The emperor's new clothes: A roadmap for conceptualising the 'new vehicle'[1]

Orian Dheu, Charlotte Ducuing and Peggy Valcke
Legal Researchers KU Leuven, Centre for IT & IP Law IMEC - Belgium

Introduction

New ICT and data-driven technologies are increasingly re-inventing and re-defining the transportation landscape. This is illustrated by the upsurge of interest in concepts such as 'smart mobility', 'Mobility-as-a-Service' or 'self-driving cars'. These technologies will allegedly bring many benefits. For instance, the vehicles' autonomy is expected to drop the number of accident-related fatalities. They are also expected to lay the ground for a shift from vehicle ownership to servitisation of transport, in other words, the foreseen evolution from the sale of vehicles to the offering of vehicles or of mobility "as a service", at its extreme without even transfer of ownership of the vehicle (Oliva and Kallenberg 2003; Lawson et al. 2016). In turn, servitisation of transport and 'smart' traffic management would allow for better infrastructure and vehicle capacity allocation as a means to come to terms with congestion.

Transport getting 'smart' is not a black or white situation, but rather a multi-level process already underway. Although the law is often criticised for lagging behind technical innovation, it is already changing in various branches. When asked about the legal impact of autonomous cars, a layperson in the street would probably first think of liability, e.g. who would be legally responsible if the car 'causes' an accident. This question has recently been extensively discussed in legal scholarship. Based on the observation that the operation of the vehicle allegedly shifts from the operator (e.g. the human driver of a car) to the 'autonomous vehicle', the scholarly focus has mostly been placed on the vehicle manufacturer. Considered as the closest link to the autonomous machine, the manufacturer would be exposed to greater liability, subject to a more or less strict regime such as based on the Product Liability Directive[2]. The manufacturer also seems to be at the core of the on-going legislative initiatives on cybersecurity for road vehicles. The vehicle's enhanced connectedness, higher automation (and, potentially, even autonomy) and, more generally, its heavy reliance on data, is mirrored by its increased exposure to cyber threats. On the international plane, the United Nations Economic Commission for Europe ('UNECE'), one of five regional commissions of the United Nations, has attempted to address this major challenge by imposing cybersecurity requirements as part of safety vehicle technical requirements. In the European Union ('EU') these are enforced by means of type-approval legislation thereby shifting the focus once again to the vehicle manufacturer.

The anticipatory efforts of legislators are to be praised. However, the question arises whether there is no contradiction in the attempt to leverage product legislation, so as to deal with new challenges of mobility, while recent trends in mobility are broadly described as a shift to servitisation? In other words, are we looking at the future of mobility through the lens of the present situation, while claiming that the future will look completely different? The paper challenges the 'product-oriented paradigm' or in other words the overwhelming claims of leveraging product legislation to regulate connected and autonomous cars – the so-called 'New Vehicles'. By doing so, the paper mainly aims to make a diagnosis of (the limitations of) product legislation to deal with connected and autonomous vehicles. Against this background, it also opens avenues for other orientations, subject to further discussion and research.

In the first section, this paper adopts an explanatory methodology to identify the 'product-oriented paradigm', namely the (over-)emphasis put on product legislation to regulate connected and autonomous cars. The second section evaluates to what extent product legislation and especially the notions of 'product' and 'manufacturing' are challenged by the features of the so-called New Vehicle, which results in limitations to the product-oriented paradigm. In an attempt to draw normative conclusions, the third and final section explores avenues for new approaches to the regulation of the 'New Vehicle', although it should be reminded that it also implies political choices.

1 THE 'NEW VEHICLE' AND THE PRODUCT-ORIENTED PARADIGM

The 'New Vehicle'

Autonomous systems and, more generally, AI-driven technologies are redefining the way society thinks about transportation mediums. The societal benefits of these smart mobility systems are said to be manifold and are often leveraged as a convincing argument in favour of a particular technology's deployment. Projects involving autonomous cars are soaring worldwide. Smart automobiles are already being tested in real-life conditions with varying degrees of success. The 'New Vehicle' concept embodies the novel reality of highly autonomous and connected mobility artefacts that are being developed by various industrial, transportation and research entities. This innovative take on mobility can be defined through its numerous technological features which make it a complex and evolving legal object.

