
IMPUTING LIABILITY IN AUTONOMOUS VEHICLES: ISSUES, CHALLENGES, AND A COMPARATIVE STUDY WITH SPECIAL REFERENCE TO THE LAWS OF THE UNITED STATES, UNITED KINGDOM, AND EUROPEAN UNION

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ABSTRACT

The introduction of autonomous vehicles as a business and regulatory reality has revealed one of the fundamental conflicts underlying the tort law: a legal framework that relies on human agency and fault may not be well-equipped to allocate responsibility when the party making the driving decision is an algorithm. The article discusses the theoretical and practical issues of imputing liability in the autonomous vehicle accident setting and in particular how the United States, United Kingdom and European Union have approached these issues and in significant ways failed to do so. Based on SAE automation levels as an analytical grid, the article identifies the following core issues in doctrines: the breakdown of the driver-vehicle distinction, the impossibility of the application of negligence principles to machine decision-making, the ineffectiveness of the existing product liability frameworks and the difficulty of the evidentiary opaqueness in AI-based systems. The comparative analysis shows that no jurisdiction has so far produced any fully consistent liability framework, and that the decisions each has made reflect more profound jurisprudential commitments of risk, innovation and the purpose of tort law.

Keywords: Autonomous Vehicles, Liability, Tort Law, Product Liability, SAE Levels, AI, United States, United Kingdom, European Union, Comparative Law

INTRODUCTION

A self-driving Uber car in self-driving mode hit and killed Elaine Herzberg as she crossed a road in Tempe, Arizona. The sensors on the vehicle recognized her but the system did not recognize her as an unknown object and did not brake. There was a safety driver but he was not monitoring the road. The issue of who, or what, had the legal responsibility of her death took years of legal wrangling and regulatory inquiry to partially answer, and it was never fully answered in a manner that would produce doctrinal clarity. In that respect, the case was a prelude to the liability issue that autonomous vehicles pose to the legal framework in any given country.

It is not merely a hole in current legislation, although the holes exist. It is even more basic than that. Tort law, in both its negligence and strict liability forms, was designed around a conception of agency: someone makes a decision, that decision causes harm and the law attaches responsibility to that someone. The autonomous vehicles upset this architecture at all levels. The driver can be passive or not present. The system made the decision which resulted in the harm, and the reasoning of this system is often unclear even to the designers of this system. All of the vehicle manufacturer, the software developer, the mapping data provider, the sensor supplier, the fleet operator, and the human occupant may have some causal relationship to the result of the accident - but current frameworks regarding distributing liability across complex chains of causality were not designed to fit in this arrangement.

This article continues in the following way. Section II defines the SAE automation taxonomy as a guideline to understanding how the challenges in liability change with the degree of automation. Section III looks at the structural doctrinal issues which cross jurisdictions. In section IV, V and VI, the policies followed in the United States, United Kingdom and the European Union respectively are analysed. Section VII provides a comparative synthesis.

THE SAE TAXONOMY AND THE LIABILITY GRADIENT

The J3016 standard by the Society of Automotive Engineers classifies driving automation into six levels (0 through 5) ranging from no automation through to full automation where the system does all the driving under all circumstances without any human intervention. Most regulatory frameworks have adopted this taxonomy as the conceptual scaffolding upon which to discuss the autonomous vehicle governance.

Lawwise the taxonomy is handy as it roughly maps onto a scale of diminution of human responsibility. Under Level 1 and Level 2, which involves driver assistance and partially automation, the human driver is left with the main responsibility, and they should not be idle. Analysis of liability at these levels can be broadly treatable within the existing negligence paradigms: the driver who fails to sack the erroneous lane-keeping assist is nonetheless a driver making (or failing to make) a driving decision.

The severe doctrinal challenge commences at Level 3 -conditional automation- whereby all driving functions are handled by the system under particular situations but the human is required to take over any driving tasks whenever requested to do so. The shift to the manual to automated control presents a category of accident that has no actual precondition within the pre-autonomous tort law: the damage caused in a handover that the human occupant was not trained to receive in a vehicle that had conditioned the human occupant not to pay attention. The fatal accidents of the Autopilot of Tesla, which are not Level 3 systems, but Level 2 systems frozen into Level 3, occupy this disputed space.

