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Robot Liability

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Robot Liability*

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I. The Concepts of Robots, Autonomous Systems and IoT-Devices

Since the invention of the steam engine, technological progress has served as a driver of innovation for liability systems.[1] The arrival of the railroad and of the motor-powered automobile led to the introduction of strict liability regimes in many European jurisdictions.[2] Today, society faces a similar challenge that may run even deeper than those that came before. The development of robots and other technical agents operating with the help of artificial intelligence will transform many, if not all product markets. It will also blur the distinction between goods and services and call the existing allocation of responsibility between manufacturers, suppliers of components, owners, keepers and operators of such devices into question. In this paper, the concepts of a "robot" and of "autonomous systems" will be used interchangeably. The characteristic shared by both entities is that their "behaviour" is determined by computer code that allows some room for "decision-making" by the machine itself, in the particular accident situation. In other words, the behaviour of the machine is not entirely under the control of human actors. The concept of "Internet of Things"-devices (IoT-devices) partly overlaps with the ones of robots and autonomous systems, but this overlap is not necessary. Many interconnected products are already marketed, and they are mostly governed by computer-code that is deterministic in the sense that it does not allow for autonomous decisions for the machine or even machine learning.

II. The European Parliament Resolution of February 2017

The European Parliament Resolution of 16 February 2017 on Civil Law Rules on Robotics identified civil liability for damages caused by robots as "a crucial issue".[3] The Parliament suggests that this issue be dealt with at Union level for reasons of efficiency, transparency and consistency in the implementation of legal certainty for the benefit of citizens, consumers and businesses. The European Commission is asked to submit a proposal for a legislative instrument addressing the liability for harm caused by robot activity or interaction between humans and robots.

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1 As to the U.S., the *locus classicus* is Morton J. Horwitz, *The Transformation of American Law, 1780–1860* (Oxford UP 1977), 67–108; for a more nuanced view Gary T. Schwartz, 'Tort Law and the Economy in Nineteenth-Century America: A Reinterpretation', 90 Yale L.J. 1717, 1734–1756 (1981).

2 As to Germany, Olaf von Gadow, *Die Zähmung des Automobils durch die Gefährdungshaftung* (2002 Duncker & Humblot); Werner Schubert, 'Das Gesetz über den Verkehr mit Kraftfahrzeugen vom 3.5.1909', (2000) 117 Zeitschrift der Savigny-Stiftung für Rechtsgeschichte, Germanistische Abteilung 238.

3 European Parliament, Resolution of 16 February 2017 with recommendations to the Commission on Civil Law Rules on Robotics, P8_TA-PROV(2017)0051, para 49.

In substance, the European Parliament suggests a choice between two different approaches which it labels as the "risk management" and "strict liability" approaches.[4] In the eyes of the Parliament, a strict liability rule requires proof of three elements only, namely damage, a harmful functioning of the robot, and a causal link between the two.[5] Whether "harmful functioning" of a robot is equivalent to its malfunctioning, i.e. requires a deviation from the behavioural design of its manufacturer, remains an open question. The risk management approach, envisaged to serve as an alternative to strict liability, should not, it is said, focus on the person who acted negligently but rather on the individual who was able to minimize risks and deal with negative impacts.[6] But once this person is found, what will the requirements for a finding of liability be? It seems that the risk management approach is in urgent need of a principle of attribution and further elaboration upon the principle that has been chosen.

Beyond these two approaches the Parliament also envisages, as a long-term perspective, the creation of a special legal status for robots, i.e. their recognition as electronic persons.[7] Such an electronic person would be liable for any damage caused by the autonomous behaviour of the robot. This is, of course, the most innovative, interesting and stimulating idea within the Parliament's resolution.

Finally, the Parliament touches upon insurance issues and considers that there might be a need for mandatory liability insurance, as is already in place for cars.[8] Such a mandatory insurance mechanism could be supplemented by a fund that would pick up losses not covered by liability insurance. Again, similar solutions already exist in the area of motor traffic.

III. The Commission Communication on "Building a European Data Economy"

A week before the Parliament Resolution outlined above was adopted, the Commission published its Communication on a European Data Economy.[9] It discusses liability issues with a view to IoT-devices as they are believed to be of "central importance to the emergence of a data economy".[10] The existing framework of Directive 85/374/EEC on product liability[11] is found to involve uncertainties in its application to robots, regarding, for example, the classification of autonomous systems as products or rather as services.[12] The Commission also distinguishes between risk-generating and risk-management approaches, depending on whether liability is attached to the party who created the risk

4 Parliament (n 3), P8_TA-PROV(2017)0051, para 53.

5 Parliament (n 3), P8_TA-PROV(2017)0051, para 54.

6 Parliament (n 3), P8_TA-PROV(2017)0051, para 55.

7 Parliament (n 3), P8_TA-PROV(2017)0051, para 59 lit. f).

8 Parliament (n 3), P8_TA-PROV(2017)0051, para 57 f.

9 Communication of the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions "Building a European Data Economy", 10.1.2017 COM(2017) 9 final.

10 Commission (n 9), COM(2017) 9 final, 14.

11 Council Directive 85/374/EEC of 25 July 1985 on the approximation of the laws, regulations, and administrative provisions of the Member States concerning liability for defective products, OJ L 210/29.

12 Commission (n 9), COM(2017) 9 final, 14.

or to the party who is in the best position to minimize risk or avoid its realization altogether.[13] In addition, the issue of insurance is raised, which could be either voluntary or mandatory.

IV. Normative Foundations

Before delving into the substantive issues, it seems helpful to identify the normative foundations on which a liability regime for new technologies may be built. It is often said that the objective of the liability system is to compensate victims. While this is certainly true, the compensation goal cannot inform lawmakers and courts as to which party is the optimal risk bearer. Furthermore, it is submitted that the EU should not only, and not even primarily, aim to shift the costs of injuries to one particular party or another. The EU Member States operate complex systems of social and private insurance for personal injuries,[14] and with respect to property damage, private insurance is widely available.[15] Thus, compensation of victims may be achieved in many ways, not only through non-contractual liability.

On the other hand, shielding businesses from liability for the harm that they cause, for instance, with a view to fostering innovation, also seems problematic. This is not to say that innovation is unimportant or that incentives to innovate should not be generated. It is doubtful, however, whether the liability system is the preferred tool to create such incentives. To shield certain parties from responsibility for the harm that they actually caused amounts to a subsidization of dangerous activities, leading to an oversupply of such activities.[16] Furthermore, immunity from liability undermines incentives to take precautions against harm. For both reasons, shielding parties from liability may impose a net cost on society, at the expense of victims. New technologies that promise substantial benefits will be able to "pay their way" into the world and do not need a subsidy in the form of (partial) immunity from liability.

As a consequence, lawmakers thinking about a framework of liability for autonomous systems should do so with a view to maximize the net surplus for society by minimizing the costs associated with personal injury and property damage. This objective requires to keep an eye on the different components that together represent the costs that accidents impose on society. One important component is the cost that accidents impose on victims, another is the cost that potential injurers incur for taking care, i.e. for taking precautions that prevent accidents from occurring.[17] Insofar as individuals suffer losses that they cannot bear easily, accidents impose additional harm on them in the form of the costs of risk-bearing.[18] The premiums paid to insurance companies, insofar as the exceed expected harm, reflect these additional losses. Finally, the administrative costs of operating a liability system must not be ignored. Liability rules should not be based on elements that are difficult

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13 Commission (n 9), COM(2017) 9 final, 15.

14 Ulrich Magnus (ed.), *The Impact of Social Security Law on Tort Law* (Springer 2003).

15 Gerhard Wagner (ed.), *Tort Law and Liability Insurance* (Springer 2005).

16 For a general exposition of the relationship between the liability system, the price system, and production levels cf. Steven Shavell, *Foundations of Economic Analysis of Law*, 2004, 208–212.

17 These two factors were together placed under the rubric of "primary accident costs" in the classic work by Guido Calabresi, *The Costs of Accidents*, (Yale UP 1970), 26–27, 68–94.

18 Calabresi (n 17), 27–28, 39–67: so-called "secondary accident costs".

and therefore costly to establish in legal proceedings before a court or in settlement negotiations with responsible parties or their insurers.[19]

In a situation that is as complex as the one described, finding the right solution is no trivial task. In order to minimize the losses suffered by victims, together with the costs of precautions incurred by potential injurers, it is essential to target incentives towards those actors who are best-situated to take precautions against harm, i.e. to develop and deploy safety measures that cost less than alternative safety measures available from other actors and less than the costs of harm that they help to avoid. There is another reason why it is important to hold actors who engage in dangerous activities accountable. Only if the cost of harm caused by dangerous activities is attributed to the actor engaging in such activities, cost internalization is achieved so that the price of the activity in question reflects its full costs. Where all or part of the risk remains externalized, as it continues to fall on third parties, the cost of the activity is too low and the extent to which individuals will engage in such activity will be excessive. Lawmakers should aim for a system that not only minimizes the costs of accidents but also maximizes the difference between the gains derived from activities and their full costs, including the costs of accidents.

