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## From Science Fiction to Reality: How will the Law Adapt to Self-Driving Vehicles?

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### ABSTRACT

This paper briefly addresses what follows when the responsibility of driving is completely shifted to the autonomous vehicle system and all of its components. It also examines the different theories of liability and their potential application in the context of autonomous vehicles. Throughout this paper, it is argued that all involved parties have to share in the payment of the cost of confidence in self-driving technology. It is also argued that the idea of custody might seem inappropriate where the accident is a function of many factors, or when an autonomous vehicle has a malfunction or operates in a manner unintended, unauthorized or unforeseen. This paper, however, is not intended to provide the final answer to all questions in this regard, but to identify the main challenges, and provide perspectives on how to deal with such issue.

**Keywords:** Artificial Intelligence, Commercialization of Autonomous Vehicles, Liability, Negligence.

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### 1. Introduction

Artificial intelligence (AI) plays a significant role in improving the quality of life in different areas. One example is in public transport, where AI technology allows the vehicle to perform all safety-critical driving functions and monitor the conditions on the road so that the only thing the human driver needs to do is providing destination or navigation input. This is not some futuristic or imaginary dream, but a well-established fact in the Automotive Industry. Many automobile companies have already developed and tested their own version of driverless cars, and they hope to commercially release a line of fully autonomous vehicles within a few years. Good examples here include Tesla, Volvo, Uber, Google, and Mercedes-Benz.<sup>2</sup> According to a recent forecast from HIS Automotive, there will be nearly 21 million autonomous vehicles on the world's roads by 2035. We are not talking about driver-assistance technology that merely contains features to avoid or mitigate collisions such as crash warning systems,

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<sup>2</sup> Khan, N. (2015, Jul 25). Google, Mercedes-Benz, Tesla, Volvo testing driverless cars across the world, The Economic Times. As available at <https://economictimes.indiatimes.com/industry/google-mercedes-benz-tesla-volvo-testing-driverless-cars-across-the-world/articleshow/48210051.cms>, on 3/6/2018.

adaptive cruise control, lane-keeping systems, and parking assistance systems. But here we are talking about autonomous technology, which transfers driving tasks to the vehicle instead of the driver.

In fact, autonomous vehicles are capable of self-learning rather than merely following instructions. They further exhibit high levels of sophistication, intelligence, and autonomy according to which their actions are not always completely anticipated or known by their users. However, it is crucial to note that self-driving vehicles will not necessarily always display the same degree or level of sophistication, autonomy, and intelligence. While the fourth and fifth generations of self-driving vehicles are capable of driving safely and making proper decisions, first, second and third generations of such vehicles exhibit a very limited level of sophistication and lack any significant ability to make autonomous decisions according to their own experiences.<sup>3</sup> Nevertheless, it is expected that artificial intelligence technology will, in the very near future, progress to the next level that allows vehicles to gain more intelligence and autonomy, and to be active initiators and decision makers rather than merely assistants or facilitators.

As human driver error is most often the main reason for traffic accidents, autonomous vehicles technology is expected to improve road safety by reducing the number of traffic incidents, reducing the negative environmental impacts of driving, and helping to resolve land-use problems. However, the transition from fully human-driven vehicles to fully autonomous vehicles is never easy. On one hand, autonomous vehicles technology has not yet arrived at the perfect level of reliability and autonomy, which is enough to guarantee a safe assignment of responsibility to them. Autonomous vehicles, like any other internet-enabled devices, are potentially vulnerable to cyberattacks from hackers. As Self-Driving vehicles become more reliant on the Internet, the risk of hacking grows. It is also possible that vehicles get a computer virus or being used by terrorists as a weapon.

On the other hand, autonomous vehicles suffer from the problem of “many hands”. This is because a number of different parties are involved in the manufacturing, developing, designing, programming, and using of such advanced vehicles, and hence there are several parties who are potential perpetrators of a wrongful act. This can make it quite difficult to determine precisely to whom the wrongful act should be attributed. Is it the manufacturers of the vehicle, the software programmer, the network providers or the owner of the vehicle? It is still unclear how the law will handle autonomous vehicles and their potential effects in public roads. Furthermore, it is questionable whether existing laws are already sufficient to address questions of liability in the context of autonomous vehicles especially if the technology behind such vehicles evolves, or is commonly used on a larger scale.<sup>4</sup> It seems then that the main challenge is how to strike a balance between consumer rights and expectations on the one hand, and the need to encourage innovation on the other. If the law fails to recognize the autonomous aspects of self-driving technology or if it attributes the liability for damages that may result from the use of this technology without sufficient contemplation of the role of different involved parties, then we will not arrive at an efficient outcome since any party might be unable to meet the demands of the responsibility alone. Moreover, placing full responsibility on one party might hinder the development of autonomous vehicles and induce others to behave recklessly on the ground that such party will be completely liable for any accident whether or not they exercise an appropriate level of care. In contrast, providing absolute protection from liability may eliminate the incentives for manufacturers of autonomous vehicle technology to make their products as safe as possible in order to prevent liability.<sup>5</sup>

