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LIABILITY OF A MANUFACTURER OF FULLY AUTONOMOUS AND CONNECTED VEHICLES UNDER THE PRODUCT LIABILITY DIRECTIVE

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Abstract. Fully autonomous and connected vehicles are products combining hardware, software and services. The main advantage of such vehicles is arguably their safety owing to the elimination of human error. Thus, the expectations of the public regarding their safety are particularly high. This article seeks to establish whether Directive 85/374/EEC which governs manufacturers' liability for damage caused by defective products is fit for the introduction of fully autonomous and connected vehicles. It presents the Directive's prerequisites for manufacturer liability and examines legal gaps arising from the definition of 'product' in the light of the characteristics of fully autonomous and connected vehicles. The article also looks into the defectiveness considerations of such self-driving vehicles under the Directive, analyses the circle of persons who can be treated as manufacturers and the development risk defence which is often associated with the decision-making process of fully autonomous and connected vehicles.

Keywords: autonomous vehicles, self-driving vehicles, product liability, Directive 85/374/EEC, development risk defence

Introduction

The first fully autonomous and connected vehicles, i.e. vehicles that have no human driver and are connected to cooperative systems enabling autonomy, are expected to hit the road in the near future. Although safety arising from eliminating the human error is often presented as the main advantage of fully autonomous and connected vehicles, accidents involving them cannot be precluded. Damage caused by a fully autonomous and connected vehicle may give rise to general fault-based delictual (tortious) liability, strict liability (no-fault liability for damage caused by a source of greater danger) and product liability (in certain cases also contractual liability may arise). In the case of fully autonomous and connected vehicles product liability can be expected to play a greater role than in the case of conventional vehicles because an error by a human driver is precluded. Furthermore, the importance of product liability legislation is bound to increase in scenarios where, for instance, the direct possessor or insurer of such vehicle pays damages to the injured person under the strict liability regime and could be entitled to bring a recourse claim against the manufacturer that may prove to be a joint and several debtor regarding the damage caused to the injured person.[2]

In the European Union, Member States cannot have entirely different product liability regimes as the field is governed by the Product Liability Directive (Council Directive 85/374/EEC). The Directive had not been subject to any formal evaluation for decades until a few years ago the EU legislature commenced efforts to evaluate the functioning and performance of the Directive, thereby addressing liability issues relating to various new and emerging technologies, notably the Internet of Things, autonomous and connected vehicles, artificial intelligence,

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[2] See, for instance, § 137(2) of the Estonian Law of Obligations Act.

etc.[3] In the context of vehicles, the Product Liability Directive forms a whole together with the Motor Insurance Directive (2009/103/EC) and the General Product Safety Directive (2001/95/EC). While the latter is aimed at preventing damage, the former are aimed at dealing with the consequences of damage caused. According to Recital 2, the Product Liability Directive aims at a fair apportionment of the risks between manufacturers and consumers. On the one hand, the Product Liability Directive imposes strict liability on the manufacturer for damage caused by defective products. On the other hand, it reduces the strictness by giving the manufacturer, among other things, a so-called development risk defence under Article 7(e) in order to ensure the industry's willingness to innovate as well as the insurability of unforeseeable risks.

The uniqueness of fully autonomous and connected vehicles lies in the interweaving of hardware, software and services. This is the main feature that poses a challenge to product liability legislation. A study commissioned by the European Parliament points out the following new risks that are likely to emerge or become more prominent upon a mass rollout of fully autonomous and connected vehicles: operating software failure; network failure; hacking and cybercrime; programming choices (European Added Value Assessment, p. 25). These emerging risks call into doubt the fitness of the Product Liability Directive for striking a balance between the interests and expectations of consumers and manufacturers of fully autonomous and connected vehicles. Based on an analysis of the relevant articles of the Product Liability Directive, interpretations given to these in the case-law of the CJEU, criticism aimed at relevant provisions of the Directive in legal writings as well as on parallels drawn with the rules transposed to national law and the interpretations given to the latter, this article seeks to establish whether the Product Liability Directive is fit for fully autonomous and connected road vehicles.

1. Prerequisites for the manufacturer's liability

In an attempt to hold the manufacturer liable, the injured person is, under Article 4 of the Product Liability Directive, required to prove the existence of the damage (Article 9), the defect (Article 6) and the causal relationship between these. However, the manufacturer's liability under the Directive is ultimately triggered by the infringement of a safeguarded legal right as a result of putting a defective product into circulation (Articles 1-3, 6 and 9), unless the manufacturer furnishes proof of existence of certain exonerating circumstances (Recital 7 and Article 7).

