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The Road to the (Autonomous) Future

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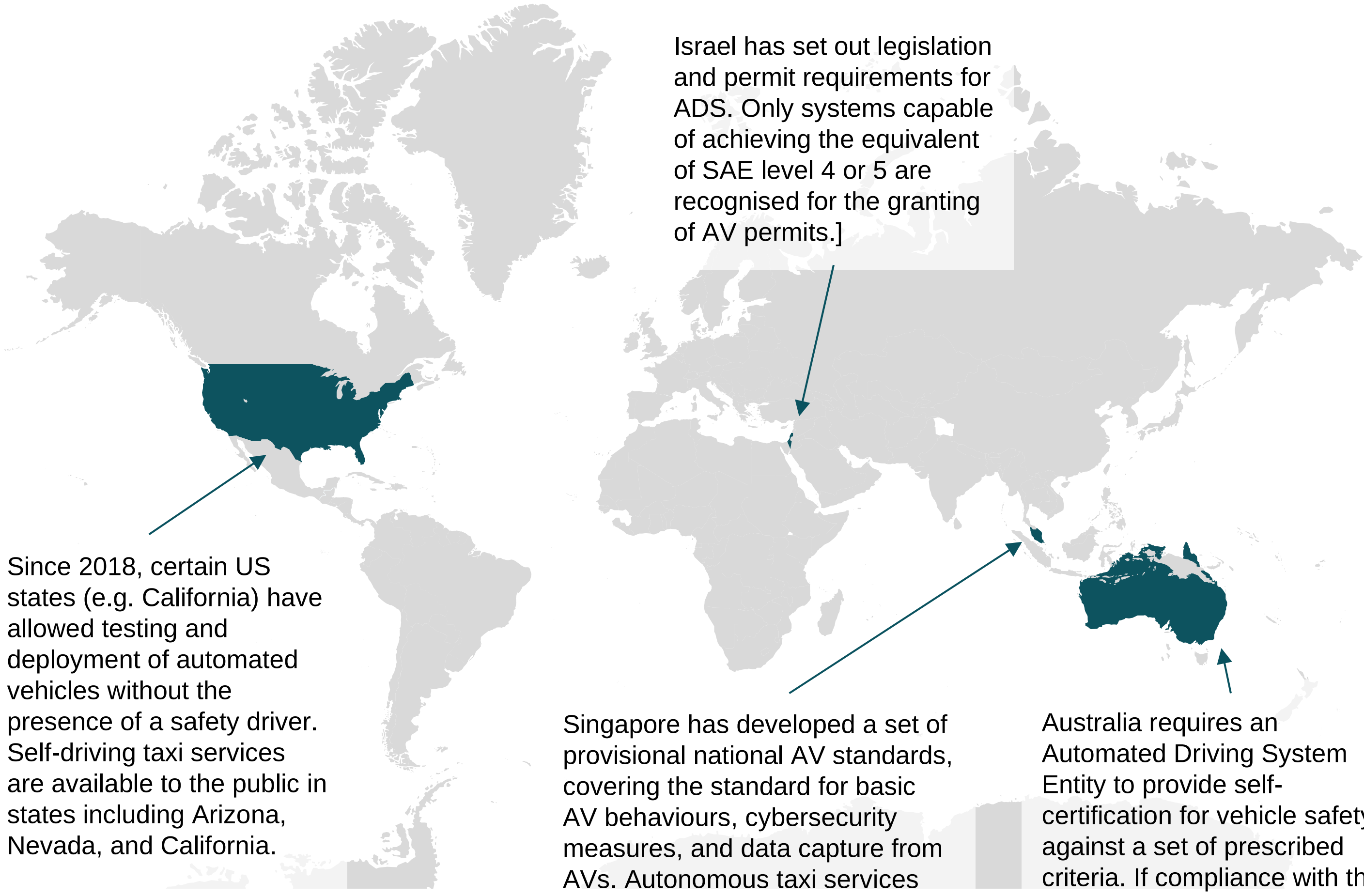
Introduction

It is no longer possible to discuss the future of transport without the question of autonomation being raised. The question of 'how long' until Autonomous Vehicle (AV) deployment becomes a reality has been a stumbling block for many developers and manufacturers over the last thirty years. A broad range of topics are raised in relation to AVs, from questions of safety and user liability, to international logistical solutions.