Despite the benefits of this socially desirable technology, the legal response to self-driving technology is still limited to testing process. In the United Kingdom, the Department for Transport has developed a Code of Practice to specifically regulate the testing of driverless and automated vehicles on public roads.<sup>6</sup> According to this code of practice, responsibility for ensuring that testing of these vehicles

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<sup>3</sup> In 2013, the National Highway Traffic Safety Administration (NHTSA) released a classification system partitioning vehicle automation into five levels, ranging from level 0 (“no automation”) to level 5 (“full self-driving automation”). For more information, see NHTSA May 30 Press Release, As available at:

[http://www.nhtsa.gov/staticfiles/rulemaking/pdf/Automated\\_Vehicles\\_Policy.pdf](http://www.nhtsa.gov/staticfiles/rulemaking/pdf/Automated_Vehicles_Policy.pdf), on 9/5/2017.

<sup>4</sup> Jessica S. Brodsky. (2016). *Autonomous Vehicle Regulation: How an Uncertain Legal Landscape May Hit the Brakes on Self-Driving Cars*. 31 *Berkeley Tech. L.J.*, 859.

<sup>5</sup> Marchant, G., Lindor, R.(2012). *The Coming Collision between Autonomous Vehicles and the Liability System*, 52 *Santa Clara L. Rev.* 1337.

<sup>6</sup> *The Pathway to Driverless Cars: A Code of Practice for testing*, Department for Transport, UK (2015).

is conducted safely always rests with those organizing the testing. It was also concluded in the Pathway to Driverless Cars review, which was published by the Department for Transport in February 2015 that “real-world testing of automated technologies is possible in the UK today, [provided] a test driver is present, and takes responsibility for the safe operation of the vehicle; and that the vehicle can be used compatibly with road traffic law”.

In the United States, many states are considering regulations related to the testing and operation of autonomous vehicles technology. Such regulations focus mainly on enabling testing of autonomous vehicles by defining autonomous vehicle technology, determining the conditions for the testing of autonomous vehicles, and establishing minimum safety standards to govern the deployment of such vehicles. Legislation in California and Nevada, for example, allows self-driving vehicles to operate on roads so long as a human driver is sitting behind the wheel on alert, and requires the adoption of safety standards to ensure the safe operation and testing of such vehicles.<sup>7</sup> Other states however permit autonomous vehicles to operate without human operators in the vehicle. Washington, for example, issued an executive order in June 2017 specifying certain requirements for vehicles operated without human operators in the vehicle.

At the international level, a first step toward recognizing self-driving technology was attained on 23 March 2016 with the entry into force of amendments to the Vienna Convention on Road Traffic. Such amendments allow control of the vehicle to be transferred to the vehicle system, provided that this system does not breach the United Nations vehicle regulations or can be overridden or disabled by the driver. Let us now explore the main theories of liability and their potential application in the context of autonomous vehicles. Let us further discuss some doctrinal questions posed by the advent of autonomous vehicle technologies, and investigate whether or not our traditional legal framework is still sufficient to realistically answer such questions.

## 2. Legal liability for autonomous vehicle’s accidents

Autonomous vehicles are posing new concerns regarding how liability should be attributed for deaths and injuries caused by such vehicles, and who is to bear the risk associated with their unintended consequences. With this kind of vehicles, the undesired outcomes or accidents might not necessarily be due to a defect in the programming or parameterisation of the vehicles, but they might be because of the intervention of third parties, or due to the peculiar nature of self-driving vehicles which provides them with the ability to react autonomously to their environments and other factors and vehicles on the road according to their own experience and surrounding circumstances, without any human control or intervention.