It follows from Article 9 of the Directive that the safeguarded legal rights include life, health and items of property (i.e. things, objects, effects). The latter category of rights should not be mistaken for one's possessions taken collectively. Furthermore, the injured party does not necessarily have to be the owner of the damaged item but may be its possessor or holder of other similar rights therein (see, for instance, clause 5 of § 1045(1) of the Estonian Law of Obligations Act; MüKoBGB/Wagner, 7. Aufl. 2017, ProdHaftG § 1 Rn. 5). The Directive does not allow for holding the manufacturer liable for simply any damage to an item of property but establishes certain exclusions. Firstly, damage caused to the defective product itself is excluded from the scope of the Directive (Article 9(b)). This ensures the precedence of contractual guarantees because defective products are normally placed on the market via a chain of contracts, which divides the risk between the parties in a balanced manner (Varul, 2009, p. 703; MüKoBGB/Wagner, 7. Aufl. 2017, ProdHaftG § 1 Rn. 8). Secondly, a threshold of 500 euros is applied. This means that any proprietary damage amounting up to 500 euros is automatically excluded from the Directive's scope as well. The underlying idea, as explained in Recital 9, is to avoid litigation in an excessive number of cases. Thirdly, damage caused to an item of property that is ordinarily in the public, business or professional domain, in other words, not meant for private use or consumption and that was not used by the injured person mainly for their own private purposes or consumption is also excluded from the scope of application of the Directive.

[3] The European Commission has set up a product liability formation of an expert group on liability and new technologies. The Commission expects to issue guidance on the Directive and a report on the issues pertaining to the liability and safety frameworks for artificial intelligence, the Internet of Things and robotics in the middle of 2019. For further information visit https://ec.europa.eu/growth/single-market/goods/free-movement-sectors/liability-defective-products_en .

Fully autonomous and connected vehicles as products and the aspects of their defectiveness are examined in greater detail in sections 2 and 3 below. The Directive does not give any legal definition of an act of putting a product into circulation, which is also required for triggering the manufacturer's liability. Therefore, some Member States have tried to clarify this concept in their national law (SWD(2018) 157 final, p. 11) and the Court of Justice of the European Union (CJEU) has, albeit not exhaustively, discussed its meaning in two cases (Veedfald and O'Byrne). First, it means that the manufacturer has caused the product to leave the process of manufacture (judgment in Veedfald, para. 16). In other words, situations where a self-driving vehicle has left the process of manufacture against the will of the manufacturer do not qualify as putting the vehicle into circulation. Second, a vehicle must be considered as having been put into circulation when it leaves the manufacturing process operated by the manufacturer and enters a marketing process in the form in which it is offered to the public in order to be used or consumed (judgment in O'Byrne, para. 27).

2. Fully autonomous and connected vehicles as a product

Under Article 2 of the Product Liability Directive, all movables are deemed to be products, even where incorporated into another movable or into an immovable.[4] While in the 1980s, when the Directive was adopted, products running an intangible component or depending thereon might have been a relatively new phenomenon for the average consumer, the tangible products of today have become and are increasingly becoming combined with and dependent on their intangible components, notably software and services.

A fully autonomous and connected vehicle is a highly complex product that combines both hardware and software (Heineke, 2017). A combination of various connected sensors and other parts (hardware) and, in particular, the operating system and applications (software) which fuse these parts and sensors makes a vehicle fully autonomous in the first place. To draw a parallel with conventional driving, the software replaces the decision-making mechanisms of a human driver, while the sensors installed in and on the car replace various senses of a human driver. Article 2 of the Directive makes no explicit mention of software. The only intangible product that the Directive explicitly refers to is electricity. Like electricity, software is intangible, made available with the help of specific tangible equipment and meant for running specific functions using specific equipment. Although software is intangible and often supplied intangibly (e.g. online downloads, cloud computing), it still requires hardware in order to exist and function, be it in the form of a computer drive, memory stick or some other tangible data medium. This has also been recognised at the national level. For instance, Estonian legislature has explicitly included software in the definition of a product set out in subsection 1 of § 1063 of the Law of Obligations Act, which transposes Article 2 of the Product Liability Directive.[5] The authors of the commentary on the Estonian Law of Obligations Act find that, for the purposes of product liability rules, programs processing data in a computer as well as any electronically recorded information explaining to the computer user the use of computer programs should be considered a product (Varul, 2009, p. 706). A similar approach is taken by the authors of the Munich commentary on the German Civil Code (MüKoBGB/Wagner, 7. Aufl. 2017, ProdHaftG § 2 Rn. 17).

