



Federal Ministry
of Transport and
Digital Infrastructure

Ethics Task Force:
Germany (Chair)
Austria, Luxembourg, United Kingdom,
European Commission, ACEA, CLEPA

Task Force on Ethical Aspects of Connected and Automated Driving (Ethics Task Force)

established by the

2nd High Level Structural Dialogue
in Frankfurt/M. on 14 and 15 September 2017

Report

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European Commission

ACEA - European Automobile Manufacturers' Association

CLEPA - European Association of Automotive Suppliers

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I. Introduction

Connected and automated driving (hereinafter “CAD”) and connected and automated vehicles (hereinafter “CAVs”) herald a new era in the way we move, the way we design our cities or the way we work. This new technology in the wider context of artificial intelligence (“AI”) has the potential to improve road safety, offer new mobility opportunities and bring about further promising benefits.

Technological developments in the field of CAVs are gathering speed. The need for extensive trialling of CAVs is widely recognised and several Member States have adjusted or are in the process of adjusting regulatory frameworks to allow trialling on public roads. Across the globe, regulators from many jurisdictions including the United States, Germany, Japan or China have adopted, or are in the process of adopting, legislation on the use of CAVs in regular traffic.

In this context of rapid technological developments policy-making risks lagging behind, with the potential result that crucial decisions affecting human lives could be taken by technology without an appropriate societal debate. In contrast, timely provisions defining the framework for new CAD technology and its deployment will help both unlock its potential and help ensure fundamental rights.

Reaching conclusions about the relation between human beings and CAVs requires a more thorough consideration of ethical implications than any other topical road transport policy area. This means that human beings are to be put first, that harm to their lives is to be minimized and their well-being is to be promoted.

II. Procedure

The High Level Structural Dialogue concluded in September 2017:

“In times of digitalization and self-learning systems new ethical issues are arising from the human-machine-interaction. Connected and automated driving is a recent innovation where this interaction becomes clearly visible. To achieve broadly based societal acceptance it needs to be examined under which framework conditions the development process should or must be supported from an ethical point of view. Member States in close cooperation with the European Commission agree to establish a Task Force chaired by Germany to highlight resulting ethical issues and examine their relevance on a European level.”¹

In order to fulfil this task and to produce tangible results for the High Level Structural Dialogue, the Task Force has drawn up proposals for discussion and decision, specifying the relevant ethical issues that should continue to be addressed jointly at European level, as well as the issues that should rather be dealt with at the national and international level, and the reasons for this.

The Ethics Task Force has been guided by the aim of ensuring a coherent approach in the context of the Single Market and the protection of citizens' rights enshrined in the Charter of Fundamental Rights of the European Union, as well as paying due respect to the principle of subsidiarity.

To assess which actions are required to better understand public perceptions of CAD, and ensure its public acceptability, a broad range of issues and concerns must be addressed and handled appropriately. The Ethics Task Force has considered a number of these issues in this report – i.e. public acceptability and participation, dilemma-based situations, responsibility, cybersecurity and data protection, socio-economic implications and Human-Machine-Interface – but only insofar as ethical aspects are concerned. The list of issues addressed is not exhaustive, and the Task Force has chosen to focus on those which were deemed to be most important for the purpose of this report.

The Task Force held four meetings at the German Federal Ministry of Transport and Digital Infrastructure in Berlin which were attended by representatives of the following participants of the High Level Structural Dialogue:

- Germany (Chair)
- Austria
- Luxembourg
- United Kingdom
- European Commission
- ACEA
- CLEPA

¹ Federal Ministry of Transport and Digital Infrastructure (Germany): Action plan automated and connected driving. 2nd High Level Structural Dialogue in Frankfurt/M. on 14th and 15th September 2017. http://www.bmvi.de/SharedDocs/EN/Documents/DG/action-plan-automated-and-connected-driving.pdf?__blob=publicationFile (2017), p. 8.

III. Recommendations

Ethical considerations linked to the protection of human life and integrity, freedom of choice or the right to privacy, among others, have to be prominently addressed in the development and operation of CAD. Addressing legitimate societal concerns on the ethics of CAD must have a central role in the process of securing public and societal acceptance and trust.

The Ethics Task Force delivers the following recommendations on possible future actions, which are further explained in the subsequent section (IV.) of this report. Depending on the ethical issue, these recommendations may require further extensive assessment and discussion. Joint collaboration in this context between industry, academia, civil society and regulators at both EU and Member State level could help Europe lead the international discussion when it comes to formulating an ethical framework for CAD.

