAKE FOREST L. REV. 293, 296 (2018); Ryan Abbott, *The Reasonable Computer: Disrupting the Paradigm of Tort Liability* 86 GEO. WASH. L. REV. 1 (2018); F. Patrick Hubbard, *Sophisticated Robots: Balancing Liability, Regulation, and Innovation*, 66 FLA. L. REV. 1803, 1866-67 (2014); 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 (2017); Jeffrey K. Gurney, *Sue My Car Not Me: Products Liability and Accidents Involving Autonomous Vehicles*, 2013 U. ILL. J.L. TECH & POL'Y 247, 271–72 (proposing strict liability for automated vehicle manufacturers); Kyle Graham, *Of Frightened Horses and Autonomous Vehicles: Tort Law and Its Assimilation of Innovations*, 52 SANTA CLARA L. REV. 1241 (2012); Andrzej Rapaczynski, *Driverless Cars and the Much Delayed Tort Law Revolution* (2016); Julie Goodrich, Comment, *Driving Miss Daisy: An Autonomous Chauffeur System*, 51 HOUS. L. REV. 265, 284 (2013); Jack B. Balkin, *The Path of Robotics Law*, 6 CALIF. L. REV. CIRCUIT 45 (2015); Omri Ben-Shahar, *Should Carmakers Be Liable When A Self-Driving Car Crashes?*, FORBES (Sept. 22, 2016), https://www.forbes.com/sites/omribenshahar/2016/09/22/should-carmakers-be-liable-when-a-self-driving-car-crashes/.

[26] *But see* Lemley & Casey, *supra* note __ (manuscript at 92) (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).

defect"[27] doctrine). And in a world where robots of "confounding"[28] complexity roam, how could we possibly find the needle of fault in a haystack composed of millions of lines of software?[29]

Today, this question is widely regarded as among the "most significant source[s] of legal uncertainty"[30] in a global policy agenda spanning courts, legislatures, regulators, practitioners, and titans of industry.[31] Its ultimate resolution will have far-reaching implications for markets measured in the trillions[32] and for lives measured in the millions.[33] With negligence liability seemingly headed the way of the horse and buggy, widespread debates have emerged over how jurisprudence must account for

[27] *See* Part III.D *infra* (discussing why "strict" liability is a misnomer as applied to design defect doctrine).

[28] *See* Abraham & Rabin, *supra* note 25 (manuscript at 18) (describing the "confounding effect of technological innovation[s]," such as automated vehicles, on conventional tort law).

[29] *See* Part III *infra; see also infra* note 42 and accompanying paragraph.

[30] *See* Geistfeld, *supra* note __ at 1622. Crucially, "uncertainty" should be understood as distinct from "calculable risks" which can be accurately predicted and priced, unlike uncertainty. *See id.* at fn. 20.

[31] *See, e.g.,* 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"); 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 (Mar. 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, at 1-2 (May 9, 2016), https://www.regulations.gov/document?D=NHTSA-2016-0036-0051 (describing liability concerns of major industry players across globe); Adam Thierer, *When the Trial Lawyers Come for the Robot Cars*, SLATE, June 10, 2016, http://www.slate.com/articles/technology/future_tense/2016/06/if_a_driverless_car_crashes_who_is_liable.html.

[32] 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), https://www.cbsnews.com/news/first-look-inside-waymo-self-driving-taxis/ (noting "[a]nalysts predict self-driving revenue will hit a staggering $2.3 trillion by 2030").

[33] *See, e.g.,* GLOBAL HEALTH OBSERVATORY, NUMBER OF ROAD TRAFFIC DEATHS, WORLD HEALTH ORG. 2013, https://www.who.int/gho/road_safety/mortality/traffic_deaths_number/en/ (reporting annual road traffic deaths in excess of 1.25 million globally).

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's most fundamental goals of fairly allocating costs, promoting safety, and fostering innovation.[35]

But, urgent as these debates may be, they're also incomplete. Until now, they've given short shrift to a critical issue: inference. Fault[36] (or its absence) needn't be proven by pointing directly to a faulty line of 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 fact that the circumstantial evidence surrounding an accident can, itself, permit the inference that a defendant was at fault.[40]

To date, scholars and practitioners have largely overlooked the extent to which inference-based analyses already play out in automated accidents.[41] And this dearth of attention has been accompanied by an uncritical acceptance that new-age robots will simply prove too complex for

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[34] *See* Part III *infra; see also supra* note 25 for a sampling of the debate's leading participants.

[35] *See supra* note 25; Part III *infra*; Part IV.C.4 *infra*.

[36] Or fault-based claims advanced under design defect theories, such as those discussed in § 3 of the Restatement of Products Liability. *See generally* RESTATEMENT (THIRD) OF TORTS: PRODUCTS LIABILITY § 3 (1998).

[37] *See* Part III *infra*.

[38] *See* Part IV *infra*.

[39] *See* Part IV.A *infra* 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 Part IV.C *supra*.

[40] *See* Part IV.A *infra*.

[41] *See generally, e.g.,* Abraham & Rabin, *supra* note 25 (failing to mention *res ipsa*); Geistfeld, *A Roadmap for Autonomous Vehicles*, *supra* note 25 (failing to mention *res ipsa*); Calo, *Robotics and the Lessons of Cyberlaw*, *supra* note 25 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); Gifford, *supra* note 25 (mentioning *res ipsa* only once in a footnote); Engstrom, *When Cars Crash*, *supra* note 25 (failing to mention *res ipsa*); Vladeck, *supra* note 25 at 129, 138-143 (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); Graham, *supra* note 25 (failing to mention *res ipsa*); Bryant Walker Smith, *Automated Driving and Products Liability*, 4 MICH. ST. L. REV. 1, 5 (2017) (mentioning *res ipsa's* relevance to automated accidents once in passing); Balkin, *supra* note 25 (failing to mention *res ipsa*); Abbott, *supra* note 25 (failing to mention *res ipsa*); Rapaczynski, *supra* note __ (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); Choi, *supra* note 25 (failing to mention *res ipsa*).

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 that tort law will somehow accommodate automated accidents, with little analysis or elaboration.[46] But the prevailing wisdom 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

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[42] *See, e.g.,* Abraham & Rabin, *supra* note 25 (manuscript at 18–19) (predicting "the greatly heightened complexity and sophistication of the computerized control systems" will "confound[]" conventional analysis); Geistfeld, *supra* note 25 (predicting robot algorithms will pose "vexing tort problems" under conventional analysis); Gifford, *supra* note 25 66–70 (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); Engstrom, *When Cars Crash*, *supra* note 25 (arguing the our "traditional negligence system, designed for the Model T and premised on personal responsibility, will fit this new world [of robots] awkwardly"); Choi, *supra* note 25 at 4 (asserting that a "fundamental attribute of software—computational complexity—confounds the usual tort calculus used to weigh the safety of ordinary manufactured goods"); Graham, *supra* note 25 131 (expressing concerns over the "difficulty" 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 25 at 129–143 (arguing "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); Balkin, *supra* note 25 at 52 (predicting robots may pose insurmountable challenges for conventional analysis that could require strict liability).

[43] *See* Abraham & Rabin, *supra* note 25 (manuscript at 51).

[44] *See id.* (manuscript at 51); Calo, *Robotics and the Lessons of Cyberlaw*, *supra* note 25 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* Parts II–III *infra*.

[45] *See* Engstrom, *When Cars* Crash, *supra* note __ at 297. This general sentiment is shared by many. *See* Part III *infra*.

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

[47] *See* Part III *infra*.

[48] *See* Subpart III.A *infra* and Part IV.B *infra* 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* STATE OF CAL. DEPT. OF MOTOR VEHICLES, REPORT OF TRAFFIC COLLISION INVOLVING AN

directed toward 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] And, contrary to the impression conveyed by the literature, conventional analysis—usually relying on inference[50]—has successfully dealt with all of them.[51]

The key, as this Article will demonstrate, lies in the advanced data-logging technologies on board these emerging technologies.[52] To navigate autonomously, robots must constantly sense their surrounding environments.[53] And as a natural byproduct, they create richly detailed, multisensory records of the events that transpire around them.[54] Thanks to these robust data-logging capabilities, authorities can reconstruct automated accidents with a degree of granularity simply unimaginable in conventional contexts.[55] Rather than getting bogged down in algorithmic esoterica, they're able to look for the inference of negligence[56] in the machine's own meticulous account.[57] The robot, in other words, speaks for itself.

To be sure, embracing a liability rule we might call "*robot ipsa loquitur*" doesn't magically resolve all of our concerns surrounding the emerging technologies. But it does supply a number of helpful insights and conceptual tools drawn from past precedents.[58] Accordingly, after showing that the "most vexing tort problems"[59] anticipated by the literature are

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AUTONOMOUS VEHICLE, (Dec. 21, 2018), https://www.dmv.ca.gov/portal/dmv/detail/vr/autonomous/autonomousveh_ol316+ [hereinafter CAL. REPORT OF TRAFFIC COLLISIONS INVOLVING AN AUTONOMOUS VEHICLE]; *see also* Part II.A *infra* for a discussion of "closed-loop" and "open-loop" automated systems.

[49] *See* Part II.B, Part III.A, and Part IV.B *infra*.

[50] Either an inference of negligence, defectiveness, or a lack thereof (more on this in Part IV).

[51] *See* Part II.B, Part III.A, and Part IV.B *infra*.

[52] *See* Part IV.B *infra*.

[53] *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 also* Appendix A *infra*.

[54] *See id.*

[55] *See* Part IV.B *infra*.

[56] As Part IV.C.1 *infra* demonstrates, this inference extends to either the presence *or* absence of negligence, and it can be attributed to any number of parties.

[57] *See* Part IV.B *infra*.

[58] As we see in Part II.B, Part III.A, and Part IV.B, these precedents include successful fault determinations for genuinely "driverless" accidents.

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

neither unprecedented, unresolvable, nor even unique to modern robots,[60] 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[61] can take to streamline fault determinations for accidents, while simultaneously promoting tort's most foundational goals.[62] With so much riding on the successful deployment of robotics technologies,[63] these steps offer a promising alternative to the increasing number of drastic—often contradictory—calls for the legal system to abandon centuries of convention.[64] As this Article will show, 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.[65] With major legislation in Congress,[66] state regulations in tumult, and increasingly vocal concerns by citizens, politicians, government organizations, and industry leaders alike,[67] it's now safe to describe liability for robot-driven accidents as among the great regulatory challenges of the coming era.[68] And though the automotive industry may be among the leading sectors, a long line of similarly ambitious applications is platooning in the vehicle's wake. Press releases announcing autonomous drones,[69]

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[60] *See* Parts II.B–III.D *infra*.

[61] Not to mention insurance agencies, technology firms, and law enforcement.

[62] *See* Part IV.C.

[63] *See supra* notes __ – __ and accompanying text.

[64] Part III *infra* offers an overview of these calls. Part IV *infra* describes the solution.

[65] To borrow Martin Luther King, Jr.'s phrase, "[T]he fierce urgency of now."

[66] *See* Aarian Marshall, *Congress Races to Pass a Self-driving Car Law by Year's End*, WIRED (Dec. 12, 2018), https://www.wired.com/story/av-start-act-senate-congress-new-language-self-driving/.

[67] *See supra* notes __ – __ and accompanying text.

[68] Numerous others have expressed substantially similar sentiment. *See infra* notes __ – __.

[69] *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.

agricultural robots,[70] automated micromobility devices,[71] self-flying cars,[72] delivery bots,[73] self-sailing ships,[74] intelligent medical devices,[75] homecare bots,[76] and automated warehouse applications[77] are now daily fixtures of the news. Robots entering these underexamined domains, too, will raise similarly vexing questions of liability.[78] Fortunately, as we'll see in the parts that follow, the insights provided by *robot ipsa loquitur* generalize well to these diverse contexts.[79] Indeed, surprising as Nilsson's negligence claim against the Cruise vehicle may have been to many experts,[80] this Article

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[70] *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.

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

[72] *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.

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

[74] *See, e.g.,* Jack Stewart, *Rolls-Royce Wants to Fill the Seas with Self-Sailing Ships*, WIRED (Oct. 15, 2018), https://www.wired.com/story/rolls-royce-autonomous-ship/.

[75] *See, e.g.,* See Hannah Devlin, *The Robots Helping NHS Surgeons Perform Better, Faster – and For Longer*, THE GUARDIAN (July 4, 2018), http://www.theguardian.com/society/2018/jul/04/robots-nhs-surgeons-keyhole-surgeryversius.

[76] *See, e.g.,* Conor McGinn, *The Robot That Could Revolutionise Home Care for Elderly People*, THE INDEPENDENT (Nov. 22 2017), https://www.independent.co.uk/life-style/health-and-families/health-news/the-robot-that-could-revolutionise-home-care-for-elderly-people-stevie-us-a8068931.html.

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

[78] 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 Your Ice Cream Will Ride in a Self-Driving Car Before You Do*, W. ST. J. (Jan. 5, 2019), https://www.wsj.com/articles/why-your-ice-cream-will-ride-in-a-self-driving-car-before-you-do-11546664589?mod=hp_lead_pos9.

[79] *See* Part IV *infra*.

[80] *See infra* notes __ – __ and accompanying text (describing how the prevailing wisdom held that claims would arrive under products liability theories).

demonstrates that it actually offers a surprisingly virtuous[81] solution—not just for robot-driven cars but for a coming world where robots roam our skies, sidewalks, seas, and even our homes.[82]

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 such 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 inferenced-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.[83] A robot—in this instance, a driverless car—was formally accused of negligence.[84] It was likely the first such accusation to breach the courthouse doors.[85] And more titillating still, it was in earnest. The suit was no mere publicity stunt (nor even an elaborate attempt to troll the Third Circuit's Judge Higginbotham, Jr.).[86] Rather, the circumstances giving rise to the

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[81] 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).

[82] *See supra* notes __ – __ and accompanying text.

[83] *See* Oscar Willhem Nilsson v. General Motors, *supra* note __.

[84] *See id.* (accusing a self-driving vehicle of driving itself negligently); *see also infra* notes __ - __ and accompanying text.