Driverless vehicles can be expected to run embedded software attuned to the specific setup of the sensors and mechanics of the vehicle. Some lawyers take the view that tailor-made and embedded software should be treated differently from non-embedded software which is mass-produced and mass-distributed (Minutes, p. 3). This approach appears to disregard the fact that software cannot exist without being bound to some tangible form (hardware) and makes software's qualification as a product or a part thereof dependent on the manner and scale

[4] Because of the possible incompatibility of such an approach with national property law it may need to be limited exclusively to the attainment of the purposes of the Directive. For further information see MüKOBGB/Wagner, 7. Aufl. 2017, ProdHaftG § 2 Rn. 12, and MüKOBGB/Wagner, 7. Aufl. 2017, ProdHaftG § 2 Rn. 19; Software – eine Sache? – Zivil- und handelsrechtliche Überlegungen anläßlich des Urteils des BGH vom 14.7.1993 – VIII ZR 147/92, DB 1993 S. 1871. DB.

[5] English translation of § 1063(1) of the Estonian Law of Obligations Act suggested by the author: 'Product' means all movables, even though incorporated into another movable or into an immovable; 'product' includes electricity and computer software.

of distribution and on the type. As regards the manner and scale of distribution, it should first be pointed out that the Directive is not limited to mass-produced goods (judgment in Veedfald, para. 22; MüKOBGB/Wagner, 7. Aufl. 2017, ProdHaftG § 2 Rn. 4). Thus, it should be of no legal relevance whether software is tailor-made for one individual customer or meant for masses. There appears to be no justification in the Directive for treating manufacturers differently based on whether they have opted for embedded or non-embedded software. Standard software and system software tends to come embedded while there is more flexibility with application software (Amuno, 2018). The equal protection of consumers and the prevention of the distortion of competition (Recital 1 of the Directive) could not be ensured in a situation where a manufacturer whose defective software application causes damage could escape liability owing to the fact that its software cannot be considered a tangible product under the Directive. Thus, the term 'product' needs to be clarified keeping in mind the characteristics of products having a digital component, such as self-driving vehicles. Alternatively, the aforementioned difficulties could be overcome by providing guidance for teleological interpretation of the existing rules governing tangible goods (MüKoBGB/Wagner, 7. Aufl. 2017, ProdHaftG § 2 Rn. 18). Ultimately, either the CJEU or the European legislature will have to clarify this issue.

Having established that software used for controlling and operating a fully autonomous and connected vehicle should be treated as part of the vehicle and included within the scope of Article 2 of the Product Liability Directive, the issue of software updates and upgrades needs to be addressed. Presumably, a fully autonomous and connected vehicle will need to be updated or upgraded over time. This begs the question if there is any difference between a situation where damage is caused by a defect in the vehicle's built-in software or in a downloaded update or upgrade of such software. Since software used for controlling and operating the vehicle remains an inseparable part of the vehicle, it makes no difference whether it was built-in or added afterwards. As discussed in section 3 below, a more pressing issue in connection with software updates and upgrades concerns the period during which the manufacturer is required under the Directive to provide software updates and upgrades for a self-driving vehicle.

It can be derived from Articles 2 and 3(1) and the defences set out in Article 7 of the Directive that where an item, including software, is installed, incorporated or embedded into a fully autonomous and connected vehicle, the item remains a product for the purposes of the Directive even where it becomes an essential part of the vehicle.

As noted above, driverless vehicles will also be dependent on services and some of these services may be of fundamental importance for the safe and proper functioning of the vehicles. The vehicle needs to be able to communicate with other road users and smart traffic signs, it needs to know the weather conditions, the layout of the surroundings, its own position with very high accuracy, etc. If such a fundamental service fails, the vehicle might be unable to operate properly. These services could be provided by public or private third parties to, among others, the vehicle's manufacturer, operator or passengers. However, services do not fall within the scope of the Product Liability Directive (judgment in Dutrueux, para. 39; AG's opinion in Veedfald, para. 16). The Product Liability Directive was adopted for the purpose of, among other things, making it easier for the injured person to bring claims against the manufacturer in spite of complex distribution chains and organisation structures (Recitals 4 and 5 of the Directive; judgment in Skov and Bilka, paras. 28-29). Difficulties experienced by injured persons in identifying the person against whom to bring a product liability claim have given rise to CJEU case-law. However, in over 30 years since the adoption of the Directive the production and supply chains have changed, and service providers play an increasingly important role therein as well. This makes distinguishing between manufacturers and service providers even more challenging. Related legal gaps could lead to normatively dubious results.

In its judgment in Dutrueux (para. 39), the CJEU explained that the liability of a service provider in providing services using defective equipment not produced by the service provider did not fall within the scope of the Directive. The CJEU noted that there were appreciable differences between the activities of service providers who, having acquired goods, used them in the provision of services to third parties and as a result thereof that activity could not be considered equivalent to the activities of manufacturers, importers and suppliers (judgment in

Veedfald, para. 33). For autonomous and connected vehicles such an opinion means that the operator of the transport infrastructure designed for self-driving vehicles whose system has a defective sensor or traffic sign that, for instance, gives a self-driving vehicle the wrong signal as a result of which the vehicle causes a traffic accident cannot be held liable for the damage under product liability provisions. Instead, a claim for damages should be brought against the manufacturer of the defective sign or sensor or against the vehicle manufacturer. However, as discussed in section 4 below, identifying the liable person among the numerous parties involved could prove a difficult task.