V. The Range of Responsible Parties

In the following analysis, the various actors involved in the creation and the operation of autonomous systems and IoT-devices will be grouped together into two distinct camps, namely the camp of the manufacturers and the group of the users. The manufacturer group includes all actors, usually businesses, who contribute to the development, design and production of autonomous systems, including software developers and programmers. The other group comprises everyone who interacts with an autonomous system or IoT-device after it was put into circulation, i.e. owners, keepers and operators of such devices. The composition of these two groups of manufacturers and users is not purely phenomenological. It also pays tribute to the fact that, within each group, it seems fairly easy to allocate the costs of liability to any one member or to share it between several members. The obvious tool for re-allocation of the costs of liability within one of the groups is a contractual agreement. Already today, standard supply agreements among the members of the manufacturer group, i.e. end-producers and component suppliers of different layers routinely include clauses that provide for the allocation of the costs of product recalls and other costs caused by defective components.[20]

The same can happen within the group of users, i.e. between owners and operators, be they employees or independent contractors. Take the example of motor cars. Here, the keeper of a car is required to take out liability insurance under the applicable European directives.[21] If the car is rented

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19 Calabresi (n 17), 28: "tertiary accident costs".

20 Omri Ben Shahar & Schneider, 'Auto Manufacturing Contracts', (2006) 104 Mich. L. Rev. 953, 959–960; Wagner, in: *Münchener Kommentar zum BGB* vol. 6 (7th ed., C. H. Beck 2017), § 823 para 789.

21 Art. 3 Directive 2009/103/EC of 16.9.2009 relating to insurance against civil liability in respect of the use of motor vehicles, and the enforcement of the obligation to insure against such liability, OJ L 263/11; cf. also Council Directive 72/166/EEC of 24.4.1972 on the approximation of the laws of the Member States relating to insurance against civil liability in respect of the use of motor vehicles, and to the enforcement of the obligation to insure against such liability, OJ L 103/1; Second Council Directive 84/5/EEC of 30.12.1983 on the approximation of the laws of the Member States relating to insurance against civil liability in respect of the use of motor vehicles, OJ L 8/17; Third Council Directive

out to somebody else, the costs of such insurance are shifted to the lessee-driver, as a component of the price he or she has to pay for the lease. The same happens where a business operates an IoT-machine in its production process. Here, the prices for products manufactured by an IoT-machine will include a component reflecting the expected costs of harm caused by the IoT-machine. Again, costs are shifted within the group of entities that operate or benefit from the use of the IoT-device. In all of these cases, as long as responsibility is attributed to one member of the group, the re-allocation of accident costs within the group may be left to the parties and freedom of contract.

VI. The Legal Background

1. National Tort Law as the Default System

Within the European Union, the law of non-contractual liability, i.e. the law of torts or delict, is a domain of the legal systems of the Member States. Each Member State operates its own liability system, and the differences among these systems are manifold. While it is not possible at this point to engage in a comparative analysis of Member States' laws, it may be said with confidence that they share common principles.[22] These principles formed the building blocks of efforts by comparative law scholars to identify the "common core" of European tort law. Prominent examples are Book VI of the Draft Common Frame of Reference[23] as well as the "Principles of European Tort Law", compiled by the European Group on Tort Law.[24] Without going into any detail, it is safe to say that a general rule of liability for fault is part of the legal systems of all the Member States,[25] and it also remains central to the principles restating the common core of European Private Law.[26] Thus, where an actor fails to take due care and this negligence causes harm to another, or where a wrongdoer causes such harm intentionally, this actor is liable to compensate the victim. The principle of fault-based liability covers harm done to a set of fundamental interests of the person, i.e. life, health, bodily integrity, freedom of movement, and private property; in some legal systems the list of protected interests also includes purely economic interests and human dignity.

The general principles of liability for fault also apply to the parties associated with the manufacture and use of robots and IoT-devices. Therefore, the conclusion presented in the Commission's evaluation of Directive 85/374/EEC, that no less than 18 Member States are lacking rules on extra-contractual liability of service-providers,[27] must be taken with a large grain of salt. While it is

90/232/EEC of 14.5.1990, OJ L 129/33; Council Directive 2000/26/EC of 16.5.1990, OJ L 181/65; Directive 2005/14/EC of 11.5.2005, OJ L 149/14; Directive 2009/103/EC of 16.9.2009, OJ L 263/11.

22 For a thorough analysis cf. Christian von Bar, *The Common European Law of Torts* vol. 1 (C.H. Beck, 1998), vol. 2 (C. H. Beck, 2000).

23 Christian von Bar and Eric Clive (eds.), *Principles, Definitions and Model Rules of European Private Law, Draft Common Frame of Reference (DCFR)* vol. 4 (Sellier 2009); cf. also Christian von Bar, Eric Clive & Hans Schulte-Nölke, *Principles, Definitions and Model Rules of European Private Law, Draft Common Frame of Reference (DCFR) – Outline Edition* (Sellier, 2009), 395–412.

24 European Group on Tort Law (ed.), *Principles of European Tort Law* (Springer 2005).

25 von Bar (n 22), vol. 1, para 11–12

26 European Group on Tort Law (n 24), Art. 1.101 (1) and (2) (a); von Bar and Clive (n 23), Art. VI. – 1:101 (1).

27 Commission, Evaluation of Council Directive 85/374/EEC of 25 July 1985 on the approximation of the laws, regulations and administrative provisions of the Member States concerning liability for defective products, SWD(2018) 157 final, 51.

certainly true that many European legal systems lack rules on extra-contractual liability protecting consumers from harm caused "*specifically* by defects of either intangibles (software) or services",[28] the conclusion drawn from this statement. that there are large gaps in the respective liability systems, would still be misguided. As a matter of course, the general rules of non-contractual liability also apply to providers of services, regardless whether the customer is a business or a consumer. Here, as in other areas, fault-based liability serves as the work-horse of the liability system in protecting victims of any status or calling against harm caused by any entity or activity. What remains true is that many European legal systems have no *special* rules in place that are specifically gauged towards service providers and premise liability on "defective" performance of services, rather than fault. The difference between the requirement of "defective performance of a service" on the one hand, and negligence in the carrying out of a service, is slight indeed, if it exists at all. In conclusion, it must be noted that everyone involved in the manufacture and use of autonomous systems and IoT-devices remains subject to the general rule of fault-based liability, as supplied by the legal systems of the Member States.

2. The Products Liability Directive

European Union law is not entirely devoid of statutes governing extra-contractual liability. Directive 85/374/EEC on product liability is the exception.[29] It supplies a comprehensive framework for damages claims based on harm caused by products, which Art. 2 of the Directive defines as "movables". A damages claim based on the Directive does not require a finding of fault on the part of the manufacturer. The recitals of the Directive emphasize that liability under its rules is strict, not fault-based.[30] However, for a finding of liability it is not sufficient that a product caused harm to another. Rather, it is required that the product was defective, and that the defect was the cause of the harm complained of. The concept of defect is defined in Art. 6 of the Directive with a view to the reasonable expectations regarding product safety, measured at the time when the product was put into circulation (Art. 6 (1 (c) Directive). What this means in application to particular cases is not entirely clear.[31] In international comparative scholarship, it is well-settled that products liability regimes of the kind inaugurated by the Directive are co-extensive with fault-based liability, at least in the important areas of design defects and liability for failure to warn.[32] And even in the case of a manufacturing defect, the Directive does not impose a pure form of strict liability, as it is known, for example, from the French doctrine of "responsabilité de fait de choses",[33] but rather a watered-down

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28 Commission (n 27), SWD(2018), 157 final, 5, emphasis added.

29 Supra, n 11.

30 Directive 85/374/EEC, recitals 2, 3: "liability without fault".

31 Simon Whittaker, *Liability for Products* (Oxford UP 2005), 481–494; Wagner (n 20), 731–733.

32 Gert Brüggemeier, *Tort Law of the European Union* (Wolters Kluwer 2015), para 306, 314; David G. Owen, *Products Liability Law* (3rd ed. West 2015), 315–334; Simon D. Whittaker, 'The EEC Directive on Product Liability' (1985) 5 Yearbook of European Law, 234, 242–243; Hein Kötz, 'Ist die Produkthaftung eine vom Verschulden unabhängige Haftung?', Festschrift für Werner Lorenz (Bernhard Pfister, ed.), (J.C.B. Mohr, Tübingen 1991) 109; Peter Schlechtriem, 'Dogma und Sachfrage – Überlegungen zum Fehlerbegriff des Produkthaftungsgesetzes', Festschrift für Fritz Rittner (Manfred Löwisch, ed.), (C.H. Beck 1991), 545; Wagner (n 20) Einleitung ProdHaftG para 18.