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

[86] *See supra* note 1 and accompanying text (contextualizing Judge Higginbotham, Jr.'s quip that "robots cannot be sued").

controversy gave the plaintiff genuine cause to advance a legal theory grounded in negligence.[87]

Viewed in this light, the moment is historic. But, oddly, hardly a soul took notice.[88] Understanding why requires, first, rewinding the tape two years prior, to another historic accident involving an automated vehicle that continues to overshadow it. What follows, therefore, is a tale of two robots. The first centers on a "driverless accident" very much in need of the scare quotes surrounding the phrase. And the second centers on one of a 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[89]

In 2016, one of the 37,461[90] fatal accidents on U.S. roadways occurred in a car that was driving itself.[91] The vehicle was a Tesla Model S, belonging to Florida resident Joshua Brown.[92] Brown was returning from Walt Disney World with his Tesla in "Autopilot"[93] mode when he collided with the broad side of a semi truck.[94] The impact killed him instantly.[95]

Initial media reports cited Brown as travelling at dangerous speeds on a divided highway when a tractor trailer made a left turn in front of him.[96] Normally, Autopilot is designed to automatically brake in moments such as this. 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

[87] *See infra* Parts B–C. There are, of course, a few oddities surrounding the claim. A major one is Nilsson's decision to file in federal court, as opposed to state court, which typically occurs with common law tort claims.

[88] *See supra* note __ and accompanying text.

[89] Not only was it not the first "driverless" fatality, it wasn't even the first fatality involving Tesla's Autopilot system. (More on this below.)

[90] *See* USDOT RELEASES 2016 FATAL TRAFFIC CRASH DATA, NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION (2017), https://www.nhtsa.gov/press-releases/usdot-releases-2016-fatal-traffic-crash-data.

[91] *See* Rachel Abrams & Annalyn Kurtz, *Joshua Brown, Who Died in Self-Driving Accident, Tested Limits of His Tesla*, N.Y. TIMES (Jul. 1, 2016), https://www.nytimes.com/2016/07/02/business/joshua-brown-technology-enthusiast-tested-the-limits-of-his-tesla.html.

[92] *See id.*

[93] *See A Tragic Loss*, TESLA (June 30, 2016), https://www.teslamotors.com/blog/tragic-loss (offering a more detailed description of Tesla's "Autopilot" technology).

[94] *See* Abrams & Kurtz, *supra* note __.

[95] *See id.*

[96] *See id.*

ultrasonic sensing systems.[97] Consequently, Brown and his Model S hit the truck without so much as braking, "with the bottom of the trailer impacting the windshield."[98]

The cacophony of media coverage that followed Brown's tragic death was deafening.[99] Thousands of outlets across the globe ran the story.[100] Many described it as the world's first "driverless" or "autonomous" fatality.[101] Others argued it "raised significant concerns for . . . the future of driverless cars." A front page story by the *New York Times*, for example, quoted experts remarking that it represented a "wake-up call" for the industry, one that cautioned us all to "reassess" driverless vehicles.[102]

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 62-year-old driving the tractor trailer—Brown had been travelling at reckless speeds before the collision.[103] The trucker's original recollection "implied . . . Brown was driving faster than 85 mph,"[104] with numerous outlets quoting the trucker as saying, "[Brown] went so fast through my trailer I didn't see him."[105] But Baressi's account didn't end there. The trucker had also accused Brown of "playing Harry Potter on the [Tesla's] TV screen" at the time of the crash.[106] The claim quickly went viral. (Though, exactly how Baressi squared this observation with his prior one that "[he] didn't see [Brown]" remained somewhat unclear.[107])

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[97] *See, e.g.,* Metz*, supra* note __ (describing difference in these sensing systems).

[98] *See* Abrams & Kurtz, *supra* note __.

[99] *See* Bolton, *supra* note __ (noting that Brown's "story has been picked up in thousands of outlets").

[100] *See id.*

[101] *See id.* (describing numerous media claims). As we'll see in Subpart C, the accident wasn't "driverless" in any meaningful sense.

[102] *See* Vlasic & Boudett, *supra* note __.

[103] *See infra* notes __ – __ and accompanying text.

[104] *See, e.g.,* Fred Lambert, *Tesla Autopilot Crash: Images of the Fatal Accident's Aftermath Emerge [Video]*, ELECTREK (Jul. 1, 2018), https://electrek.co/2016/07/01/images-aftermath-fatal-tesla-autopilot-crash-video/.

[105] *See, e.g.,* Sam Levin & Nicky Woolf, *Tesla Driver Killed While Using Autopilot Was Watching Harry Potter, Witness Says*, THE GUARDIAN (Jul. 1, 2016), https://www.theguardian.com/technology/2016/jul/01/tesla-driver-killed-autopilot-self-driving-car-harry-potter*;* Will Oremus, *The Tesla Autopilot Crash Victim Was Apparently Watching a Movie When He Died*, SLATE (July 1, 2016), http://www.slate.com/blogs/moneybox/2016/07/01/tesla_autopilot_crash_victim_joshua_brown_was_ watching_a_movie_when_he_died.htm.

[106] *See id.*

[107] Baressi alleged that he somehow heard the movie playing—apparently, even over the noise of the accident.

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,[108] Brown's story actually survived his passing.[109] 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.[110] And when they did, the trucker's account fell to pieces.[111]

Brown's Tesla, as it turns out, had been travelling at the more modest speed of 74 miles per hour.[112] Nine miles over the posted speed limit of 65, to be sure. But hardly a speed putting him at risk of a reckless driving citation. Further, investigators found no evidence to corroborate Baressi's claim that Brown had been watching Harry Potter.[113] Instead, authorities deemed Baressi, himself, blameworthy.[114] And they cited the trucker "for failing to give right of way during the left turn."[115]

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."[116] During this time, visual and audio warnings prompting Brown to keep his hands on the wheel went off at least six times, to no avail.[117] According to one investigative report, Brown had as many as seven seconds to react before impact after Baressi failed to give him the right of way.[118] But he "took no braking, steering, or other actions to avoid the collision."[119]

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[108] For a detailed description of these technologies, *see* Part IV.B *infra*.

[109] *See* Jordan Golson, *Read the Florida Highway Patrol's Full Investigation into the Fatal Tesla Crash*, THE VERGE Feb. 1, 2017), https://www.theverge.com/2017/2/1/14458662/tesla-autopilot-crash-accident-florida-fatal-highway-patrol-report (discussing reports by NHTSA, NSTB, and the Florida Highway Patrol).

[110] *See id.*

[111] *See infra* notes __ – __ and accompanying text.

[112] *See* Golson, *supra* note __.

[113] *See id.*

[114] *See id.*

[115] *See id.*

[116] *See* David Shepardson, *Tesla Driver in Fatal 'Autopilot' Crash Got Numerous Warnings: U.S. Government*, REUTERS (Jun. 19, 2017), https://www.reuters.com/article/us-tesla-crash/tesla-driver-in-fatal-autopilot-crash-got-numerous-warnings-u-s-government-idUSKBN19A2XC.

[117] *See id.*

[118] *See* Golson, *supra* note __.

[119] *See* Shepardson, *supra* note __.

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 such 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.[120] And driving this dramatic twist in the narrative was the Tesla vehicle's unique ability to speak for itself.[121]

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.[122] The vehicle at the center of the tale was a Chevy Bolt belonging to Cruise, an automated vehicle outfit owned by General Motors.[123] Though the accident failed to garner the level of media attention of Brown's, a data-generated "disengagement report" filed in its aftermath allows us to recreate the event in similar detail.

According to the report, Cruise's vehicle was "operating in autonomous mode" in the center lane of San Francisco's Oak Street, a one-way road that's three lanes wide. 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.[124] Meantime, a motorcyclist by the name of Oscar Nilsson was filtering up Oak Street at about seventeen miles per hour, behind the Cruise vehicle.[125] 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" by driving on dividing lines.[126]

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

[121] For illustrations of this accident reconstruction, s*ee* Appendix A *infra*.

[122] As we'll see in Part IV.B, it wasn't the first accident involving a fully automated vehicle. But it was the first to breach the courthouse doors.

[123] *See* David R. Baker, *Cruise Reports Its First Injury Involving Self-Driving Car*, SAN FRANCISCO CHRONICLE (Dec. 20, 2017), https://www.sfchronicle.com/news/article/Cruise-reports-its-first-injury-involving-12445072.php.

[124] *See id.*

[125] *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.

[126] *See Lane Splitting General Guidelines*, STATE OF CAL. DEPT. OF MOTOR VEHICLES, https://www.dmv.ca.gov/portal/dmv/detail/about/lane_splitting.

Nilsson's motorcycle was between the center and the right lanes when the Cruise vehicle started merging leftward.[127] 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.[128] "Sensing that its gap was closing, the [Cruise vehicle] stopped making its lane change and returned fully to the center lane."[129] But in the process, the car sideswiped Nilsson. The motorcyclist "wobbled[] and fell over," injuring his shoulder and neck on impact.[130]

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"[131] before filing a report.[132] 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 21755(a)]."[133] 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."[134]

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."[135] And that, "[a]s a result of such negligent driving, Mr. Nilsson sustained serious injuries of body and mind and incurred expenses for medical care and attendance."[136]

Surveying the literature, it's no overstatement to characterize Nilsson's legal strategy as utterly unanticipated.[137] To date, an overwhelming consensus within the field has characterized products

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[127] *See* CRUISE ACCIDENT REPORT, *supra* note __.

[128] *See id.*

[129] *See id.*

[130] *See* Complaint, Nilsson v. General Motors, *supra* note __ at ¶ 12.

[131] *See* CRUISE ACCIDENT REPORT, *supra* note __.

[132] *See id.*

[133] *See id.*

[134] *See* CAL. VEHICLE CODE 21755(a). The code section also adds, "In no event shall that movement be made by driving off the paved or main-traveled portion of the roadway." *See id.*

[135] *See* Complaint, Nilsson v. General Motors, *supra* note __ at ¶ 16.

[136] *See id.* at ¶ 17.

[137] *See generally, e.g.,* Abraham & Rabin, *supra* note 25 (predicting such claims would proceed under products liability theories); Geistfeld, *supra* note 25 (same); Calo, *Robotics and the Lessons of* Cyberlaw, *supra* note 25 (same); Choi, *supra* note 25 (same); Crane et al., *supra* note 25 (same); Bryant Walker Smith, *Automated Driving and Products Liability*, 4 MICH. ST. L. REV. 1 (2017) (presuming products liability will predominate, with *de minimus* consideration given to negligence).

liability theories against automated vehicles as all but foreordained.[138] Yet, Nilsson's attorney apparently didn't get the memo. Rather than abiding the conventional wisdom, he opted to ground the claim in negligence.[139] And with it, the U.S. legal system witnessed what is very likely the first such utterance to grace the pages of a court filing.[140] A robot[141] was formally accused of operating itself negligently—a tort allegation once exclusively reserved for human operators.

If only for the sheer shock value, the accusation would seem to be a newsworthy event. But, in actuality, 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 subpart, 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 actually diverge radically.

Despite the media frenzy surrounding Brown's death, the description of his accident as "autonomous" or "driverless" is actually a misnomer.[142] As the Tesla owner's manual, multiple disclaimers, and the company's CEO have repeatedly stressed, Autopilot is not a driverless system.[143] 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, [*sic*] and that you need to maintain control and responsibility for your vehicle while using it."[144] Thus, in the aftermath of Brown's fatal death, Tesla stressed that Autopilot "is not perfect and still requires the driver to remain alert." And shortly after the company's response, a preliminary report by the National Highway Traffic Safety Administration (NHTSA) largely aligned with the position.[145] The agency described Tesla's Autopilot as a "driver assistance system," not a *truly* driverless technology.

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[138] *See supra* note 137.

[139] *See* Complaint, Nilsson v. General Motors, *supra* note __ at ¶¶ 16–17.

[140] *See supra* note __ and accompanying text.

[141] *See infra* note __ for a discussion of the definition of "robot."

[142] In fact, as we'll see below, if ever there's been a truly driverless fatality, it occurred long before the Tesla crash.

[143] *See* Golson, *supra* note __ (describing these warnings and disclaimers).

[144] *See A Tragic Loss*, TESLA (June 30, 2016), https://www.teslamotors.com/blog/tragic-loss.

[145] *See* Golson, *supra* note __.

Thus, from a doctrinal viewpoint, 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.[146] 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, or when we consume risky foods such as herbal products.[147] In fact, it even happens in conventional cars. When, for instance, we activate assistive systems such as cruise control or advanced lane keeping, the legal complexion looks markedly similar.[148]

Now, that's not to suggest there are no doctrinal novelties arising from technologies like Autopilot.[149] Just ask the National Transportation Safety Board (NTSB). In 2018, the agency offered a scathing rebuke of both Tesla's and NHTSA's defense of Autopilot.[150] According to the agency, "[t]he combined effects of human error and the *lack of sufficient system controls* resulted in a fatal collision that should not have happened."[151] The NTSB acknowledged that Autopilot had functioned as intended, but nonetheless insisted that the system "lacked [sufficient] safeguards to prevent drivers from using it improperly."[152] (And Tesla, notably, went on to implement additional safeguards in the aftermath of the report's release via mass software updates.[153])

But 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."[154] That is, the "mismatches between control and responsibility" that can emerge in AI systems which rely on human

[146] Izzarelli v. R.J. Reynolds Tobacco Co., 136 A.3d 1232, 1249 (Conn. 2016) (describing this foreclosure).

[147] *Id.*

[148] Or when pilots activate autopilot technologies. *See* Brouse v. United States, 83 F. Supp. 373, 374 (N.D. Ohio 1949) (ruling pilot had an obligation "to keep a proper and constant lookout").

[149] After all, "Warnings are not . . . a substitute for the provision of a reasonably safe design." RESTATEMENT (THIRD) OF TORTS: PRODUCTS LIABILITY § 2 Cmt. 1 (1998).

[150] *See* 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.

[151] *See id.*

[152] *See id.*

[153] *See id.*

[154] *See* M.C. Elish, *Moral Crumple Zones: Cautionary Tales in Human-Robot Interaction*, WEROBOT (2016), http://robots.law.miami.edu/2016/wp-content/uploads/2015/07/Elish_cautionary-tales_prelim_draft.pdf (manuscript at 1).

oversight.[155] In Elish's telling, "Just as the crumple zone in a car is designed to absorb the force of impact in a crash, the human in a robotic system may become simply a component—accidentally or intentionally—that is intended to bear the brunt of the moral and legal penalties when the overall system fails."[156] Legal inquires into moral crumple zones, therefore, examine the complex interplay between assistive technologies and legally responsible operators.[157] They're similar to those we'd ask if cruise control routinely induced drivers into taking their attention off the road. Indeed, if we saw a national epidemic of RV drivers activating cruise control, only to wander off to cook a meal—as opposed to a mere urban legend—it would raise tough questions of the kind we saw the NTSB ask of Tesla. But, at bottom, these are questions that implicate assistive systems, not autonomous ones.