First, the New Vehicle relies largely on deep reinforcement learning involving regression algorithms, pattern recognition algorithms, cluster algorithms and decision matrix algorithms. These algorithms enable it to perform object detection, identification, recognition, classification, localisation and movement prediction. Second, the New Vehicle depends on large volumes of data which are the essential fuel for AI systems. Although 'autonomy' and 'connectivity' of vehicles are different features, future higher levels of automation and autonomy will largely depend on connectivity. Vehicle connectivity is seen as a building block for vehicles to sense their environment based on which they can take operational decisions. For example, Cooperative Intelligent Transport Systems (C-ITS) communications – also known as V2V (vehicle to vehicle), V2I (vehicle to infrastructure) or V2X (vehicle to everything) – aim to allow vehicles to exchange information with their environment. Thirdly, both autonomy and connectivity imply reliance on multiple communication networks, services and technologies. To sum up, the 'New Vehicle' will depend upon various cyber-physical components, services and processes. Its main feature, namely its autonomy, stems from the combined interaction of both physical (hardware, sensors, probes, etc.) and digital components (software, data, GPS signals etc.)[3]. Furthermore, these components, services and processes are provided or operated by a range of actors which may not always be in the same vertical value chain; they may even be in competition with each other. The advent of the 'New Vehicle' will undoubtedly disrupt the automotive industrial ecosystem as new actors will enter the picture, such as ICT service providers, data service providers etc.

Though researchers working on autonomous cars have distinguished different levels of autonomy[4], ranging from 0 to 5 (0 being no autonomy and 5 being full autonomy), current mobility systems still require a human to oversee their operation, and, when appropriate, regain control of the vehicle at some point. However, this is set to change as the fast-paced development of new autonomous systems would increasingly shift the driver's role into that of a passenger with little, if any, control over the vehicle itself.

The product-oriented paradigm

In light of these foreseen changes, many have commented on the technology's potential for disrupting the legal and regulatory frameworks that are essential safety- and trust-building tools. The most commonly shared assumption among legal scholars asserts that the regulatory focus should consequently be placed on the manufacturer, seen as the best-placed entity to have significant impact on the machine (Lohmann 2016). This is largely based on the observation that operational control will shift from the human operator (the driver) to the machine itself, with few or no direct human involvement.

This 'product-oriented' or 'manufacturer-oriented' paradigm – as we call it here - would logically permeate product legislation, which plays an essential role in the transportation sector. By product legislation we mean two branches of law. The first concerns (technical) regulation of the product itself, applying to the manufacturing phase in the product's lifecycle. In the field of road transportation, this technical regulatory framework is harmonised at EU level. As a product aggregator, the (vehicle) manufacturer is responsible for the conformity of the products with technical requirements, prior to their placing on the market. This is achieved mainly by type-approval followed by individual certification of vehicles[5]. Most of the substantive technical requirements are developed at the international level by the UNECE which is responsible, among other things, for the development of harmonised regulations[6]. Admittedly, these frameworks assure a general level of safety and serve as a prophylactic measure against accidents caused by product defects. However, should the inevitable happen, EU product legislation includes a second branch constituted by the specific liability regime dealing with the manufacturer's liability:

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[2] 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 ('Product Liability Directive').

[3] See European Commission, Communication 'A European strategy on Cooperative Intelligent Transport Systems, a milestone towards cooperative, connected and automated mobility' (2016), COM(2016) 766 final; European Commission, Communication 'Europe on the Move' - Sustainable Mobility for Europe: Safe, connected and clean' (2018), COM(2018) 293 final; European Commission, Communication 'On the Road to Automated Mobility: An EU strategy for mobility of the future' (2018), COM(2018) 283, final.

[4] See the most commonly referred to SAE (Society for Automotive Engineers) automation scale: https://www.sae.org/news/2019/01/sae-updates-j3016-automated-driving-graphic. Other scales exist worldwide.

[5] Type-approval is harmonised in the EU, mainly through Regulation (EU) 2018/858 on the approval and market surveillance of motor vehicles and their trailers, and of systems, components and separate technical units intended for such vehicles [...], OJ L 151/1 ('Type-Approval Regulation').

[6] Agreement Concerning the Adoption of Harmonised Technical United Nations Regulations for Wheeled Vehicles, Equipments and Parts which can be Fitted and/or be used on Wheeled Vehicles and

the so-called 1985 Product Liability Directive[7]. This cornerstone piece of legislation, which establishes a harmonized semi-strict no-fault regime, facilitates the injured parties' claims against the manufacturer.