33 Francois Terré, Philippe Simler and Yves Lequette, *Droit civil – Les obligations* (11th ed., Dalloz 2013), para 767, 794; Wagner, 'Custodian's Liability', Klaus J. Hopt, Reinhard Zimmermann & Andreas Stier, The Max Planck Encyclopedia of European Private Law, vol. I (Oxford UP 2012, 441–443).

version of negligence liability, with the concept of product defect containing much of the elements necessary for a finding of negligence.

Where a defective product has caused harm to another, recovery under the Directive is not without limits. Art. 9 allows recovery for damage caused by death or personal injury, as well as damage to property, provided that the property item adversely affected is not the product itself, that it was intended for private use and that is was actually used mainly for private purposes. Even then, a threshold of EUR 500 applies. Some Member States have transposed this threshold as a deductible applicable to all claims for compensation of property damage, while others allow the victim to sue for full compensation, provided only that the threshold has been overcome.[34] Where an infringement of one of the protected interests listed in Art. 9 is lacking, liability does not apply. This leaves purely economic interests as well as harm to human dignity outside of the protective perimeter of the Directive.

3. The Proposed Directive on the Liability of Service Providers

Attempts to supplement the Product Liability Directive by another legal instrument covering the liability of service providers have failed so far. The Commission proposal for a directive on the liability of service providers of 1990, which was designed to supplement the Product Liability Directive never matured into a binding legal instrument.[35] From the perspective of European law, the isolation of the Product Liability Directive may seem regrettable. However, it would be wrong to conclude that service providers are exempt from extra-contractual liability. As has been pointed out above (*supra*, 1), the legal systems of the Member States invariably provide for fault-based liability of actors of all callings, including service providers. The Commission proposal for a directive on the liability of service providers was not predicated on the concept of a "defective service" but embraced the same principle of fault that also governs in the systems of the Members States. Under Art. 1 of the Proposal, the service provider would have been liable for harm to protected interests "caused by a fault committed by him in the performance of the service". Even without careful analysis of the legal systems of the Member States, it is safe to say that service providers face liability for damage caused through their fault under these systems anyway.

4. Conclusion

In summary, the current situation is characterized by a fragmentation of European law and a comprehensive scope of national law. The responsibility of the business that puts a product into the chain of commerce, together with the responsibility of upstream suppliers, is covered by the uniform regime of the Product Liability Directive. Where businesses do not distribute "products" but rather licence rights or provide a service, the Product Liability Directive does not apply and consequently, no uniform European system of liability is applicable. Furthermore, the responsibility of those actors who own, keep or operate a certain product remains subject to national liability regimes. As far as

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34 Commission (n 27), SWD(2018), 157 final, 25.

35 Commission, Proposal for a Council Directive on the liability of suppliers of services, COM(90) 482 final, OJ 1991, C 12/8 ff.; cf. Emmanuela Truli, *Probleme und Entwicklungen der Dienstleistungshaftung im griechischen, deutschen und Gemeinschaftsrecht* (Duncker & Humblot 2001), 29–39.

manufacturers are concerned, approaches towards law reform must therefore start with a re-consideration, and possibly also a supplementation, of the Product Liability Directive. In contrast, with regard to the "group" of owners, keepers and operators, a European liability framework is missing entirely.

VII. Shifts in Control Induced by Technology

1. The Shift from User Control to Manufacturer Control

While it is difficult and not without serious risk of error to predict the safety characteristics of robots and IoT-devices, it seems reasonable to assume that the advent of such technology will shift control over these machines and appliances away from users and towards manufacturers. Legacy products rely on mechanical technology that is designed and produced by manufacturers, but that needs to be operated by users. While the manufacturer determines the general design of the product, including its safety features, and provides the interfaces between the product and its user – buttons, steering wheels, pedals and the like – it is the user who exercises control in real-world situations and determines the "behaviour" of the mechanical device. The most obvious example is that of cars. Conventional cars are operated by individual users who determine their direction of movement and their speed. It is also within their power and their responsibility to avoid impact with other cars, property or persons. It is for the driver to hit the brakes and slow the car down, to stop it or to change its direction in order to avoid an accident. The manufacturer is far removed from the accident scene and is unable to influence the behaviour of the vehicle in the relevant situation. Of course, the car manufacturer determines the safety features of the cars he produces and may be held liable under the Product Liability Directive where these features are found wanting. However, cars that fail to satisfy the requisite standards of product safety are a rare exception. By far the most traffic accidents are caused by human failure of the driver,[36] with speeding and mistakes in turning representing the most important causes of accidents.[37]

In contrast to conventional cars, autonomous vehicles will be steered and controlled not by a human driver but by an algorithm developed and installed into the car by its manufacturer. Fully autonomous cars that satisfy Level 5 of the classification system for automated vehicles do not require any human intervention when in operation. On the contrary, the intervention of the passenger into the process of driving is prohibited or rather prevented through technical safeguards. As a consequence, the "behaviour" of the autonomous car is not in the hands of the human driver but in those of the manufacturer. With regard to other autonomous systems and IoT-devices, matters will be similar. The whereabouts and movements of an automated lawnmower are determined by the software operating

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36 Europe: TRACE, Project No. FP6-2004-IST-4-027763, 16; USA: 94%; NHTSA, National Highway Traffic Safety Administration, Federal Automated Vehicles Policy, 2016, at 5, http://www.nhtsa.gov/AV. Germany: 88,1%; Statistisches Bundesamt, Fachserie 8 Reihe 7, Verkehr, Verkehrsunfälle 2016, (Statistisches Bundesamt 2017) at https://www.destatis.de/DE/Publikationen/Thematisch/TransportVerkehr/Verkehrsunfaelle/VerkehrsunfaelleJ2080700167004.pdf?__blob=publicationFile, 49.

37 SafetyNet, Alcohol (2009), 3, at https://ec.europa.eu/transport/road_safety/specialist/knowledge/alcohol_en; SafetyNet, Speeding (2009), 3, at https://ec.europa.eu/transport/road_safety/sites/roadsafety/files/specialist/knowledge/pdf/speeding.pdf; Statistisches Bundesamt, ibid.

within the device. The user of the lawnmower can hardly do anything except switching it on and off at a particular location.

The shape of current liability systems is adapted to the division of power and control between manufacturers and users. In short, the main focus of liability rules and the legal practice developed under them is on the users of technical appliances, not on the manufacturers. Again, motor cars provide the best example. The systems of motor traffic liability existing in the Member States differ greatly from one another, but they have in common that they target the users of cars – keepers and/or drivers – rather than manufacturers.[38] Of course, car manufacturers may be held liable under the Products Liability Directive as well as under national law, but the enforcement of such claims is the rare exception.[39] By far the greater share of the total cost of traffic accidents is internalized by the users, or rather by their liability insurers.

Continuing the example of motor traffic, autonomous cars of the future will transform the user from a driver into a passenger, i.e. into a person who travels inside the car, but has no control whatsoever over it. Even without legal analysis it seems obvious that this shift of control will upset established modes of cost attribution through the liability system. From a functional perspective, the focus of the extra-contractual liability must track the shift in the focus of control. As a first approximation, the liability of manufacturers will increase in size and relevance, and the responsibility of users will diminish proportionally.[40] The following analysis accounts for this shift in control by zooming in on manufacturers first (infra, VIII.), and by discussing the liability of users in second rank (infra, IX.).

2. Dispersion of Control: Unbundling

The future is inherently uncertain, and it is impossible to predict with sufficient probability the design and operating mode of technological systems that are yet to be developed and marketed. There is a serious possibility that autonomous systems and IoT-devices may follow an open-system approach that allows users to intermingle with the software that operates the device. It is conceivable that hard- and software will not be marketed in a bundle, as envisaged for autonomous cars, but separately – so that it is for the user to decide what software product to combine with which kind of hardware product. Further, one can imagine that users will be authorized and enabled to modify the software running a robot or IoT-device, e.g. by adding new features, by choosing between different modes, or by combining the original software with products made by other software companies. If such unbundling takes place, it no longer makes sense to place the manufacturer of the original product on the center stage. The task of attribution of responsibilities may become rather complicated, as it must be somehow shared or divided between original equipment manufacturers, suppliers of additional components, and users. Whatever principle is adopted in this area, it will almost certainly make it more difficult for the victim to identify the responsible party and to furnish proof that the requirements of liability were in fact satisfied by that party.

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38 Cees van Dam, *European Tort Law* (2nd ed. Oxford UP 2013), 408–420.

39 For Germany: Statistisches Bundesamt (n 36), 49: less than 1% of traffic accidents are caused by mechanical failure and poor maintenance.

40 Mark A. Geistfeld, 'A Roadmap for Autonomous Vehicles: State Tort Liability, Automobile Insurance, and Federal Safety Regulation', (2017) 105 Cal. L. Rev. 1611, 1691.