In a conventional vehicle crash, the damage can often be easily traced to human mistakes or a vehicle malfunction or defect. This is why most analyses of the responsibility focus on the human driver and put the full responsibility on his shoulders. Such analyses of the responsibility arouse little or no difficulties when they are applied to ordinary vehicles or even to semi-autonomous vehicles that have only very limited autonomy.<sup>8</sup> It can then be argued that there should be no problem if we apply to such vehicles the same rules relating to the guardianship of things and objects. This will provide drivers with a strong incentive to ensure that their vehicles operate appropriately and are adequately controlled, since they know that they will be entirely liable if something goes awry. The matter, however, might take a different turn, and the idea of custody might seem inappropriate in respect of the fully autonomous vehicles where the harm is a function of many factors, and no one can either know the full context of vehicle programs or forecast its reaction in all possible circumstances. Even programmers involved in the manufacturing of such vehicles will be incapable either of writing instructions to handle all circumstances optimally or determining the pattern of their mechanism of action over both the middle and the long term.

<sup>7</sup> Other states also have passed legislation related to the testing or operation of self-driving vehicles such as Alabama, Colorado, Florida, Louisiana, Michigan, Nebraska, New York, Pennsylvania, Utah, and Washington. For more information, see <http://www.ncsl.org/research/transportation/autonomous-vehicles-legislation.aspx>

<sup>8</sup> In 2016, a man was killed in Florida when his 2015 Tesla Model S car with the Autopilot system crashed into a truck that was crossing the road in front of his car. Tesla Company has attempted to apportion blame onto the driver by arguing that the system provided the driver with sufficient messages during the trip warning him to put his hands on the wheel. The official investigation found that there was no defect in the Autopilot system and that the driver was not paying attention to the road.

From a legal perspective, autonomous vehicles are not yet recognized as legal persons qualified to be held liable for their actions, or to be sued separately from their owners. This basically implies that injuries stemming from their accidents would automatically be attributed to the natural or legal persons who utilize them, even if these vehicles were operating autonomously beyond the control of such persons. As long as self-driving vehicles continue to be merely sophisticated automata, their roles will not be considered separately, and such vehicles will continue to be governed by the legal discipline which deals with objects, and not by that which deals with subjects. Courts around the world have a tradition of attributing the actions of automated technologies to the person who uses them, and considering such user as the locus of liability even if he was unaware of the operations of his automated machines.<sup>9</sup> This attitude however can be criticised not only because it ignores the active role and autonomous ability of some intelligent software applications, but also because it has the potential to produce harsh results on the users who would be bound to any actions or mistakes made by their software machines. Holding someone responsible is unfair, as long as no one has done anything that specifically caused harm, nor could have prevented or foreseen it. It is also unreasonable to expect from a person, who is unable to appreciate the extent of the risk or to take steps to avoid its occurrence, to control the uncontrollable.

The question of liability in the case of using autonomous vehicles is far from simple. As self-driving technologies continue to develop and gain self-awareness, the legal claims related to these technologies will also rise in the not too distant future. This suggests that a different rule of attribution may need to be developed to contemplate both human actor and autonomous program. It may also be necessary for the law to seriously consider the role every party plays in producing the action in question, and then use different standards of responsibility depending on whether the action is done autonomously by an unattended software, or whether it is done automatically by an attended software. The list of potential parties shall include the owner of the vehicle, the software programmer, the vehicle manufacturer, the network providers, and the road designer, etc.

Let us now shine a spotlight on the main legal rules of liability that might be applied in this regard.

## 2.1 Types of liability

We can distinguish three basic types of liability rules that might be applied in the case of damages stemming from accidents involving self-driving cars:

### 2.1.1 Strict liability

Such kind of liability is usually applied in connection with dangerous products and ultra-hazardous activities,<sup>10</sup> and it is based on the relationship between risk and confidence and on the assumption that whoever uses such products would quite simply bear the risk of their mistakes and pay the cost of confidence in the binding nature of their outcomes. According to this rule, the liability will be attributed whenever damage is occurred without having to demonstrate fault or address whether the damage could have been expected or avoided. This implies that liability could be allocated to the owners in light of the risks they accept through using the autonomous vehicle not only regardless of whether the operations of vehicle were intended, authorized, or controllable, but also regardless of whether he was physically present in the vehicle at the time of the accident. Similarly, a vehicle manufacturer can be held responsible if the vehicle malfunctions or departs from its intended design even if he exercised all possible care in the preparation, marketing and sale of the vehicle.