The difference between Autopilot and a host of operator-assistive technologies, in other words, 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) 2014 "Grand Challenge" announced the possibility—if only a distant one—of truly automated accidents.[158] And, as it so happens, that's precisely where our second tale involving the Cruise vehicle arrives on the scene.

To be sure, Cruise's automated system also required constant vigilance on the part of the safety driver on board. But unlike Brown's accident, the Cruise accident occurred under conditions that triggered neither a prior warning nor a request for driver intervention. 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."[159]

It's exactly this type of scenario that practitioners, policymakers, and plain old sci-fi nerds had long anticipated. And, in fitting sci-fi fashion,

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[155] *See id.* (manuscript at 1).

[156] *See id.*

[157] *See id.* 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 25 at fn. 23.

[158] *See* Casey, *supra* note __ (describing DARPA Grand Challenge involving autonomous vehicles); Balkin, *supra* note 25 at 52 (discussing "why lawyers care about" the doctrinal challenges of robots).

[159] *See* Geistfeld, *supra* note 25 at 1629 (describing the moment as "a legal discontinuity").

the accident was also accompanied by an accusation of Asimovian[160] proportions—one that few experts had anticipated. Seen through this lens, it's clearly 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.[161]

But 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'll see why claims about the "revolutionary" liability ramifications of robots are largely overstated, and, further, why age-old negligence[162] 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.[163] The sheer speed of advancement has been breathtaking. But it has also led many such technologies to come of age in a veritable "policy vacuum."[164] From this vacuum, a tale of impending "revolution" has recently emerged.[165] Robots able to drive cars or fly drones, so the tale goes, will revolutionize industries, economies, and entire societies.[166] And 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.[167]

This Part attempts to show why these claims are overstated. In doing so, it again tells a twofold tale—juxtaposing the "revolutionary" ramifications robots pose for legal *responsibility* with those they pose for

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

[161] *See infra* notes __ – __ and accompanying text.

[162] Or products liability theories derivative of *res ipsa*s, such as those articulated by § 3 of the Restatement of Products Liability.

[163] *See supra* notes __ – __ and accompanying text.

[164] *See* Mashaw & Harfst, *supra* note __ at 269 (describing this "policy vacuum").

[165] *See, e.g.,* Gifford, *supra* note 25 (describing robots as the next "revolutionary" technology); Calo, *Robotics and the Lessons of Cyberlaw*, *supra* note 25 at 515 (describing robotics as "the next transformative technology"); Abraham & Rabin, *supra* note 25 (writing: "We are on the verge of another new era, requiring another new legal regime. This time, it is our system of transportation that will be revolutionized.").

[166] *See* Part II.B *infra*.

[167] Part III *infra* surveys the dozens of leading scholars who have advanced this claim.

legal *liability*. As we'll see, "driverless," "pilotless," and "autonomous" systems will surely upend current conventions surrounding accident responsibility. But the claim that they'll also upend conventional accident liability is far less certain. Subpart 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. Subpart B then uses a framework based on closed- versus open-loop systems to show why robots that revolutionize current notions of legal responsibility will not, inexorably, revolutionize legal liability in the process.

A. Why "Loops," Not "Levels," Matter for Robot Responsibility

In Part I, we saw that automated accidents will cause a break from conventional tort analysis involving assistive systems. Yet, whether they'll cause a "revolutionary" break from tort convention *writ large*—as many have argued[168]—is another matter altogether. To be sure, the tort questions presented by automated accidents are numerous, and the challenges, real. But as this subpart shows, robots are actually not as revolutionary as many suggest. Understanding why this is true requires, first, establishing a basic conceptual understanding of the technology underneath the proverbial hood. Here, the literature provides a description that needn't be revisited in detail.[169] But certain confusions (which, in turn, beget further confusion) nevertheless loom large. Accordingly, it's worth clarifying a few key terms.

The first is "artificial intelligence" (AI). AI is a term notoriously resistant to definition. But it refers, roughly, to a suite of technologies that attempt to automate the complex behaviors we refer to as exhibiting "intelligence."[170] Notionally, as the level of machine intelligence increases, intervention by humans decreases. Ultimately, AI systems aim to create discrete operating states where machines can perform tasks by purely automated means.

Though automation exists on a spectrum, its immediate legal consequences are better understood as binary. Automating a complex task can either produce a system with a discrete operating state involving neither a need, nor expectation, of appropriate[171] human intervention, referred to as

[168] *See* Part III *infra.*

[169] For a detailed overview of artificial intelligence and its key technological constituents, *see, e.g.,* Lemley & Casey, *supra* note __ (manuscript at 9–19).

[170] *See generally* PEDRO DOMINGO, THE MASTER ALGORITHM: HOW THE QUEST FOR THE ULTIMATE LEARNING MACHINE WILL REMAKE OUR WORLD (Hachett Book Group, NY 2015).

[171] The term "appropriate" here refers to questions of the type raised by the NTSB in response to Brown's fatalities, discussed in Part I.C *supra.*

"closed-loop" or "human-out-of-the-loop."[172] Or it can produce a system that still envisages some degree of human intervention,[173] referred to as "open-loop" or "human-in-the-loop." Critically, a liability loop needn't encompass an entire operating domain to be considered "closed."[174] 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 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 of 2016, for example, the National Highway Traffic Safety Administration adopted the Society of Automotive Engineers' (SAE) six-tiered description of automated vehicles. The SAE describes each level as follows:[175]

- 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 "Drive 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

[172] *See* Marc Canellas et al., *Framing Human-Automation Regulation: A New Modus Operandi From Cognitive Engineering*, WEROBOT (2017) (manuscript at 16–20), http://www.werobot2017.com/wp-content/uploads/2017/03/Canellas_2017_FramingHumanAutomationRegulation.pdf.

[173] *See id.*

[174] *See infra* notes __ – __ and accompanying text.

[175] *Taxonomy and Definitions for Terms Related to On-Road Motor Vehicle Automated Driving Systems*, SOCIETY OF AUTOMOTIVE ENGINEERS 1 (2014), https://www.sae.org/misc/pdfs/automated_driving.pdf.

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."

Relying on this framing, numerous scholars have zeroed in on the jump between SAE Level 3 and Level 4 autonomy as representing a crucial break with conventional tort doctrine.[176] 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. And when, in Brown's case, the system collided with a semi truck, its loop was "open." Because human intervention was both expected *and* legally appropriate, Brown retained an obligation to respond under the circumstances. But if, by way of counterfactual, Brown's Autopilot system had suddenly accelerated into the same tractor trailer due to software error (as recently occurred in *In re Toyota*),[177] the legal complexion would change 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."

Seen in this framing, the focus on "levels" as opposed to "loops" is, at best, a distraction. In fact, if ever there's been a truly "driverless accident," it happened long before Joshua Brown's. Automated loops don't require "deep neural networks"[178] 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.[179] Rather, the proper inquiry simply asks whether a system was closed or open at the crucial juncture of a

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[176] *See, e.g.,* Abraham & Rabin, *supra* note 25 at 4–5 (describing the jump from Level 3 to 4 vehicles as representing a crucial legal juncture); Geistfeld, *supra* note 25 at 1629 (describing the moment that "automated driving technologies fully take over the dynamic driving task" as "a legal discontinuity"); Daniel A. Crane et al., *supra* note 25 (defining an "'autonomous vehicle' … [as] a vehicle equipped with NHTSA level 3 or 4 technology.").

[177] *See* In re Toyota Motor Corp. Unintended Acceleration Mktg., Sales Practices, & Prod. 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 below.

[178] *See* Jürgen Schmidhuber, *Deep Learning in Neural Networks: An Overview*, 61 NEURAL NETWORKS 85 (2015) (explaining the term).

[179] *See* Part IV.A (describing *res ipsa* cases involving unoccupied vehicles).

harmful[180] event. This answer can be established with a pair of questions: (1) Was a specific automation loop active when involved in an event with legal repercussions? (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 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. But 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" verbiage, the possibility of human intervention is closed.

As we saw above, the legal system has previously encountered many such loops. Precedent involving closed-loop systems ranges from absentmindedly parked cars to complex software componentry responsible for "sudden acceleration" defects.[181] And this long line of precedent, in turn, means that the only genuine novelty posed by modern robots is the size of the loops they're capable of closing. Unlike the "good old-fashioned artificial intelligence" (GOFAI) systems of recent years,[182] emerging robots are capable of automating more complex tasks than was ever true of their technological antecedents.[183]

As the next subpart 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. But whether merely increasing the size of loops will also revolutionize accident *liability* is far less certain.

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—wouldn't have sat well with automakers.[184] 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. The industry called it "incremental autonomy." Under the philosophy, the "dynamic driving task" would not be handed over to robots wholesale. Instead,

[180] Or allegedly harmful.

[181] *See* Part IV.A; In re Toyota, *supra* note __; *infra* notes __ – __.

[182] For a description of GOFAI systems, *see* Lemley & Casey, *supra* note __ (manuscript at 13–14).

[183] *See, e.g., id.*; Abbott, *supra* note 25 (observing machines are less and less "just inert tools directed by individuals").

[184] *See* Alex Davies, *The Sneaky Way Automakers are Getting Us to Accept Self-Driving Cars*, WIRED MAG. (May 30, 2014), https://www.wired.com/2014/05/automakers-self-driving-cars/.

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.[185] 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.[186]

Nowadays, however, this iterative vision has largely faded.[187] 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."[188] Study after study has 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.[189] Confidence, in turn, begets complacency.[190] Operators' "attention wanders, and they often begin to doze."[191] It's this very phenomenon that got Tesla into hot water with the NTSB in the aftermath of Joshua Brown's fatal collision. And 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.[192]

As this industry-wide ambition approaches reality, its consequences for tort 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, versus 2% to manufacturer error.[193] But all signs now suggest "we are apt to leave the current world of auto

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[185] *See id.*

[186] *See id.*

[187] *See* Alex Davies, *The Very Human Problem Blocking the Path to Self-Driving Cars*, WIRED MAG. (Jan. 1, 2017), https://www.wired.com/2017/01/human-problem-blocking-path-self-driving-cars/ (describing industry-wide pushes for closed-loop systems).

[188] *See id.* (describing "human reengagement after periods of occupation with another task [a]s difficult and dangerous").

[189] *See* Robert Peterson, *Letter to California Department of Motor Vehicles Re: Proposed Autonomous Vehicle Regulations* (Feb. 23, 2016), https://orfe.princeton.edu/~alaink/SmartDrivingCars/Papers/RPeterson_CA_DMV%20_RegsComments032316.pdf.

[190] *See id.*

[191] *See id.*

[192] *See* Davies, *The Very Human Problem Blocking the Path to Self-Driving Cars*, *supra* note __.

[193] For estimates, see 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; 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.

accidents [where] the vast majority . . . are caused by human error . . . to a world that is flipped 180 degrees."[194] And this coming inversion appears poised to extend far beyond the automotive realm—with self-flying drones,[195] self-sailing ships,[196] self-navigating delivery robots,[197] self-operating agricultural machines,[198] and countless other sophisticated automated applications also adopting closed-loop designs.

The immediate legal implications of this coming era are, nowadays, 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.[199] As Subpart A showed, this is consistent with a long line of tort precedent, not to mention common sense.[200] 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.[201]

But reaching a resolution on the question of responsibility is just the beginning. Liability, after all, doesn't flow axiomatically from responsibility. Accidents occur for many reasons—some of which we hold responsible operators liable for and some of which we don't. Thus, any sense of comfort brought by reaching this "shared conclusion"[202] is better regarded as fleeting. Having settled the preliminary question of *responsibility*, a subsidiary question of far greater import follows. Namely, how should accident *liability*[203] function in this world flipped 180 degrees?

[194] See Engstrom, *When Cars Crash*, *supra* note 25 at 296.

[195] *See* Manjoo, *supra* note __.

[196] *See* Stewart, *supra* note __.

[197] *See* Hunt, *supra* note __.

[198] *See* Lohr, *supra* note __.

[199] *See, e.g.,* Geistfeld, *supra* note 25 at 1619 (observing that experts have reached "the shared conclusion that elimination of a human driver will shift responsibility onto manufacturers") (internal quotations removed).

[200] As the University of Chicago's Omri Ben-Shahar puts it, "There will be no drivers to blame, and the only remaining culprit would be the technology." Omri Ben-Shahar, *supra* 25 note (citing the author's identically titled piece that appeared in Forbes Magazine).

[201] *See, e.g., Volvo Cars Responsible for the Actions of its Self-Driving Cars*, VOLVO CARS (Oct. 20, 2015), http://www.volvocars.com/intl/About/OurInnovation-Brands/IntelliSafe/IntelliSafe-Autopilot/News/Volvo-Cars-responsible-for-the-actions-ofits-self-driving-cars ("Volvo Cars will accept full liability for the actions of its autonomous cars when in Autopilot mode, making it one of the first manufacturers to take this vital step forward in the development of self-driving cars.").

[202] *See* Geistfeld, *supra* note 25 at 1619.

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

Today, this open question of liability for closed-loop robots is viewed as among the "most significant source[s] of legal uncertainty"[204] in a global policy agenda spanning courts, legislatures, regulators, and titans of industry.[205] How we answer it will have lasting consequences for markets measured in the trillions[206] and for lives that number in the millions.[207] As we'll see in the part that follows, many have now weighed in on the topic—the field's leading lights among them.[208] And though responses vary widely,[209] experts are almost unanimous on one front. They view conventional negligence claims of the type levelled against Cruise's automated vehicle as essentially unworkable.[210] Negligence, after all, requires a showing of fault. And when it comes to the vastly complex technological constituents that make up modern robots, finding the needle of negligence in a haystack comprised of millions of lines of computer code is seen as uniquely "vexing."[211]

With conventional negligence 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."[212] And from this vacuum, a second tale of "revolution" has recently emerged.[213] It begins in much the same way as the

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[204] *See* Geistfeld, *supra* note 25 at 1622 (noting "most significant source of legal uncertainty stems from the manufacturer's potential liabilities for crashes caused by a fully [automated] system").

[205] *See supra* notes __ – __ and accompanying text.