3. Defects of fully autonomous and connected vehicles

The legal definition of a defect is given in Article 6 of the Product Liability Directive. Thereby account must be taken of all circumstances, including the presentation of the vehicle, the use to which it could reasonably be expected to be put and the time of putting the vehicle into circulation. Ultimately, it comes down to what a person is entitled to (reasonably) expect of fully autonomous and connected vehicles in terms of their safety. Recital 6 of the Directive points out that the defectiveness of a product must be assessed having regard to the reasonable expectations of the public at large.

It follows from the CJEU's explanations that safety must be assessed taking into account, among other things, the intended purpose, the objective characteristics and properties of the vehicle in question and the specific requirements of the group of users for whom the vehicle is intended. The CJEU has discussed the issue of reasonable expectations in the context of product liability in Boston Scientific. The CJEU explained (judgment in Boston Scientific, paras. 37-41) that a product is defective when it does not provide the safety which the public at large is entitled to expect, taking all the circumstances into account, including the intended purpose, the objective characteristics and properties of the product in question and the specific requirements of the group of users for whom the product is intended. Thus, in the light of the function of self-driving vehicles and the particularly vulnerable situation of passengers using them, the safety requirements for fully autonomous and connected vehicles, which the passengers are entitled to expect, are particularly high. The CJEU also agreed with the Advocate General (AG's opinion in Boston Scientific, para. 30) in that the potential lack of safety which would give rise to liability on the part of the manufacturer under Directive 85/374 stems from the abnormal potential for damage which products might cause to the person concerned. Therefore, the CJEU pointed out that where it is found that products belonging to the same group or forming part of the same production series have a potential defect, it is possible to classify as defective all the products in that group or series, without there being any need to show that the product in question is defective.

Clearly, in the light of the function of fully autonomous and connected road vehicles and the particularly vulnerable situation of passengers using such vehicles (i.e. that they trust the vehicle with their life), the safety expectations regarding the vehicles are particularly high. Yet, the manufacturer's level of care is not relevant in this context because for those purposes the EU has, above all, the General Product Safety Directive and applicable standards (i.e. public law as opposed to the Product Liability Directive which largely falls within the sphere of private law).

The presentation mentioned in Article 6(1)(a) and the use mentioned in Article 6(1)(b) might put different persons (vehicle owner, vehicle user, road user) in a different situation. It all depends on the ultimate business models, which determine how fully autonomous vehicles are sold, owned and used. There are plans of creating them exclusively for fleet operations (e.g. taxi service providers, transportation companies, company cars, etc.) as well as for personal use (Harreman, 2016). The presentation of the vehicle needs to take the different characteristics and purposes of the end customer into account.

The case of product liability for fully autonomous and connected cars is further complicated by the fact that in reality there is no fully defect-free software in existence (What is a Software Defect, n.d). In the context of software development, a defect means that software does not provide the expected value to any person whom it is supposed to provide the respective value. The Product Liability Directive, however, focuses on product safety. Combining

these two approaches, the primary value of an autonomous and connected car lies in safe autonomous driving from the point of departure to the prescribed destination. A software defect could put that in jeopardy. A defect in software may arise from a human error made in the development process, be inherent in the very design of the software controlling the car or result from misleading information given to a person.

While development errors are attributable to negligence and thus avoidable, design-related defects are those of an inadequate concept. In the case of a combination of hardware and software both types of defect affect all products of the same build. Software vulnerabilities pose some of the most serious threats to fully autonomous and connected vehicles. A manufacturer who is unaware of a vulnerability is unable to eliminate it. Sometimes there may not even be a quick patch for it. For instance, it was discovered that WPA2, the most commonly used WiFi security protocol, had a fundamental vulnerability that allowed the attacker to hijack connections and eavesdrop on network traffic (Vanhoef, 2017; Whittaker, 2017). There are already plenty of examples of the vulnerability of the software of conventional cars (Greenberg, 2017).