The most evident break is at levels 4 and 5. In cases where the human-as-driver is not present and there is no human intervention whatever, the human-as-driver no longer appears in the equation of liability in any form. All that is left is a machine, its manufacturers, its operators, and the question of which legal category best describes the distribution of responsibility the product liability, operator negligence, statutory strict liability. The jurisdictions have responded to this question in different ways.

CORE DOCTRINAL CHALLENGES

A. The Driver Category Crash.

The majority of the road traffic laws establish the duties and the responsibility based on the definition of the driver of a vehicle- a human being. In a case where the vehicle is self-driving, the driver category will either disappear or will have to be artificially extended to include the vehicle owner, operator, or manufacturer. Neither of the extensions is doctrinally clean. Being found liable as a driver to an algorithm to which the responsible individual is not a programmer confuses ownership with agency. The analogy of holding the manufacturer liable as driver collapses the distinction between product liability and traffic liability - two bodies of law that differ in standard, defence and damage regime.

B. Negligence and Reasonable Machine Standard.

The liability of negligence needs a breach of a duty of care measured against a standard of reasonable behaviour. In the case of human drivers, the reasonable driver standard, although not devoid of complications, has a relatively settled content. In the case of an autonomous system, whether one can say that reasonable performance has a particular appearance is a highly disputed issue. What is the negligence of an AV that does a better job than an average human driver, but a worse job than the best human driver? Would it be negligent to make a decision that any rational algorithm would make based on the sensor data available, but the decision has a harmful outcome? The negligence framework was not formulated to address probabilistic machine decision-making, and the application of this model to AV accidents would require the creative application of the negligence framework by judges, or legislative intervention.

C. Product Liability and the Design Defect Problem.

Product liability, according to which a manufacturer is liable to the harms caused by a defective product, appears to be a natural fit to AV accidents. In case the autonomous system of the vehicle breaks down, that is a product defect. But in a number of material aspects the fit is not perfect. To start with, the design defect test of consumer expectations is hard to apply to a system whose behaviour cannot be fully anticipated or understood by the consumer. Second, the risk-utility test or the reasonable alternative design test involves a court assessing whether a different algorithm would have led to a more desirable outcome - a counterfactual query that is technically sophisticated and may be indeterminate. Third, software updates (which AV systems receive on an ongoing basis) raises the question whether the product that at the time of the accident was offered is the same product that was initially sold, and whether the liability profile of the manufacturer changes with each update.

D. The Black Box Problem

Probably the most fundamental practical problem is evidentiary. To establish liability, we have to establish causation, to establish causation we need to know what the autonomous system did and why. AV decision-making systems, especially deep learning-based systems, are infamously hard to interpret even to their creators. The reasoning of the system is coded in billions of parameters whose interaction will generate the output that cannot always be traced

back to identifiable input or rules. The event data recorders (which are mandatory in certain jurisdictions) are able to capture what the vehicle did but not necessarily why it did it. The structural disadvantage of establishing fault faced by claimants unable to access or read this data is only partially addressed by the current rules on disclosure and expert evidence.

THE UNITED STATES: FRAGMENTATION AND FEDERAL STATE TENSION

The United States is possibly the most disjointed AV liability environment of the three jurisdictions reviewed here. Vehicle safety regulation is mainly federal, the National Highway Traffic Safety Administration administers the National Traffic and Motor Vehicle Safety Act but tort liability is a state law and laws specific to AVs have been passed at the state level and not in a federal manner. The outcome is a patchwork: California, Arizona, Texas, Florida, and others have passed different AV deployment frameworks, none of which fully addresses the question of liability.

In 2017, the federal AV START Act, which would have created a national framework of AV testing and deployment, passed the House of Representatives but never came to fruition in the Senate. The guidance documents of NHTSA, such as the successive voluntary guidance frameworks since 2016 through 2020, are not legally binding and do not establish or change liability rules. The practical implication is that in the US AV liability remains subject to the state tort law as it has been developed under the ordinary common law principles, without AV-specific adaptation.

The framework, which is arguably the most developed, requires AV operators to have substantial insurance or prove financial responsibility, and puts the primary liability on the permit holder in the case of driverless operations. It is a type of enterprise liability: the liability lies with whoever is commercially deploying the autonomous system, whether or not they are at fault in the conventional sense. It is a practical measure that eschews the causation problems of tort law analysis - yet it is regulatory option, not a tort law formulation, and it is only applicable within the state of California.