We define here the product-oriented paradigm as the regulatory focus placed on product legislation as the main tool leveraged to regulate the 'New Vehicle'. This pattern is already visible, for instance, in the attempts of international and EU regulatory bodies to use vehicle technical regulation and (in the EU) the type-approval procedure as an avenue to try and ensure not only safety but also increasingly (cyber)security of the 'New Vehicles' 'by design'. In this respect, UNECE is currently developing technical regulation on cybersecurity requirements, on one hand[8], and on certification of automated / autonomous driving systems, on the other[9]. Similarly, the EU is revising its type-approval legislation to implement such new vehicle technical regulations as part of vehicle safety requirements[10]. With respect to liability,, many authors assume that the technologically-induced shift in control (Wagner 2018)[11] would be mirrored by a shift in liability (Kalra et al. 2009; Lohmann 2016). Their reasoning is premised on the idea that, since the operator will no longer have control over the vehicle, the manufacturer should be held liable as it would be in the best position to prevent and mitigate technical failures or errors from occurring. In the context of automated mobility, the manufacturer would be the 'closest' entity to the machine retaining some control over it.

Although product legislation will continue to play an important role, using it as the main regulatory tool dealing with 'New Vehicles' overlooks their evolving and dynamic nature. Furthermore, it neglects their growing interconnectedness and interdependence within an emerging mobility eco-system. These technical and business features have legal implications which are discussed in the following section. The present paper claims that the notions of 'product' and 'manufacturing', which lie at the heart of product legislation, are challenged by the 'New Vehicle'.

2 CHALLENGING PRODUCT LEGISLATION AS A 'CURE ALL' TOOL FOR REGULATING THE 'NEW VEHICLE'

Product legislation was developed with tangible and clearly delineated objects in mind. Traditionally, the regulatory focus has been on the standalone product. Against this background, it is submitted here that product legislation is, to an appreciable extent, ill-suited to apprehend the 'New Vehicle' in its new and more 'diffuse' ecosystem. This section introduces three identified limitations to the product-oriented paradigm.

■ The 'New Vehicle' at the crossroads of product and service

The first limitation of the product-oriented paradigm relates to the very essence of the 'New Vehicle'. It is submitted here that the latter should be legally conceptualised as a hybrid concept between service and product. The manufacturing activity – as traditionally regulated by the law – is profoundly affected. First, the inherently self-adaptive character of autonomous vehicles, or at least some components thereof, implies that their behaviour could be altered after their placing on the market. In the context of product liability in the aviation domain, it has been argued that "it is not clear whether […] the alteration of an autonomous system's behaviour or an update/upgrade of its functionality could be considered a defective product […] or as a new product" (Emanuilov 2017). Analogue products are characterised by a linear and clearly-delineated lifecycle: they are first manufactured and then consumed – and operated - at a later phase, the two being clearly separated by the act of placing on the market. Product legislation and the obligations attached to the manufacturing activity are based entirely on this dichotomy. However, it does not easily fit the 'New Vehicle' reality where the manufacturing and operational phases are getting intertwined in time.[12]

The growing convergence of 'manufacturing' and 'operations' was also symptomatically observed through the regulators' attempt to tackle 'New Vehicles', based on a purely product-oriented paradigm perspective. Indeed, the UNECE is pondering on how to ensure (cyber) security of connected and autonomous vehicles through the use of vehicle technical regulations applicable to manufacturers. Within UNECE, the Working Party on Automated/Autonomous and Connected Vehicles (GRVA) issued in 2018 a "Proposal for a Recommendation on Cybersecurity"[13] and a "Draft recommendation on Software Updates"[14], both including respectively a draft vehicle technical regulation. Because of the dynamic nature of cyber-threats, a mirroring dynamic management of cyber risks is allegedly required throughout the lifecycle of vehicles, including the need for a constant monitoring of threats as well as for dynamic adaptation of responses. Such obligations to monitor and adapt the 'product' according to risks arising

the Conditions for Reciprocal Recognition of Approvals Granted on the Basis of these United Nations Regulations, ECE/TRANS/WP.29/2016/2 ('1958 Agreement').

[7] Product Liability Directive (n 2).