It seems that this is the situation that the European Parliament had in mind when it articulated the idea to take the autonomous system or robot itself and accord it the status of a legal entity, or "ePerson".[41] Doing so would relieve the victim of the burden to identify the responsible party and would spare courts the task to allocate liability between a multitude of defendants. However, as we shall see, the proposal to create ePersons is not without problems that need careful analysis (*infra*, X.). Once this has been done, they must be balanced against the costs of such a move in the form of diminished incentives to take care and adjust activity levels.

VIII. Liability of Manufacturers

1. The Manufacturer as Best Cost Avoider

Manufacturers of robots and IoT-devices will be able to exercise much more control over the performance and behaviour of their creatures than manufacturers of mechanical products. To the extent that manufacturers do or can exercise control, liability must follow. This is particular obvious in the case of a closed software system that prevents third parties, including the user, from tampering with the algorithm that runs the device. Here, it is only the manufacturer who is in a position to determine and improve the safety features of the device; nobody else can. Phrased in economic terms, the manufacturer is clearly the cheapest cost avoider.[42] Legal doctrine aligns well with this insight, as it is well accepted that the duty to take care is contingent on the actual availability of precautions and their economic reasonableness.[43] Precautions are economically reasonable if they generate gains in the form of reduced accident costs, which exceed their cost. In the case of a machine or device that comes as an integrated and closed system of hard- and software, the manufacturer is not only the cheapest cost avoider but the only party in a position to take precautions at all. This suggests that the focus of the liability system must be on the manufacturer.

2. The Scope of the Products Liability Directive

The movement of manufacturers of robots and IoT-devices onto the central stage of the liability system raises a number of important issues for the Product Liability Directive. An initial question concerns its scope and applicability. Art. 2 of the Directive limits its application to "movables". This term is understood to refer to corporeal objects or things.[44] Where a corporeal object, such as a car, a machine or a household appliance, is operated by software, it is generally accepted that the bundle of hard- and software together represents the product or "movable" within the meaning of the Directive.[45] Thus, even if only the software was defective, the Directive applies and the manufacturer may be held liable.

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41 Supra, I, n 6.

42 Calabresi (n 17), 136–150; but see also Shavell (n 16), 189–190.

43 van Dam (n 38), 235–246; von Bar, *The Common European Law of Torts* vol. 2 (C.H. Beck, 2000), 251 – 254; Wagner (n 20), § 823 para 421–429.

44 Brüggemeier (n 32), para 293.

45 Wagner (n 20), 714–715.

A problem arises if software is distributed as a separate product that is acquired through the internet in the form of a download. In this case, there is no "movable", i.e. no corporeal asset that the manufacturer placed into the stream of commerce. Computer code is intangible and does not qualify as a "thing". Therefore, the Directive may not be applicable to defective software that was distributed separately from the hardware for which it was designed and also without a corporeal storage device, such as a USB-stick that itself qualifies as a corporeal asset.

It is not entirely clear that the Directive does not apply to computer code. One option is to operate with an expanded notion of "movable" that included anything that is neither real estate nor a service,[46] regardless whether the object was tangible or intangible. The other options are an expanded, "digitalized" interpretation of the concept of "movable"[47] or the application of Art. 2 of the Directive by analogy in order to capture "quasi-things". Both options are problematic, as Art. 2 is rather elaborate as to the meaning of "movable", listing a number of examples that all refer to corporeal objects. And the last sentence of Art. 2 reads: "'Product' includes electricity". Against this backdrop, it is not easy to argue that the framers had a broad notion of "movable" in mind, that was not limited to corporeal objects. Otherwise, it would not have been necessary to explicitly include electricity. It may also be argued, however, that electricity is mentioned merely as an example of a non-corporeal object that is to be treated like a corporeal asset, and that software is another, and even better example. On this view, the Products Liability Directive, already in its current form, does apply to software "products". This expansive view, that applies Art. 2 of the Directive in a functional way, excluding only real estate and services, is preferable. The Directive should not be limited in scope to "old-school" products, and its application should be independent of the mode in which computer programs are stored, copied and distributed.

3. The Requirement of a Defect

The Products Liability Directive does not impose pure strict liability on manufacturers of movables but makes liability contingent on the finding of a product defect. The concept of defect is defined in Art. 6 of the Directive with a view towards the safety standard, which a reasonable person was entitled to expect at the time when the product was put into circulation. The problem with this definition is that product users rarely form specific expectations regarding product safety, and even where they do, these expectations are not determinative, as they are subject to the requirement of reasonableness, encapsulated in the "entitled to expect" language. As consumer expectations are often lacking or illusive, and not determinative anyway, courts and commentators of products liability law in the USA and Europe therefore favour the so-called risk/utility-test.[48] Notably, it was also embraced by the German Supreme Court (Bundesgerichtshof – BGH).[49]

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46 Services are clearly outside of the scope of the Directive; ECJ, 21.12-2010, Case 495/10 (Centre hosptialier universitaire de Besancon v. Dutrueux), para 39; cf. also ECJ, 10.5.2001, Case 203/99 (Veedfald v. Arhus Amtskommune) para 17 – Dutrueux; Brüggemeier (n 32), para 298.

47 Wagner (n 20), 717–718.

48 Owen (n 32), 482–503; Whittaker (n 31); 487 – 488; Terré, Simler and Lequette (n 32), para 989; Wagner (n 20), 731–733; cf. also Brüggemeier (n 32), para 306.

49 BGH, 16.6.2009, VI ZR 107/08, BGHZ 181, 253 para 18.

A finding of defectiveness is relatively straightforward in the area of so-called manufacturing defects. It is characteristic of a manufacturing defect that the product that was put into circulation does not fit the description of the manufacturer because something went wrong in the production process. Examples involving digital products include the incomplete installation of software in an autonomous car or IoT-device, as well as accidents caused by software bugs that were inadvertently included in the computer code. Even though a quality level of "zero defect" is unattainable, manufacturers of legacy products have worked hard and successfully in recent decades to minimize the occurrence of manufacturing defects. Whether they will be as successful with digital appliances that run on software remains to be seen. It is often said that it is impossible to write perfect computer code, free of any defects. However, to avoid liability for defective products an item need not be perfect but only risk minimizing. A bugged computer program in an IoT-device, for instance, does not trigger liability if the system shuts down orderly and safely when the software crashes.

Design defects are by far more serious than manufacturing defects. A product has a defective design if its layout, chosen by the manufacturer during the research and development process, is found wanting. Under the risk/utility-test, the layout of a product is defective if the court is able to identify an alternative design that would have helped to avoid the accident in question, provided that the accident costs avoided by the added safety feature of the alternative design would have exceeded the added costs of the alternative design. Applying the risk/utility-test to autonomous systems and IoT-devices requires an inquiry into software programming. The court or other decision-maker will need to identify shortcomings of the software that could have been avoided by an alternative program that would have performed as well as the one that was used – but would have avoided the accident in question. This issue, of whether the software is defective by design, will require the involvement of a technical expert. This alone is not problematic as, also in cases involving mechanical products, the involvement of technical experts into the fact-finding process is standard practice.

However, autonomous systems probably will pose special problems when it comes to design defects. A first inclination may suggest to compare the performance of an autonomous system to the one of a legacy product, operated by a human being. As to autonomous cars, this solution would amount to a "human driver test". Whenever the autonomous system caused an accident, which a reasonable human driver would have been able to avoid, the algorithm would be found defective in design. Intuitive as the human operator test may seem, its application to autonomous systems is misguided.[50] Autonomous systems are expected to decrease the number and severity of accidents dramatically, but accidents will continue to occur. The critical point is that the pool of accidents that an autonomous system still causes will not be the same as the pool of accidents a reasonable driver is unable to avoid. For instance, an autonomous car operating in orderly mode will never speed, and it cannot be drunk. However, it might fail to observe and account for a freak event that any human would have recognized and adapted his or her behaviour to. To subject autonomous systems to a human operator test would miss the mark as it would hold the system to a standard that it cannot live up to.

By definition, an autonomous system cannot and shall not be controlled by humans, neither by its manufacturer nor by its user. In particular, the software engineer who programs the algorithm running

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50 Geistfeld (n 40), 1644–1647; Wagner (n 20), 733–734.

the system does not use a finite set of commands of an "if … then" nature.[51] Rather, the algorithm is trained on sets of data, and then evolves through self-learning. The learning process unfolds not within one particular car or device, but rather with respect to the whole fleet of cars or devices designed by the same manufacturer. What is required, therefore, is a system-oriented concept of design defect.[52] The crucial question must be whether the system in question, e.g. the fleet of cars operated by the same algorithm, causes an unreasonable number of accidents overall. Whether the individual accident in question would have been avoided by a reasonable human driver or by another algorithm, these questions should be irrelevant.