The world is changing with emerging technologies and it seems likely that AVs will take a central spot within this market. This autonomous future may seem far away, but progress and refinements are constantly being made. This future is already coming into focus: the regulatory landscape required to support our autonomous future is already taking shape; AV trials are taking place across the world; and fully autonomous services are beginning to be delivered.

As with all new technologies, we can expect some bumps along the way. The more AVs are used on the public streets, the more examples we are likely to see of AV performance issues that need to be corrected, or safety issues that need to be overcome. While the use of AVs on motorways will soon be a reality, some question whether it will ever be possible to bring non-supervised vehicles into the inner cities. We should keep in mind that these driving systems are not yet fully developed and regulatory and technological advances continue.

Many countries are preparing for AVs through developing broad and flexible frameworks for their regulation, for example keeping future utilisation within the logistics sector in mind, whilst a more basic AV strategy is being set out first. A robust legal framework is important to ensure the safe deployment of AVs and allow for technological growth. The ability to reduce road traffic incidents and reduce loss of life through the use of automation has always been central in the development of AVs, with enhanced safety as one of the key ambitions driving development. This all feeds into the introduction of international terminology, the creation of international standards, and putting protections in place to ensure the safety of AV users as well as other road users and the public. We may not yet know the timescale within which AVs will become part of our daily lives, but we are starting to get a good idea of what this journey will look like.



Paths to the future: where are we now on the journey to get there?

There has been a shift in debate surrounding AVs, from disputing when they will appear on our roads, to how they will appear. This shift comes as two main paths to automation have emerged from those involved in the development of these systems: those who are taking a direct route to developing fully self-driving Automated Driving Systems (ADS) (such as Google's Waymo and Cruise), and those who are developing increasingly sophisticated Advanced Driving Assistance Systems (ADAS) (such as those provided by Daimler and Tesla).

Although not as hot a topic of AV conversation as the trolley problem, the new point of debate within the AV industry is whether ADAS systems, no matter how advanced, will ever be capable of achieving levels of full automation. There is scepticism of whether ADAS should be compared to ADS in terms of safety and reliability as the systems and technology are fundamentally different from one another. With these differences in mind, further higher-level questions are being asked about whether the safety benefits gained from the increasing use of ADAS can ever be used as evidence to justify the risk/benefit decision for increasing the use of ADS on public roads.

ADAS as a first step

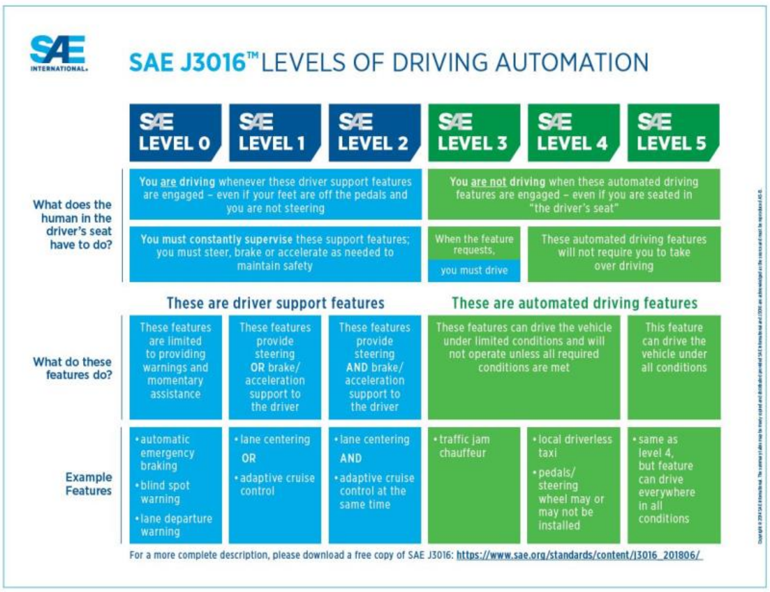
Setting aside the opinions on either side of this discussion, there are benefits to be gained from those following the path of developing progressively advanced ADAS. The introduction of ADAS as a standard feature of vehicles and the cumulative improvement of these systems over time through updates, allows for the positive impact of improved safety to be realised while we steadily transition towards full driving automation. There are also financial incentives to this approach. There is money to be made during the development process, as these systems can be sold and updated, generating profit during the development of more advanced features.