[8] Proposal for a Recommendation on Cyber Security submitted by the experts of the Task Force on Cyber Security and Over-the-air issues, 19.11.2018, ECE/TRANS/WP.29/GRVA/2019/2 ('Proposal for a Cyber Security Recommendation'); Draft Recommendation on Software Update of the Task Force on Cyber Security and Over-the-air issues, 19.11.2018, ECE/TRANS/WP.29/GRVA/2019/3 ('Draft Recommendation on Software'); Guidelines on Cybersecurity and Data Protection – Guidelines on measures ensuring cybersecurity and data protection of connected vehicles and vehicles with Automated Driving Technologies', Annex 6 of Consolidated Resolution on the Construction of Vehicles (R.E.3), ECE/TRANS/WP.29/78/Rev.6).

[9] Proposal for the Future Certification of Automated / Autonomous Driving Systems, submitted by the experts from International Organisation of Motor Vehicle Manufacturers, 19.11.2018, ECE/TRANS/WP.29/GRVA/2019/13 ('Proposal for ADS').

[10] Proposal for a Regulation of the European Parliament and of the Council on type-approval requirements for motor vehicles and their trailers, and systems, components and separate technical units intended for such vehicles, as regards their general safety and the protection of vehicle occupants and vulnerable road users […].

[11] Gerhard Wagner develops the notion of control shift from the user to the manufacturer within the more general context of robotics (see p. 8 of his paper, "Robot Liability", 2018).

[12] See EC commissioned Report from the Expert Group on Liability and New Technologies, "Liability for artificial intelligence and other emerging digital technologies", 2019, 70p. At pages 39 and 44 they seem to evoke the possibility of the manufacturer acting as an

after the placing on the markets typically lie beyond the traditional role – and obligations – of product manufacturers. The draft proposal and recommendation discussed within the Working Party on Automated/Autonomous and Connected Vehicles at UNECE suggest imposing such obligations onto the vehicle manufacturers by partly shifting the regulatory focus from the vehicle (the product) to the manufacturer. Under the draft proposal and recommendation, a new certification regime would be created with regard to the internal organisation of the manufacturer. Because of their inherent technical features, the activity of 'securing' vehicles appears to be closer to a service than to manufacturing activities, traditionally related to the features of the product before its placing on the market. This attempt to secure the vehicles 'by design' solely based on product legislation is only possible at the cost of seriously overstretching the manufacturer's role (Ducuing 2019). Paradoxically as it may sound, regulating the cybersecurity of the New Vehicles by forcing a sole product-oriented paradigm approach demonstrates that the manufacturer is functionally sliding towards service provision.

Furthermore, there is a broadly shared expectation that servitisation of mobility will replace ownership of road vehicles. Precisely because they blur the delineation between products and services, business models related to New Vehicles are deemed to be based on an economy of usage of mobility rather than ownership of vehicles. On the freight side, automated driving of trucks is expected to deliver truck platooning, where coordination of the fleet is necessary to optimise road and truck capacity. On the passenger side, some companies foresee the operation of a fleet of cars making for their efficient use without requiring individual persons to own their automobile. Servitisation of mobility also lies at the heart of the support of regulators for the New Vehicles, as illustrated by the Communication from the Commission "On the Road to Automated Mobility"[15] Servitisation of mobility is expected to lead to better infrastructure and vehicle capacity allocation and would play an important role in reducing car emissions. Policy expectations of shifting to greater forms of servitisation of mobility are for instance encapsulated in the expression "Mobility-as-a-Service" (Maas).

These business models – either spontaneously emerging from the market or pushed for by public authorities – are based on the core activities of fleet management and coordination of traffic. The product-oriented paradigm appears to run counter the 'servitisation' of mobility expected from the emergence of New Vehicles. As the law-maker will be required to play an active role in this regard, the current regulatory focus on product legislation lacks consistency and seems even a little schizophrenic.

■ The blurring boundaries of the New Vehicle in its environment

The product-oriented paradigm also suffers another limitation, in that it focuses on the manufacturer as the regulated subject. As a product aggregator, the manufacturer is indeed traditionally deemed - and mandated – to control the production phase. Product legislation is based on the premise that the manufacturer is best placed to "retain the overall control for the product and ensure that he received all the information that is necessary to fulfil his responsibilities according to the relevant [product regulation]"[16]. It is on that basis that safety requirements, included as part of vehicle technical regulations, lie first and foremost with the vehicle manufacturer, with the policy purpose to make vehicles safe. However, the New Vehicles are highly connected objects that constantly interact with numerous actors, such as data service providers, infrastructure managers, communication network providers etc., who will additionally not all qualify as subcontractors of the manufacturer and therefore not be under his control (Schellekens 2016). They may even be competitors, as in the case of multi-brand vehicle platooning, contemplated as a first use case of connected and automated driving[17].