In order to avoid the undesired effects of strict liability rule and keep the minimum level of balance between the various interests of involved parties, this rule is accompanied by the principles of reasonableness and good faith which may play a role in ensuring that such a rule will only be applied to

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<sup>9</sup> See *Brouse v. U.S.*, 83 F. Supp. 373, 374 (N.D. Ohio 1949) in which the court attributed the error to the pilot rather than the design of the autopilot feature of the plane, with the judge opining that, “[t]he obligation of those in charge of a plane under robot control to keep a proper and constant lookout is unavoidable.” See *Register.com, Inc. v. Verio, Inc* 356 F.3d 393, (2d Cir. 2004) in which the court attributed the search robot’s actions to Verio and held it liable for breach of contract. See also the American case of *State Farm Mutual Auto. Ins. Co. v. Brockhurst* 453 F.2d 533, 10th Cir. (1972) in which the court ruled that the insurance company was bound by the mistaken actions of its computer.

<sup>10</sup> This theory of liability is set forth in §§519–524A of the Restatement (Second) of Torts (1977): “One who carries on an abnormally dangerous activity is subject to liability for harm to the person, land or chattels of another resulting from the activity, although he has exercised the utmost care to prevent the harm.”

the extent necessary to protect the society without any extensiveness or exaggeration in that. It is however important to recognize that a software vehicle's dangerousness does not reveal itself clearly, and hence it will be unfair and even commercially unreasonable, to hold the manufacturer or owner bound by unexpected reactions just because it was theoretically, or remotely, possible that the vehicle would produce them. This may deter people from purchasing autonomous vehicles and discourage companies from developing self-driving technologies.

While the application of this strict rule looks acceptable and convincing in relation to dangerous products that have the probability to produce serious physical injuries or death, the same cannot be said with regard to self-driving vehicles that are mainly used to reduce deaths and injuries from road accidents. In fact, the application of the strict rule of liability in the context of autonomous vehicles can be subjected to many criticisms; first, such rule has failed to recognize the inherent characteristics of such vehicles, which may act beyond our control. Instead of accommodating such characteristics (such as intelligence, autonomy, reactivity, proactivity, adaptivity, etc), it has dealt with these vehicles as if they are mere conventional cars that human drivers are able to fully control whenever they want. Second, by holding users liable for any damage caused by their vehicles whether or not they exercise an appropriate level of care, this rule places a too heavy burden on the shoulders of users who will consequently be less willing to use self-driving technology. This rule can be justified if such vehicles exist in a vacuum in which the user is the only director and instructor and no one other than the user plays a role in forming a vehicle's reaction. But is that the reality of driverless vehicles?

### 2.1.2 Negligence liability

Negligence may be defined as the failure to do something that the reasonably prudent person would have done under the same circumstances, or doing something that a prudent and reasonable man would not have done under the same or similar circumstances.<sup>11</sup> From this definition, it is clear that the standard of care which is used to determine whether or not there is negligence is that of the hypothetical reasonable man. Whether or not the owner of an autonomous vehicle has reached the required standard in any given case is a question of fact whose answer depends greatly on what a reasonable man would have done under similar circumstances. According to this rule, the owner is only liable when it is proved that the damage occurred due to his negligence and failure to exercise a reasonable level of care in using and controlling his vehicle.<sup>12</sup> Unless the injured party demonstrates the existence of negligence on the part of the owner, he will not be compensated and the owner will then be absolved of the liability. Similarly, the manufacturer is only liable when it is proved that the accident occurs in an autonomous vehicle as a result of a flaw or shortcoming in its systems<sup>13</sup> or because of the failure to provide adequate instructions or warnings.<sup>14</sup> The manufacturer can also be held liable if a product fails to be of sufficient quality or if he provides misleading information about the vehicle's capabilities.

As human driver has no direct control over the functioning of the fully autonomous vehicle, it is highly likely that autonomous vehicle technologies will shift the responsibility from the driver to the vehicle manufacturer in most cases. The application of negligence liability rule in cases involving fully autonomous vehicles can however be criticised since it is sometimes extremely difficult, if not impossible, for the injured party who might know little or nothing about the peculiar complexity of artificial intelligence, to prove and identify the source of negligence. By following this rule, we might then reach the position in which nobody would be legally responsible for incidents involving autonomous vehicles, and the injured party would thus become entirely unprotected. The position is further complicated if one

<sup>11</sup> See *Blyth v Birmingham Waterworks Co*, 1856. 11 Exch. 781 in which negligence was defined as "the omission to do something which a reasonable man, guided upon those considerations which ordinarily regulate the conduct of human affairs would do, or doing something which a prudent and reasonable man would not do".