The European Commission has made a proposal to set up a dedicated forum to deal with ethical implications.² The Ethics Task Force welcomes that step and would be ready and willing to support the process of establishing the forum and its work, e.g. by sharing its experience and the knowledge acquired.

The Ethics Task Force suggests that – until this new group is set up and fully operational and the exact scope of its mandate is clear – it stands at the disposal of the High Level Structural Dialogue for any other tasks required.

1. Public Acceptability and Participation

The Ethics Task Force recommends:

- a. Further actions to better understand public perceptions, concerns, and potential behaviours and responses, with regard to CAD and its ethical implications:

At the national level:

- i. Raising the profile of current social and behavioural research, to encourage user-centred design for the development of CAD and to understand its likely uptake;
- ii. Encouraging further projects which offer a mix of technical and social research with regard to CAD and its ethical implications;
- iii. Supporting knowledge sharing and coordination between CAD research projects.

At the European level:

- i. Raising the profile of current social and behavioural research, to encourage user-centred design for the development of CAD and to understand its likely uptake;
- ii. Encouraging further projects which offer a mix of technical and social research with regard to CAD and its ethical implications;
- iii. Continuing to support knowledge sharing and coordination between research projects, to accelerate learning and avoid duplication of effort between organisations and Member States;
- iv. Promoting European research globally, to encourage global knowledge-sharing; and
- v. Fostering a wider societal debate on the role of ethics in the development and uptake of CAD in Europe.

- b. Establishing a plan for public information communications on CAD, to give sufficient explanations of CAD functionalities, their benefits and limitations, questions of equal access and fairness, as well as the proper use of CAD and associated user responsibilities:

² European Commission: Communication, On the road to automated mobility: An EU strategy for mobility of the future. https://ec.europa.eu/transport/sites/transport/files/3rd-mobility-pack/com20180283_en.pdf (2018), p. 16.

At the national level:

- i. That public information communications around CAD should be informed by research with the public and tailored and delivered at the national level, as different countries will have different values, perceptions and concerns;
- ii. Governments should identify their role in handling public acceptability issues with regard to CAD, including whether there is a need for government to intervene at all. If there is, they should identify how (who is the best messenger; what should the message be) and when is appropriate, according to the national context.

At the European level:

- i. Preparing an ‘information pack’: a guidance document of public information/verified statistics for governments to use as they see fit. Any such information should be meaningful for governments (i.e. providing realistic comparisons) and the public. Given the rapid development of CAD technologies, the EU may be well placed to coordinate updates and disseminate the latest information;

➔ The Ethics Task Force suggests that a proposal for such an ‘information pack’ is presented to the High Level Structural Dialogue by the European Commission.
- ii. Sharing best practice from successful public information campaigns at the national level (in Europe and around the globe), for all Member States to learn from.

2. Dilemma-based Situations

The Ethics Task Force recommends

- a. Developing a harmonised European and international approach to handle dilemma-based situations with regard to CAD. This could include drafting guidelines and/ or recommendations.
- b. Further international discussion and research at the European level on the issue of reducing personal injury in genuine dilemma-based situations, i.e. situations in which a CAV will unavoidably cause harm to a human being, and must decide how to proceed.

Both actions should be implemented by an appropriate group of experts at European level comprising international expertise. An account of this work should be given to the High Level Structural Dialogue.

3. Responsibility

The Ethics Task Force recommends:

- a. The European Commission should – in due consideration of the whole responsibility network and hardware and software implications – examine the need for action in the respective EU legal framework for liability, especially with regard to Council Directive 85/374/EEC of 25 July 1985 concerning liability for defective products (product liability) and give an account of this assessment to the High Level Structural Dialogue.
- b. Member States should – with regard to the changes in the responsibility network – examine their national responsibility network in road transport, including amongst others map service providers, road operators and telecommunication operators, and adapt legislation where needed.

4. Cybersecurity and Data Protection

The Ethics Task Force recommends:

- a. Member States and the European Commission should continue to support the work carried out at United Nations Economic Commission for Europe (UNECE) Working Party 29 on data protection and cybersecurity, especially the regulation on cybersecurity and over-the-air software updates currently being developed, and actively follow this process and incorporate the results into EU policy and regulation.
- b. Member States should proactively seek to promote – within their competencies – the importance of a high level of cybersecurity throughout the entire manufacturing supply chain.
- c. Member States, the European Commission and Industry should highlight the importance of data protection issues – amongst others the necessity to ensure data sovereignty, i.e. road users should generally be able to decide themselves whether their vehicle data are to be forwarded and used – raised by the Ethics Task Force and should transfer these considerations into the ongoing initiatives addressing data protection in CAD.