To develop a system-oriented concept of defect is easier said than done. It is difficult to see how an alternative design could be identified other than by comparing the algorithm in question to the ones used by other manufacturers. However, under such an "optimal algorithm test" the algorithm that caused the accident will always be found defective, whenever there is an algorithm in the market that would have avoided that particular accident. And even applied to the full class of accidents caused by any one fleet of autonomous cars operated by the same algorithm, this method would lead to finding all the algorithms in the market defective – except for the safest of them all.[53] Assuming that one and the same algorithm is operating in a whole fleet of cars or other products marketed by a particular manufacturer, only the manufacturer with the best algorithm would be spared, while all the other manufacturers would be saddled with the full costs of accidents caused by their products. This outcome would be problematic as it would overburden the manufacturers of sub-optimal algorithms and, in doing so, stifle competition in the respective product market.

At this point of the technological development, it is not easy to predict how serious the problems just described will turn out to be. Possibly, courts will be in a position to identify design defects without comparing the performance of the algorithm involved in the accident with other algorithms operating in similar products. This may be true for programming bugs and other shortcomings of the algorithm that may be easy to identify and isolate.

4. Burden of Proof – Strict Liability as a Response?

The study that underlies the European Commission's evaluation of the Products Liability Directive suggests that the burden of proof poses a serious obstacle for victims seeking compensation from the manufacturer.[54] Pursuant to Art. 4 of the Directive, the burden of proving defect, damage, and the causal link between the two, is upon the injured person. Some observers expect that the burden of proof will weigh even more heavily upon the person injured by a digital product than the one injured by a legacy product.[55]

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51 Geistfeld (n 40), 1644–1645.

52 Geistfeld (n 40), 1645–1647; Wagner (n 20), 737–740.

53 Wagner (n 20), 737–740.

54 Commission (n 27), SWD(2018), 157 final, 25–26.

55 Jeffrey K. Gurney, 'Sue My Car Not Me: Products Liability and Accidents Involving Autonomous Vehicles', (2013) University of Illinois Journal of Law & Technology, 247, 265–266; Lennart S. Lutz, Tito Tang & Markus Lienkamp, Die rechtliche Situation von teleoperierten und autonomen Fahrzeugen, (2013) Neue Zeitschrift für Verkehrsrecht 57, 61.

At this stage, where very few autonomous products are operating in the market, it is difficult to know whether these concerns are justified. On one hand, it is to be expected that the digital revolution will make products even more complex than they previously were.[56] In particular, it may become increasingly difficult to analyse and evaluate self-learning algorithms and complex operating systems more generally. On the other hand, digitalization also offers unprecedented opportunities to monitor the operation of an autonomous system or IoT-device and to store this information for the benefit of victims. Robots and IoT-devices that were involved in an accident will offer victims, courts and regulators the same comprehensive sets of data that are now available in the case of an airplane crash. This will greatly diminish the evidentiary burden on victims and courts. After a recent reform, the German Road Traffic Act (Straßenverkehrsgesetz – StVG) already includes a right for victims of motor accidents to access the "black box" of a car equipped with autonomous driving functions (Section 63a (3) StVG). This is meant to enable the victim to identify the true cause of the accident, i.e. whether the automated system or the human driver was responsible.

With access rights like the one just described already in place or readily conceivable, it cannot be said that the remaining difficulties with proving product defect will pose a serious obstacle against recovery. Therefore, lawmakers are well-advised to remain cautious, to hold their fire, and to resist the urge to legislate, i.e. to sharpen the liability system. It is one of the virtues of legal systems in general, and of the development of private law in particular, that the system is able to evolve on a case-by-case basis. In the rather slow process of case-by-case adjudication, society can engage in an iterative process of learning and adjusting that promises better results than aiming for bold goals and easy solutions through early legislation.

If it should turn out that, indeed, victims face excessive difficulties to establish product defectiveness with regard to autonomous systems or IoT-devices, two remedies come to mind. One would be to reverse the burden of proof with regard to the requirement of defect, i.e. to turn Art. 4 Product Liability Directive around and to hold the manufacturer liable unless he is able to prove that the product was not defective. Moving even further, it would be conceivable to abandon the concept of defect altogether and to switch to a system of pure strict liability for autonomous systems and IoT-devices. Under such a system, the manufacturer would be responsible to make good any injury caused by the autonomous system, unless the harm was caused through the fault of the victim, the fault of a third party or force majeure. The switch from quasi-fault-based liability for defective products towards strict liability for autonomous systems may seem revolutionary, but, in reality, it would not be so. To the extent that the manufacturer shapes the algorithm that, in turn, determines the "behaviour" of the technical system or device, strict liability may be appropriate. Other than with legacy products, the user cannot do anything to prevent accidents from occurring and thus need not be incentivized through the liability system. Incentives to take care of users and third parties as victims would be held in check by the defence of contributory fault, as provided for in Art. 8 (2) Product Liability Directive.

5. Unbundled Products

The situation just described, where the manufacturer of the autonomous system fully controls its "behaviour" in the real world, would change rather dramatically, however, if digitalized products such

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56 Wagner (n 20), 747.

as autonomous cars and IoT-devices would not be marketed as a bundle of hard- and software that remains closed to user interference. Where the user had acquired hard- and software separately, and from different suppliers, it may be very difficult, in the event of harm, to figure out whether the hardware component or the software component or the mismatch of the two was the cause of the accident. The same problem arises where the user acquired hard- and software together, from a single manufacturer, but was in a position to add software to the programs already installed by the original equipment manufacturer or to tamper with the operation of the pre-installed software. Here, again, it will be very difficult to figure out whether a particular accident was caused by the original software or by add-ons or alterations executed by the user. In both cases, it remains innocent, from the perspective of the liability system, that the user was able to add software that remained outside of the program that operates the system, like entertainment software in an autonomous car. As long as it is assured that the software that governs the safety features of the car or other device remains isolated from user interference, it qualifies as a closed system for purposes of product liability law.

The upshot of the distinction between open and closed systems is that manufacturer liability is of paramount importance with regard to closed systems of hard- and software bundles. This is much less so where hard- and software are manufactured by different suppliers and marketed separately, or where the user is in a position to modify or supplement the safety features of the original software. In the latter case, it does not make sense to channel liability exclusively towards the hardware manufacturer, or towards the software manufacturer. Rather, it is important for the liability system to provide incentives to take care for everyone who is in a position to impact the safety characteristics of the autonomous system or IoT-device.

Thus, much will depend on the characteristics of autonomous systems and IoT-devices and the development of markets for these products. With regard to bundles of hard- and software that remain closed to the user, liability of the manufacturer who placed the bundle on the market is of utmost importance. For unbundled products, the proper solution is much more obscure. In theory, there is a simple remedy, namely a combination of product liability for manufacturers of hard- and software and fault-based liability of users and third parties. Of course, this is exactly what the law provides for today, as the Product Liability Directive not only applies to end-manufacturers but also to component suppliers of any layer (Art. 3 (1) Directive), while users and third parties are liable for fault under national tort law. In practice, however, the current state of the law may pose serious obstacles towards recovery, as the victim needs to prove who of the various actors involved in the accident does bear responsibility. While Art. 1 and Art. 3 (1) Directive hold end-producers responsible for the safety of the entire product, this does not apply to product bundles, in which the components are marketed separately. Thus, the victim would have to investigate whether the accident was caused by defective hardware, defective software marketed by the supplier of the original software, software manufactured by a third party and added to the device by the user, or by other modifications made by the user subsequent to acquisition of the device. This burden may deter many victims from bringing suit and may seriously undermine the success even of meritorious actions. Under Art. 4 Product Liability Directive, it is the risk of the victim that the court may fail to identify the true cause of the accident. The same applies under the fault-based liability systems of the several Member States.

Again, there is no easy way out of this conundrum. Reversing the burden of proof offers no remedy. It makes no sense, from a deterrence perspective, to reverse the burden of proof against manufacturers of hardware, for example, when, in all likelihood, the accident was caused by defective software. The same applies with a view to the other parties involved. Where users are authorized to

access the safety-related software of the system, the manufacturers of the original components may no longer be held responsible for the performance of the aggregate product. For unbundled products, there simply is no single responsible party that controls the safety feature of all components. Thus, liability must be apportioned between all the actors who contributed to the safety features of the device that caused the accident, at the time of the accident.

It seems that the only solution that would alleviate the burden on the victim of identifying the responsible party when the accident was caused through the interaction of unbundled products is to hold the system itself liable, i.e. to create some form of "robot liability". This solution will be examined in more detail below (*infra*, X.).