<sup>12</sup> As if he were careless in choosing or instructing his vehicle, or if he used his vehicle in an inappropriate environment which clearly conflicts with the instructions of use, or if he negligently failed to control the vehicle or was not diligent or serious in eliminating the unsuitable circumstances which increase the likelihood of the occurrence of damage.

<sup>13</sup> *Colon Ex Rel. Molina v. Bic USA, Inc.*, 199 F. Supp. 2d 53 (S.D.N.Y. 2001) (the plaintiff must show that a specific product unit was defective as a result of "some mishap in the manufacturing process itself, improper workmanship, or because defective materials were used in construction," and that the defect was the cause of plaintiff's injury).

<sup>14</sup> There is, however, no clear consensus on the case in which warnings are required. Nor is there a clear test as to when existing warnings are adequate. For more information, see Kalra, N., Anderson, J., Wachs, M. (April 2009). *Liability and Regulation of Autonomous Vehicle Technologies*. As available at [https://www.rand.org/pubs/external\\_publications/EP20090427.html](https://www.rand.org/pubs/external_publications/EP20090427.html).

thinks of the fact that different persons have contributed different skills to the development of self-driving technology and that the standard of care differs from one contributor to the next. It is then difficult, in most circumstances, to show a chain of causation for damages back to the programmer, owner, or any other involved parties. Furthermore, this rule can also be criticised because it has the potential to produce different conclusions regarding similar facts and situations. This is because this rule does not determine specific degrees or levels of negligence, but leaves such issues to be determined by the reasonableness standards which differ from place to place and from one judge to another. By doing so, this rule does not only create a kind of uncertainty and insecurity among the involved parties, but also unduly increases legal costs.

### 2.1.3 Vicarious liability

As we have seen, it is clear that both of the above rules do not lead us to the optimal level of liability in which everyone faces the consequences in a way that strikes an appropriate balance between the various interests of the relevant parties. This necessitates that we should think about other rules that consider seriously the sophistication degree of autonomous vehicles and their functional role in the public road, and recognize at the same time the extent to which human drivers have control over their vehicles and the extent to which other parties contribute to producing an accident in question. It does not make sense any more to deal with the advanced generations of self-driving vehicles as mere neutral tools. Given the considerable level of intelligence and autonomy such vehicles exhibit, it seems sensible to begin considering the principles of vicarious liability and dealing with autonomous vehicles as employees once they arrive at more reliable levels of autonomy, intelligence, safety, and sophistication.

The most common example of vicarious liability is the liability of an employer for the torts and acts of his employees when those torts or acts are committed within the course and scope of their employment. According to this kind of liability, the employer might not be liable for the acts of his employee, if these acts are wholly unconnected with the course of his employment.<sup>15</sup> This implies that an employee in some cases might be responsible and sued for acts alleged to have occurred outside the course and scope of his employment. In such cases, he will be asked not only to answer for the damage caused to other third parties, but also to meet the demands of his employer who might claim contribution from him to recover what he had paid as a compensation for the injured party. The fact that an employee might exclusively be held liable to pay damages raises the question of whether it is still possible to apply the principles of vicarious liability in the case of accidents caused by autonomous vehicles.

There are still substantial differences between human employees and self-driving vehicles which might prevent analogy being drawn between them for the purpose of applying the principles of vicarious liability. While a human employee enjoys legal personality and juristic capacity, and he is employed under a contract of service according to which he agrees, in consideration of a wage or other remuneration,<sup>16</sup> an autonomous vehicle lacks such legal personality or capacity which enables it to contract on its own or to provide a required consent to any contract of service. Moreover, unlike human employees who have separate patrimonies distinct from their employers, the vehicle by itself has no patrimony or personal assets and thus it cannot compensate the victim for the damage it caused. This means that any liability will practically fall back on the user of such vehicle whether or not the acts of the vehicle were authorized or within the course of users' businesses. If that is the case, does it still make sense to consider the application of vicarious liability in the cases of accidents caused by autonomous vehicles?

The other solution is to apply Agency Law to self-driving vehicles, and develop a theory for liability on that basis. The same solution has been mentioned by a number of authors as a way to set limits on

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<sup>15</sup> See *Beard v London General Omnibus Co* [1900] 2 QB 530 in which the employer of a bus conductor who in the absence of the driver negligently drove the bus himself was held not vicariously liable. See also *Twine v Bean's Express Ltd* [1946] 1 All ER 202 when a hitchhiker had been given a lift contrary to express instructions and was fatally injured. In this case, it was held that the employer was not vicariously liable since the servant was doing something totally outside the scope of his employment, namely, giving a lift to a person who had no right whatsoever to be there.