5. Socio-economic Implications

The Ethics Task Force recommends:

- a. The European Commission should – in light of the results of the recent study on possible socio-economic effects of CAD in Europe³ and a new study to explore possible implications on employment (Horizon 2020 Transport Work Programme 2018-2020) – assess possible necessary actions on EU level to address current and future socio-economic impacts of CAD, e.g. on the labour market, and give an account of this assessment to the High Level Structural Dialogue.
- b. Member States should examine potential national actions to address current and future socio-economic impacts of CAD, e.g. on the labour market.

6. Human-Machine-Interface (HMI) / Handover Procedures

The Ethics Task Force recommends:

Member States and the European Commission should continue to support the work carried out at the UNECE Working Parties, actively follow this process and incorporate the results into EU policy.

³ European Commission: An analysis of possible socio-economic effects of a Cooperative, Connected and Automated Mobility (CCAM) in Europe. <http://publications.jrc.ec.europa.eu/repository/bitstream/JRC111477/kjna29226enn.pdf> (2018).

IV. Explanations and Discussion Outcomes

1. Public Acceptability and Participation

CAD has the potential to profoundly change the way we travel, offering significant benefits to individuals and society as a whole. However, no progress can be made without public acceptance and adoption of these technologies, no matter how well-founded the benefits may be in the view of experts.

Public acceptance of new technologies can often take time to develop. This is particularly the case for technologies that are as disruptive and revolutionary as those used in CAD. The public – that is, the aggregation of all individuals in society – will only accept these technologies if they feel confident in placing trust not only in the safety and reliability of the technology, but also in its ethical standing and use. Without the required trust, the technology will not be accepted, and society will miss out on the potential benefits.

It is essential that public acceptance of CAD technologies is not taken for granted. Assuming change will happen smoothly could mean that we underestimate the challenges that lie ahead, and fail to ensure that the transport user is at the focus of the design, development, and use of CAD technologies.

Overview of Public Acceptability and Participation

For the purposes of this report, it is important to note a few characteristics of public acceptability in general:

- a. There is no single ‘public perception’ or public opinion with regard to either ethics or disruptive technologies. Perspectives will vary immensely across different societies, and within them, depending on factors such as age, gender, socioeconomic status, geography, physical ability, education, religion, political perspective, and values;
- b. Perceptions, opinions, and societal values change with time. These changes may happen gradually, over a matter of years and decades, or very rapidly, in response to events or high-profile media stories;

- c. Perceptions of benefits and risks may or may not be based on, or aligned with, fact. As with all emerging technologies, there are many unknowns surrounding CAD, leaving much scope for speculation, confusion, and misconception;
- d. What the public find acceptable may not always align with what government deems as ‘best’ serving the public interest;
- e. Even high levels of public acceptance will not mean one hundred percent endorsement; there will always be a range of opinions and perspectives, including some which are not likely to change quickly;
- f. To ensure that CAD technology is acceptable to the public, and meets people’s needs, a knowledge of what drives public acceptability must feed into the technology’s design and development.

Overview of the relevant ethical issues

First, to be able to develop informed opinions on the acceptability of CAD, the public must be aware of, or at least have access to, a wide range of relevant and qualified facts and information on the aspects of CAD that most concern them. The public should be in a position to make informed choices that benefit them.

Second, public acceptance of CAD requires the acceptance of the resultant ethical issues. Indeed, if any of these issues are addressed in a way that is not deemed ethically acceptable by a critical mass of the public, the uptake of CAD will be reduced.

This is particularly important for the high-profile ethical issues that attract public attention. For example, dilemma-based situations, such as the so-called ‘trolley problem’⁴, are frequently discussed in the media and capture the imaginations of politicians, academics and the public

⁴ Lin, P.: Why Ethics Matters for Autonomous Cars. In: Maurer, M./ Gerdes, J.C./ Lenz, B./, Winner, H. (eds.). *Autonomes Fahren, Technische, rechtliche und gesellschaftliche Aspekte*. Heidelberg (2015), pp. 78, 79.

alike. While dilemma-based situations are edge-cases, and unlikely to happen often, they can be heavily reported in the media. Consequently, evidence suggests that the public are likely to perceive their handling as a high priority.