The case of Herzberg as such was settled out of court instead of being litigated, which implied that the doctrinal issues the accident brought about were never directly confronted in a court of law. The investigation by the National Transportation Safety Board named the safety driver as the primary cause of the accident, and asserted systemic failures in the Uber safety culture,

however, this was an administrative finding, not a determination of liability. The loophole between the regulatory accountability and the civil liability has not been filled.

The most feasible course of action that AV claims can have without specific legislation is the product liability under the Restatement (Third) of Torts: Products Liability. Courts that apply Section 2 of the Restatement would need to determine whether the autonomous system of the AV was flawed in design - which would also require the risk-utility assessment identified above - or flawed in its failure to issue sufficient guidance or warnings. The latter route might be more practically available: It could be that manufacturers who do not effectively communicate the limitations of their systems to users will face liability without necessarily requiring the court to second-guess the algorithmic design decisions made by manufacturers.

THE UNITED KINGDOM: STATUTORY INNOVATION AND ITS LIMITS

The United Kingdom has adopted the most direct legislative approach between the three jurisdictions by passing legislation addressing the insurance and liability aspect of automated vehicles specifically the Automated and Electric Vehicles Act 2018 ('AEVA 2018'). The Act is a real effort to doctrinally what it does, and to omit what it does not address.

AEVA 2018 establishes a direct insurer liability scheme in the event of an accident by automated vehicles which are in automated mode. In the context of the automatic vehicle driving itself, causing an accident to the injured person (under Section 2), the insurer of the vehicle is directly liable to the injured party without necessarily having to prove fault. It is a clean, victim-friendly solution that avoids the negligence causation problem altogether: the injured party pursues his claim against the insurer, and the insured in turn has rights of contribution against the manufacturer or any other party by subrogation. The complexity of the doctrine is no longer transferred to the action taken by the claimant but is instead transferred to the action to recover taken by the insurer where, with the parties being better resourced, the matter can be fought out.

The beauty of such a scheme is somewhat marred by its reliance on the notion of a driving itself concept - which, as the SAE taxonomy would suggest, it needs to be. The Secretary of State has the power to keep a list of vehicles which are automotive vehicles under the Act, but as of the time of writing, no vehicle has been formally listed. Since 2018 the Act has resided on the statute book without being operationally activated in the sense envisioned by its drafters

(partly because fully automated vehicles have not yet been commercially deployed in the UK at scale and partly because the groundwork has not been laid in the definitional sense of the term).

The Automated Vehicles Act 2024, which was given Royal Assent in May 2024, is a key development - building on AEVA 2018 and the 2022 joint report on automated vehicles by the Law Commission and others to introduce a more comprehensive framework including an Authorised Self-Driving Entity (ASDE) concept. The ASDE, or in other words, the organisation that is in charge of the automated driving system, is firstly the primary responsibility in the safety of the system, and a new category of no-user-incharge vehicles is recognised along with the corresponding distribution of liability. The most complex AV-specific legislation that has been enacted by one of the three jurisdictions that are being discussed in this paper, but the implementation of the Act in the form of secondary legislation is still ongoing.

THE EUROPEAN UNION: PRODUCT LIABILITY REFORM AND THE AI ACT DIMENSION

The approach of the European Union to AV liability lies at the nexus of two major legislative initiatives: the reform of the Product Liability Directive and the development of the AI Act. Collectively, these tools are transforming the liability environment in AI-based systems overall, and AV-specific impacts.

The initial Product Liability Directive of 1985 subjected the producers to strict liability as a result of damage caused by defective products. Its extension to software was not clear in the original text, which applied to tangible goods and could be interpreted to mean that software is not a separate product. The updated Product Liability Directive, adopted in 2024, expressly covers software, such as AI systems and digital services that are embedded into products. Manufacturers of AV systems are thus unequivocally liable under EU law in strict product liability to damages caused by defects in their systems - without necessarily having to prove fault.

The revised Directive also tackles the evidentiary problem in a more claimant-friendly manner than the US or UK approaches. Article 9 of the revised Directive, national courts may request defendants to disclose pertinent evidence, and a rebuttable presumption of ineffectiveness is

available where the defendant is found not to comply with disclosure requirements. It is a direct answer to the black box problem: the responsibility of being able to explain the system behaviour is shifted at least somewhat to the party that is best placed to do so.