<sup>16</sup> See *Ready Mixed Concrete (South East) Ltd v Minister of Pensions and National Insurance* [1968] 2 QB 497, in which it was held that three conditions must be fulfilled for a contract of service to exist. First, the servant agrees, in consideration of a wage or other remuneration, to provide his own work and skill in the performance of some service for his master; secondly, he agrees, expressly or impliedly, that in the performance of that service he will be subject to the other's control in a sufficient degree to make that other master; thirdly, the other provisions of the contract are consistent with its being a contract of service.

the liability of the person using a software agent so that the user will not be supposed liable in cases where a software agent has exceeded its authority.<sup>17</sup> This approach, however, leaves so many questions unanswered and some gaps unfilled. It is not really clear how a software agent can be chargeable with any loss or depreciation in value resulting from exceeding its authority? Answering this question is not an easy task at all especially if we remember that the law does not yet recognize electronic agents as capable legal persons, and hence these agents do not enjoy the consequences of legal personality such as financial autonomy, and patrimonial rights. After that, can we still describe intelligent software agents as a distinct party who can consent to agency contract or act as a legally binding agent on behalf of its user? What is the point then in declaring electronic agents or autonomous vehicles liable if they both lack personal assets and cannot incur liability in a material way?

Furthermore, this approach turns a blind eye to the active role that the intelligent software applications play through their own experience and by the assistance of their unique characteristics, and it does not contemplate or recognize the inherent unreliability of these applications, nor deals with the cases in which an application malfunctions or being redirected by hackers or some kind of virus. It is also not yet clear whether autonomous vehicles are endowed with all requirements and qualities that should be fulfilled in the case of agency, and whether or not they have the ability to exercise judgment, suspect a traffic problem, and interpret a mistaken action. More precisely, does an autonomous vehicle have the ability to look after the interests of its owner, and to act dutifully and in good faith as required by the law? It is then questionable whether the theory of agency still presents any interest in this regard. There is no reason however why artificial intelligence applications might not some day be conferred at least some elements of legal personality and provided with a minimum level of patrimonial rights. Our experience with conferring legal personality on corporations indicates the possibility of personifying such applications once they arrive at more advanced levels of autonomy, intelligence, and reliability.<sup>18</sup>

### 3. What the law should be

The advent of autonomous vehicles that operate autonomously and not just automatically has pushed to the fore many questions: whether and how an adaptation of existing law would be appropriate and sufficient enough to meet commercial and technical demands, and to catch up with the problems and consequences thrown up by such newcomers. Answering such questions inevitably involves dealing with the issue of what the current law is, but it does not necessarily exclude the issue of what the law ought to be.

The law, as it stands now, does not comprehensively regulate autonomous vehicles, and it is still dealing with them as it is doing with automated machines, ordinary tools, or other conventional vehicles. By following this approach, this law fails to take into consideration the autonomous aspects of such vehicles, nor does it seriously consider their function, characteristics, or even the possible parties and factors involved in autonomous vehicle crashes. It seems that the current law is still based on the principle of neutrality of the technology, which is no longer accurate, at least with regard to the technology of artificial intelligence generally and autonomous vehicles particularly which are already changing the way we think about accident responsibility.

This suggests that the role of autonomous vehicles needs to be realistically considered and regulated. This also suggests that a different rule of attribution may need to be developed to address the emergence of self-driving technology in a manner that strikes a balance between the interests of consumers and producers of autonomous vehicles, as well as the practical and ethical considerations of such technology. In order to achieve this goal, the following points are highly recommended:

#### 3.1 Everyone should face the consequences

When we establish a rule of responsibility, we must be careful to arrive at an efficient outcome, and to encourage an appropriate incentive of the involved parties. We must further take the reasonable

<sup>17</sup> See for example Fischer, J. (1997). Computers as Agents: A Proposed Approach to Revised U.C.C. Article 2. *Indiana Law Journal* 72 (2): 545–570. See also Smed, S. (1998). Intelligent Software Agents and Agency Law. 14 *Santa Clara Computer & High Tech. L.J.* 503.