Ultimately, if socially and ethically acceptable solutions are not found to these ethical implications of CAD technology, then its uptake will likely be reduced, and society will potentially miss out on the benefits.

Implications for government

There is a role for government to both engage in dialogue with the public and to ensure the public have access to factual information about CAD technology and its applications. This will help to ensure that the public develop an informed opinion on CAD and have a voice in the decisions made on the ethical implications of CAD technologies.

Consequently, it is vital that industry, governments, academia, and opinion-formers (at the local, national and international levels) have a comprehensive understanding of:

- a. The hopes and fears of the public, with regard to CAD;
- b. What the public find acceptable, as well as the dynamics and mechanisms of the public's opinion, with regard to the ethical issues of CAD;
- c. The factors that would deter the public from accepting CAD technologies; and
- d. How different types of information and means of information-sharing affect public opinion, with regard to CAD.

Assessment of the current situation

Currently, we have a limited understanding of public perceptions of CAD. The vast majority of funding to date has gone towards the technical aspects of CAD technologies, and there has been a lack of focus on social and behavioural research.

At the European level, the Horizon 2020 Transport Work Programme 2018-2020 includes activities for in-depth analyses of the behaviour of users and public acceptance, and an assessment of the medium and long-term impacts of CAD on society. Several ongoing and upcoming projects focus on user aspects, such as user-centred design.

Furthermore, Horizon 2020 also includes several knowledge-sharing activities, where societal and user aspects, as well as impact assessment, are among the thematic areas addressed.

Some research has been carried out at the national level. For example, the UK government has commissioned a programme of social and behavioural research to understand the public's attitudes and potential behavioural responses to CAD. This research indicates that:

- a. In the UK, there are high levels of awareness of CAD (due to media reporting), but the public know very little about CAD technology itself, and its potential future impact. The technology is perceived as being some way off becoming a reality;
- b. The public will have wide-ranging concerns, some of which are ethical in nature. For example, they are likely to be concerned about: the safety of the driver and the general public; societal impacts of driver behaviour (emissions, congestion, accessibility); cybersecurity and data protection; social exclusion; equity; job losses; who holds ultimate responsibility; who would be liable for an accident in an automated vehicle, etc;
- c. Significant parts of the public may not intuitively see the benefits to themselves of CAD technology; the need for it is not immediately obvious. Instead, it is often easier for people to call to mind potential disadvantages (such as safety issues, job losses, cybersecurity issues);
- d. CAD technology has the potential to challenge many strongly held assumptions about driving, such as the notion that driving enhances individual freedom, choice and control. The challenge is to help people more readily see the potential new benefits of CAD technologies, such as having more free time to do

things other than driving, or access to new mobility options;

- e. The public may raise questions about the ability of machines to assess moral dilemmas and make the kinds of complex decisions that may be required;
- f. The public are likely to question how new technologies would interact with conventional technology during any 'transition' period, and how this could be managed in a safe and equitable way (such as by ensuring interoperability and transparency);
- g. It is likely that the particular 'messengers' who communicate with the public about the benefits and disadvantages of CAD technology will influence the levels of public acceptance. The type of messenger that is likely to be effective may vary across different countries, depending on national levels of trust in the media, government, industry and academia;
- h. There may be concerns that, in the future, people might be coerced into adopting CAD technology against their will by governments and industry;
- i. People in general tend to be receptive to information that reinforces what they currently think (called "confirmation bias"). Therefore, any information campaigns will need to be sensitive to current perceptions of CAD technology;
- j. Member States are at different stages of developing and talking about CAD, which will likely have an impact on local perceptions of the technology.

Next Steps

National governments and the EU, in cooperation with academia, could work to increase the quality and quantity of research into public perceptions of CAD, to better understand public needs, hopes and fears, and encourage a wider societal discussion.

This research can be used to develop nuanced informative communication plans, with the EU providing agreed public information, and national governments disseminating that

information as they see fit. The research can also be used on a continuous basis to facilitate user-centred design, for the development of CAD and to aid understanding of its likely uptake.

2. Dilemma-based Situations

Overview of the relevant ethical issues

Dilemma-based situations in the context of CAD "are characterized by the fact that an automated vehicle has to decide which of two evils it necessarily has to perform."⁵ In the following section, a distinction is made between genuine and non-genuine dilemmas. While non-genuine dilemmas can be resolved by means of a trade-off, genuine dilemmas – such as a decision between one human life and another – cannot. While genuine dilemmas will occur, it is likely that they will be rare events.