Under Annex III, the EU AI Act (which came into force in August 2024) categorizes some autonomous vehicle systems as high-risk AI systems, which are also mandatory to undergo conformity assessments, technical documentation requirements, and post-market monitoring requirements. Although the AI Act is not a liability instrument in itself, being obligated by its terms to comply with the standards and requirements of an AI contract will be an important part of any subsequent liability case: compliance with the requirements and standards of the AI contract by a manufacturer will be an important part of any subsequent liability case.

The Motor Insurance Directive, revised in 2021, of the EU obligates member states to make sure that compulsory motor insurance covers damage caused by autonomous vehicle operation. This forms a floor of victim protection throughout the EU - although the level to which manufacturers can be paid back by insurers differs depending on the product liability implementation of the EU member states. An instructive example of how membership state law can supplement the EU framework is the situation in Germany, where a keeper liability - strict liability against the vehicle registered keeper - is imposed on accidents that occur during automated operation, and the keeper is not deprived of a right of recourse against the manufacturer.

COMPARATIVE SYNTHESIS: THREE MODELS, ONE UNRESOLVED PROBLEM

An overview of the three jurisdictions shows that they all are characterized by three broadly different approaches to the same underlying problem, each with a different set of institutional and jurisprudential priorities.

The United States has, to date, had to rely largely on the existing common law frameworks - negligence and product liability - and has had to supplement them with state-level regulatory schemes that apportion the liability to the operators without necessarily resolving the underlying tort questions. The result of this strategy is geographic discontinuity, continuity in doctrinal terms, and has failed to generate the type of judicial elaboration that would be of meaningful guidance to AV manufacturers and operators. The lack of the federal laws has been the characteristic structural aspect of the US landscape.

The UK has made the most radical legislative move in developing a direct insurer liability scheme - a scheme which places the victim compensation and administrative simplicity entities at the forefront rather than the elegance of doctrine. The ASDE concept of the 2024 Act is a real innovation: it attempts to designate a responsible body to the system, instead of trying to shoe-horn responsibility in the driver category. The constraint is on the implementation side: the framework is more evolved on paper than on practical implementation, and the secondary legislation that would bring the core provisions to life is still in development.

The most structurally ambitious approach is the one used by the European Union that is based on the newly revised Product Liability Directive and the AI Act in combination to create a layered framework in which strict liability, disclosure requirements, and regulatory compliance interrelate. The explicit coverage of software and AI systems, the rebuttable presumption mechanism, and the post-market monitoring requirements tackle the problem of black boxes more directly than either the US or UK frameworks. The supranational nature of the EU implies that the structure will be uniformly applied across 27 member states - a great benefit compared to the US patchwork. The restriction is that the framework is relatively new and its application in practice in AV accident litigation has not been tried yet.

There are a number of cases which have not been resolved in all three jurisdictions. The multi-party causation problem, i.e. how to apportion liability between manufacturers, software developers, mapping data providers, infrastructure operators and fleet managers has not been conclusively resolved by any of them. The question of over-the-air software update liability profile: whether the profile of a manufacturer changes when the system that caused the accident was a version that was released after the original sale, is doctrinally open. And the intersection of AV liability frameworks and cybersecurity - what happens when an autonomous vehicle is hacked and causes harm - has not been addressed at the legislative level anywhere.

A more philosophical question that all three frameworks avoid answering instead of answering is whether the purpose of AV liability law is primarily compensatory (ensuring victims are made whole), deterrent (incentivising manufacturers to invest in safety), or distributive (spreading the costs of technological risk across society). The insurance liability model used in the UK is skewed towards compensation. The hard product liability policy followed by the EU is one that is deterrent. The common law system of the US tries to accomplish all three goals concomitantly and arguably accomplishes none of them to the greatest good in the AV context.

Such decisions are not only technical but they are also fundamental commitments of who bears the cost of technological advancement.

CONCLUSION

Liability of autonomous vehicles is not an issue that any jurisdiction has addressed. The spectrum of responses that the comparative analysis has revealed is the reluctant dependence of the US on the current doctrine, through the pragmatism of statutory innovation by the UK, to the overlay of regulation-liability architecture in the EU, each of which captures something important and leaves something important unaddressed.