The New Vehicle can be clearly assimilated to a 'system' refuting its characterisation as a pure standalone product. Because it is part of a wider mobility environment where different technologies, actors and elements come to interact with each other, interdependencies are at play. It is precisely these interdependencies that challenge the traditional approach towards transportation mediums as clearly delineated legal objects that are subject to specific ad hoc product legislation, either technical regulations or product liability rules. To give an example, should data flowing in and out of a vehicle (e.g. C-ITS communications from another vehicle or from the road infrastructure) be considered as being part of the legal definition of the product? The back-end server of connected vehicles is currently a hot topic regarding who can / should get access to in-vehicle data. Several models are competing, e.g. in the vehicle, at the manufacturer's premise or jointly managed by several manufacturers or even together with other interested stakeholders, with third parties having more or less access to the data (McCarthy et al. 2017). To what extent, then, if at all, should the back-end server be considered as part of the vehicle and should the answer depend upon its

'operator'. They also distinguish the 'frontend' operator from the 'backend' operator (which could potentially be the manufacturer).

[13] Proposal for a Recommendation on Cyber Security submitted by the experts of the Task Force on Cyber Security and Over-the-air issues, 19.11.2018, ECE/TRANS/WP.29/GRVA/2019/2.

[14] Draft Recommendation on Software Updates of the Task Force on Cyber Security and Over-the-air issues, 19.11.2018, ECE/TRANS/WP.29/GRVA/2019/3.

[15] European Commission, Communication 'On the Road to Automated Mobility' (n3).

[16] European Commission, 'Blue Guide' on the implementation of EU products rules (2016), 2016/C 272/01.

[17] See the Proposed General Safety Regulation from the Commission, Art. 11.

[18] Such road traffic liability can either be fault or strict based. Some countries have no fault compensation schemes which can be disconnected from the concept of responsibility.

[19] Proposal for a Regulation of the European Parliament and of the Council on type-approval requirements for motor vehicles and their trailers, and systems, components and separate technical units intended for such vehicles, as regards their general safety and the protection of vehicle occupants and vulnerable road users [...], COM/2018/286 final - 2018/0145 (COD), Article 3 (13).

[20] Commission Delegated Regulation (EU) .../... of 13.3.2019 supplementing Directive 2010/40/EU of the European Parliament and of the Council with regard to the deployment and operational use of cooperative intelligent transport systems, C(2019) 1789 final ('the proposed C-ITS Regulation').

[21] The C-ITS Platform is described here: https://ec.europa.eu/transport/themes/its/c-its_en (last visited 13 November 2019). Reports issued by the C-ITS Platforms are also available.

location, namely inside or outside the vehicle e.g. in the case of server shared with other parties?
This limitation cannot be overcome by a simple legal fiction, e.g. by laying down an extensive legal definition of the vehicle in technical regulations. It questions more fundamentally the factual absence of control of the manufacturer over part of what is –or closely interacts with– the vehicle. The emergence of this new road mobility eco-system also comes to question the current assumptions on the allocation of liability risks, most notably the manufacturer's foreseen increased legal exposure.

■ The New Vehicle and the 'systemic' diffusion of (legal) responsibilities and liabilities