To be able to assess the impacts of an accident, trade off different harm scenarios against each other, and ultimately take a decision, the technical demands on an automated vehicle system are high, and currently are either not yet available at all, or only partially. However, the public debate is intensively addressing the issues and challenges that might be produced by such dilemma-based situations.

Therefore, policymakers and the industry, working with the public, have to find answers to these issues, and provide an impetus for dealing with dilemma-based situations in an appropriate manner. This is the only way we can steer technological developments in a direction compatible with current values and conventions at an early stage, thereby ensuring that the issues are discussed positively in society. This will also have an effect on whether users are prepared to engage with the new technology or not. However, since certain technological developments have not yet taken place, the Ethics Task Force believes that dilemma-

⁵ Federal Ministry of Transport and Digital Infrastructure (Germany): Report of the Ethics Commission on Automated and Connected Driving. http://www.bmvi.de/SharedDocs/EN/publications/report-ethics-commission.pdf?__blob=publicationFile (2017), p. 17.

based situations should be addressed in an appropriate relationship to the way in which the other ethical aspects of CAD are dealt with. They should not assume a dominant position, especially since they are, in practice, likely to occur extremely rarely, if at all.

In Germany, the Ethics Commission on Automated and Connected Driving has already dealt with this topic in depth and has drawn up guidelines for genuine and non-genuine dilemmatic situations. In the case of genuine dilemma-based decisions, it has also pointed out that it is necessary to address this topic more in detail.⁶ The “AVEthics” project⁷ of several French institutes and establishments also deals with the problems associated with dilemma-based situations and aims to develop a framework for handling these situations.

The question is whether these initiatives at national level are sufficient to achieve the objective of developing suitable European and international guidelines for handling dilemma-based situations now or in the future. A European and international approach would be more appropriate for addressing ethical questions arising in dilemma-based situations for which guidelines can already be formulated, or have already been formulated at the national level. In order to achieve that, a European and internationally coordinated approach should be aimed for. However, concerning the issue of reducing personal injury in genuine dilemma-based situations, more evidence and a much wider societal debate is required before guidelines can be established in that context.

Guidelines for *non-genuine* dilemmatic decisions

The Ethics Task Force believes that it is necessary to establish a broad societal debate on the ethical questions relating to non-genuine dilemma-based situations. Even though it can be assumed that there is a common

set of values within the EU, new technologies require new discussion and debate. This is particularly true for technologies with decision-making capabilities, such as the software within automated vehicles. The criteria for how a system should behave – in situations where harm is unavoidable – must not differ from one country to another, to ensure public acceptability, interoperability, and to realise the potential benefits of CAD. Harmonised European and international guidelines could be required to achieve these aims.

The High Level Structural Dialogue is the right forum to initiate the work to create such a harmonised approach at European level at an early stage. However, for this work to be truly effective, a common international understanding (especially at United Nations level – for instance within the framework of UNECE) has to be developed in addition to any EU level work. For coordination efforts at EU level, a perspective that goes beyond the EU level also has to be taken into account right from the beginning.

The Ethics Task Force believes that findings that are either already available or are to be expected soon can and should be used as a basis for discussion. In Germany, initial basic guidelines for handling non-genuine dilemma-based situations in CAD are already available. They can be used as a starting point for future efforts on this topic.

It almost goes without saying that technology, depending on the state of the art, must be designed in such a way that critical situations – and hence dilemma-based situations – do not arise in the first place. Should such a situation occur, the protection of human life should take top priority when balancing protected legal interests. Therefore, for *non-genuine* dilemma-based situations, it should be discussed at EU level to what extent harm to animals or damage to property should be accepted if this means that personal injuries can be prevented.⁸

In this context, reference should be made to the approach of the AVEthics project as well. This approach suggests

⁶ Federal Ministry of Transport and Digital Infrastructure (Germany): Report of the Ethics Commission on Automated and Connected Driving, p.18.

⁷ Dogan, E./ Chatila R./ Chauvier, S./ Evans, K./ Hadjixenophontos, P./ Perrin, J.: Ethics in the design of automated vehicles: the AVEthics project. <http://ceur-ws.org/Vol-1668/paper2.pdf>

⁸ Federal Ministry of Transport and Digital Infrastructure (Germany): Report of the Ethics Commission on Automated and Connected Driving, p.11, ethical rule 7.

that using a limited set of values and principles (still to be determined) for specific situations depending on their functionalities (casuistic approach) might be more likely to result in ethically responsible decisions than using general principles for a large number of situations (regulative approach).⁹ This approach should also be taken into account for consideration at EU level.