IX. Liability of Users

There is no European liability regime for users of autonomous systems or IoT-devices, or in fact any kind of product. This does not mean, that users go scot-free. Rather, they are subject to national tort law. In all of the Member States, fault-based liability is the first and central pillar of the liability system. Liability for fault applies to all members of society, including the users of products of any kind, and notably autonomous systems and IoT-devices (*supra*, VI. 1.). Thus, the user of such an appliance is answerable in damages, where he or she misused or abused it and harmed others. For example, if the user of an autonomous car overrides the software's firewall in order to steer the vehicle off the streets or in order to use it like a weapon against another person, his or her liability is out of the question. Further, as has just been explained (*supra*, VIII. 5.), the user is responsible for any software installed subsequent to the purchase of the original system, and for any modifications made to the original software. It has also been noted that it may be difficult for the victim to prove that it was the user – rather than the end- or component manufacturers – who is responsible for the defect that caused the harm complained of.

Some legal systems have gone beyond fault-based liability and subjected users to strict liability for harm caused in the operation of an installation, appliance or machine. The most widespread of these categories is strict liability of keepers of motor cars.[57] The most notable exception to this principle – the United Kingdom that holds on to fault-based liability even in the area of motor traffic – is about to leave the EU. On the other end of the spectrum, France has moved far beyond subjecting motorists to strict liability, in providing a liability system for traffic accidents that is even farther removed from fault and rather settles on mere involvement (implication) in a traffic accident.[58] Outside the special area of motor traffic, France subjects any keeper of a "thing" to strict liability for any harm, regardless whether the "thing" was defective or not.[59]

The French solution of strict liability for keepers of any "thing" did not win over the drafters of the Common Frame of Reference or the European Group on Tort Law. Art. VI.–3:202 seq. Draft Common Frame of Reference provide several categories of strict liability, namely for immovables

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57 Supra, n 38.

58 Geneviève Helleringer & Anne Guédan-Lécuyer, 'Development of Traffic Liability in France', in: Wolfgang Ernst (ed.), The Development of Traffic Liability, Comparative Studies in the Development of the Law of Torts in Europe (John Bell & David Ibbetson, eds.), vol. 5 (Cambridge UP 2010), 50, 67–69; van Dam (n 38), 408–411. Terré, Simler & Lequette (n 32), 984–1012.

59 Supra, n 33.

that are unsafe (Art. VI.–3:202 DCFR), animals (Art. VI.–3:203), defective products (Art. VI.–3:204), motor vehicles (Art. VI.–3:205) and dangerous substances and emissions (Art. VI.–3:206), but not for simple "things".[60] Under Art. 5:101 Principles of European Tort Law strict liability is confined to abnormally dangerous activities, while national lawmakers retain the option to extend strict liability to activities that are dangerous, though not abnormally so.[61] The advent of autonomous systems and IoT-devices may force European lawmakers to reconsider the issue. If markets developed towards unbundling, and original equipment manufacturers lost control over the safety features of the products they put into circulation, responsibilities become blurred. It will thus become increasingly difficult for the victim to single out the actor who bears responsibility for the accident in question. To the extent that the victim fails to pinpoint responsibility, the damages claim fails and incentives to take care are lost. Such outcomes could be avoided if users were held strictly liable for any harm caused in the course of the operation of an autonomous system. The question as to who bears responsibility for a particular accident would then be shifted towards the user and his insurers who, in turn, would seek recourse against hardware- and software manufacturers.

It seems that, at this point in time, it is too early for such a sweeping solution. Up to the present day, unbundling has not taken place, and the evidentiary burden for the victims of digital products is no greater than the burden for victims of any other product. As long as the situation remains as is, there is no need to discuss the introduction of broad strict liability of users of digital appliances.

On the other hand, the national legal systems are well-advised to keep systems of strict user liability in place, where they are already established. This advice is particularly important for road traffic liability, which provides the backbone of the tort system in many jurisdictions. In Germany and other countries, liability is channeled towards the keeper of the car, who in turn is required, under European law, to cover the risk through liability insurance.[62] The result is a two-step system of strict liability for motor accidents that offers victims a "one-shop-stop"-solution to compensation. The question of who bears responsibility for the accident, be it the driver who drove too fast, the owner-keeper who failed to afford proper maintenance of the car, the shop owner whose repairs were deficient or the manufacturer who failed to meet the required standard of safety, is not a concern of the victim. Whoever the culpable party may be, the insurance company that insured the keeper against liability will indemnify the victim. The attribution of liability and the enforcement of legal claims are shifted to recourse actions by the motor insurer against the responsible party. These are managed by the insurance carriers, who are professional and well-informed parties willing and able to enforce such claims. It would be foolish to abolish or restrict these well-oiled systems of compensation for traffic accidents that exist in the Member States. Also, in a world with autonomous cars, traffic victims should be able to obtain compensation from the keeper of the car, or rather, the liability insurer of the car, and not be forced to identify the party within the group of manufacturers, service providers, keepers and users who bears responsibility for the accident in question.

In the same vein, proposals to restrict the rights of recourse of motor insurers against manufacturers of autonomous cars should also be resisted.[63] If rights of recourse against these manufacturers were

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60 von Bar & Clive (n 23), 3544, 3558; von Bar, Clive & Schulte-Nölke (n 23) 401–405.

61 European Group on Tort Law (n 24), 5–6, 104.

62 van Dam (n 38) 408–420; as to the duty to take out liability insurance supra, n 21.

63 Wagner (n 20), 760–764.

removed or restricted, the costs of their failure to take precautions against harm would be externalized to motor insurers and, ultimately, the keepers of cars, who would have to pay higher insurance premiums. This consequence does not raise distributive concerns as the keepers must front the costs of compensation anyway, be it in form of higher premiums for their insurance policies, be it in the form of a higher purchase price for the car, reflecting a component of liability insurance running with the sale. The real concern is behavioural: To isolate auto manufacturers from rights of recourse would effectively remove any financial incentive for them to take care and to avoid accidents from occurring. These incentives are needed, however, to entice manufacturers to invest in the safety of the autonomous driving machines they are about to market.[64] Contrary to popular thought, these incentives are no less needed in case of a new technology, but even more so. It is unavoidable that manufacturers know less about the safety requirements of new technologies than they know about the features and risks of long-established technological appliances. Thus, at the early stages of a technology, it is particularly important to provide incentives to take care as manufacturers still have a lot to learn. Abolishing the rights of recourse of insurance carriers against manufacturers would essentially remove the financial incentive to do so and provide a subsidy to manufacturers of new technologies.

X. Liability of the IoT-Device, the Robot Itself

1. A Legal, not a Philosophical Question

The fanciest topic in the area discussed in this paper is, of course, the liability of the robot itself. The fact that robots are anthropomorphic may lead to the idea that they should be treated as persons, so-called "ePersons," for that matter. In a more serious way, scholars of sociology and philosophy of law have pointed to the fact that, with the advances in technology that are now visible on the horizon, the gap between humans and machines becomes increasingly blurred.[65] If the distinctive feature of being human is to be able to "think" and to autonomously set goals for oneself, then it might be conceivable that artefacts acquire these same capabilities. And if they do, it seems, they must lose their status as "objects" and be recognized as persons, i.e. subjects, by the legal system.

The suggestion to promote autonomous software agents to legal subjects raises a number of issues that cannot and need not be discussed in the present context. One obvious question that troubles academics and the public alike, is whether it is at all realistic that machines will get to the level of "artificial intelligence" or whether they will remain confined to execute the computer program they were trained on. This question is obviously of a technological nature, and, as such, not for lawyers to discuss and decide. The legal question rather, is whether autonomous software agents should be

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64 Horst Eidenmüller, 'The Rise of Robots and the Law of Humans' (2017) Zeitschrift für Europäisches Privatrecht 765, 771–772; Gerald Spindler, Roboter, Automation, künstliche Intelligenz, selbst-steuernde Kfz – Braucht das Recht neue Haftungskategorien?, CR 2015, 766, 771–772; Wagner (n 20), 762.

65 Pathbreaking Gunther Teubner, 'Elektronische Agenten und große Menschenaffen: Zur Ausweitung des Akteursstatus in Recht und Politik', (2006) 27 Zeitschrift für Rechtssoziologie 5–30; *idem*., 'Digitale Rechtssubjekte? Zum privatrechtlichen Status autonomer Softwareagenten', (2018) 218 Archiv für die civilistische Praxis (forthcoming); cf. also F. Patrick Hubbard, '"Do Androids Dream?": Personhood and Intelligent Artifacts', (2011) 83 Temple Law Review, 405, 418–433; Erich Schweighofer, Thomas Menzel & Günther Kreuzbauer (eds.), *Auf dem Weg zur ePerson: aktuelle Fragestellungen der Rechtsinformatik*, (Verlag Österreich 2001).

accorded entity status, on the assumption that and at the point in time when they have acquired the requisite capabilities.