Enhanced standard safety features

From as early as 2022, the inclusion of certain ADAS features will become mandatory in all new European vehicles. In particular, with the goal of reducing traffic fatalities to zero by 2050 (‘Vision Zero’), the EU introduced the General Safety Regulation 2019/2144, the terms of which are that some passenger vehicles[1] will, for example, be required to include Automated Lane-Keeping Systems (ALKS) and advanced emergency braking. In addition, all cars, vans, trucks, and buses will be required to have an Event Detection Recorder (EDR) installed. The introduction of these ADAS features will be another step in the journey towards reducing the number of road incidents and fatalities to zero.

The Society of Automotive Engineers Guidance Update

The levels of automation set out by the Society of Automotive Engineers (SAE) are one of the common staples of any discussion on vehicle autonomation, with the guidance provided by the SAE being designed to give technical guidance for engineers and developers. However, in order to standardise terminology and give enhanced clarity regarding the various SAE levels, the SAE joined with the International Organization for Standardization (ISO) for their most recent update to the SAE J3016 ‘Levels of Driving Automation’ guidance paper (the SAE Levels of Driving paper), the technical document which has become one of the cornerstones within industry for discussing AV development.



[1] Vehicles in categories M1 and N1.

Automation levels update

The recent update provided by the SAE Levels of Driving paper does not change the scope of the SAE levels but gives further clarification on the level of automation an AV may achieve. This is done by categorising the different types of features available within a vehicle as either a driving assistance feature (generally ADAS) or an automation feature (ADS).

The parameters of level 3 conditional driving automation commonly cause the most confusion. Unlike at level 1 or 2, level 3 ADS features will monitor their Operational Design Domain (ODD) and enforce their engagement only within their prescribed ODD. The SAE Levels of Driving paper also gives further clarification on the transitions to fallback performance when the ODD limits of an ADS are reached and whether this fallback requires to be performed by a fall-back ready user. More situational examples are given on ODD limits and how these may be reached, including poor weather, poor road maintenance, and poor road signage/markings.

Fleet operators

The SAE Levels of Driving paper also specifies the types of responsibilities that the SAE envisage for those operating a fleet of 'ADS-equipped vehicles in driverless operation', laid out in a non-exhaustive list. These include responsibility for vehicle road worthiness and repair and maintenance, authorising trips, managing emergency situations, and responding to law enforcement and emergency responders whilst the vehicle is in use.

The inclusion of this definition is helpful in illustrating what may be covered by fleet operations and what an individual performing this role may be responsible for in any given jurisdiction. However, it is expected that the definition of 'fleet operations' will vary greatly in practice, as the scope of these operations and the allocation of responsibility is more a legal and regulatory question than a technical one and will be influenced by national legal systems and by how similar functions are already allocated within a given jurisdiction.

Remote operation

One of the major updates to the SAE Guidance was the addition of guidance on remote operations:

— Remote assistance: The guidance explains that remote assistance and the role of the remote assistant does not involve real-time Dynamic Driving Task (DDT) or fallback performance but would involve assisting an ADS in making non-strategic driving decisions in situations where the ADS has identified an issue and sent the remote assistant a request for assistance.

— Remote driving: In comparison, remote driving does involve real-time performance and monitoring of the DDT and/or DDT fallback by a remote driver. The remote driver will take over the DDT from the ADS and would become responsible for ensuring performance of Object and Event Detection and Response (OEDR).

— Remote fallback-ready user: The remote fallback-ready user would perform the fallback-ready user role for level 3 vehicles in situations where a request to intervene was sent by a level 3 ADS. Once the transition has been completed from the ADS to the remote fallback-ready user, the remote fallback-ready user would then become a remote driver and bear the same operational responsibilities for the vehicle.

The SAE levels are not without their critics, however, reference to them is so commonplace it is hard to find information on AVs which does not include at least some reference to the SAE standards.

There is an increasingly extensive number of guidance papers being produced by the SAE on AV systems and data collection to help further standardise all technical areas relating to AVs, adding to the many core guidance papers such as the above J3016 already produced. It will be interesting to see how these ideas for standardisations develop.