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

[207] *See, e.g.,* GLOBAL HEALTH OBSERVATORY, NUMBER OF ROAD TRAFFIC DEATHS, WORLD HEALTH ORG. 2013, https://www.who.int/gho/road_safety/mortality/traffic_deaths_number/en/ (reporting annual road traffic deaths in excess of 1.25 million globally). The number of U.S. accidents reliably tops 6 million a year, resulting in tens of thousands killed, millions more injured, and hundreds of billions of dollars in economic losses. *See* TRAFFIC SAFETY FACTS, NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION, https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812412.

[208] *See supra* note 25; Part III *infra*.

[209] *See supra* note 42; Part III *infra*.

[210] *See supra* note 42; Part III *infra*.

[211] The adjective "vexing," as we'll see below, is sometimes exchanged for "confounding," "awkward," or other synonyms. *See* Part III.A–D *infra*.

[212] *See* Mashaw & Harfst, *supra* note __ at 269 (describing this "policy vacuum").

[213] *See, e.g.,* Gifford, *supra* note 25 (describing robots as the next "revolutionary" technology); Calo, *Robotics and the Lessons of Cyberlaw*, *supra* note 25 at 515 (describing robotics as "the next transformative technology"); Abraham & Rabin, *supra* note 25 ("We are on the verge of another new era, requiring another new legal regime. This time, it is our system of transportation that will be revolutionized."). *See also* Part III *infra*.

first: Robots capable of previously unimaginable feats—such as driving a car or flying a drone—represent a technological paradigm shift. So, it's only natural to conclude that they'll require a legal paradigm shift of similar kind.[214] In this account, "Our traditional negligence system, designed for the Model T and premised on personal responsibility, will fit this new world awkwardly."[215] Some have taken more measured approaches, insisting that conventional analysis will somehow accommodate the "vexing tort problems"[216] posed by robots without offering much in the way of elaboration.[217] But the prevailing view now appears to hold that tort is "on the verge of a new era, requiring another new legal regime." [218]

As the next part will show, however, this tale of revolutionary liability doesn't follow quite 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.[219] And while 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.[220] This part challenges that view. Despite the wonder and wizardry of modern robots, its shows that 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.[221] Instead, the legal rule of *res ipsa loquitur* allows plaintiffs to show fault through inference—even in accidents involving

[214] For a detailed description of these claims, *see* Part III *infra*.

[215] *See* Engstrom, *When Cars* Crash, *supra* note 25 at 297. Though this specific quote comes from Stanford Law School's Nora Engstrom, the general sentiment is shared by many. *See* Part III *infra*.

[216] *See* Geistfeld, *supra* note 25 at 1612.

[217] *See supra* note 46.

[218] *See* Abraham & Rabin, *supra* note __ (manuscript at 1); *see also* Part III *infra*.

[219] *See* Part II.B *supra*.

[220] *See* Subparts A–D *infra*.

[221] *See* Subparts A–D and Part IV.A *infra*.

confoundingly complex machines.[222] Before delving into this crucial doctrine, however, it's worth first engaging the current scholarship. The following subparts examine four predominant claims about the unique legal challenges posed by emerging robotics. The first section of each subpart describes the claim. And the second section responds to it, showing why the features cited as demanding a departure from negligence are neither conceptually novel, unresolvable under conventional analysis, nor even unique to emerging robots.

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,[223] 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.[224] According to these scholars, age-old approaches for allocating liability will become infeasible or impossible in a world dominated by sophisticated robots.[225] The most developed of these arguments comes from the University of Virginia's Kenneth Abraham and Stanford University's Robert Rabin.[226] The 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."[227] In their telling, legal "contests over blameworthiness will be replaced by examination of esoteric, algorithm-based design differences" that will prove "both needlessly contentious and costly" for courts, administrators, and accident victims.[228]

The solution proposed by these experts? To "break with the tort system" altogether by imposing "strict," "no-fault," or "common enterprise" liability on robot manufacturers—in this instance, automakers.[229] The primary appeal, here, is simplicity. Proponents argue

[222] *See* Part IV *infra*.
[223] *See infra* notes __ – __ and accompanying text.
[224] *See supra* note 42.
[225] *See supra* note 42.
[226] *See generally* Abraham & Rabin, *supra* note 25. For a more comprehensive list of the scholars who subscribe to this view, *see supra* note 42.
[227] *See id.* (manuscript at 18).
[228] *See id.* (manuscript at 18–19).
[229] *See, e.g.,* Abraham & Rabin, *supra* note 25 (proposing abandonment of fault-based analysis); Vladeck, *supra* note 25 (same); Gurney, *supra* note 25 (same); Engstrom, *When Cars Crash*, *supra* note 25 at 296 (remarking that autonomous vehicles will "bring[] enterprise liability principles, long foreign to

that regimes which disregard fault would "better fit[] the new world of [automated] accidents than our current negligence and product defect liability system."[230] And even though the transition may seem "dramatic and unsettling,"[231] the scholars argue that "substantial efficiencies . . . could be achieved by eliminating hotly contested issues of reasonable technological expectations."[232] 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.[233]

2. The Reality: Conventional Analysis Already Tames Complexity, and There's Nothing Magic About Robots

In Arthur C. Clarke's arresting turn of phrase, "Any sufficiently advanced technology is indistinguishable from magic."[234] And with all the hype and mystique surrounding emerging robotics technologies, it's easy to see the staggering sophistication of their "deep neural networks"[235] and "blackbox algorithms"[236] 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"[237] for age-old tort liability.[238] 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 all the way back to the introduction of the automobile—when practitioners routinely insisted that vexingly complicated "devil wagons" and their drivers should be subject to strict liability.[239] And the claims are as unfounded today as they were then.

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automobile accident litigation, finally to the fore"). Each regime envisages an "elimination of the fault concept in compensating victims for their losses." *See* C. L. Gaylord, *Fault, No Fault or Strict Liability?* 58 AM. BAR ASS'N J. 589 No. 6 (1972) (describing subtle differences between regimes).

230 *See* Abraham and Rabin, *supra* note 25 (manuscript at 51).

231 *See id.* (manuscript at 51).

232 *See id.* (manuscript at 18).

233 *See id.* (manuscript at 17–19) (describing the various benefits purportedly offered by strict liability).

234 ARTHUR C. CLARKE, PROFILES OF THE FUTURE: AN INQUIRY INTO THE LIMITS OF THE POSSIBLE (Revised Ed., Harper & Row, 1973) at 21.

235 *See* Schmidhuber, *supra* note __ (describing this technology).

236 *See* Andrew D. Selbst & Solon Barocas, *The Intuitive Appeal of Explainable Machines*, 87 FORDHAM L. REV. 1085 (2018) (discussing the inscrutability of "blackbox" algorithms).

237 *See* Abraham & Rabin, *supra* note 25 (manuscript at 18).

238 *See supra* note 42.

239 *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

To start, it's unclear how "the greatly heightened complexity"[240] of modern robots would impose any more "stress on the premises of conventional tort analysis"[241] 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."[242] And crucially, it's an activity accomplished by algorithms that are universally recognized as utter "blackboxes."[243] 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 we should apply the brakes when we see a cluster of brake lights in the distance. We make 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.[244]

Today, our understanding of how humans navigate the sprawling maze "of uncharted, little-understood dynamics" we call "traffic" remains woefully imperfect.[245] And, 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

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driver"); Richard M. Nixon, *Changing Rules of Liability in Automobile Accident Litigation*, 3 L. AND CONT. PROBS. 476, 476–77 (1936) (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'"). 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).

[240] *See supra* note __ and accompanying text.

[241] *See supra* note __ and accompanying text.

[242] *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 (quoting the preeminent Carnegie Mellon University professor).

[243] Indeed, ones of even greater complexity than the deepest of neural nets. *See, e.g., Prying Open the Black Box of the Brain*, NAT'L SCI. FOUND. (Jun. 12, 2013), https://www.nsf.gov/discoveries/disc_summ.jsp?cntn_id=128239 (surveying literature that reveal brain as "the most complex biological structure on Earth").

[244] TOM VANDERBILT, TRAFFIC: WHY WE DRIVE THE WAY WE DO (AND WHAT IT SAYS ABOUT US) (First Vintage Books ed. 2009).

[245] *See id.*

again—to battle over "reasonable" human reaction times, attentiveness, or multitasking capabilities. But even though the possibility of these esoteric contests is—at least in theory—ever present, they rarely eventuate in practice. The reason 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."[246] There's no reason why similar heuristics can't be applied to the "esoteric, algorithm-based design difference[s]" of robots (more on this in Part IV).[247] 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.[248] They're comprised of roughly 150 million lines of code,[249] over 100 "programmable computing elements,"[250] "numerous different types of electronic signaling and interconnect[ed] buses," and thousands of intricate, interlocking parts.[251] And 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.[252] 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

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[246] *See* H. LAURENCE ROSS, SETTLED OUT OF COURT 19 (2d ed. 1980). This extends to rules found in both negligence and products liability.

[247] This could include performance metrics, data auditing, simulation or real-world safety testing, piloting, etc., *see, e.g.,* Erik Coelingh and Jonas Nilsson, *Creating Driving Tests for Self-Driving Cars*, IEEE SPECTRUM (Feb. 27, 2018), https://spectrum.ieee.org/transportation/self-driving/creating-driving-tests-for-selfdriving-cars. In fact, it is precisely the type of proposal advanced by Mark Geistfeld below.

[248] *See infra* notes __ – __ and accompanying text.

[249] *See* Ondrej Burkacky et al., *Rethinking Car Software and Electronics Architecture*, MCKINSEY & COMP. (Feb. 2018), https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/rethinking-car-software-and-electronics-architecture.

[250] Bob O'Donnell, *The Digital Car*, TECH SPOT (May, 23, 2017), https://www.techspot.com/news/69430-digital-car.html.

[251] *See id.*

[252] *See* Ondrej Burkacky et al., *supra* note __.

expectations."[253] But, in actuality, the law simplifies the conceptual complexity of "reasonably safe manufacturing" using highly-developed heuristics the include licensing requirements, manufacturing regulations, professional state-of-the-art standards, industry best-practices, and tort and insurance conventions.[254] What's more, when the circumstances giving rise to an accident become too perplexing even for these modes of analysis, plaintiffs have another tool in their kit. Rather than advancing a theory of negligence *per se*,[255] or showing direct evidence of fault,[256] they can instead rely on the doctrine of *res ipsa loquitur* (*res ipsa*) to prove negligence or a design defect through inference.[257]

A recent action against the automaker, Toyota, is illustrative.[258] It arose after plaintiffs accused the automaker's luxury Lexus vehicles of inexplicably accelerating due to a software error.[259] The plaintiffs alleged that the vehicle's software had caused the cars to suddenly accelerate, leading to the injuries and deaths of Lexus owners.[260] But even after extensive investigations, the plaintiffs failed to pinpoint the precise cause of the error in the code.[261] Jurors, however, ruled in the plaintiffs' favor all the same.[262] Applying the rule of *res ipsa*, they found that the circumstantial

[253] *See id.* (manuscript at 18).

[254] *See* H. LAURENCE ROSS, *supra* note __ (describing this legal machinery).

[255] *See* H. LAURENCE ROSS, *supra* note (describing how statutory violations proceeding under negligence *per se* theories resolve many accidents).

[256] Under either negligence or products liability theories.

[257] For a full-throated description of *res ipsa*, *see* Part IV.A *infra*.

[258] *See* In re Toyota, *supra* note __.

[259] *See id.*

[260] *See id.*

[261] *See id.*

[262] *See* Bloomberg, *Toyota Loses First Acceleration Lawsuit, Must Pay $3 Million*, AUTOMOTIVE NEWS (Oct. 24, 2013), http://www.autonews.com/article/20131024/OEM11/131029935#axzz2r8ypeVIJ. Before the settlement, the court had 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,

evidence surrounding the event permitted the inference of Toyota's fault.[263] Similar theories have succeeded in cases involving other vehicle software defects.[264] And, outside of the automotive realm, plaintiffs have advanced inference-based claims against the software systems controlling commercial airplanes,[265] fishing ships,[266] elevators,[267] passenger trains,[268] surgical robots,[269] and assembly plants.[270]

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, algorithm-based design differences." Yet, not

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> 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 *supra* note __ at *33.

[263] *See id.* (noting Oklahoma jurors awarded the plaintiffs $3 million in damages after applying *res ipsa)*. The settlement led the automaker to settle upwards of 400 related cases that were pending against it. *See* Vladeck, *supra* note __ at 143 (detailing this outcome).

[264] *See, e.g.,* Estate of Edward W. Knoster v. Ford Motor Co., 200 F. App'x. 106, 114 (3d Cir. 2006) (finding the Restatement of Products Liability preserved the possibility that "common experience" can lead to a *res ipsa* inference that a product wouldn't have failed absent a defect); Buck v. Ford Motor Co., 526 F. App'x 603 (6th Cir. 2013) (applying *res ipsa* to claims involving sudden acceleration).

[265] *See, e.g.,* Nelson v. American Airlines, Inc., 70 Cal. Rptr. 33 (Cal. Ct. App. 1968) (applying *res ipsa* to airplane's autopilot); In re Korean Air Lines Disaster of Sept. 1, 1983, 932 F.2d 1475, 1478 (D.C. Cir. 1991); Boucvalt v. Sea-Trac Offshore Servs., Inc., 06-103 (La. App. 5 Cir. 10/17/06); 943 So. 2d 1204, 1208. Ferguson v. Bombardier Service Corp., 244 F. App'x 944 (11th Cir. 2007) (same).

[266]*See* Shaun Fisheries, Inc., No. CIV. 82-529, 1983 WL 699 (D. Or. 1983) (*res ipsa* claim against fishing barge's autopilot system).

[267] *See* Barretta v. Otis Elevator Co., 677 A.2d 979 (Conn. App. 1996) (*res ipsa* claim involving defective elevator).

[268] 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 in which it was famously said: "If two trains are in the same place at the same time, someone was negligent.").

[269] *Family Gets $7.5 Million In Death After Spleen Removal*, MCNABOLO & ASSOCS. LLC (Feb. 21, 2012), https://www.personalinjurylawchicago.com/blog/2012/february/family-gets-7-5-million-in-death-after-spleen-re/ (describing $7.5 million award for *res ipsa* case involving surgical robotics device). *But see* Payne v. ABB Flexible Automation, No. 96-2248, 1997 U.S. App. LEXIS 13571, at *5 (8th Cir. 1997) (dismissing suit for lack of evidence).