Guidelines for *genuine* dilemma-based decisions and the question as to whether programming to reduce the number of personal injuries is ethically justifiable

Germany, and others, have realized¹⁰ that genuine dilemma-based decisions, such as a decision between one human life and another, depend on the actual specific situation and the "unpredictable" behaviour by parties affected. They can thus not be clearly normalized, nor can they be programmed such that they are free of ethical doubts. However, in Germany, initial basic guidelines have been formulated in this context as well. In the event of unavoidable accident situations, it is neither permissible to distinguish between individuals based on personal features (age, gender, physical or mental constitution), nor to offset victims against each other nor to sacrifice parties that have not been involved in the generation of mobility risks.

The Ethics Task Force believes that these approaches can also serve as a basis for discussion at the European and international level.

Since offsetting human lives against each other should be prohibited, it was also discussed in Germany whether a different decision may be permissible if several lives were already imminently threatened and the only thing that mattered was saving as many people as possible.¹¹ In this case, a broad societal discussion on whether it is justifiable

to programme software to reduce the number of personal injuries could be useful.

The Ethics Task Force concludes that this issue and the way in which it is addressed could have direct effects on both the technological development and the social acceptance of CAD technology. Having to ensure that as many lives as possible are saved would initially present the technology with major challenges as to its realization. Based on the state of the art, it may not be possible to adequately meet this challenge in the foreseeable future. Programming that is not regarded as fair and acceptable by all parts of society – in particular by road users themselves – might have a deterrent effect and inhibit the use and acceptance of the technology rather than promoting it.

The Ethics Task Force believes that the consequences of protecting as many lives as possible with regard to options of CAD have so far not been examined sufficiently.¹² Corresponding studies are to be initiated where this has not happened yet. In this context, it is not so important at what level (national/ EU) these studies are conducted but rather that the findings from the study are freely accessible.

Next Steps

The Ethics Task Force concludes that, in principle, all ethical aspects outlined in the context of dilemma-based situations lend themselves to being addressed jointly at EU level, to support a European and international approach at the UNECE, and that in some cases this would even seem imperative.

3. Responsibility

The deployment of automated and particularly fully automated (analogous to SAE Level 5)¹³ vehicles can result

⁹ Dogan, E./ Chatila R./ Chauvier, S./ Evans, K./ Hadjixenophontos, P./ Perrin, J.: Ethics in the design of automated vehicles: the AVEthics project, p. 3.

¹⁰ Federal Ministry of Transport and Digital Infrastructure (Germany): Report of the Ethics Commission on Automated and Connected Driving, p.11, ethical rules 8 and 9.

¹¹ Federal Ministry of Transport and Digital Infrastructure (Germany): Report of the Ethics Commission on Automated and Connected Driving, p.18.

¹² Raising awareness of the problem: Lin, P.: Why Ethics Matters for Autonomous Cars. In: Maurer, M./ Gerdes, J.C./ Lenz, B./ Winner, H. (eds.). *Autonomes Fahren, Technische, rechtliche und gesellschaftliche Aspekte*. Heidelberg (2015), pp. 69-85.

¹³ Smith, B.W.: SAE Levels of Driving Automation. <http://cyberlaw.stanford.edu/blog/2013/12/sae-levels-driving-automation> (2016).

in a shift of responsibility raising fundamental questions including ethical issues. Can machines be made responsible for the misbehaviour of a machine, if machines and not human beings steer vehicles, and (programmed) algorithms make decisions? Who would be responsible in case of an accident: the software engineer, the manufacturer, third-party providers, (telecommunications) operators and/ or even the passenger?

Ethical Issues of Responsibility (Responsibility Network)

On one hand, the question of responsibility is linked to the notion of 'autonomy', which is understood in the Kantian sense of 'moral autonomy' or the ability of humans to give themselves a set of moral instructions guiding their behaviour. In effect, this means that humans should have the final say in taking decisions which may result in harm or damage to humans and, conversely, it is morally unacceptable to let machines decide over the life or death of [a] human being[s]. This is the basic premise of the principle of meaningful human control.¹⁴

Etymologically, "responsibility" relates to the ability or duty to give a "response". In the context of CAD, responsibility could also mean "the duty of a person to account for decisions taken by and attendant actions performed by the automated vehicle system and/ or the software on which it is based, to assume liability and, if necessary, be willing to accept any legal consequences".¹⁵

Thus, the term responsibility embraces the ability to be held accountable and implicitly assumes that a person has certain capacities that allow them to take responsibility, such as the ability to communicate and to act, autonomy and good judgment. For a questionable event with complex constellations of actors, we attribute responsibility to all those parties involved to the extent that they demonstrate or have taken on the necessary capacity for such an

attribution of responsibility. In the responsibility network of road transport, all stakeholders have to be integrated when talking about the assignment of responsibility, such as the human driver, the vehicle owner/ keeper, the manufacturer, the operator of technological systems, the infrastructure operator, the planner, the general public, the lawyer, the trainer and many more.