Type approval

New scenario: The car without a driver

For the use of AVs on public roads, vehicles must comply with the type approval regulations and must operate in accordance with road traffic laws. The existing international regulatory framework, including the Vienna Convention on Road Traffic from 1968 (the Vienna Convention), was originally designed for the basic scenario in which vehicles are driven by a human who would also bear the responsibility for performing the driving task. However, with vehicle automation quickly developing, vehicles will be increasingly driven by driving systems and/or a remote driver. But has the regulatory framework kept up with the speed of automotive development?

The Vienna Convention

There have been several amendments to the international framework on road traffic in recent years to adapt to new driving technologies, but unfortunately this process is slow. Quick adaption is necessary to make sure that innovation is not hindered, and new driving technology can be deployed on our streets without unnecessary obstacles. The Vienna Convention has already been amended to allow for automated driving systems which can take over the DDT if such systems can be overridden or switched off by the driver. However, as it stands the Vienna Convention does not support ADS. Because driverless technology is available on the market, but further legislative and regulatory amendment required to fully support it will require more time, the Working Group of the UN-ECE responsible for the Vienna Convention has decided that the use of automated technology in general is compliant with the Vienna Convention.

UN-ECE Regulations

The United Nations Economic Commission for Europe (UN-ECE) promotes pan-European economic integration, including in relation to sustainable transport. The various regulations produced by the UN-ECE in relation to AVs, including type approval, are referred to in both the EU regulations (EU Regulation 2018/58) as well as the relevant national regulations. In 2017, the UN-ECE published new regulations on automatic steering, but these rules require that a driver always remains ready to take control.

In 2021, the UN-ECE introduced a new regulation which allows the use of Automated Lane Keeping Systems (ALKS) that keep the vehicle within its lane for travelling speeds of 60 km/h or less by controlling the lateral and longitudinal movements of the vehicle for extended periods without the need for further driver input. In the situation of a system failure, if the driver does not take over the control of the vehicle, then the driving system must initiate a minimum risk manoeuvre. In this way the UN-ECE has regulated ADAS which are already in use on the market (e.g. traffic-jam pilot). It has also introduced data protection and cyber security regulations. In relation to ADS, further amendments of the international regulations will be necessary.

Germany update (new legislation on autonomous vehicles in Germany in 2021)

Germany introduced innovative new legislation on autonomous vehicles. This Act on Autonomous Driving allows the use of level 4 vehicles (without an active driver) in predefined operating areas if the vehicle is under special ‘technical supervision’, for example full remote control. It is yet to be seen what the first use cases for this new regulatory framework will be. As many international and national rules still do not accept ADS, the first use cases for ADS may be realised in private areas such as car parks or in logistic hubs.

Liability issues

When an AV is fully autonomous or is operating in autonomous mode, who is responsible for the vehicle? There is global recognition that all ADSs will have to be backed by a designated entity which is legally responsible for the ADS, commonly referred to as an Automated Driving System Entity (ADSE). However, the general liability rules for vehicles are not harmonised in the EU. If a vehicle causes damage when operated in the autonomous mode, the national liability rules for the vehicle will apply first.

General vehicle liability in UK

In the UK, an ADSE - commonly the entity which put the AV forward for approval - would also be responsible for the on-going safety of the system, for meeting regulatory responsibilities, and for cooperating with regulatory bodies. The ADSE may be required to prove that they can meet certain standards, for instance, meeting certain technical expertise, meeting any requirements for sufficient financial resources, or having adequate insurance in place. Crucially, once the ADS is fully and safely engaged and has taken over the DDT, the driver would become the user and would no longer be responsible for the control of the vehicle. The ADSE becomes legally liable for the driving performance of the ADS whilst it is engaged, and if any problem occurs the ADSE would be held responsible. The ADSE would be liable for any civil sanctions applicable whilst the ADS was engaged. In conditional automation ADSs (SAE level 3), the fallback-ready user would only resume driving responsibilities for the vehicle after a transition-demand back to manual driving had been safely executed and the fall-back ready user had begun manually driving the vehicle. The question of liability then largely becomes one of proving who was 'driving' at the time of any incident, whether it was the human user or the ADS.