[270] *See* Complaint at ¶¶ 52–56, William Holbrook v. Prodomax Automation Ltd. Et Al., Case No. 1:17-cv-00219 (W.D. Mich. Mar. 07, 2017) (*res ipsa* case against "escaped" manufacturing bot that killed worker).

only do proponents of stricter liability regimes largely overlook *res ipsa's* applicability to automated accidents,[271] they also exhibit another oversight. After all, the claim that such accidents will present uniquely tort problems is an empirical one. And, given that the world has already witnessed scores of crashes involving closed-loop vehicles,[272] it stands to reason that evidence of this claim would have already begun to emerge in practice. Again, though, a close examination of the facts suggests the opposite.[273]

Consider, for example, California. The state saw one hundred and twenty accidents involving automated vehicles between January 2014 and September of 2018.[274] As we'll see in Part IV, eighty-six of them involved closed-loop vehicles, meaning that the robot, itself, was in control when the accident occurred.[275] Crucially, of these eighty-six, none gave rise to significant contests over fault.[276] In fact, none so much as went to trial. Authorities successfully resolved questions of blame and compensation in each—a ratio far exceeding that of conventional accidents.[277]

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. 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.[278] 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. Thanks to these detailed records, investigators

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[271] *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 (manuscript at fn. 37).

[272] For a detailed discussion of the 86 accidents involving closed-loop vehicles, *see* Part IV.B *infra*.

[273] *See infra* notes __ – __ and accompanying text.

[274] *See* CALIF. REPORT OF TRAFFIC COLLISIONS INVOLVING AN AUTONOMOUS VEHICLE, *supra* note __ (documenting every accident involving an automated vehicle reported in the state thus far).

[275] *See* Part IV.B *infra*.

[276] Even the Cruise accident discussed in Part I involved a straightforward determination of fault—an outcome that very likely influenced Nilsson's swift settlement after filing the complaint.

[277] In California, for example, roughly 30,000 were contested (and this figure doesn't include claims of less than $25,000 made in small claims courts which the state doesn't track). 2016 COURT STATISTICS REPORT, STATEWIDE CASELOAD TRENDS 2005–2006 THROUGH 2014–2015, JUDICIAL COUNCIL OF CALIF. (2016), http://www.courts.ca.gov/documents/2016-Court-Statistics-Report.pdf.

[278] *See* Part IV.B–C for a detailed discussion of these telematics technologies.

didn't need to cross-examine witnesses or resort to fraught battles of experts, as many experts 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 (more on this in Part IV).

From this mounting number of fault determinations, another brittle assumption underlying calls for stricter liability regimes emerges. As it turns out, fault in the overwhelming majority of crashes resided with human, not robot, operators.[279] This trend, too, bodes ominously for scholars calling to abandon fault-based analysis. For 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 stemmed from human error, stricter liability regimes would routinely impose the costs of behavior we currently call "negligent" on parties exhibiting no evidence of it. Such an outcome would be suboptimal from the dual vantage points of fostering life-saving technologies and fairly allocating costs, as Part IV.C further details.

But it gets worse. Even supposing, *arguendo*, that this trendline reversed, it's also unlikely that the beneficiaries of the "substantial efficiencies"[280] purportedly offered by strict liability are the same ones as proponents appear to have in mind. Those calling for the regime often paint a vision of downstream customers becoming hopelessly embroiled in litigation over technologies that they neither control nor understand.[281] But these concerns, too, 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. But, as we saw in Part II, this question is all but settled. Aside from edge cases involving negligent maintenance or aftermarket modification,[282] responsibility for the operation of closed-loop robots will almost certainly reside with their

[279] *See* CALIF. REPORT OF TRAFFIC COLLISIONS INVOLVING AN AUTONOMOUS VEHICLE, *supra* note __ (according to the most recent reports, faulted resided with the closed-loop system in two of the eight-six accidents); 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 (noting "[h]umans continue to be the cause of most accidents")*;* Francesca M. Favaro, *Examining Accident Reports Involving Autonomous Vehicles in California*, PLOS ONE 12(9): e0184952. https://doi.org/10.1371/journal.pone.0184952.

[279] *See* CALIF. REPORT OF TRAFFIC COLLISIONS INVOLVING AN AUTONOMOUS VEHICLE, *supra* note __ (according to the most recent reports, fault resided with the closed-loop system in two of the eight-six accidents).

[280] *See supra* note __ and accompanying text.

[281] *See supra* notes __ – __ and accompanying text.

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

manufacturers[283]—meaning that downstream consumers will interact with insurance, not tort, liability systems in the event of an accident.[284]

The closest contemporary analogs to the types of insurance models expected to prevail in this coming era are already standard fare in ridesharing fleets.[285] Much like conventional cab providers, companies such as Uber and Lyft directly insure passengers who purchase their services, instead of requiring that they carry individual policies.[286] Passengers injured during a trip receive up to $1 million in insurance coverage automatically.[287] Similar practices have been codified into automated vehicle legislation in states throughout the U.S.[288] Michigan, for example, requires that each "automaker assumes liability and insures every car in its fleet when driverless systems are at fault."[289]

The conclusion that follows from this shift toward fleet-level insurance is a straightforward one. The potential burdens of litigating automated accidents won't fall on the customers riding inside them, as many scholars seem to fear.[290] Rather, such individuals will be insured—meaning it will be the prerogative of highly resourced, sophisticated, and incentive-aligned manufacturers to sort out any thorny questions of fault, indemnity, or joint liability that might arise down the road. (Even if, as Part IV argues, such questions are only likely to arise rarely.)

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 above, but

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[283] *See* Part II.B *supra*.

[284] *See infra* notes __ – __ and accompanying text.

[285] John Cusano & Michael Costonis, *Driverless Cars Will Change Auto Insurance. Here's How Insurers Can Adapt*, HARVARD BUS. REV. (Dec. 05, 2017), https://hbr.org/2017/12/driverless-cars-will-change-auto-insurance-heres-how-insurers-can-adapt (describing future insurance models).

[286] *See* THE CHAOTIC MIDDLE, KMPG (2017), https://assets.kpmg.com/content/dam/kpmg/pdf/2016/06/id-market-place-of-change-automobile-insurance-in-the-era-of-autonomous-vehicles.pdf.

[287] *See id.*

[288] *See id.*

[289] *See* Sam Rutherford, *Waymo Teams Up With Insurance Startup to Cover Riders in Its Self-Driving Cars*, GIZMODO (Dec. 19, 2017), https://gizmodo.com/waymo-teams-up-with-insurance-startup-to-cover-riders-i-1821422677.

[290] To be sure, some accident victims will be third parties.

promptly parts ways.[291] Geistfeld shares Abraham's 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 a crash."[292] 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.[293] According to Geistfeld, evidence of reaching this threshold could be established using "aggregate driving data" from fleets of automated vehicles.[294] And 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."[295]

2. The Reality: Granting Blanket Safe Harbor is Fatally Flawed

In so far as Geistfeld's proposal serves as a recognition that indirect evidence can illuminate questions of liability, 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[296]), but he also fails to show why a multiplier of two "would necessarily satisfy the manufacturer's tort obligation."[297] 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. And in any event, 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."[298] Tort has never compared modern safety standards to those of obsolete predecessors. By the same token, we

[291] *See generally* Geistfeld, *supra* note 25.

[292] *See id.* at 1623.

[293] The term "safe harbor" refers to blanket immunity from liability upon meeting certain predetermined criteria.

[294] *See* Geistfeld, *supra* note 25 at 1622.

[295] *See id.* at 1692.

[296] *See, e.g.,* Zachary C. Lipton & Jacob Steinhardt, *Troubling Trends in Machine Learning Scholarship* (forthcoming 2019) (manuscript at 5) (describing troubling tendencies to make inapposite comparisons between human and machine performance capabilities).

[297] *See* Geistfeld, *supra* note 25 at 1651 (arguing that a 2x "performance standard would necessarily satisfy the manufacturer's tort obligation").

[298] *See* Abbott, *supra* note 25 at 5.

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.[299]

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 (and that's just one of the many high-stakes sectors robots are entering).[300] Halving this figure would, no doubt, constitute an enormous societal achievement. But we don't want manufacturers to start tapping the brakes after dropping the number to a similarly tragic 20,000 deaths. Sure, just as is true of Abraham's and Rabin's proposal, some amount of litigation may conceivably be avoided by granting manufacturers safe harbor. But, as we will see in Part IV.B, this purported benefit would, again, 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.[301] Some scholars now speculate that the software-centric nature of emerging technologies could lead plaintiffs to encounter novel doctrinal roadblocks.[302] One leading article, by Ohio State University's Bryan Choi,

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[299] *See* Eric Morris, *From Horse Power to Horsepower*, ACCESS MAG. (Jul. 7, 2016), https://www.accessmagazine.org/wp-content/uploads/sites/7/2016/07/Access-30-02-Horse-Power.pdf (describing data from Chicago showing "that in 1916 there were 16.9 horse-related fatalities for each 10,000 horse-drawn vehicles. . . nearly seven times the city's fatality rate per auto in 1997").

[300] *See supra* note __ and accompanying text.

[301] *See* Choi, *supra* note 25 (manuscript at 1) (noting robots "have rekindled interest in understanding how tort law will apply when software errors lead to loss of life or limb").

[302] *See, e.g.*, *id.*; Calo, *Robotics and the Lessons of Cyberlaw*, *supra* note 25 at 533-538 (noting possible liability breakdown due to intangibility doctrine); Graham, *supra* note 25 at 131 (expressing concerns that robot software will present formidable hurdles for injured plaintiffs); Abbott, *supra* note __ (same); Nora Freeman Engstrom, *3-D Printing and Product Liability: Identifying the Obstacles*, 162 U. PA. L. REV. ONLINE 35, 38 (2013) (noting "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

describes the problem thusly: "As the software industry ventures from purely cyber systems toward cyber-physical systems [*i.e.* robots], anticipation has been building that the rules for cyber-physical liability" may shake the foundations of tort.[303] According to Choi, "Traditional software did not kill, at least not without opportunity for human intervention. . . . But when code controls physical systems directly, code crashes will cause physical crashes."[304] And this technological paradigm shift, so the account goes, may require a legal paradigm shift, too.[305]

The core challenge, in this view, comes from the code itself. In general, courts have refused to subject software defects to products liability.[306] The justifications are somewhat varied. Courts have done so because the software in question was seen as a "service"[307] or, alternatively, as representing "intangible thoughts, ideas, [or] expressive content."[308] In other circumstances, courts have precluded tort liability due to the economic loss doctrine (*i.e.* "because there [was] no physical injury at stake")[309] or because the case at hand was better suited to a "breach of warranty" claim.[310]

Whatever the precise legal rationale may be, though, the underlying concern remains the same. Despite some precedent to the contrary,[311] many scholars now worry that conventional products liability theories may not be available to plaintiffs involved in software-driven accidents.[312] And, in such a world, scholars fear that the burden of proof facing plaintiffs would be considerable, if not insurmountable.[313] They argue that precluding products

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Regulating Automated Vehicles: A Case Study of Texas Technology, 1 J. OF L. AND TECH. AT TEX. 1, 30 (citing David Polin, Proof of Manufacturer's' Liability for Defective Software, 68 AM. JUR. PROOF OF FACTS, 3d § 333 (West 2015)) (arguing "plaintiffs [are] likely to face considerable difficulty in proving that software was negligently coded").

[303] *See* Choi, *supra* note 25 (manuscript at 4).

[304] *See id.* (manuscript at 4).

[305] *See supra* note 302; *infra* notes __ – __ and accompanying text.

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

[307] *See* Choi, *supra* note 25 (manuscript at 18–20) (surveying such cases).

[308] *See* Sanders v. Acclaim Entm't, Inc., 188 F. Supp. 2d 1264, 1277-79 (D. Colo. 2002); Engstrom, *3-D Printing and Product Liability*, *supra* note __ at 38–39 (surveying such cases).

[309] *See* Choi, *supra* note 25 (manuscript at 3).

[310] *See, e.g., Motorola Mobility, Inc. v. Myriad France SAS*, 850 F. Supp. 2d 878 (N.D. Ill. 2012) (defective software case proceeding under breach of warranty theory); *In re All Am. Semiconductor, Inc.*, 490 B.R. 418 (Bankr. S.D. Fla. 2013) (same).

[311] *See, e.g.,* Singh v. Edwards Lifesciences Corp., 210 P.3d 337 (Wash. Ct. App. 2009) (allowing liability theory to proceed).

[312] *See infra* notes __ – __ and accompanying text.

[313] *See supra* note 42.

liability would render "plaintiffs likely to face considerable difficulty in proving that software was negligently coded."[314] 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."[315] Plaintiffs, according to this view, would need to "engage in a searching review of the computer code that directs the movement of [robots]."[316] And just as Abraham, Rabin, and Geistfeld argue, experts adopting this position insist such an undertaking would be "difficult[] and expensive," if not impossible.[317]

2. The Reality: Faulty Software Has Killed Before and Establishing Fault Didn't Require Pinpointing a Faulty Line of Software

The reality, however, is that the concerns expressed above are largely overstated. First, as we saw in Subpart A *supra*, contemporary vehicles already contain hundreds of electronic control units running millions of lines of code.[318] 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).[319] Even when the software directly determines the performance of such products, tort liability doesn't 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.[320] No matter the industry, product manufacturers are duty bound to ensure their products operate in a reasonably safe manner, including when it's software that determines the performance of such products.[321] And in dozens of cases centering on software-driven injuries spanning diverse industrial contexts, this duty has

[314] *See* Wagner & Loftus-Otway, *supra* note __ at 30.
[315] *See* Choi, *supra* note __ at 3.
[316] *See* Graham, *supra* note __ at 131.
[317] *See id.* at 131; *supra* note 302.
[318] *See* Part II.A *supra*.
[319] *See* Geistfeld, *supra* note __ at 1631 (describing legal system's regard for software as part of a broader product).
[320] *See id.* at 1631.
[321] RESTATEMENT (THIRD) OF TORTS: PHYSICAL & EMOTIONAL HARM § 7(a) (2010) ("[A]n actor ordinarily has a duty to exercise reasonable care when an actor's conduct creates a risk of physical harm.").

not been "negated by the economic loss rule [n]or contractual provisions that disclaim the manufacturer's liability."[322]

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 did not kill, at least not without opportunity for human intervention," the reality is that software actually *has* killed and maimed many times before, going decades back.[323] And, crucially, those software-driven injuries included instances "without opportunity for human intervention."[324] Closed-loop software has injured in aviation, elevators, assembly plants, medical settings, and numerous other contexts.[325] In fact, as the "sudden acceleration" cases discussed in Part A show, it has even killed or maimed in the automotive realm.[326]

But the problems with the view outlined above don't end there. As Part A also makes clear, assertions about the "exceedingly difficult"[327] burden of proving fault without conventional products liability theories are also dubious. *In re Toyota* and numerous other examples show that demonstrating fault caused by faulty software doesn't require that plaintiffs "engage in a searching review of the computer code that directs the movement of [robots]."[328] 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.[329] And that, in turn, suggests plaintiffs won't face nearly as insurmountable an evidentiary burden as some now suggest.[330]

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

[322] *See supra* notes __ – __; Geistfeld, *supra* note __ at 1631 (noting the liability is not "negated by the economic loss rule or contractual provisions that disclaim the manufacturer's liability").