As explained, there is no defect-free software in the sense attributed to the word 'defect' by software developers. In addition, the security of software is a service or process rather than a product. On the one hand, these observations of foreseeability call into question the very possibility of exoneration of the manufacturer in the case of a software defect. On the other hand, the legal definition set out in Article 6 of the Product Liability Directive takes its own approach to defectiveness, which largely comes down to people's safety expectations. If people cannot trust the self-driving technology, they will not accept or adopt it. Driving a vehicle and riding in a vehicle is an activity involving a greater danger. Due to the laws of physics, the consequences in the event of an accident could be fatal. Thus, a person who takes a ride in a fully autonomous vehicle trusts the manufacturer with their own life. In the light of the considerations expressed by Bundesgerichtshof in its request filed with the CJEU in the framework of Joined Cases C-503/13 and C-504/13 (judgment in Boston Scientific, para. 26), it could be argued by way of analogy that, in terms of establishing liability for a defective product, it is of little consequence that it is accepted in software development circles that it is not possible for software to be 100% safe. In view of the life-threatening risk presented by defective embedded software of a fully autonomous and connected vehicle, any road user may reasonably expect the embedded software to have a failure rate of close to zero. It follows from the guidelines given by the CJEU in Boston Scientific that the assessment of reasonable safety expectations must be carried out from the perspective of the public at large, taking into account the intended purpose, the objective characteristics and properties of the fully autonomous and connected vehicle and the specific requirements of the group of users whom the vehicle is intended (judgment in Boston Scientific, para. 38). In the light of the function of fully autonomous and connected vehicles and the particularly vulnerable situation of people using such products, the safety requirements for those vehicles which all road users are entitled to expect are particularly high. Furthermore, it can be derived from the CJEU's analysis set out in Boston Scientific that the potential lack of safety of a fully autonomous and connected vehicle stems from the abnormal potential for damage which those vehicles might cause to the person concerned.

In numerous legal writings on self-driving cars and other artificial agents, authors often tend to mystify the decision-making mechanisms of algorithms as something unforeseeable, unpredictable or unquantifiable. The world has already witnessed how a self-driving car programming choice coupled with negligence on the part of the operator can have fatal results for a road user (Lee, 2018). This raises the issue of whether some unforeseeable, unpredictable or unquantifiable behaviour of a self-driving vehicle could be considered a defect under the Product Liability Directive. Assuming that such behaviour was not triggered by a third party (e.g. a hacker[6]), the answer to this question must be affirmative, provided that a fully autonomous and connected vehicle operates within a specific set of rules, which have been consciously and intentionally given, in other words, designed by the

[6] One is also bound to wonder if the mere hackability of the software of a self-driving vehicle should also be considered a defect. Drawing on the analogy of a vehicle door lock that can be picked, the answer would have to be negative, but one should also keep in mind here that a vulnerability of the software of self-driving vehicles may have fatal consequences at a far larger scale.

manufacturer. If the vehicle is designed to misinterpret the input received from the sensors and, as a result thereof, causes damage, it qualifies as a design error. The road users are entitled to expect the absence of such outcomes. Whether the manufacturer has a development risk defence in such a situation is another matter which will be discussed further in section 5.

Article 6(1)(c) in combination with Article 11 also raises the issue of the applicability of the Directive to specific defects of fully autonomous and connected vehicles. As noted above, a fully autonomous and connected vehicle is a combination of hardware and software. While the upgrading of the physical components of vehicles after they have been put into circulation is a common practice in the automotive industry where some specific safety issue has been identified, software is a different phenomenon. Even after being put into circulation, software cannot be considered finished or final. The main concerns in that regard are related to security, which is a process or service rather than a one-off result. Ensuring the security of the software controlling the vehicle remains a work-in-progress as long as the vehicle remains in operation. Such an obligation is usually established in national product safety legislation the infringement of which may give rise to general delictual liability and a breach of such duty may result in the obligation to pay damages even if the product was not defective at the time of putting it into circulation for the purposes of the Product Liability Directive.

Article 11 currently limits all the rights of the injured person under the Directive to a period of 10 years from the date on which the manufacturer put into circulation the actual fully autonomous and connected vehicle which caused the damage. Thus, once this 10-year period expires, the injured person is no longer be able to claim damages based on the defectiveness of the vehicle, unless they instituted proceedings against the manufacturer in the meantime. Owing to rapid technological progress even vehicles age fast. It would be counterproductive to make the manufacturer liable for a longer period (judgment in Aventis Pasteur, paras. 43-48; AG's opinion in Aventis Pasteur, para. 107). Usually, manufacturing and design defects manifest themselves in the first couple of years after putting the vehicle into circulation. Conventional vehicles are built to last for more than a decade and they have an active aftermarket as well. While the hardware of conventional vehicles and self-driving vehicles can be expected to remain similar over a longer period of time, the latter are inherently more dependent on software which needs to be kept up to date for as long as the vehicle remains in circulation. When the manufacturer stops releasing updates for a self-driving vehicle, the issue of the roadworthiness of such vehicle can be raised under national law. There cannot be any problem with liability where such a vehicle simply becomes unusable after it can no longer be updated. If it does not run, it cannot cause any damage. Whether a self-driving vehicle that no longer receives updates can be considered defective, currently depends on the outcome of a reasonable expectations test prescribed by Article 6(1) of the Product Liability Directive. The public at large can certainly expect more than 10-year-old self-driving vehicles to be either safe or removed from circulation. In cooperation with the legislature, market players (i.e. manufacturers, financial institutions and insurance undertakings) will need to find balanced solutions for such vehicles in the framework of contract law and the strict liability regime. Naturally, the manufacturer is free to extend its liability on its own initiative beyond the limits provided by law (Gorzelany, 2015).