One interesting area of liability regarding the current position on AVs within the UK is that liability for insurers under the Autonomous and Electric Vehicles Act 2018 only occurs where a vehicle is insured at the time of an incident. It is not unforeseeable that regardless of the efforts to prevent such situations from occurring, incidents may still arise where an AV is used without insurance or with inadequate insurance coverage which does not include the use of AV features. For conventional vehicles there is an insurer of last resort if such an incident occurs as the Motor Insurance Bureau will step in to compensate victims. No such insurer of last resort exists for AVs, so if an incident involving an uninsured AV occurs, there is a gap in compensation under the Act as insurer liability would not arise in such situations. This results in an imbalance in the treatment of AVs and conventional vehicles which is yet to be resolved. Discussions are on-going between the Motor Insurance Bureau and UK Government on the introduction of an insurer of last resort for AVs within the UK.

Introduction of a new liability subject by the new Act on Autonomous Driving in Germany

According to the traffic legislation and the general legal rules in Germany, the operator ('Halter'), the driver, and under certain circumstances also the manufacturer could be liable. According to the existing vehicle liability rules, the operator has strict liability for any damage caused by a vehicle they operate. The operator's mandatory liability insurance would be liable for any civil sanctions applicable whilst the ADAS and ADS was engaged. In addition, according to the current rules the driver may also be liable in situations where they cannot prove that the ADAS was engaged. Furthermore, the driver will be liable if they negligently delayed to re-gain control from the ADAS or they did not regain control even if it was obvious that the driver had to take control according to the surrounding traffic situation.

According to the new rules the technical supervisor must be a natural person. Where the vehicle was driven by ADS under technical supervision, the technical supervisor is liable according to the general extra-contractual liability regime if they were at fault.

Finally, the German liability regime has a fault-based liability for the vehicle producer for damage caused by the vehicle whilst the ADAS/ADS is engaged, but this is restricted to cases in which the manufacturer violated its observation or quality assurance duties.

Product liability in case of the malfunction of the driving system

The reform of the EU wide harmonised product liability rules (PLD Rules) in the light of the technical developments and use of artificial intelligence (AI) is ongoing. In 2020, the European Commission published a White Paper on Artificial Intelligence, and its Report on the safety and liability implications of AI stresses that the legal framework should be improved - including with regard to the uncertainty surrounding the allocation of liability between different economic actors.

The main points of discussion in relation to the application of the PLD rules to AI based systems are whether all tangible and non-tangible items (including software) should be covered, and whether any malfunction of the ADAS or ADS should be deemed as a product defect and trigger strict liability. In this regard, the notions of reasonable and expected use may require thorough revision.

For example, could the failure to recognise a traffic sign by the ADAS/ADS be deemed as a programming error? To what extent should manufacturers prevent any foreseeable misuse or provide consumers with special instructions (this is already regulated in the new German act on autonomous driving)? When reviewing the PLD rules, it will be important that too strict an approach to product liability is not taken, as this could have a prohibitive effect on the development of ADS.

Liability shift if there is no driver – reform of the liability regime for ADS

In many countries, the current liability regime assumes that the operator and the driver will be the liability subjects. But with the use of an ADS where there is no human driver, a new allocation of liability risks becomes necessary. The remaining liability candidates are the operator and the manufacturer, and where applicable also the remote operator. The main risk is that the incorrect allocation of liability between manufacturer and operator could hinder technical innovation within practical implementation. Here are some of the main discussion points[2]:

— Does the automation of vehicles automatically lead to a shift of liability risks towards the manufacturer? In this regard it will be crucial that the product liability (as described above) will be interpreted restrictively and the standard of care might be lowered.

— The role of the operator of the vehicle should be reviewed. When using ADS the operator has no ability to influence the ADS, nor do they have they any insights into the decision-making process. On the other hand, it is the operator who maintains the vehicle and benefits from its use.

— New liability regimes are discussed with the creation of an ePerson. The idea behind this is that the ADS itself will get a special legal status as a liability subject. The ePerson would be directly liable for damage the vehicle caused while driven by ADS. However, one main practical hurdle would be that an ePerson would have no tangible assets. Critics of this proposal say that ADS cannot be compared to human beings because they do not have capability to make conscious decisions.

— A new category of liability subject could be introduced. The new German Act on Autonomous Driving introduces the role of the technical supervisor. If the operator and the technical supervisor are not the same person, the technical supervisor bears personal responsibility and is thus an additional addressee of liability.