[323] *See* Part IV.A.

[324] *See supra* notes __ – __.

[325] For a discussion of these cases, *see infra* notes __ – __ and accompanying text.

[326] *See, e.g.,* In re Toyota, *supra* note __.

[327] *See* Choi, *supra* note __ at 3.

[328] *See* Graham, *supra* note __ at 131.

[329] *See* Part IV.A.

[330] *See id.*

scholars calling for an outright "break with tort"[331] lies another group whose outlook is less dire. In this view, the vexing challenges inherent to robotics accidents won't require a page one rewrite of conventional liability. Rather, patience will cure tort's impending ails.[332]

According to this account, a natural transition to "strict products liability" will resolve the thorny challenges complex robots would otherwise pose for negligence analysis.[333] Tort theorists of this view tend to spin out the following syllogism: (1) closed-loop machines will shift accident liability from human operators to product manufacturers; (2) plaintiffs injured by such products can ground their claims in "strict products liability" doctrine; and, consequently, (3) tort will naturally hold robot manufacturers strictly liable[334] for accidents.[335] 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

[331] *See* Subpart A–B *supra*.

[332] *See infra* notes __ – __ and accompanying text.

[333] *See, e.g.,* Calo, *Robotics and the Lessons of Cyberlaw*, *supra* note 25 at 535 (writing that "plaintiffs injured by the products they buy can generally avail themselves of strict liability"); Abbott, *supra* note 25 at 4–5 (asserting products liability entails strict liability whereas negligence entails a distinct reasonableness standard); Jeremy Levy, *No Need to Reinvent the Wheel: Why Existing Liability Law Does Not Need to Be Preemptively Altered to Cope with the Debut of the Driverless Car*, 9 J. BUS. ENTREPRENEURSHIP & L. 355, 377 (2016) (asserting product liability regime will hold manufacturers "strictly liable for every choice the autonomous vehicle makes, regardless of fault"). Unfortunately, the list of student notes that have repeated his error is long. *See, e.g.,* 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 "society already accepts that car manufacturers can be held strictly liable for defects in their products"); 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 products liability is a strict regime). 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.,* Richard A. Epstein, *The Irrelevance of the Hand Formula: How Institutional Arrangements Structure Tort Liability*, in Jef De Mot (ed.), LIBER AMERICORUM BOUDEWIJN BOUCKAERT (2012) (making such an argument); Escola v. Coca-Cola Bottling Co., 150 P.2d 436, 440 (Cal. 1944) (Traynor, J., concurring) (noting a manufacturer's difficulty overcoming "the negligence rule approaches the rule of strict liability"). But neither of these nuanced claims underlies the arguments set forth above.

[334] For accidents causing physical harm, at least.

[335] *See supra* note 333.

can generally avail themselves of strict liability. They do not need to show negligence."[336]

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, wouldn't require us to reinvent the liability wheel. For, unlike negligence, "strict products liability" obviates the need to show fault. And that, in turn, means liability for automated accidents will shift—of their own accord—toward analytic approaches better suited to the "current competency of judges" by sheer virtue of the fact that they'll involve products.[337]

2. The Reality: "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.[338] Consult virtually "any book or article [and you'll] find that the field of nonintentional torts is divided into two domains, negligence liability and strict liability" for product defects.[339] 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."[340]

But even though the notion of "strict" products liability remains "so well ingrained as to be well-nigh impregnable," the description is actually a misnomer.[341] 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,"[342] or it must hold defendants accountable for conduct even in the absence of intent. Modern products liability, of course, does neither.

To be sure, several early rulings saw it as a genuinely "strict" standard.[343] But that's long since changed. Products liability tests in force

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[336] *See* Calo, *Robotics and the Lessons of Cyberlaw*, *supra* note 25 at 535.

[337] *See* Schroll, *supra* note __ at 820–21.

[338] *See* Richard L. Cupp Jr. & Danielle Polage, *The Rhetoric of Strict Products Liability Versus Negligence: An Empirical Analysis*, 77 N.Y.U. L. REV. 874, 893 (2002) (noting the view "permeates . . . torts casebooks and treatises").

[339] *See id.*

[340] *See* PETER GERHART, TORT LAW AND SOCIAL MORALITY, 194-5 CAMBRIDGE U. PRESS (2010) (quoting Mark Geistfeld, Essential of Tort Law 406, Wolters Kluwer (2008)).

[341] *See id.*

[342] *See* Cupp & Polage, *supra* note __.

[343] *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 §

in the majority of states turn on principles of reasonableness, foreseeability, and causation that are congruent with findings of fault in negligence.[344] The *Third Restatement*, for example, describes products liability "as equivalent to negligence," noting 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 only attach when harm is reasonably preventable."[345] 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.[346] Where manufacturers have fulfilled their obligation to adequately warn consumers, the various tests function essentially as "[different] labels for the same liability rule"—one that turns on a cost-benefit analysis resembling negligence.[347]

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 [negligence as] "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."[348]

Nowadays, the claim that negligence and products liability theories are substantively similar in application isn't new.[349] It's not even controversial.[350] Yet, mystifyingly, no matter how many times scholars conclusively kill "strict products liability," like a zombie it lives on. And,

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402A (1965) (noting manufacturer that "sells a product in a defective condition unreasonably dangerous to the user or consumer" is strictly liable).

[344] *See* Geistfeld, *supra* note __ (observing: "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.").

[345] *See* RESTATEMENT (THIRD) OF TORTS: PRODUCTS LIABILITY § 2.

[346] *N.B.* This excludes manufacturing defect theories, which are rare but in fact "strict" in the true sense of the standard.

[347] *See id.*

[348] *See* GERHART, *supra* note __ at 194-5.

[349] *See, e.g., supra* notes 344–345; Crane et al., *supra* note __ (describing two standards as equivalent); John C. Goldberg, Anthony J. Sebok & Benjamin C. Zipursky, TORT LAW: RESPONSIBILITIES AND REDRESS 887 (3d ed. 2012).

[350] *See, e.g.,* Cupp & Polage, *supra* note __ (showing consensus); GERHART, *supra* note __ (same); Crane et al., *supra* note __ (same); James A. Henderson, Jr. & Aaron D. Twerski, *Achieving Consensus on Defective Product Design*, 83 CORNELL L. REV. 867 (1998) (same).

unfortunately, it continues to survive in the contemporary literature—causing significant analytic confusion even among leading experts.[351]

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.[352] But, in actuality, the regime is no panacea. Simply shifting away from negligence toward products liability regimes won't allow plaintiffs to "avail themselves of strict liability," as some claim.[353] Rather, plaintiffs will still need to show fault—even when their injuries are caused by profoundly complex products.[354] And, as it so happens, *res ipsa* theories are actually particularly well suited to this type of analysis.[355] 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, in any event, alternative regimes proposed by leading experts fail to offer satisfying solutions. But simply pointing out these analytic defects doesn't resolve the very real liability challenges posed by the technologies. 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 an inference-based analysis about the fault of the software running underneath the hood.[356] The robot, in other words, speaks for itself.

Thus, 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 subparts will show why doctrinal claims based on *res ipsa*-style negligence theories actually offer a surprisingly virtuous solution to one of the great regulatory challenges of the coming era. Subpart A describes the rule of *res ipsa*, as well as its application to modern suits involving liability for automated accidents. Subpart B shows how informal versions of *res ipsa* have already shown promise in scores of accidents involving automated vehicles and makes the

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351 *See* Part III.D.1 *supra*.
352 *See supra* note 333.
353 See Calo, *Robotics and the Lessons of Cyberlaw*, *supra* note 23 at 535.
354 *See supra* notes __ – __ and accompanying text.
355 *See* Part IV *infra*.
356 *See* Part III.B *infra*.

case for an analytic approach we might call "*robot ipsa loquitur*." Finally, Subpart 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.[357] A crash's mere occurrence, as we saw in Part 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."[358]

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.[359] In many cases, plaintiffs invoke inference without any specific reference to formal tort doctrine.[360] If, for example, "a man is found with his throat cut and the defendant was the last person seen with him, the 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."[361] But when the relevant circumstantial evidence stems directly from an allegedly tortious accident, "we speak of it as a case of *res ipsa loquitur*."[362]

The Latinism, of course, means nothing more than "the thing itself speaks."[363] It entered the legal canon through Chief Baron Pollock in the 19th century case, *Byrne v. Boadle*.[364] The case centered on a hapless pedestrian injured by a flour barrel that inexplicably fell from the

[357] Under either negligence or products liability theories.

[358] *See* Meiring De Villiers, *Virus Ex Machina Res Ipsa Loquitur*, 1 STAN. L. TECH REV. 1 (2003) (manuscript at ¶ 5) (citing United States v. Carroll Towing Co., 159 F.2d 169, 171–73 (2d Cir. 1947)). As Part III.D showed, this is true under negligence or products liability theories.

[359] *See generally* William L. Prosser, *Res Ipsa Loquitor in California*, 37 CALIF. L. REV. 183 (1949) (describing rule).

[360] *See id.* at 189.

[361] *See id.* at 189.

[362] Griffin v. Manice (1901) 166 N.Y. 188, 196, 59 N. E. 925, 927.

[363] *See* Prosser, *supra* note __ at 190.

[364] *See* David Kaye, *Probability Theory Meets Res Ipsa Loquitur*, 77 Mich. L. Rev. 1456, 1458 (noting the phrase "appears to have been introduced into the law of torts by Chief Baron Pollock" in Byrne v. Boadle).

defendant's warehouse.[365] The defendant argued that a lack of direct evidence precluded liability. But Pollock, the presiding judge, disagreed. He ruled: "There are certain cases of which it may be said *res ipsa loquitur* . . . . [T]he mere fact of an accident's having occurred is evidence of negligence."[366]

Today, virtually every state recognizes *res ipsa*,[367] 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 (1) the event does not ordinarily occur absent negligence; (2) other possible causes, including the conduct of the plaintiff and third persons, are sufficiently eliminated by the evidence; and (3) the indicated negligence is within the scope of the defendant's duty to the plaintiff.[368] 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.[369] Early cases invoking the doctrine, for example, frequently involved overturned stagecoaches, defective vehicle componentry, and derailed trains.[370] 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 less infrequent than one might imagine. And when a parked car inexplicably begins barreling down a hill, it's hardly a stretch to analogize the circumstantial evidence to barrels inexplicably falling from warehouses.[371]

Of course, *res ispa* is hardly limited to accidents involving 19th and 20th century technologies. As Part III.A's discussion of *In re Toyota* reveals, the negligence rule has also shown great promise in cases involving modern automated products. But the "sudden acceleration" case against Toyota, as we also saw, is just one exemplar. Analogous theories have been advanced against other automakers.[372] And beyond these automotive cases, *res ipsa* is also commonly invoked in other contexts. It has been advanced in suits

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[365] *See generally*, Byrne v. Boadle, 159 Eng. Rep. 299 (Ex. 1863).

[366] *See id.*

[367] *But see, e.g.,* Watson v. Ford Motor Company, TRW, Inc., 699 S.E. 2d 169 (2010) (noting that South Carolina does not recognize the rule of *res ipsa*).

[368] RESTATEMENT (THIRD) OF TORTS: RES IPSA LOQUITUR § 17; RESTATEMENT (THIRD) OF TORTS: PRODUCTS LIABILITY § 3 (1998).

[369] *See* Part III.A; *infra* notes __ – __ and accompanying text.

[370] Wyatt v. Pacific Elec. R. Co. (1909) 156 Cal. 170, 103 Pac. 892.

[371] *See* Prosser, *supra* note __ at 196 (describing *res ipsa* cases involving a "parked car which starts down a hill").

[372] *See, e.g.,* Buck v. Ford Motor Co., 526 F. App'x 603 (6th Cir. 2013) (using *res ipsa* in claims involving sudden acceleration).

involving commercial airplanes,[373] fishing barges,[374] elevators,[375] passenger trains,[376] surgical robots,[377] and even "escaped" assembly line bots.[378]

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's 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."[379] Indeed, as the next subpart 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 such claims largely 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.[380] And rather than confounding the question of fault, the overwhelmingly weight of the evidence indicates that the involvement of robots more often simplifies it.[381]

Consider California. Since 2014, state law has mandated that autonomous vehicle operators file public reports in the event of an accident.[382] Consequently, we know that the state witnessed at least one hundred and twenty accidents involving autonomous vehicles between 2014 and September 2018.[383] And of these, eighty-six involved vehicles in "autonomous mode," meaning that the liability loop was effectively closed at the time of the accident.[384] (As Part II.A shows, this closing of the loop is true regardless of whether the system was nominally referred to as Level

373 *See supra* note 265.
374 *See supra* note 266.
375 *See supra* note 267.
376 *See supra* note 268.
377 *See supra* note 269.
378 *See supra* note 270
379 *See, e.g.,* Fowler v. Seaton, 61 Cal. 2d 681, 687 (Cal. 1964).
380 *See* CAL. REPORT OF TRAFFIC COLLISIONS INVOLVING AN AUTONOMOUS VEHICLE, *supra* note 48 (describing more than 120 accidents reported in California, 86 of which involve closed-loop robots).
381 *See id.* (allocating fault in every accident).
382 *See id.*
383 *See id.*
384 *See id.*

2, 3, or 4.) Taking the literature's claims regarding the vexing complexity of such accidents at face value, we might already expect there to be a considerable amount of litigation stemming from these accidents.[385] But in actuality, blame and compensation have been successfully allocated in each instance.[386] And, as we saw in Part III.A, fault for almost every accident has resided with a human, not robot, driver.[387]

The successful resolution of so many fault determinations, however, begs the question: How could authorities be so confident in their conclusions? After all, none had direct access to the robot's underlying software. And, complicating matters further, even if authorities did have access, they'd still have to overcome the fact that relevant software is very likely an algorithmic "blackbox."[388] The answer to this seeming 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 "event data recorder" (EDR)—investigators tasked with reconstructing accidents are actually able to recreate detailed, moment-by-moment accounts of accidents.[389]

EDR technologies, of course, aren't novel to modern accident analysis.[390] But when used in conjunction with modern robotics applications, they offer investigators unique 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.[391] And as a natural byproduct, they collect richly detailed, multisensory records of the events leading up to accidents.[392] Consequently, authorities can simply examine the evidence captured by the vehicle's componentry, navigational

[385] *See supra* note 42. Particularly given the fact that potential plaintiffs were deemed to be at fault in the overwhelming majority of accidents, as Part III showed.