Driving autonomy is heavily dependent on various communication services, which fall outside the scope of the Product Liability Directive. An autonomous vehicle's ability to operate safely could rely on, among other things, a connection to a network of sensors around it, i.e. other vehicles, smart traffic signs, smart road markings, global and local positioning systems, etc. Even if the manufacturer has explicitly declared that a service is an inseparable part of the vehicle, the Product Liability Directive is not applicable to the service. The CJEU's has pointed out in para. 39 of its judgment in Dutrueux that the liability of a service provider which uses defective products of which it is not the producer within the meaning of Article 3 of the Product Liability Directive and thereby causes damage to the recipient of the service does not fall within the scope of the Product Liability Directive but that of national law. The CJEU has noted that the application of national rules may not impair the effectiveness of the Product Liability Directive (judgment in Veedfald, para. 27). However, the situation in the case of a defective self-driving car would most likely be reversed, with the manufacturer using a defective service. Therefore, one would again have to resort to the reasonable expectations test and ask if the public at large is entitled to expect that a fully autonomous and connected vehicle is able to refrain from causing damage even in the case of a vital service

disruption. Given that safety is the underlying idea of developing such vehicles, the answer would have to be affirmative.

Finally, it must be pointed out in the light of Article 6(2) of the Product Liability Directive that a fully autonomous and connected vehicle should not be considered defective for the sole reason that a better vehicle is subsequently put into circulation. In this context, 'better' should be interpreted as having better qualities. However, where better qualities also include patches of the vulnerabilities of the software, the manufacturer should make these available also to vehicles that have already been put into circulation if the manufacturer is to avoid liability for a defective product. However, as demonstrated in section 5 below, there are situations where it may be justified to discharge the manufacturer from liability for a defect of its fully autonomous and connected vehicle.

4. Manufacturer of fully autonomous and connected vehicles

The class of persons specified as obligated persons in Articles 1 and 3 of the Product Liability Directive must be regarded as exhaustive (judgments in Skov and Bilka, para. 33; O'Byrne, para. 35; and Aventis Pasteur, para. 36). In the context of fully autonomous and connected vehicles, obligated persons are the manufacturers of finished vehicles, their component parts and raw materials. Having laid this foundation, Article 3(1) of the Product Liability Directive moves on to broaden the circle of obligated persons to include those who present themselves as manufacturers by putting their name, trade mark or other distinguishing feature on the vehicle. Subject to certain specifications and conditions, Article 3(2) adds importers and Article 3(3) suppliers to the mix. It has been argued in a commentary to the German ProdHaftG that, in doing so, the Directive seems to go beyond the limits of delictual product liability because in commerce one's liability is usually limited to one's own actions (MüKoBGB/Wagner, 7. Aufl. 2017, ProdHaftG § 4 Rn. 1).

A vehicle consists of numerous parts made by numerous manufacturers. Likewise, the supply chain of the vehicle may consist of numerous links. In the context of the circle of obligated parties, the issue of application of the Product Liability Directive to various links in the distribution chain has been repeatedly discussed before the CJEU (see, for example, Skov and Bilka, paras. 27-29). The reason behind extending product liability to other links in the supply chain lies in an attempt to make it easier for the injured person to bring direct action against the manufacturer, as confirmed by the CJEU case-law (see judgments in Commission v France, para. 40; Skov and Bilka, paras. 28 and 36). In its judgment in O'Byrne (paras. 27-29), the CJEU held that when one of the links in the distribution chain is closely connected to the manufacturer, that entity could be regarded as being involved in the manufacturing process. However, in its judgment in Skov and Bilka (para. 36), the CJEU pointed out that unlimited product liability could not be extended to a supplier because this was exactly what the Product Liability Directive tried to avoid. In its judgment in Aventis Pasteur (paras. 55-58), the CJEU confirmed that a supplier who fails to inform the injured person of the identity of the manufacturer within a reasonable time must be treated as the manufacturer. Both the person who manufactured the autonomous and connected vehicle on the whole as well as a component part thereof (incl. software) can be considered the manufacturer under Article 2 of the Directive. However, a third party who provides services required for operating and using the vehicle cannot be considered the manufacturer. Where, for example, a network service failure results in a traffic accident, the network service provider cannot be deemed to be the liable manufacturer.