[2] Thesenpapier Cluster Elektromobilität – Intelligente Mobilität und Recht (Cluster Elektromobilität Süd-West)

In conclusion, harmonised liability regimes that are adapted to the new technologies and which do not change at each national border are essential for the success of the new driving systems. According to a recently published fact sheet the main aspects that must be considered are (i) that the shifting liability risks can become a barrier to market entry with a detrimental effect on progress in the mobility sector, (ii) the new role of the person who has direct control of creating and maintaining the risk, (iii) what effectively ensures victim protection, (iv) can insurance solutions provide adequate results, (v) it should be relevant in connection with liability that the manufacture remains obliged to intervene/update during the product life cycle[3].

Data collection and application

As increasing numbers of AVs are being trialled on the roads, the question of data collection and storage also comes to the forefront. What data should be collected and how? How should it be stored and how long for? Who should have access to it? By 2022, all European vehicles, both autonomous and conventional, are to have an Event Detection Recorder (EDR). Questions of data collection and storage will become increasingly important as more automated driving features come into use and become mandatory safety requirements for all vehicles.

Data

A common point of discussion is whether location data will be required for AV related insurance claims. Insurance claims rely in part on the information provided by the driver to determine liability. In a situation where the driver has engaged the ADAS and is no longer driving the vehicle, or in ADS systems where passengers may not at any point perform any part of the driving and travel purely as passengers, the disengagement of the human from the DDT and OEDR may mean that they are no longer able to give reliable evidence if an incident occurs. The use of location data will therefore be of increasing importance the more automated the vehicle is and may also help to reduce the possibility of fraudulent claims being made.

No discussion of data is complete without reference to the European General Data Protection Regulation (GDPR), and GDPR certainly gives rise to some interesting questions over location data: GDPR applies to any personal data, which would include location data, and location data can also fall into the further protected ‘special categories of personal data’. As a result, there are likely to be tight restrictions on the collection and processing of location data from AVs.

Data use for insurance

A balance may need to be struck for the sharing of data to allow for the effective insurance of AVs. The sharing of personal data by the ADSE with an insurer would have to meet the GDPR requirement of falling within one of the six lawful bases on which sharing is permitted. This requirement is not straightforward, as the different bases may require legal obligations to be put in place to release necessary data or for the different interests of different parties to be weighed up.

A legal obligation for sharing necessary data with insurers would also have the added benefit of preventing potential market abuse from the dominance of ADSE-appointed insurers. The obligation would mean that an ADSE would have to release data to any insurer and therefore give consumers more choice. This is an area which will likely come more into the spotlight when we are closer to AVs becoming a more regular feature within our transport systems.

[3] Thesenpapier Cluster Elektromobilität – Intelligente Mobilität und Recht (Cluster Elektromobilität Süd-West)

Current events

COVID-19 pandemic

Although a lot of the discussion on AVs focuses on private ownership and passenger services, the COVID-19 pandemic has somewhat reshaped the debate and put a greater focus on the development and uptake of AVs in the logistics industry.

The pandemic has increased the demand on delivery services. In some countries AVs were viewed as the ideal way to meet this demand by providing a method of delivery which reduced the risk of exposure for both workers and consumers without overly burdening drivers. Unmanned, driverless delivery vehicles can shoulder some of the burden, often being best utilised to undertake the 'last mile' portion of a delivery. Countries such as China saw an increase in the number of delivery providers utilising AVs during periods of lockdown to deliver groceries and medical supplies.

Interest has also increased in alternatives to traditional public transport and for on-demand services providing door to door services. The need to travel as directly as possible with minimal contact seems to have increased public acceptance of AVs and introduced new safety concepts into travelling (such as socially distanced travel). In the USA, several AV fleets which were previously used exclusively for passenger transport services were converted into delivery vehicles to provide contactless delivery of groceries and essentials to vulnerable people. This highlights the flexibility of service which can be provided by the same vehicles, and may provide solutions to concerns over empty-cruising by providing multi-service vehicles which can switch between passenger and delivery services and be flexible to fluctuating daily or even hourly customer and transport demands.

Driver shortages

For countries like the UK, the pandemic combined with other events such as Brexit and a shortage of freight drivers, has put even greater pressure on the logistics industry. In some places, last mile delivery services have been automated for some time, with local logistics companies using fleets of miniature autonomous robotic vehicles to deliver packages as well as local grocery and food delivery. As these fleets are zero-emission, this is also a great example of the positive environmental impact which could be gained from the use of last mile unmanned AVs.