[386] *See id.*

[387] *See id.*

[387] *See* Kokalitcheva*, supra* note __ (noting "[h]umans continue to be the cause of most accidents").

[388] *See* Selbst & Barocas, *supra* note __ (describing this term).

[389] *See* Kristen Hall-Geisler, *The Importance of Black Boxes in an Autonomous Automotive Future*, TECH CRUNCH (Dec. 13, 2016), https://techcrunch.com/2016/05/13/the-importance-of-black-boxes-in-an-autonomous-automotive-future/ (describing the rise of EDRs).

[390] *See* Jaclyn Trop, *A Black Box for Car Crashes*, N.Y. TIMES (Jul. 21, 2013), https://www.nytimes.com/2013/07/22/business/black-boxes-in-cars-a-question-of-privacy.html (describing narrow uses of telematics technologies to determine braking and positioning of vehicles involved in conventional accidents).

[391] *See* Hall-Geisler, *supra* note __ (describing how the proliferation of sensing technologies vastly increases the capabilities of EDRs). For illustrations of these sensing technologies in action, s*ee also* Appendix A *infra*.

[392] *See id.*; Appendix A *infra*.

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.[393]

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.[394] It's as easy as letting the robot's account of the accident "speak for itself." To be clear, no fault assignments involving automated vehicles have yet occurred under the formal auspices of *res ipsa*. But, as we saw in Subpart A, it's not necessary to throw around Latinisms to invoke inferential evidence. Without displaying a "learned tongue," authorities ranging from federal agencies to local police have, nonetheless, relied on EDRs to navigate around what might otherwise prove to be "confounding" algorithmic roadblocks.[395] After reconstructing the events, they simply looked for fault in the robots' records.[396] Where the relevant evidence spoke of human negligence, robot fault was presumptively absent.[397] Conversely, where the evidence didn't 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,[398] each has displayed this unique ability to turn the "vexing" tort inquiry dreaded by many scholars on its head. It's a somewhat counterintuitive outcome, given that modern robots are routinely described as utterly inscrutable "algorithmic blackboxes."[399] But if we liken the opacity of these algorithms to the opacity of the warehouse in the canonical *res ipsa* case of *Byrne v. Boadle*, the applicability of inference becomes immediately apparent. Just as is true in human-driven accidents, investigators needn't uncover direct evidence of fault in the code running on the robot's proverbial brain.[400] Instead, they can look to the accident itself. Indeed, it seems a solution to the "vexing" tort challenges of automated accidents may have been hiding in plain sight all along. Rather than requiring a "revolutionary" new liability regime,[401] *robot ipsa loquitur*—let the robot speak for itself.

[393] Metz*, supra* note __ (describing these sensing capabilities).

[394] Not to mention direct evidence and evidence of negligence *per se*.

[395] *See* Kokalitcheva*, supra* note __ (describing over 100 successful fault determinations in California alone).

[396] *See id.*

[397] *Cf.* CAL. REPORT OF TRAFFIC COLLISIONS INVOLVING AN AUTONOMOUS VEHICLE, *supra* note 48.

[398] People, for example, have kicked and stabbed automated vehicles.

[399] *See, e.g.,* Selbst & Barocas, *supra* note __ (surveying these descriptions).

[400] *See* Part III.A *supra*.

[401] *See* Parts II.B and III *supra*.

C. Letting Robots Speak for Themselves

Above, we saw that inference-based[402] analysis provides a potent tool for establishing fault in complex machine-driven accidents and, further, that 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. Just as occurred in early medical malpractice cases involving *res ipsa* claims,[403] 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. But, as we saw in Part III, 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's necessary to go beyond theoretics. Contemporary evidence, high-stakes policy tradeoffs, and possible doctrinal pitfalls must by 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.

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[404] 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 providing: (3) clear causal evidence[405] or (4) not.

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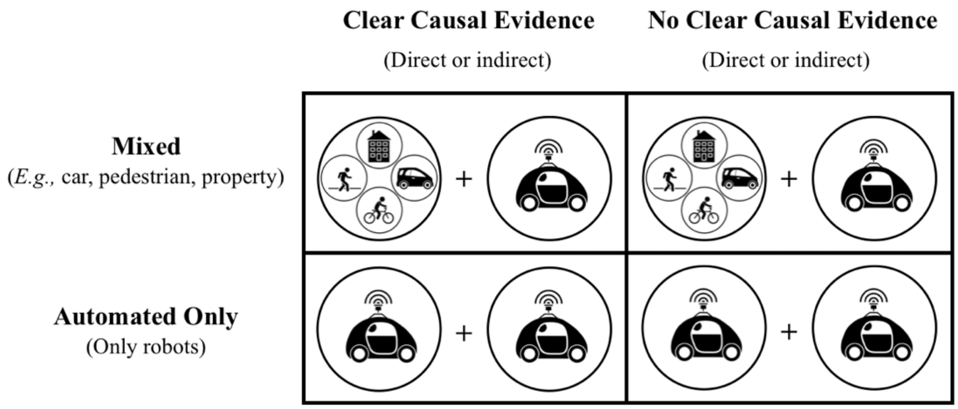
402 In accidents with direct evidence of human negligence, the "inference" referred to here involves the robot's presumptive lack of negligence or defectiveness.

403 Certain forms of medical liability, for example, foreclosed *res ipsa* due to a "guilty knowledge" requirement.

404 *E.g.* pedestrians, cyclists, property, etc.

405 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



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."[406] But walking through how *robot ipsa* would actually play out in each instance helps to shrink these fears down to size.

To start, as Subpart B demonstrated, conventional analysis is already well-equipped to handle automated accidents exhibiting clear[407] evidence of negligence or a design defect (*i.e.* 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 opaque warehouse found in *Byrne v. Boadle*, then these detailed logs should shed considerable light on the question of fault—whether it ultimately comes in the form of direct evidence, indirect evidence, or evidence of negligence *per se*.[408] 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.[409]

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lack of negligence (or defectiveness) on behalf of the parties exhibiting no evidence of it.

[406] *See* Part III *supra*.

[407] Again, the evidentiary standard is a preponderance.

[408] *See* Part IV.B *supra*.

[409] *See, e.g.,* 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; Notice of Proposed Rulemaking: Fact Sheet on Vehicle-to-Vehicle Communication Technology, NAT'L HIGHWAY TRANSP. SAFETY ADMIN. (2016), https://icsw.nhtsa.gov/safercar/v2v/pdf/V2V_NPRM_Fact_Sheet_121316_v1.pdf . For a seminal work on the new role of machine evidence in modern law, *see generally* Andrea Roth, *Machine Testimony*, 126 YALE L. J. 1972 (2017).

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[410]) by looking at direct evidence of negligence on behalf of any non-robot actor. Where no such evidence exists, it's absence will give rise to the inference that the robot's causal role in accident "was of a kind that ordinarily occurs as a product defect" or negligence.[411] 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.[412] Moreover, as incremental advances in safety technologies enter into automated fleets over time, they'll introduce new considerations that help to inform and update contemporary assessments—just as occurs today.[413]

Having, thus, dispatched with what the current evidence indicates will be the overwhelming majority of accidents using *robot ipsa*, what remains is the left-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 isn't only useful in accidents where plaintiffs lack strong causal evidence. As we saw in Subpart A *supra*, it's also useful where the cause of an accident is an outright "mystery."[414] In such instances, *res ipsa* transforms from a mere liability rule to an information-forcing one.[415] When non-robot actors (*e.g.* conventional drivers, cyclists, pedestrians, or even property) are harmed by a closed-loop robot, and there's no evidence that the plaintiff's own negligence was solely responsible, *res ipsa* will shift the evidentiary burden to manufacturers. Having done so, it will then be up to those in the best position to produce exculpatory evidence to rebuff the inference. When they cannot, the liability burden will fall upon these sophisticated, well-resourced parties, *i.e.* the parties almost certainly best placed to handle it. And that outcome, in turn, means *robot ipsa* is amply capable of handling the first of the two scenarios in the left-hand column of the taxonomy. That said, it's important to note

[410] Perhaps more often than not.

[411] RESTATEMENT (THIRD) OF TORTS: PRODUCTS LIABILITY § 3(a) (1998).

[412] As Abraham & Rabin note, the complex "issues that arise out of such situations have been addressed and resolved—albeit not in a single voice." *See supra* note 23 (manuscript at 16).

[413] *See* Daniel J. Fagnant & Kara Kockelman, *Preparing a Nation for Autonomous Vehicles: Opportunities, Barriers, and Policy Recommendations*, 77 TRANSPORTATION RESEARCH PART A 167, 176 (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").

[414] *See* Fowler v. Seaton, *supra* note __ (noting: "Res ipsa loquitur may apply where the cause of the injury is a mystery . . .").

[415] *See id.*

the variation between states today surrounding this burden shifting process.[416] 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.

Finally, with three out of the four conceivable scenarios dispatched using conventional analysis, we're left with one remaining: those accidents between two or more robots *with no clear causal inference of fault by any party*. To be frank, it's not at all apparent what such a 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. And, 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.

But 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 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 would 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.[417] 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.

But, while this small (perhaps infinitesimally small) subset of accidents will certainly pose its share of challenges for conventional tort, they aren't actually the same as those which scholars typically raise when advocating for new liability regimes. First, as Part 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 ridesharing customers do today.[418] Secondly, this shift away from individual insurance policies and towards fleetwide insurance models will, in turn, mean that the burden of litigating this rare category of accident will fall—once more—on the parties best situated to handle it. 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 such an undertaking

[416] *See* KENNETH ABRAHAM, THE FORMS AND FUNCTIONS OF TORT LAW 108–11 (4th ed. Thomson Reuters Press 2012) (describing varying applications).
[417] *See* Part III.A *supra*.
[418] *See* Part III.A *supra*.

might adversely affect individual victims. But, even here, this type of outcome is unlikely. Indeed, just as occurred in the vehicle component manufacturing industry and the car insurance industry,[419] the inefficiencies of pursuing formal legal actions against other manufacturers will likely drive certain industry sectors to devise parallel systems for more efficiently allocating liability and compensation.

2. Artificial Operators

Having explored the practical applications of *robot ipsa* as it would apply to each conceivable automated accident scenario, we can now begin addressing 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."[420] 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."[421]

Here, it's commonly said that plaintiffs must show that an "instrumentality" which caused an accident was under the defendant's "exclusive control."[422] But as Prosser observed long ago, this description "is misleading and pernicious."[423] 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."[424] 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."[425] A better articulation comes from the *Third Restatement*, which asks whether intervention by outside parties[426] has been "sufficiently eliminated by the evidence."[427]

Nowadays, producing this kind of evidence for human-driven accidents is largely a formality.[428] Conventional analysis presumes that

[419] *See generally* ROSS, *supra* note __.

[420] *See* Prosser, *supra* note __ at 196.

[421] *Id.* at 197.

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

[423] *See* Prosser, *supra* note __ at 199.

[424] *Id.*

[425] *Id.* at 200.

[426] *I.e.* parties other than the defendant(s).

[427] *See supra* note __. As is true of tort law generally, "the evidence need not be conclusive, but should eliminate intervening causes with a greater than 50 percent likelihood." *See* Villiers, *supra* note __ (manuscript at ¶ 53).

[428] *See infra* notes __ and accompanying text.

responsibility lies with the "driver," "operator," or, in some circumstances, "owner" of a vehicle.[429] 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 even though there's little controversy surrounding this shift *in theory*, ensuring that it occurs in practice is actually less straightforward than we might imagine. 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.[430] 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."[431] In 2015, Google's automated vehicle outfit sought clarification on precisely this issue in a letter to the National Highway Traffic Safety Administration (NHTSA). 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.'"[432] But Google, meanwhile, was set on developing a vehicle "entirely controlled by artificial intelligence . . . such that no driver was needed, or indeed, wanted."[433] 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 that "it 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."[434] As such, the agency recommended that Google instead petition for an outright exemption from the federal regulatory requirements, so that the company could continue to advance its AV technology apace.

Thankfully, now that this potential legal roadblock has been identified, a massive typological overhaul is underway across the nation to redress it.[435] Numerous states have clarified that machine operators needn't necessarily be flesh and blood.[436] 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,"

[429] *See also* Daniel A. Crane et al., *supra* note (stating that at the present time, "we commonly speak of crashes as being caused by one or more at-fault drivers."); Jerry L. Mashaw & David L. Harfst, *supra* note __.

[430] Jerry L. Mashaw & David L. Harfst, *supra* note __ at 267–8.

[431] *See id.*

[432] *See id.*

[433] *See id.*

[434] *See id.* at 267–8.

[435] *See id.* at 267–271 (describing the overhaul).

[436] *See id.*

"operators," or "owners" of carriages.[437] 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

So far, we've seen the power of analogy to overcome some of the thorniest doctrinal challenges posed by closed-loop robots. Nationwide legislative revamps doing away with statutory definitions that presume the presence of human operators serve as strong examples. So, too, do the scores of automated accidents resolved by drawing straightforward analogies from human drivers to their machine-driven counterparts.[438] But just because analogizing from people to robots is appropriate in some contexts doesn't mean it is in *all* contexts. Rather, plaintiffs advancing *robot ipsa* claims must also be cautious of the approach's limits.

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. 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.[439] And with this footage in hand, authorities promptly exonerated the tech company. Despite its low quality, the video showed Herzberg stepping suddenly into the well-lit roadway from the shadowy median. From this footage, the police chief determined that fault for the accident lay not with Uber but Herzberg. In the chief's telling, Herzberg "came from the shadows right into the roadway."[440] And in his estimation, no human could have reacted in time—effectively exonerating Uber.