The product-oriented paradigm described above was based on the premise that the liability focus will or should be placed on the manufacturer, seen as the best risk mitigator and cost avoider. The New Vehicle model challenges the premise of control lying at the heart of such paradigm, by potentially diffusing responsibilities and liabilities through a wide arrow of parties/actors involved in its functioning. The product-oriented paradigm also fails short to provide fair and predictable allocation of risks, which lies at the core of liability regimes, especially when dealing with innovative technologies.
Currently, the large majority of road traffic accidents trigger extra-contractual liability regimes and/or compensation schemes which put the onus on the driver/keeper and/or his/her insurer[18]. This makes sense in a 'driver-centric' environment where most vehicles are manned and operated by private individuals and where faulty personal behaviour is usually an important component in the accident's occurrence, but less so for autonomous vehicles. On the contrary, product liability claims are scarcely invoked for the time being.
The manufacturer-focused assumption seems to be a rather fictional one since it omits the foreseen multi-layered setting that reflects a much more complex and nuanced reality. Notwithstanding the practical difficulties in implementing product liability, and even if the manufacturer were to be considered as the best first-line liability bearer, this would not prejudge the legal responsibilities of all the other actors involved in the New Vehicle eco-system. In the event of an accident, multiple concurring responsibilities could be triggered and applied. On the one hand, and subject to further legal analysis, it may result in complex joint liability cases, as already observed in US legal scholarship with respect to C-ITS communications managed by consortia of car manufacturers and other interested parties, for lack of specific legal regulation (Crane, Logue, and Pilz 2017). On the other hand, the New Vehicle's technological and functional interconnectedness will make it extremely difficult to identify, attribute and apportion liabilities. Technical means are being envisioned to determine the cause of accidents (and by extension determine responsibilities), such as digital forensics or 'event data recorders' (Bose 2015) newly proposed to be imposed as part of vehicle technical regulation[19]. Experience gathered in aviation and the railways suggests, though, that sole technical means may not be sufficient. Furthermore, in both aviation and the railways, data recorders have been used primarily in safety accidents and incidents to discover safety issues and prevent future accidents, not to deal with liability allocation (Challinor 2017, 43–44). As a result, the ensuing legal uncertainties and liability exposure are both likely to have a chilling effect over the sustainable deployment of such novel mobility systems.
Against these backdrops, the product- (and thus manufacturer-oriented) paradigm appears to suffer from serious limitations, with respect to the regulation of the New Vehicles. This finding does not ban the relevance of product legislation to regulate (New) road Vehicles. Rather, it pleads against the use of product legislation as a 'cure-all' tool and thus requires discerning the boundaries of product legislation. The features of the New Vehicles question the core notions of product legislation, such as 'product' and 'manufacturing' (or manufacturer) and therefore calls for further research. This being said, it remains to be seen which other complementary instruments can regulate the New Vehicles. Departing from a consideration of the vehicle as a standalone product, the following section pleads in favour of an eco-system wide approach.

3 A NECESSARY RE-THINKING OF THE REGULATORY FRAMEWORKS ACCOMMODATING THE NEW VEHICLE

These technology-driven challenges call for a new regulatory approach that would allow for an effective and relevant framing of the New Vehicle. As outlined above, the current overstretch of product legislation cannot address the full spectrum of the New Vehicle reality and the evolving and dynamic nature of such autonomous

[22] On the need for prospective regulation of smart mobility, see (Docherty, Marsden, and Anable 2018).

[23] Directive (EU) 2016/797 of the European Parliament and of the Council of 11 May 2016 on the interoperability of the rail system within the European Union [...], OJ L 138/44 ('Railway Interoperability Directive'), Chapter III.

[24] Railway Interoperability Directive, Chapters IV and V.

[25] Directive (EU) 2016/798 of the European Parliament and of the Council of 11 May 2016 on railway safety, OJ L 138/102 ('Railway Safety Directive'), Article 9 and Chapter III.

[26] Railway Safety Directive, Articles 4 and 9 (4).

[27] Proposed C-ITS Regulation, Article 2 (3).

[28] Proposed C-ITS Regulation, Article 7 (3).

[29] Proposed C-ITS Regulation, Article 22 (2) and Annex IV, point 1.6.2.

[30] Proposed C-ITS Regulation, Article 27 and Annex IV.

[31] For instance, in the railway sector, see Convention concerning International Carriage by Rail, 1980 [so called "COTIF convention"]. In the aeronautical sector, see the Convention for the Unification of Certain Rules Relating to International Carriage by Air, 1929 [so called "Warsaw Convention"] and the Convention for the Unification of Certain Rules for International Carriage by Air, 1999 [so called "Montreal Convention"].

vehicles. Complementary approaches will need to be identified and implemented. This section elaborates on the appropriateness of drawing analogies from network industries in other transport modes. A system-wide assessment and potentially new legal qualifications of the different functions are prerequisites for the development and implementation of new legislation. Eventually, the regulation of 'New Vehicles' will highly depend upon priorities identified by policymakers, although research is required to inform the legal implications of the respective regulatory options.