Another interesting question is of anthropological nature: What does it take to be human? This goes to the level of cognitive capabilities an entity must possess in order to be qualified as "intelligent". The next step then is to determine whether intelligence is enough for acceptance into the group of humans or whether it takes more. If it does take more, what else is required? Autonomous goal-setting, moral agency, the capacity for empathy? Again, these questions are not of a legal nature. Legal systems take it for granted that humans are persons, i.e. legal subjects, not objects, without discussing what it takes to qualify as a human. More precisely, legal systems refer to "speciecism", i.e. they classify living organisms as humans and accord them the status of persons if they belong to the species of *homo sapiens*.[66] Whether a particular human being is really able to think for him- or herself, whether it has a moral sense, whether it sets its goals autonomously, and develops emotional ties towards others, is irrelevant.

This strategy of defining legal subjectivity not with a view towards certain intellectual and emotional capabilities, but simply on the basis of belonging to the human race, suggests that the expansion of entity status to non-human actors is not a question of capabilities. It is rather a decision for the legal system to make. The legal system is a creation of and operated by humans. The same people who (virtually) agreed on a constitution and who inaugurated a legislature to make laws can and will decide on whether to accord entity status to autonomous software agents. Even the closest similarities between machines possessing artificial intelligence and humans will not predetermine the answer to this question.

The "anthropocentric" approach to the question of entity status for robots, outlined above, is confirmed by the concept of the juridical person as it exists in modern legal systems, including the Member States of the EU. Juridical persons are formed of groups of humans who together pursue a certain purpose, usually to run a business for profit.[67] On the basis of statutory instruments or other legal norms, corporations and certain kinds of partnership enjoy "entity status", i.e. they qualify as a distinct legal person, even though they are not human. The classification of groups of people operating a business as a "legal person" obviously rests on decisions made and institutions supplied by the legal system itself. It is not "in the nature of things" that corporations are legal entities, but it is a matter of legislative fiat.

Advocates of ePersons often point to the example of corporations in order to argue that entity status is not strictly confined to humans. As we have seen, this argument is correct, but it cuts both ways. There is nothing in the concept of a legal entity or in philosophy that stands in the way of

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66 The term "speciecism", originally coined by Richard D. Ryder, is popular in the animal rights community; cf., e.g., Paul Waldau, 'Speciecism: Ethics, Law, and Policy', in: Marc Beckoff & Jane Goodall (ed.), *Encylopedia of Animal Rights and Animal Welfare* (2nd ed., Greenwood Press 2009) 529–534; Peter Singer, *Animal Liberation* 1975; idem, 'Ethics Beyond Species and Beyond Instincts', in: Cass R. Sunstein & Martha C. Nussbaum (eds.), Animal Rights (2004 Oxford UP) 78, 79; Beyond Richard Dawkins, 'Gaps in the Mind', in: Paola Cavalieri & Peter Singer (eds.), *The Great Ape Project* (St. Martin's Griffin 1993), 81–87. Without subscribing to the propositions of the animal rights movement, the point that existing legal systems are anthropocentric, in that they endow only humans with rights, is uncontroversial.

67 John Armour, Henry Hansmann, Reinier Kraakman & Mariana Pargendler, 'What is Corporate Law?', in: Reinier Kraakman, John Armour, Paul Davies, Luca Enriques, Henry Hansmann, Gerard Hertig, Klaus Hopt, Hideiki Kanda, Mariana Pargendler, Georg Ringe & Edward Rock, *The Anatomy of Corporate Law: A Comparative and Functional Approach* (3rd ed. 2017, Oxford UP), 1–15; for an historical perspective Andreas M. Fleckner, *Antike Kapitalvereinigungen* (2010 Böhlau), 239–496.

recognition of autonomous software agents as legal persons. On the other hand, there is nothing in the concept of the legal person or in anthropology or philosophy that requires the legal system to accord entity status to autonomous software agents. These may be as human-like as they get, the decision whether they qualify as persons still needs to be made by humans, and they can decide not to take this step.

Even if humans decided to accord entity status to autonomous software agents, they need not do so wholesale. As for corporations, legal systems take a nuanced approach, treating them like persons in the commercial area, but withholding other privileges, such as the right to vote. Whether corporations are within the protective perimeter of fundamental rights like free speech or freedom of religion is a much-discussed issue on both sides of the Atlantic.[68] In the present context, it is neither possible nor necessary to delve into the discussion on fundamental rights. Entity status is no black-and-white decision but allows for graduation; the accordance of legal status in one context need not lead to an award of the same status in another. Within the context of non-contractual liability, the crucial question that needs to be answered is whether robots should be recognized as wrongdoers or otherwise liable parties, i.e. whether they should be accorded entity status for purposes of ascribing liability. Again, this question must not be approached in a fundamentalist or essentialist way, asking whether robots are sufficiently similar to other persons who may become "liability subjects", i.e. entities that may be held liable under the applicable legal rules, in the same way that humans, corporations, and perhaps partnerships may be held liable. According entity status to non-humans is not a question for anthropology but one for the liability system to answer. The question is: Does it make sense, for the liability system, to recognize autonomous software agents as legal entities who may be held liable in damages?

2. Externalization of Risk through Recognition of ePersons as "Liability Subjects"

As a first approximation, the answer to the question posed above, whether robots should qualify as entities capable of attracting liability, must be "no", i.e. autonomous software agents cannot be recognized as "liability subjects". The obvious explanation is that robots have no assets for paying off damages claims. If they were nonetheless accepted as legal entities, victims would receive nothing. Entity status would result in a complete externalization of accident risk. Victims would receive no compensation, and incentives to take care would be lost.

In this context, it is important to note that recognizing robots as ePersons would protect all the actors "behind" the robot from liability. The creation of a distinctive legal entity, such as a corporation, works as a shield against liability for the actors who created the entity, in the example of corporations the shareholders.[69] The purpose of this shield is to stimulate risk bearing; shareholders cannot lose more than the money they invested into the corporation.[70] Applying the principle of

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68 Citizens United v. Federal Election Commission, 558 U.S. 310 (2010); Burwell v. Hobby Lobby, 573 U.S. __ (2014); Thomas Ackermann, 'Unternehmen als Grundrechtssubjekte', in: Susanne Baer, Oliver Lepsius, Christoph Schönberger, Christian Waldhoff, Christian Walter (eds.), Jahrbuch des öffentlichen Rechts der Gegenwart, vol. 65 (Mohr Siebeck 2017), 113.

69 Frank H. Easterbrook & Daniel R. Fischel, *The Economic Structure of Corporate Law* (Harvard UP 1991), 40–62; Stephen M. Bainbridge & M. Todd Henderson, *Limited Liability* (Elgar 2016), 44–85; John Armour, Henry Hansmann, Reinier Kraakman & Mariana Pargendler (n 67), 5–6.

70 Frank H. Easterbrook & Daniel R. Fischel (n 69), 40; Stephen M. Bainbridge & M. Todd Henderson (n 69) 2.

limited liability to ePersons, manufacturers and users of robots would be exempt from liability as they qualify as quasi-shareholders of the robot. Its manufacturers, programmers, and users would no longer be liable as the "behaviour" of the robot would no longer be ascribed to them – but instead to the robot itself. This could be tolerated, in the sense of a price worth paying, if the newly created legal entity itself were capable of responding to the threat of liability. This is emphatically not true for robots. It seems that, under the proposition of ePerson liability, no one responsive to the financial incentives of the liability system would in fact be exposed to it.

For purposes of deterrence, such an outcome is intolerable. The quasi-shareholders of the robot would have no financial incentive to manufacture the robot and operate it in a way that reduces the risk of harm. No incentives to take precautions would exist. Furthermore, the price charged for the robot would not reflect the true social cost of its creation and operation, as the harm caused to third parties would remain with the victims. Thus, entity status externalizes the risks created by the robot itself, but also the risk created by those who put the robot into circulation and others who decided to put the robot to a certain use or otherwise release it into society.

3. Incentives for Robots?

In the case of limited shareholder liability, at least the corporation is not immune from liability. As an organization that ties together individuals through a nexus of contracts, it may respond to the incentives generated by the liability system.[71] It is essential to understand that matters are different when it comes to ePersons. The reason is that robots – however "intelligent" they may become – will never be able to respond to the incentives generated by the liability system. Sure enough, an autonomous software system can be programmed to "learn" from past experience in the sense that the algorithm improves with every accident it becomes involved in. However, the capacity of the algorithm for improvement is based on its programming, i.e. on the decisions of software programmers. Whether or not the autonomous system will be held liable for the consequences of an accident it has caused, is irrelevant to the learning curve, or lack thereof, of the algorithm. Obviously, software can be programmed to improve itself even without the concept of an ePerson. Thus, autonomous software agents are immune from the financial incentives generated by a credible threat of being hold liable for harm caused. The fact that potential ePersons are unreceptive to financial incentives to avoid harm, raises serious concerns with a view to deterrence, even if minimum asset requirements or insurance mandates apply.