Ethical Issues of Liability

The faculty to freely decide which course of action to take is the cornerstone of moral responsibility and the coupled notion of legal responsibility. The concept of liability is intertwined with the notion of moral and legal responsibility, and as such we decide whether to condemn or exonerate individual behaviour or actions conducing to harm to others.

New traffic scenarios including CAD raise the prospect of 'accountability gaps' – e.g. what happens in terms of responsibility and liability when a CAV crashes into another vehicle, causing human loss or economic damage? Should the human [co]driver be deemed responsible and therefore liable even when the accident was caused by a technical mishap? Or should the manufacturer/ operator/ third-party provider/ telecommunications operator, or any other relevant party be also considered responsible (in whole or in part) and therefore liable for their share in causality or the defectiveness of their product?¹⁶ Clarifying these issues is of paramount importance for the development of new rules on civil and criminal liability in traffic accidents as well as insurance schemes for the use of CAVs.

Council Directive 85/374/EEC of 25 July 1985 concerning liability for defective products (product liability) is part of the relevant framework on EU level. Monitoring the need to revise this framework¹⁷ could include the line of

¹⁴ Santoni de Sio, F./ van den Hoven, J.: Meaningful Human Control over Autonomous Systems: A Philosophical Account. <https://www.frontiersin.org/articles/10.3389/frobt.2018.00015/full> (2018).

¹⁵ Federal Ministry of Transport and Digital Infrastructure (Germany): Report of the Ethics Commission on Automated and Connected Driving, p.26.

¹⁶ See also: Federal Ministry of Transport and Digital Infrastructure (Germany): Report of the Ethics Commission on Automated and Connected Driving, pp. 27, 28.

¹⁷ European Commission: Final Report of the High Level Group on the Competitiveness and Sustainable Growth of the Automotive Industry in the European Union, p. 45. <https://ec.europa.eu/docsroom/documents/26081> (2017).

thinking outlined above¹⁸. Several cases of product liability could even be discussed and clarified in advance (and not only by jurisdiction retrospectively) so that manufacturers and road users can expect a clear framework.

Liability frameworks will have to embrace more complex issues as fully automated vehicles develop. If the driver is no longer asked to make steering decisions or if a driver no longer exists at all, then driver's liability is likely to disappear and be replaced. The way in which this transition will be reflected in law – including within liability provisions – will have to be sorted out both at national and EU level.¹⁹

4. Cybersecurity and Data Protection

Media reports of CAVs being hacked have demonstrated the risks posed by cybersecurity gaps. Similarly, privacy concerns have been raised about the broad range of data which may be continuously collected and processed by CAVs.

The Ethics Task Force is of the opinion that cybersecurity and data protection of CAV need to be addressed in order to enable the safe deployment of the technology and facilitate positive public perceptions. This will be needed even before fully automated vehicles are deployed and it will be necessary to develop safe and balanced solutions for both cybersecurity and data protection. This will also be an important factor in the extent to which consumers invest in and use these technologies. Furthermore, over the long term, our economies are likely to become ever more dependent on the reliability of the digitalised transport

network. It is therefore important to ensure that our road networks are also resilient to threats such as cyberattacks.

Overview of the relevant ethical issues

The CAV ecosystem is highly complex. The intent and capability of hackers, knowledge of the systems, vulnerabilities and possible mitigations are constantly changing. Previously unknown vulnerabilities will be exposed over time and the capability of adversaries to do harm will change. Even with advanced measures in place to prevent security breaches, a residual level of risk will exist. This complexity and change means that any assessment of cybersecurity risks will always be subjective. Nevertheless, at any given moment there are sources of risk and threats that are known and which can be mitigated.

The ethical case around cyber security for CAV systems is therefore a combination of: a) taking reasonable steps to prevent attacks, especially those that could exploit known vulnerabilities; b) being able to detect attacks and react to them when they do occur; and c) having plans in place to minimise, contain, and recover from them. It is also incumbent on those involved with the CAV ecosystem to keep systems secure over their lifetime, for example by providing software updates and patches in a timely fashion when new threats or vulnerabilities are discovered.