5. Circumstances precluding the manufacturer's liability: development risk defence

The manufacturer's liability for a defective self-driving vehicle is not absolute. Article 7 of the Product Liability Directive sets out an exhaustive list of the grounds for discharging the manufacturer from liability for a defective product. Article 7(a) which discharges from liability the manufacturer who did not put the product into circulation, protects manufacturers of self-driving vehicles in the testing phase. Article 7(b) exonerates the manufacturer in a situation where it is probable that the defect which caused the damage did not exist at the time when the product was put into circulation by the manufacturer or that this defect came into being afterwards. This protects the manufacturer against the vehicle becoming defective as a result of some outside influence. Under Article 7(c), the

manufacturer is vindicated where the self-driving vehicle was not manufactured by it for sale or any form of distribution for economic purpose nor manufactured or distributed by it in the course of its business. Article 7(d) discharges from liability the manufacturer who follows mandatory public regulations that are to blame for the vehicle's damage-causing defect. Article 7(e) makes the manufacturer's liability dependent on the objective discoverability of the defect with the help of the most advanced state of scientific and technical knowledge at the time when the manufacturer put the product into circulation (development risk defence). Article 7(f) defends the manufacturer of a component by shifting liability to the maker of the final vehicle in a situation where the vehicle's design is flawed or the manufacturer's instructions to the component-maker are flawed.

Among these six defences, the development risk defence stands out as one that is not dependent on the subjective acts or omissions of the manufacturer. It is also the manifestation of a choice (Stolker, 1990) made by the European legislator of which only two Member States (Finland and Luxembourg) have chosen to opt out with regard to all product types (COM/2011/0547 final, p. 8). As summarised by the Advocate General in his opinion in Case C-300/95 Commission v UK, the very first case adjudicated by the CJEU concerning Directive 85/374/EEC, the European Commission initially proposed a system of no-fault liability, but the Council ultimately opted for a system of limited strict liability (AG's opinion in Commission v UK, para. 19). According to Recital 7, the European legislator thereby sought a fair apportionment of risk between the injured person and the manufacturer. To that end the Council chose not to make manufacturers bear unquantifiable development risks (ibid.). The underlying idea of the development risk defence is to encourage innovation by reducing manufacturers' risks so that they would take advantage of the most recent knowledge and spend money on research and development rather than insurance policies (SWD(2018)157 final, p. 35). However, the opponents argue that it unfairly forces injured persons (consumers) to bear risks arising from developing new products (BEUC Position Paper, 2017).

The unique feature of fully autonomous and connected vehicles is the absence of a driver who has been replaced by software, numerous interconnected sensors both in, on and outside the vehicle and services emanating from outside the vehicle. Furthermore, the manufacturer should be held liable for defects in software as well as in services constituting an inseparable and fundamental part of the product. This leads to the question of the scope of the development risk defence in the case of software and driving autonomy infrastructure services. Due to software defects, the vehicle may misinterpret the input received from sensors or be vulnerable to hacking. Defects in a service of fundamental importance may also give rise to damage.

In a described situation where the injured party has been able to prove the damage, the defect and the causal link between the two, the manufacturer's exoneration ultimately depends on whether the manufacturer is able to prove that the state of scientific and technical knowledge at the time when it put the vehicle into circulation was not such as to enable the existence of the defect to be discovered. This formulation sparks the question of whether 'knowledge' means the subjective knowledge of the manufacturer or some broader level of objective knowledge.

The CJEU, siding with the Advocate General, pointed out in its judgment in Case C-300/95 (paras. 26-29) that Article 7(e) was not aimed at the practices and safety standards in use in the manufacturer's industrial sector, but at the most advanced level of scientific and technical knowledge at the time when the product in question was put into circulation. In other words, the exclusion of the manufacturer from liability could in no way be influenced by the acts or omissions of manufacturers of the same class in eliminating or preventing the defect. The Court did not elaborate on this, but in para. 20 of his opinion the Advocate General also pointed out that aspects related to the practicability and expense of measures suitable for eliminating the defect from the product were outside the scope of Article 7(e). The Advocate General was of the opinion that even the manufacturer's failure to keep up to speed with the state of scientific and technical knowledge or developments in the area through specialist literature did not have any relevance to the exclusion of liability (AG's opinion in Commission v UK, para. 21).

Another important observation made by the Advocate General concerning the state of knowledge is that scientific progress is not linear: new studies and discoveries may initially be criticised and considered unreliable by most of the scientific community, but eventually come to be almost unanimously endorsed (ibid.). Depending on the point

of time when the fully autonomous and connected vehicle is put on the market, the majority of scientists may find that the vehicle is either defective or not defective. The Advocate General concludes that the state of knowledge cannot be identified with the views expressed by the majority of learned opinion, but with the most advanced level of research which has been carried out at a given time. The CJEU supports this position by stating that the clause providing for the development defence did not contemplate the state of knowledge of which the manufacturer in question actually or subjectively was or could have been apprised, but the objective state of scientific and technical knowledge of which the producer is presumed to have been informed (judgment in Commission v UK, para. 27). Thus, the manufacturer can protect itself against foreseeable and quantifiable risks by investing in testing and R&D as well as taking out respective civil liability insurance (AG's opinion in Commission v UK, para. 22). Thereby the manufacturer needs to keep in mind that if in the entire range of scientific opinion there is even one isolated opinion[7] as to the potentially defective nature of the self-driving vehicle, the risk can no longer be deemed unforeseeable and falls outside the scope of Article 7(e) provided, of course, that this isolated opinion has been accessible to the manufacturer.