Driver shortages were becoming a critical concern internationally even before the pandemic. This pressure has increased interest in collaboration between many logistics operators and AV developers. Autonomous logistics services may become more typical as AVs become more sophisticated and are able to be deployed into bigger cities with more complex infrastructure.

Although a far cry from the common fantasy of having a fully autonomous AV as a personal chauffeur at your beck and call night and day, an increased uptake in AVs for the use of last mile deliveries, although not as flashy, may have a greater impact on our lives. An uptake of AVs within the logistics industry will shape the goods transport of the future. Some main logistics hubs have already started piloting driverless trucks (e.g. HHLA) or autonomous internal terminal vehicles (e.g. Port of Dubai) at their container terminals.

Environmental impact

The climate crisis and international goal of reducing carbon emissions could be helped through further exploration of the use of autonomation to solve logistical issues. Optimising vehicle operation, for example through the use of AVs for platooning, could significantly reduce the emissions produced when transporting goods. Platooning is when two or more trucks are linked in a convoy and automatically keep a fixed, close distance between each connected truck whilst driving using automated and connective technology, with only the vehicle leading the convoy requiring a human driver. Fuel economy is improved through minimising breaking and accelerating, and the close proximity of the trucks allows each vehicle to drive in the slipstream of the vehicle in front which can significantly reduce carbon emissions.

Using AVs for last mile inner city deliveries could greatly reduce congestion and air quality, improving our individual health and wellbeing, and helping the planet by taking us closer to reaching net-zero. Increased potential for on-demand shared-use transport services may result in a move away from private vehicle ownership, resulting in less vehicles overall and reduced requirements for parking infrastructure. There are some negative impacts which may also occur, such as concerns over the potential for increased congestion due to empty cruising or initial displacement of traditional public transportation services during the initial stages of AV introduction, however overall, it seems that the environmental benefits will be greater.

Some of the greatest environmental impacts will come with the increased future development of connected autonomous vehicles. The effectiveness of many of the initial benefits will be increased, as well as the introduction of additional benefits from connective solutions.   For example, connectivity between vehicles and infrastructure will allow for reduced fuel consumption and congestion through coordinated braking and acceleration at traffic lights and intersections. Connectivity between vehicles will also allow for improved fuel economy through platooning both for freight and domestic vehicles on all road types, and coordinated adherence to optimising travel within speed limits at all times.

The reduction of environmental impacts that can be achieved through increased used of automotive technologies was raised during the Transport Day of COP26. During the Future of International Road Freight panel discussion, Cynthia Williams, Ford Motors' Global Director of Sustainability, Homologation and Compliance, discussed the ongoing work within the heavy-duty fleet sector running pilot schemes to discover business needs and where vehicle technology can be utilised to improve service and reach net zero targets. Mary Nichols of the Commission of the Future of Mobility for California stressed the importance of new technologies to streamline and improve both efficiency and data sharing in the transition towards carbon neutral transport solutions. AV related technology represents a huge and growing portion of transport technology which is continuing to be developed.

Conclusion

As autonomous technology continues to develop, we will likely see gradually more and more integration and normalisation of automation within our daily lives and transport systems. Most of us have not seen an AV let alone thought about the liability concerns of owning or travelling inside one, and so such questions raised may still seem far-fetched to many. The AV world is developing at a continually increasing rate and it may not be long until AV services are available in our own home cities. In many cities across the world, people are already taking autonomous shuttles and taxis to and from work on a daily basis.

AV use within the logistics industry may be coming faster than we think. The first autonomous journey was made in 1987 by a retrofitted five-ton autonomous van, designed by scientist Ernst Dickmanns. The recent increased interest in automation within the logistics industry may be taking us closer to the next stage of the AV journey. Especially with the use of autonomous truck platooning for larger scale freight and delivery services, many of us may begin to use AV based services when ordering goods without even realising. Smaller scale delivery models are already being introduced in cities with suitable infrastructure, and it may not be long until these smaller AV models are sophisticated enough to be released on a wider scale.

Although many of the questions raised in this article may not be capable of answer until the uptake on AVs is greater and their existence becomes more commonplace, the frameworks and testing being laid down now are paving the way for more widespread testing and deployment, especially if social demands and business pressures continue to increase. It may not be long until we ourselves are travelling by AV.

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