■ System wide assessment as a prerequisite for activities not fitting the current taxonomy

As outlined above, the foreseen technology-induced mutation of land transportation will impact the way we frame its activities and associated actors. Functional boundaries may be blurred, creating much legal uncertainty. The technology's evolving and dynamic features may question the relevance of the current legal taxonomy which heavily relies on the traditional 'manufacturing versus operations' dichotomy. The lack of legal certainty is further aggravated by the fact that traditional actors, such as vehicle manufacturers, are increasingly involved in new activities whose legal qualification remains unclear. Such new activities could involve, for illustration, management and supervision of the learning loop of the AI application embedded in the vehicle driving system or new operational ways induced by technology to manage vehicle fleets (e.g. with truck platooning). This pattern may be exacerbated by regulation itself, as illustrated by the attempt from the international and EU regulators to ensure cybersecurity of vehicles by means of vehicle technical regulations. In doing so, they would require the vehicle manufacturer, in its capacity as such, to exert activities which lie beyond the traditional understanding of 'manufacturing'. Such activities would be much closer to the operation of the 'New Vehicle', e.g. the continuous supervision of a fleet of vehicles to ensure cybersecurity.

Ensuring legal certainty and consistency and genuinely achieving the desired regulatory purposes (e.g. safety and security of the 'New Vehicles' but also the MaaS-related political expectations) requires that the roles and functions de facto at work be clarified. The assessment of activities at stake needs to be conducted with a fresh eye rather than by looking backward at incumbent actors and trying to fit circles into the squares of existing legal categories. This is however not an easy task as technological and economic developments are constantly on-going.

The assessment exercise will have legal implications. It may lead to a rethinking of existing or the emergence of new legal categories in light of manufacturing tipping towards new activities. The proposal of the European Commission (EC) to regulate C-ITS (the proposed C-ITS Regulation), which was turned down by the Council in June 2019 and thus never enacted[20], is a good illustration of this assessment and (re-)qualification exercise. Preceded by a study and pilot initiative (the C-ITS Platform)[21], the C-ITS Regulation proposed by the EC introduced and regulated a new function as 'C-ITS station operator', defined as "any natural or legal person who is responsible for the putting in service and the operation of C-ITS stations […]". Interestingly, the notion of C-ITS station operator was viewed as independent from this of the vehicle manufacturer and the emphasis was placed on the operation of external communications (C-ITS). Obligations were attached to this function, with a view to securing C-ITS communications.

Other functions would deserve further consideration, such as professional fleet management and/or operation, or the development of road traffic management (towards what some have called "smart traffic"), to name but a few (Sánchez-Corcuera et al. 2019). The function of traffic management may have to be reflected upon not only from the perspective of existing technological and market developments, but also with a view to the policy benefits expected from the 'New Vehicle' ecosystem, i.e. prospectively[22]. In turn, apprehending a new or changing fleet management function remains pretty much a question mark, in particular vis-à-vis other existing functions such as (in the freight sector) those of the carrier and of the freight forwarder. The complexity is further aggravated by the growing and disrupting significance of online platforms conducting various coordination and other intermediary activities in the digital layer, yet difficult to rightly qualify (Montero and Finger 2017).

While being a preliminary task for any substantive regulation, it is obvious that legal qualification would impact in turn the way in which policymakers frame the 'New Vehicle' and the way its ecosystem will and should further develop. For instance, this legal qualification exercise will most importantly determine the applicable regulatory and liability regimes. The following sub-section provides introductory thoughts on substantive regulation, by drawing analogies with other transport modes regulated as network industries.

■ Analogies with network industries? Lessons and limitations

We discerned increasing operational functions associated to the 'New Vehicles' and with the probable servitisation of mobility as well as a growing interconnection of Vehicles within their environment (other vehicles, road infrastructure, etc.). As a result, an eco-system approach appears to be required. As noted by Stadler et al., the autonomous vehicle is not an independent one. Quite on the contrary, the 'New Vehicle' gets closely intertwined into a "network of mobility services" (Stadler, Brenner, and Hermann 2018). The advent of autonomous cars was even compared by Bassett and Jones to the operation of the railways, to underline the criticality of coordinating what they call the 'smart [or digital] infrastructure', which is illustrated by the expected increasing significance of smart traffic management. Comparing the 'New Vehicles' ecosystem with the operation of the railways or of other network industries is a useful source of inspiration for both the legal qualification of the new activities and their regulation. Both are regulated based on their qualification as a 'system of systems', which could also serve the regulation of the 'New Vehicles', in particular with the purposes of ensuring safety and of allocating responsibilities and liability. It would indeed accommodate the move towards a dynamic and interconnected mobility environment.