<sup>18</sup> Leon E. Wein (1992). The responsibility of intelligent artefacts: toward an automated jurisprudence. *Harvard Journal of Law and Technology*, Vol.6, 116.

expectations as well as the commercial considerations into account. If we adopt the negligence rule of liability, a vehicle owner or driver will only be liable when, and to the extent that, he has negligently failed to control the vehicle. Under such a rule, the plaintiff must show that the driver did not meet his duty of care, and that the driver action was the proximate cause of the failure. However, it may be very difficult to prove negligence or to identify a lack of control, since autonomous vehicles might have the capacity to act beyond the control of their owners, and in such a manner that the latter could not anticipate. If we follow this rule, then it is highly likely that nobody would be liable for damages caused by such vehicles, and this is of course unacceptable. On the other hand, if we apply the strict liability rule, the owner or manufacturer will be liable for the accidents of the vehicle in all cases and regardless of the care taken by him. This rule puts too heavy burden on the shoulders of owners and manufacturers, and may contribute to undermining trust in this modern type of technology and hindering the expected development in the field of artificial intelligence. Furthermore, such a rule clearly ignores the role of other involved parties in forming the actions of autonomous vehicles.

It seems then that we need another rule to establish an appropriate balance between the various interests that are involved in using such technology. A moderate rule that forms a middle ground between the negligence rule and the strict rule can be reached by means of common liability that considers both legal and technical aspects and based on the business practices and commercial demands. Such rule simply provides that all involved parties have to share in the payment of the cost of confidence in Artificial Intelligence technology. This rule however necessitates the full contemplation of the role of the different parties and explicit recognition of the machine-made mistakes. It would be useful if the law examines the extent to which the human driver has knowledge, accessibility, and control over the actions of his vehicle system, and whether or not he participated in some way in determining or choosing the degree of autonomy, mobility, and intelligence of that system. When attributing liability, the law must also differentiate between semi-autonomous vehicles that act automatically within the realm of human control, and fully autonomous vehicles that operate outside the realm of human control. This implies that we should not always hold the human driver responsible for the actions of his vehicle regardless of the circumstances of the accident, but we should instead consider and examine the role of other parties such as the manufacturer of the vehicle or any component parts, road designers, service centres, pedestrians, programmers, Internet providers, etc.

In an environment where many parties are unwilling to solely take full responsibility for the actions of their intelligent software, or are unable to be fully accountable for the unexpected events that happen on a road trip, insurance companies might play a role in making the distribution of liability more realistic and smooth. However, such role or task will not be easy at all. On the one hand, insuring the risk posed by the use of autonomous vehicles still faces difficulties in checking, assessing, or analysing the operations of such vehicles. On the other hand, creating an insurance scheme or building a control system may be too expensive to justify seeking insurance for the risk posed by using self-driving technologies. In order to overcome this difficulty, better coordination and cooperation amongst all parties involved is essential.

### 3.2 The source of the actions, and the reason for the mistakes should be identified

Errors and mistakes in the context of self-driving technology could have enormous destructive consequences that cost too much to handle, manage, and deal with. One of the reasons why we have to classify the actions of autonomous vehicles and identify the source of their mistakes is that it may be unfair to attribute to the owner all acts of the vehicle, including mistakes, distortions and unauthorized acts that may have serious legal and practical consequences that cannot be met individually by the owner. By identifying the source of the actions and the reason for the mistakes, liability will be properly and fairly attributed according to the type of the problem rather than to some general rules that do not take the particular facts and circumstances into account. This identification however necessitates that the nature and importance of the mistake, as well as the role of the different parties involved be studied and analysed thoroughly in order to determine which events have actually been caused by an autonomous vehicle, and which ones have been caused by its owner. We need also to examine whether the owner did something wrong that caused the damage, or whether such damage has occurred because the software system was not working properly, or due to the role of a third party. It can thus be said that the actions and mistakes of such agent can be classified as follows:

1. The actions or mistakes caused and determined by the autonomous vehicle itself according to its own experience: Here, it can be suggested that we have to consider the importance of the mistake and its degree. If the mistake was simple, obvious, and does not cost too much to handle or deal with, then the liability can be attributed to the owner or to the person who can effectively prevent the damage at a lower price. But if the mistake was unobvious, and its consequences are very serious, excessive, and cost too much to meet and deal with, then everyone has to face such consequences according to the concept of collective responsibility.