4. Risk Internalization through Asset Requirements and Insurance Mandates

It is true that the problem of risk externalization, together with the frustration of incentives to take care, may be addressed by the legal system, and this is what serious advocates of ePersons actually propose. The remedies are similar to the ones employed in corporate law. The robot could be required to be endowed with minimum assets in order to qualify as a legal entity. Such a minimum asset requirement would force other parties to provide the funds necessary to satisfy potential damages claims. These funds would then be transferred to the robot and held in its own name. From this pool of assets, damages claims would be paid off.

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71 Frank H. Easterbrook & Daniel R. Fischel (n 69), 40–41.

An alternative means to minimum asset requirements that serves the same end is mandatory liability insurance. The law could simply stipulate an insurance mandate, as a precondition for incorporation of a robot as an ePerson. Again, the burden for providing the mandatory liability insurance would fall on the natural and legal persons who put the robot into circulation or operate it. They would have to supply the insurance contract and pay the premiums, as the robot would have no assets to pay them from. Looked at solely through the eyes of the liability system, mandatory liability insurance seems preferable over minimum asset requirements. Other than for the largest of enterprises, who can easily self-insure, market insurance is usually more efficient than self-insurance through the setting aside of assets. Tellingly, liability insurance for business enterprises is very common even though there is no legal requirement for it. The main advantage of insurance over other forms of hedging risk is that there is no saving period until a sufficient pool of assets has been compiled, and that the assets remain liquid as they need not be set aside as savings for the benefit of victims. This suggests that mandatory insurance may be the better solution also for ePersons.

Within the scope of the insurance cover or asset cushion, the crucial issue is as to who will be liable to contribute. The robot cannot pay for insurance, so somebody else needs to do that. The usual suspects are already familiar: the manufacturers of the robots and their users. If the manufacturers have to front the costs of insurance, they will pass these costs on to the buyers/keepers of the robot. In one form or another, they would end up with the users. The same outcome obtains if the users contribute directly to the asset cushion or become liable for the insurance premiums. In the end, therefore, the producers and users of the robot have to pay for the harm caused by the robot. The ePerson is only a conduit to channel the costs of cover to the manufacturers and users.

Whatever tool would be chosen by the legal system, both, minimum asset requirements and mandatory insurance are well-suited to avoid risk externalization. At least up to the amount of the insurance ceiling or the value of the minimum assets, victim compensation is assured. Beyond this amount, however, risk externalization would persist.[72] Again, the essential point about entity status for robots is that this move helps to shield other parties from liability, namely manufacturers and users. Within the corporate context, the protective function of limited liability is acceptable for voluntary creditors who can easily protect themselves against risk externalization, but it is much more problematic for involuntary creditors like tort victims who lack any means to do so.[73]

It may well be argued that manufacturers and users should be protected from excessive liability so that caps on liability are in order. There is also no doubt that limited liability of the quasi-shareholders, such as the manufacturers of robots, is functionally equivalent to a cap on the direct liability of these same manufacturers. Here, as in corporate law, the creation of a legal entity helps to limit the exposure of the individuals who created the entity and thus may stimulate them to take on more risk at lower cost.[74] However, it must be remembered that any "liability subsidy" accorded to certain activities stimulates an excessive amount of such activities (*supra*, IV.). If autonomous systems really generate the great savings in accident costs that they are promised to, then no liability subsidy is needed.

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72 Frank H. Easterbrook & Daniel R. Fischel (n 69), 49–50.

73 Frank H. Easterbrook & Daniel R. Fischel (n 69), 50–54; Wagner, 'Deliktshaftung und Insolvenzrecht', in: Eberhard Schilken, Gerhard Kreft, Gerhard Wagner & Diedrich Eckardt (eds.), Festschrift für Walter Gerhardt (RWS 2004), 1043, 1048–1051.

74 Stephen M. Bainbridge & M. Todd Henderson (n 69) 2, 47–48, 69.

As a general matter, it is submitted that the issue of limited liability should be addressed and discussed head-on rather than hidden in the issue of recognition of autonomous systems as ePersons. Whether caps are useful and, if so, what their appropriate level shall be, must be discussed separately from and independently of the ePerson issue. Art. 16 (1) Product Liability Directive provides such a cap with regard to the liability of the manufacturers; their exposure is limited to 70 million ECU. Pending reform of the Directive, this cap also applies to manufacturers of robots and IoT-devices, however intelligent they may be. On the other hand, the liability of users, insofar as it is fault-based, is typically unlimited.

5. The Benefit of Robots as Liability Subjects

As has been pointed out, it is conceivable to develop tools that aim to preserve, or restore, the incentives generated by the liability system. In particular, ePerson liability could be supplemented by rights of recourse that the robot, or rather its liability insurer, would have against the manufacturer of the robot, and perhaps also its user. If such rights of recourse are generously granted, manufacturers and users may be exposed to the exact same incentives that they would face if the robot would not have been promoted to a liability subject. However, under this assumption, the question arises as to the purpose of the whole enterprise. If ePersons do not effectively shield the parties that created and operated them from liability, then why the effort?

The best answer to this question seems to be that the creation of a new entity may solve the evidentiary problems victims may face in markets for unbundled digital products. As has been explained above (*supra*, VIII. 5.), persons injured by a robot may face serious difficulties in identifying the party who is responsible for the misbehaviour of the device. Where robots are no longer marketed as a closed bundle of hard- and software, the mere malfunctioning of the robot is no evidence that the hardware product put into circulation by the manufacturer or the software downloaded from another manufacturer was defective. Likewise, the responsibility of the user may be difficult to establish. In a market of unbundled products, the promotion of the robot to a liability subject may serve as a tool for "bundling" responsibility. The burden to identify the party who was in fact responsible for the malfunction or other defect would then be shifted away from victims and onto the liability insurers of the robot. Liability insurers, in turn, are professional players who may be better able to investigate the facts, evaluate the evidence and pose a credible threat to hold hardware manufacturers, software programmers or users accountable. The first question liability insurers would consider is, however, whether the investigation of the facts for the purpose of identifying the responsible party is worth the cost.

Whether the evidentiary problems to be expected from markets with unbundled products are worth the cost of creating a new legal entity is doubtful. Moreover, digital technologies offer unique opportunities to record evidentiary data and to provide access to them at zero cost. It may well be that the information stored in the "black boxes" that will be installed in robots and IoT-devices will allow victims to identify the responsible party easily and accurately. Until it has been proven that these hopes will not materialize, legislation to create ePersons as liability subjects is not recommended.

XI. Conclusions

As the preceding analysis has revealed, the advent of robots and IoT-devices poses some challenges to the liability system. From a European perspective, it is noteworthy that the legal rules governing the liability of manufacturers are harmonized by the Products Liability Directive while the liability of users is subject to the legal systems of the Member States. Unfortunately, there is some uncertainty as to the responsibility of software programmers under the Directive, as it may be argued, incorrectly, that computer code does not qualify as a "movable" within the meaning of Art. 2 of the Directive. This uncertainty will remain inconsequential as long as autonomous systems are marketed as a bundle of hard- and software, as such bundles surely qualify as products. Once the bundle is unpacked and software is distributed separately, the situation changes. In this case, the need arises to add a clarification to the Product Liability Directive that software qualifies as a movable.

The difference between bundled and unbundled products turns out to be of crucial importance in other respects as well. In the former case, when hard- and software are marketed together and in a package that remains closed to the user, the manufacturer is the pivotal actor. Here, it is only the manufacturer who determines the safety features and the behavior of the robot or IoT-device. In other words, the manufacturer clearly is the cheapest cost avoider, in fact, he is the only person in a position to take precautions at all. In the interest of meaningful incentives of the manufacturer to employ available safety measures and to balance their costs and benefits, manufacturer liability is essential. In the case of closed systems marketed as a bundle, the incentives of users are secondary, as the user cannot influence the behavior of the robot. The temptation of users to tamper with the system, to override firewalls or otherwise abuse the robot, is effectively held in check by fault-based liability that exists in the legal systems of all the Member States.

Matters are much more complex when it comes to unbundled products. Here, it may be difficult for the victim to identify the responsible party, be it the hardware manufacturer, the software provider, or the user. Reversing the burden to prove a defect under Art. 4 Product Liability Directive, makes no sense as long as the question of who the responsible party remains unsettled. Robot liability, i.e. the promotion of autonomous systems and IoT-devices to legal entities or liability subjects, would offer a solution. The downside of entity status for robots is that a technical appliance, artificially intelligent as it may be, is never responsive to the financial incentives generated by the liability system. For this reason, and also for the purpose of avoiding the externalization of risk, it is essential that the parties who created and operated the robot, i.e. hardware manufacturers, software programmers and users, are made accountable for the cost of harm. This end can be achieved by requiring ePersons to take out liability insurance in an amount that reflects the amount of harm that they might potentially cause, and to force manufacturers and/or users to front the premiums for such insurance cover. Whether the advantage in terms of victim compensation is worth the price of shielding the truly responsible parties, namely manufacturers and users, from liability remains to be seen. As long as autonomous systems and IoT-devices do not arrive in large numbers, there is no need for legislative action.