Unfortunately, the officer's determination failed to account for the fact that Uber's autonomous vehicles navigate using a combination of sensory inputs, including LIDAR, ultrasonic, and radar systems that don't all rely on the visible light spectrum.[441] With no physical occlusions in their way, these sensory systems are capable of spotting objects even in pitch black—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

[437] *See generally* Huddy, *supra* note __ (describing these typological problems).

[438] *See id.*

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

[440] *See id.*

[441] For an illustration of these systems, *see* Appendix A *infra*.

excuse.[442] Rather, the vehicle's sensory system experienced a catastrophic error, causing it to fail to detect Herzberg. Fortunately, investigators quickly realized the error in their analogy, eventually pointing the finger of blame squarely at Uber. But the incident, nonetheless, provides a cautionary tale. For some robot behaviors, direct comparisons to humans simply don't make sense. And practitioners, courts, legislatures, and regulators considering the application of *robot ipsa* must be cognizant of these instances.

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. But 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.[443] And 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 on offer, and (3) provides a pragmatic solution that neither requires "dramatic and unsettling"[444] legal changes, nor precludes industries from devising parallel allocative systems that promote fairness and efficiency among manufacturers.

First, the available evidence indicates that *robot ipsa* would better promote tort's fundamental goals of "inducing firms to improve product safety, causing prices of products to reflect their risks, and providing compensation to injured consumers."[445] 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 such accidents would shift to manufacturers. 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—as recently occurred in Arizona[446]—the law would automatically impose the costs on the automated vehicle manufacturers. This state of affairs would require manufacturers to raise the price of their (potentially safer) services,[447] allow drivers to externalize the

[442] *See id.*

[443] *See supra* notes __ – __.

[444] *See* Abraham & Rabin, *supra* note 23 (manuscript at 51).

[445] *See* A. Mitchell Polinsky & Steven M. Shavell, *The Uneasy Case for Product Liability*, 123 HARV. L. REV. 1436, 1440 (2010).

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

[447] *See generally* Richard Craswell, *Passing on the Costs of Legal Rules: Efficiency and Distribution in Buyer-Seller Relationships*, 43 STAN. L. REV. 361

costs of behavior we currently consider negligent,[448] and potentially disincentivize additional spending on safety.[449] As Mark Lemley and I recently discussed, "[w]ithout the addition of a contributory[450] 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,[451] 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."[452] Meanwhile, safe harbor liability would produce a different, albeit similarly troubling, set of incentives (as discussed in Part III.B).

Second, *robot ipsa* provides a more generalizable solution than the ones currently on offer. 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.[453] But as we saw above, the same 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. And 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* doesn't 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 promisingly, if manufacturers, industries, regulators, or insurers do, ultimately, decide to devise their own parallel regimes for allocating liability costs, *robot ipsa* won't stand in their way. Indeed, all signs suggest that industry-wide movements in this direction are already underway—with insurance liability, for instance, likely to shift away from individual,

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(1991) (describing how redistributing costs through liability can be undone through price increases by manufacturers).

[448] *See* Louis Kaplow & Steven Shavell, *Economic Analysis of Law*, in HANDBOOK OF PUBLIC ECONOMICS 1667–82 (A.J. Auerbach and M. Feldstein eds., 2002) (describing this phenomenon).

[449] *See id.*

[450] Or, of course, comparative negligence.

[451] By either accident costs, increased insurance premiums, or, most likely of all, a more competitive transportation price.

[452] *See* Mark A. Lemley & Bryan Casey, *Remedies for Robots*, U. CHI. L. REV. (forthcoming 2019) (manuscript at 92).

[453] *E.g.* by relying on "aggregate driving data" or cost pooling mechanisms only applicable to automakers.

coercive models towards fleetwide ones that companies build into their pricing structure. Not only would r*obot ipsa* allow the continuation of this trend, it would do so without jeopardizing the interests of accident victims, nor imposing additional costs on the deployments of life-saving—potentially world-changing—technologies.

CONCLUSION

In the end, those who argue that emerging robotics applications will pose "vexing tort problems" for conventional analysis have it 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 not necessitate a wholesale "break with the tort system," nor a sharp doctrinal turn toward "strict products liability."[454] The legal system has successfully dealt with complex, software-driven accidents many times before. And it has done so using age-old approaches that offer an elegant solution to the purportedly "confounding" challenges raised by automated accidents.[455]

If this Article's assessment is accepted, it implies that serious consideration should be given to fault-based theories that rely on the inference of negligence or design defect—an approach it calls *robot ipsa loquitur*. The deficiencies of the alternatives proposed by leaders of the field are clear. Of course, decades from now, the stark policy differences between fault-based liability and stricter alternatives[456] may become less consequential. Robots might, for example, become so safe as to 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 only attach when harm is reasonably preventable"[457] 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.

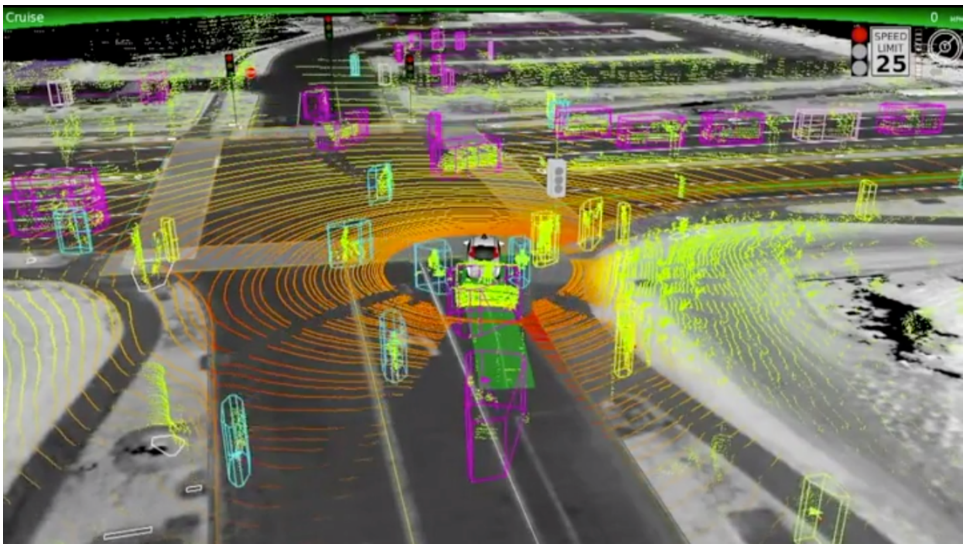
[454] *See supra* notes __ – __ and accompanying text.
[455] *See* Part III *supra*.
[456] Be it in the form of strict, common enterprise, safe harbor, or no-fault liability.
[457] *See* RESTATEMENT (THIRD) OF TORTS: PRODUCTS LIABILITY § 2.

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 NHTSA produced in the aftermath of Joshua Brown's fatal collision.

Figure 1: Examples of Robot Sensory Inputs

(a) Multisensory Inputs at Intersection



(b) LIDAR Sensing Pedestrian

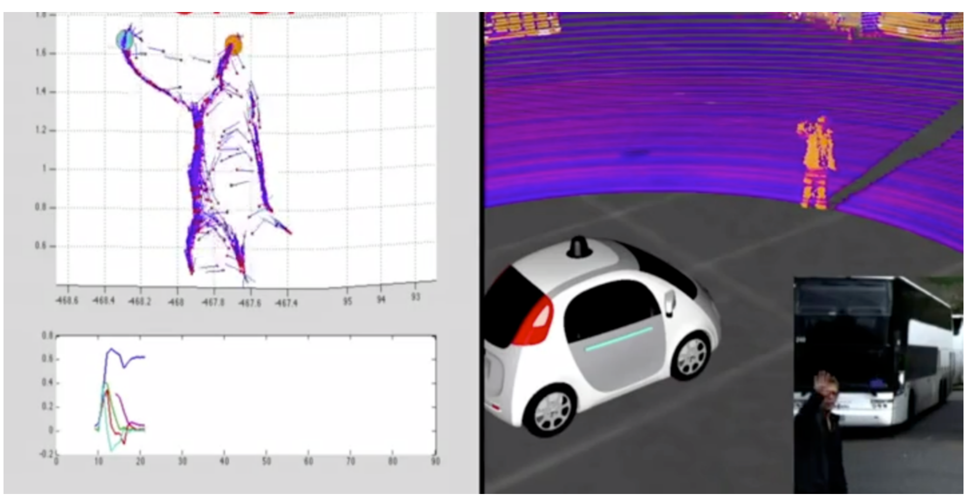


Figure 2: Examples of Robot Planning Systems

(a) Robot at Intersection

(b) Robot Allowing Bus to Enter Lane

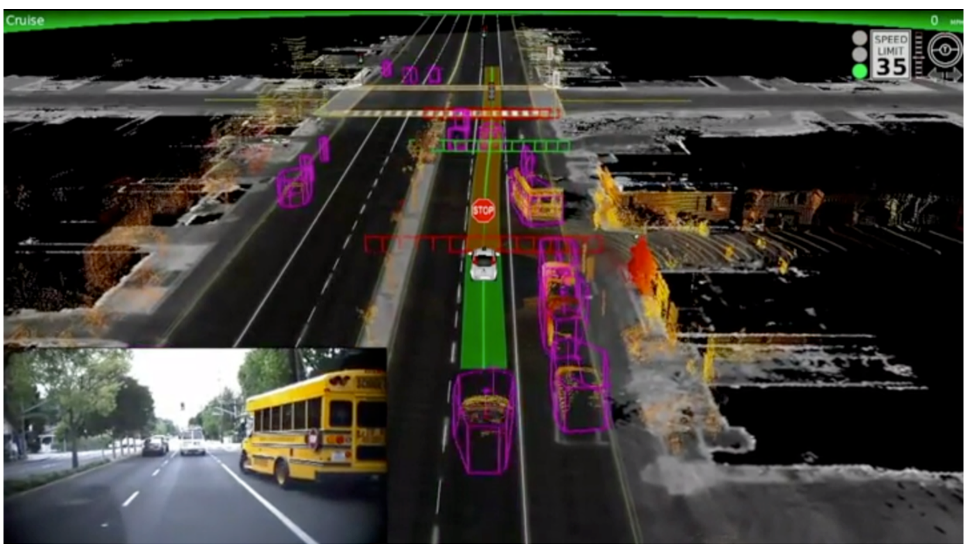


Figure 3: NHTSA Accident Reconstruction, Joshua Brown (1 of 2)

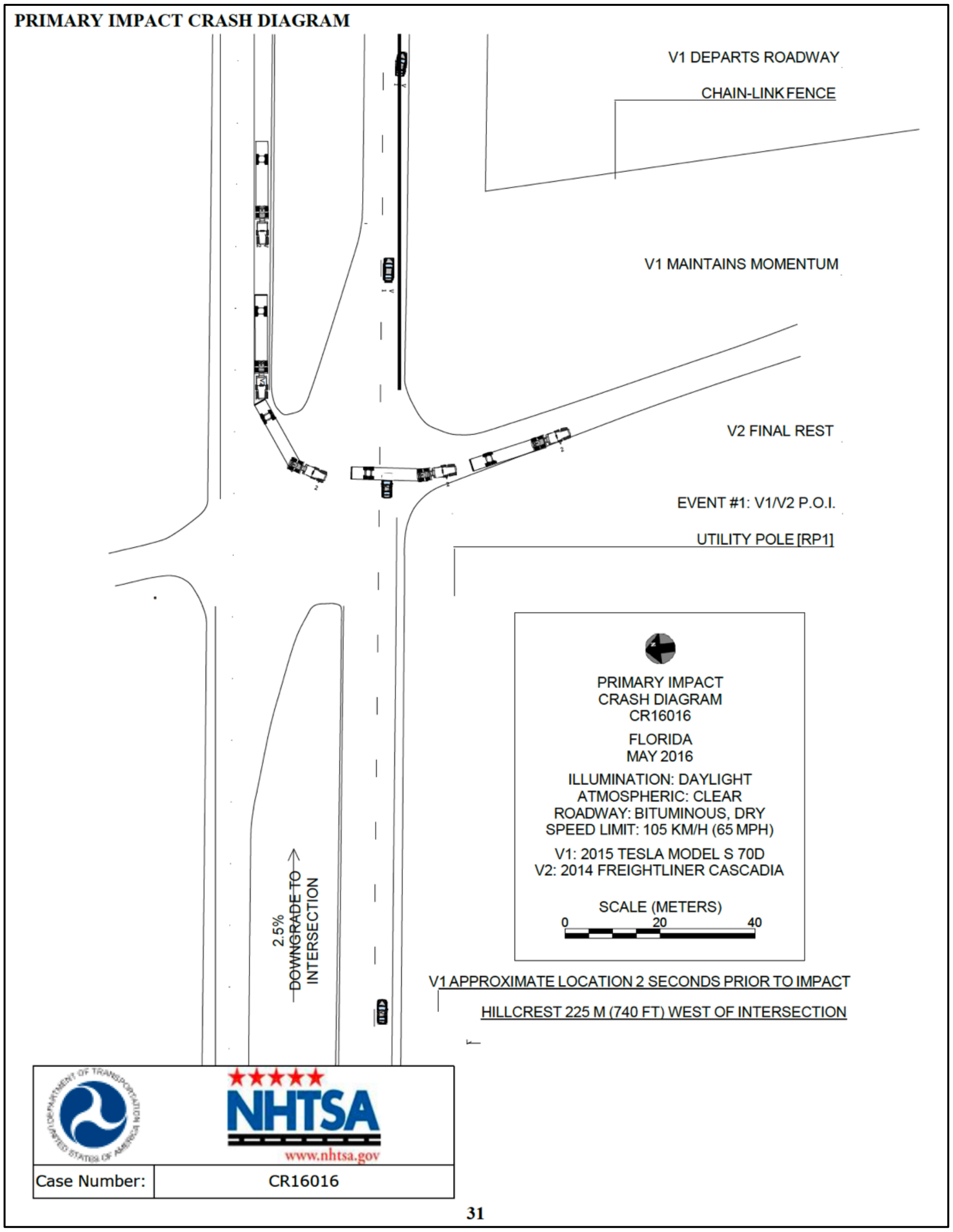


Figure 4: NHTSA Accident Reconstruction, Joshua Brown (2 of 2)