2. The actions or mistakes caused by the owner of the vehicle: if the mistake was due to the instructions of the owner, if such owner did not take due care in using such agent (eg., if he sent his vehicle to inappropriate environments and did not estimate or determine adequately the autonomy, intelligence, and mobility of his vehicle), or if he failed to update the software of his vehicle or negligently provided such vehicle with inappropriate destination, unsuitable parameters, wrong configuration, etc, then it would be reasonable to hold him liable for that.

3. The actions or mistakes caused by a technical fault: if the vehicle has a flaw in the software (source code) or a problem in programming that results in an accident, then liability should not be attributed to the owner who uses an autonomous vehicle appropriately. Problems that are solely because of a flaw in the original programming are the responsibility of the programmer. Owners should also not be responsible for design defects, manufacturing defects, and inadequate warning instructions. Liability for such defects shall fall on the manufacturer.

4. The actions or mistakes occurred due to the role of other parties or external factors: it is unfair to hold owners or manufacturers liable in all cases even when the reasons of the accident were due to the role of other factors and involved parties. The consequences that arise when the vehicle is attacked by hackers, terrorists or other malicious actors should not be automatically attributed to the owner. The owner should also not be entirely responsible when a software system in the vehicle becomes contaminated by a virus, or when the problem happened because of a fault in the road. In some cases, it would be better if we clearly consider the role of other parties for the purpose of holding them liable. The network provider, for example, who changes the direction of the vehicle or illegally modifies its instructions should be responsible for any consequences following his act. We may even take into consideration contributory negligence on the part of the person who suffers the damage.

It is further essential to determine whether the action was intentional, and whether it was within the control and access of the operator. Determining such issues is surely not an easy task. It is very difficult to trace precisely the source of a given problem, and to identify the party that should be blamed for that problem. This does not however mean that such task is impossible. This is particularly true if we establish a reciprocal cooperation between law and technology and if we give computer scientists an opportunity to play a role in the legislative process. Furthermore, it is essential that law should not deal with autonomous vehicles as if they all belong to the same category, but should be creative enough to distinguish between them according to their degree of sophistication and in light of their autonomy, role, and function.

In order to bridge the gap between technology and law, there are some considerable steps that should be taken at a technical, legal, and commercial level. This implies that proposed solutions must consider both legal and technical aspects, and at the same time, they should be based on business practices. Unless we understand the “why” of the technical failure, and unless we recognize the commercial demands of different business models, we cannot provide an appropriate legal framework, which can cope with the rapid pace of change and development in Artificial Intelligence technologies. This implies that law should take the lead and intervene in the earlier stages rather than waiting for the technological outcomes and reacting once society has been affected. This however necessitates further insight into software development process so that the question of who is going to decide how an autonomous vehicle will operate and consequently what users will be able to do, will be discussed collectively by all the relevant parties of society involved in such technology (legislators, consumers, programmers, businesses). On the other hand, it is essential that technological process takes legal requirements into account during the initial stages of product design so that resulting outcomes reflect the existing legal framework pertaining to traffic safety. Such cooperation between law and technology should be exercised appropriately and in a manner that takes into account the balance between commercial, technical, and legal considerations.

#### 4. Conclusion

The question of liability in the case of using autonomous vehicles is far from simple, and cannot sufficiently be answered by deeming the human driver as being automatically responsible for all accidents and mistakes of his vehicle. This does not however mean that such driver should be absolved of entire liability since self-driving vehicles currently lack the distinct personality and patrimony that enable them to answer the financial demands of liability or to sue or be sued. What we mean is thus some collective form of liability that takes into account the role every party plays in producing the action in question, and considers critically the type of the problem that caused the damage. It seems then that the real challenge is how to keep technology in line with law, and how to strike a balance between the different interests involved when dealing with the results of an autonomous vehicle's operation. This necessitates that law should be creative enough to sensibly intervene in the earlier stages of the technical process rather than merely waiting for the technological outcomes and then struggling to introduce them into the existing legal framework. It is also essential for policymakers to contemplate the cases when self-driving vehicles autonomously generate errors in a manner that could not have reasonably been anticipated or avoided.

It should be noted that the introduction of "one-size" legislation without prior contemplation of the nature and technical aspects of autonomous vehicles will not provide us with an appropriate legal framework, but might create a feeling of unease and wariness, and could ultimately lead to a divorce between the legal theory and technological practice. For this reason it is necessary to think about law both as a concept (what is the law) and also as a process (what it is designed to achieve). Instead of traditional jurisprudential thinking, it is desirable now to think outside the box.

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