The railways and aviation are understood as safety critical sectors and subject to heavy safety and interoperability regulation. This includes both product legislation and regulation of sensitive operational activities. In the aeronautical sector, aircraft evolve within a highly complex and dynamic (three dimensional) environment where data and communication mediums are already a reality. The current safety regulatory framework covers every aspect of aviation, ranging from the aircraft's initial airworthiness (product certification), its maintenance, crew licensing, operations etc. But these different dedicated regulatory instruments are mostly activity- and sector-specific, though transversal elements exist. In the railways, safety regulation includes the certification of components[23], the authorisation to place in service railway subsystems (e.g. a train) with a view to their safe compatibility with the railway system as a whole[24] and the certification of the railway operators (carrier and infrastructure manager) for their respective operational safety management system (including for instance maintenance, safety-sensitive staff, etc.)[25]. Their safety management system shall take into account risks arising as a result of activities by other [railway] actors[26].

The C-ITS Regulation proposed by the European Commission shared interesting similarities with such layered approach with respect to safety and (cyber)security regulation, with a view to ensure safety and security while taking into account the whole dynamic network ecosystem. Under the EC proposal, the manufacturer of the 'C-ITS Station', namely the set of hardware and software components required to collect, store, process, receive and transmit secured and trusted messages in order to enable the provision of a C-ITS service […]"[27] had to affix the CE marking to attest conformity with technical (safety) requirements.[28] Then, the C-ITS station had to be enrolled to the 'C-ITS network' (the network of C-ITS stations) and certified with regard to the security policy of the entire C-ITS network[29]. Finally, the C-ITS station operator also had to set up its own information security policy in conformity with the security policy applicable throughout the entire C-ITS network. The EC proposal required the security policy to take into account risks arising for the other C-ITS stakeholders[30] A well-known concern in network industries, the strong focus on interoperability and coordination in the proposed C-ITS Regulation of the European Commission was also indicative of this move towards a complex and inter-dependent mobility system.

However, it remains unclear to what extent the comparison with other modes of transports, regulated in their quality as network industries, can be helpful. In the railways and aviation, the carriage activity is generally a professional one, as opposed to the operation of land vehicles, which is at the moment also open to non-professionals, in particular for passenger traffic. As a result, the liability regime in the railways and in aviation is mostly governed by contracts (between the passenger and the carrier, between the carrier and the infrastructure manager, etc.) and contract law, as harmonised from time to time by international law[31] Growing professionalization is foreseen in the field of road transport too. This is reflected in the emergence of new business cases for autonomous vehicles' fleet management and the servitisation of mobility associated with the MaaS paradigm. However, whether these new business cases signal road transport's shift towards increased and significant professionalization of carriage (also, among others, through increased 'platformisation') remains yet unclear. A few remarks need to be made in that respect. First, such a move would depend upon the economic players, but also upon the legislator's policy agenda. Second, the legislator should be aware of the fact that such a move towards professionalisation of road transport and mobility – and more generally the

ecosystem surrounding the 'New Vehicles' - will have significant impact on the current liability mechanisms as discussed in this paper. Similar to the railway or air carrier, the fleet operator (allegedly, as a new form of carrier) could become the contractual counterpart of mobility customers (e.g. passengers). It is through this counterpart that (contractual) liability could be channelled and be subject to further action against third parties active in the ecosystem (e.g. the traffic management operator, etc.). Such contractual liability regime, however, would not do away with the need to secure extra-contractual remedies for third parties, e.g. pedestrians. Thirdly, the (digital) intermediarisation of transport activities comes with uncertainty with regard to determining the relevant regulatory and liability target(s). Fourthly, network industries and in particular aviation are also not immune from digital disruption.

Conclusion

The paper criticizes the attempts to leverage product legislation as a 'cure all tool' for regulating the New Vehicle – in particular to ensure its safety and (cyber) security. Called the 'product-oriented paradigm', such pattern fails to reckon the consequences of the changing nature of road vehicles induced by increased connectivity and autonomy. The latter features challenge the existing notions of 'product' and 'manufacturer' in (vehicle) product legislation and thereby call for legal research. The paper identifies avenues for other complementary regulatory frameworks to regulate the 'New Vehicles', subject to further research. Enshrined in a (new) mobility ecosystem, their regulation could be partly inspired by the safety regulation of transport network industries, such as the railways and aviation. The operation of such industries is subject to safety regulation and supervision, viewing the entire network as a 'system of systems'. The future regulation of the New Vehicles will obviously depend upon technological and economic developments still to come as well as upon the policy objectives pursued by the law-maker in this field. In this respect, the paper highlights the contradictions between the servitisation of transport and mobility ('MaaS') expected from connected and autonomous vehicles and the 'product-oriented paradigm'.

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