As for the accessibility of this knowledge, the CJEU admitted that the wording of Article 7(e) raised difficulties of interpretation (judgment in Commission v UK, para. 29). Therefore, the Court emphasised that the relevant scientific and technical knowledge must have been accessible at the time when the product in question was put into circulation. The Advocate General found it undeniable that the availability of information was affected by objective factors such as its place of origin, the language and the circulation of the journals where it was published, suggesting that the actual circulation opportunities be subjected to a test of reasonableness (AG's opinion in Commission v UK, para. 23). It could be argued that by taking such an approach to the accessibility of knowledge, the CJEU has brought a certain subjective element to its otherwise objectiveness-based approach to the development risk defence.

The development risk defence is ultimately a choice in terms of the apportionment of risks arising from innovation. On the one hand, it would not be fair to hold the manufacturer liable for a vulnerability which was impossible to discover. On the other hand, it would not be fair to force a person who has been harmed by a development defect of the vehicle to bear the risk of damage. The European legislature has made this choice possible and most of Member States have decided that the development risk defence is necessary and justified. For manufacturers of fully autonomous and connected vehicles this can be considered an encouraging solution not because of the possibility to escape liability for the frequently mystified decision-making process of the self-driving vehicle associated with artificial intelligence but rather in the light of information security concerns. As demonstrated by the vulnerabilities of the WiFi security protocol and the chips used in ID cards, even the most sophisticated top-class software is never completely defect-free. With the advancement of the state of scientific and technical knowledge over time, previously unforeseeable, unpredictable and unquantifiable vulnerabilities may be uncovered. The related unfairness towards the injured person in the case of self-driving vehicles needs to be addressed through means other than product liability legislation, possibly strict liability and contract law.

Conclusions

The fitness of the Product Liability Directive for responding to challenges posed by fully autonomous and connected vehicles appears to be questionable at least in one aspect. It seems to fall short due to its underlying tangibility-based approach which disregards the fact that a fully autonomous and connected vehicle is a highly complex product that consists not only of hardware but also software and is highly reliant on services. While in the case of at least embedded software this gap might be overcome by way of interpretation, an explicit reference

[7] A vivid example of this in addition to the aforementioned WiFi security protocol flaw is the recent case concerning Estonian ID cards. Czech researches discovered a flaw in chips that were, among others, also used in some of the Estonian ID cards. For further information see ROCA Vulnerability and eID: Lessons Learned. Available at: https://www.ria.ee/sites/default/files/content-editors/kuberturve/roca-vulnerability-and-eid-lessons-learned.pdf .

to software would certainly increase legal clarity. The continued lack of an explicit reference to software in the legal definition of the term 'product' may give rise to diverging interpretations at national level.

As confirmed by CJEU case-law, services are precluded from the scope of application of the Directive. However, the safety of a fully autonomous and connected vehicle is also reliant on services. Therefore, a damage-causing defect in the software or in a built-in service of fundamental importance to the safety of a fully autonomous and connected vehicle should be automatically deemed a defect of the vehicle. The injured party should be able to claim damages for such defects directly from the manufacturer. In that regard the notion of defectiveness contained in the Directive appears to be sufficiently flexible and does not need to be revised.

Once a fully autonomous and connected vehicle stops receiving software updates or the manufacturer's liability period of 10 years expires, the vehicle essentially becomes defective in the light of the reasonable expectations test because the public at large can no longer consider the vehicle safe. Ensuring software security is a service but the Directive is product-oriented. While the manufacturer must design a fully autonomous and connected vehicle in such a manner that the vehicle does not cause damage and remains safe even where a vital service fails, liability arising from keeping the software of the vehicle up-to-date and, thus, the vehicle safe therefore needs to be regulated under a service contract.

Finally, while the development risk defence could indeed lead to a fair solution in a context where decades after the introduction of a technology that is globally considered secure it turns out to have a fundamental vulnerability, more light needs to be shed on the decision-making processes of fully autonomous and connected vehicles from the legal perspective. It needs to be established whether these are indeed unforeseeable, unpredictable or unquantifiable in view of the state of scientific and technical knowledge at the time of putting the vehicle into circulation and how high a level of safety the public at large can truly expect from such technology. There might be reason to consider any unforeseeably, unpredictably and unquantifiably acting fully autonomous and connected vehicle which has caused damage as having inherently defective design for the purposes of the Product Liability Directive.

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