The core difficulties are not going away. The more the level of automation, the further the human driver is pushed out of the causal chain. The more complex AI systems are, the greater the interpretability issue becomes. The number of accidents that should be processed by the legal system will increase as the scale of AV deployment grows - and the shortcomings of the existing frameworks will be even more noticeable. In 2018, Herzberg accident was a prelude. On many vital points the legal questions which it raised remain, in important aspects, unanswered.

What the three jurisdictions reviewed herein indicate, together, is that no one approach to doctrine, be it negligence, strict liability, insurer liability, enterprise liability, etc., suffices in its own right. Probably a coherent framework would need to have the elements of each: strict liability of AV manufacturers to ensure that victims are compensated without the interference of the element of fault; mandatory disclosure obligations to address the evidentiary obscurity; a defined responsible party (comparable to the UK concept of ASDE) to anchor the liability chain; and insurance requirements that would be adjusted to the risk profile of autonomous operation. Whether one or another jurisdiction will ever compile these elements into a perfectly coherent framework before the autonomous vehicles become literally ubiquitous, will remain at this stage an open question.

REFERENCES

1. Automated and Electric Vehicles Act 2018 (c. 18), United Kingdom.
2. Automated Vehicles Act 2024 (c. 22), United Kingdom.
3. Directive 85/374/EEC of 25 July 1985 on the approximation of the laws, regulations and administrative provisions of the Member States with regard to liability of defective products, Official Journal of the European Communities.
4. European Parliament and of the Council Directive (EU) 2024/2853 on liability on defective products, Official Journal of the European Union.
5. Regulation (EU) 2024/1689 of the European Parliament and of the Council that lays down harmonised rules on artificial intelligence (Artificial Intelligence Act), Official Journal of the European Union.
6. Directive (EU) 2021/2118 amending Directive 2009/103/EC regarding insurance against civil liability regarding the use of motor vehicles.
7. SAE International, J3016: Taxonomy and Definitions of Terms in Driving Automation Systems of On-Road Motor Vehicles (Rev. 2021).
8. National Transportation Safety Board, Collision between Vehicle Controlled by Developmental Automated Driving System and Pedestrian, Tempe, Arizona, March 18, 2018, Highway Accident Report NTSB/HAR-19/03 (2019).
9. Automated Vehicles: Joint Report (Law Com No 404, Scot Law Com No 258, 2022).
10. German Road Traffic Act (Strassenverkehrsgesetz — StVG), as amended by Act of 16 June 2017 (BGBl. I S. 1648) introducing Sections 1a-1c.
11. Torts (Third) Restatement of Torts: Products Liability (American Law Institute, 1998).
12. A Vision of Safety 2.0: A Framework of Automated Driving Systems (2017), National Highway Traffic Safety Administration.

13. Chagal-Feferkorn, K. (2021). Can Reasonable Standard Standard Sustain Up with the Emergence of Artificial Intelligence? *North Carolina Journal of Law and Technology*, 22(1), 1-58.
14. Davola, A., & Picard, R. (2021). 'A Model of Attributing Liability in the Autonomous Vehicles Ecosystem.' *Erasmus Law Review*, 14(1), 32–47.
15. Duffy, S., & Hopkins, J. (2013). Sit, Stay, Drive: The Future of Autonomous Car Liability.' *SMU Science & Technology Law Review*, 16(3), 453–480.
16. Geistfeld, M. A. (2017). Autonomous Vehicles, Federal Safety Regulation and A Roadmap for Autonomous Vehicles: State Tort Liability. *California Law Review*, 105(6), 1611–1694.
17. Gurney, J. K. (2013). Sue My Car Not Me: Products Liability and Accidents Involving Autonomous Vehicles.' *Journal of Law, Technology and Policy*, 2013(2), 247–277.
18. Marchetti, I. (2022). The EU AI Act and Product Liability: A New Framework to Accidents of Autonomous Vehicles.' *European Journal of Risk Regulation*, 13(4), 601–622.
19. Ngo, T. (2020). The Autonomous Vehicles Liability Landscape Navigation.' *Berkeley Technology Law Journal*, 35(1), 247–296.
20. Vladeck, D. C. (2014). Machines Without Principals: Liability Rules and Artificial Intelligence.' *Washington Law Review*, 89(1), 117–150.