The Ethics Task Force is of the opinion that it would be unethical to expose consumers to an unacceptable level of risk by selling CAV products or services that fail to identify and control vulnerabilities that could be exploited to compromise safety or data security. It would also be unethical to sell CAV products or services that do not have the means to respond to changes in the threat landscape (new or evolving threats), such as through the ability to provide software updates or patches.

Concerning data protection, finding the right balance between data collection and data protection is of paramount importance in this context. In this regard, an important underlying ethical issue is to find out how data sovereignty – meaning in this context that road users should generally be able to decide themselves whether their vehicle data are to be forwarded and used – can be best ensured. Ultimately, this leads to the question of how

¹⁸ E.g. in the future process outlined in: European Commission: Communication, On the road to automated mobility: An EU strategy for mobility of the future. https://ec.europa.eu/transport/sites/transport/files/3rd-mobility-pack/com20180283_en.pdf (2018), pp.10-11.

¹⁹ New EU legislation concerning CAVs in this context is proposed in: European Parliament: A common EU approach to liability rules and insurance for connected and autonomous vehicles – European Added Value Assessment. [http://www.europarl.europa.eu/RegData/etudes/STUD/2018/615635/EPRS_STU\(2018\)615635_EN.pdf](http://www.europarl.europa.eu/RegData/etudes/STUD/2018/615635/EPRS_STU(2018)615635_EN.pdf) (2018).

“consent” should be understood, realized and developed in an appropriate way in the context of CAD. It is also important to consider whether or not, and under which circumstances, data processing in the context of CAD could be based on an appropriate and balanced (EU wide) legal act.

However, the Ethics Task Force considered questions of data ownership and data access, which undoubtedly have to be resolved in the near future, not as part of their mandate.

Assessment of the current situation

Action on cybersecurity and data protection is required at a global level. Within the UNECE, on the initiative of Germany and Japan, Working Party 29, known as the World Forum for the Harmonization of Vehicle Regulations, adopted a Guideline on cybersecurity and data protection laying out a “basis for the development of prescriptions in UN Regulations to ensure cybersecurity and data protection”.²⁰

Subsequently, Working Party 29 convened a task force to address these issues and to recommend potential actions. The task force is chaired by the UK and Japan. Since the last High Level Structural Dialogue in Frankfurt, the UNECE WP.29 task force looking at cybersecurity and over-the-air software updates has made significant progress. Following a steer from WP.29, the task force is now developing its guidelines in the form of a draft regulatory paper. This draft paper, designed to introduce approval of vehicle cybersecurity and vehicle update processes, will be presented to WP.29 for discussion later this year. Once agreed, WP.29’s draft paper on cybersecurity and over-the-air software updates will need to be translated into a UN regulation.

²⁰ World Forum for Harmonization of Vehicle Regulations (UNECE): Guideline on cybersecurity and data protection. Consolidated Resolution on the Construction of Vehicles, R.E.3. <https://www.unece.org/fileadmin/DAM/trans/main/wp29/wp29resolutions/ECE-TRANS-WP.29-78r6e.pdf> (2017), pp.114-117.

There have also been efforts at national level to raise awareness and capability in the sector. For example, in August 2017, the UK Government published *The key principles of cyber security for connected and automated vehicles*²¹. The principles apply to all parties involved in the automotive supply chain, from designers and engineers to retailers and senior level executives and third party service providers. The purpose of these principles is to provide a consistent set of guidelines that support the global CAV industry, which will help to set the bar for automotive security without prescribing technical solutions.

In Germany, the Ethics Commission on Automated and Connected Driving outlined in its report that the new technology is only justifiable to the extent to which possible impairments of the IT system do not lastingly shatter people’s confidence in road transport.²² Moreover, the German Federal Government has published key recommendations concerning cybersecurity, among other topics, in its *Report on the Implementation of the Automated and Connected Driving Strategy* stating the necessity of a “holistic cyber security concept for automated and connected vehicles, covering the whole life cycle of a vehicle, from the development of a vehicle type up to its taking out of service”.²³

Regulatory approaches to data protection have been newly harmonised throughout the EU via the General Data Protection Regulation²⁴ (GDPR) which entered into force on 25 May 2018. This regulation will also apply in the

²¹ Centre for Connected and Autonomous Vehicles/ Centre for Protection of National Infrastructure/ Department for Transport (UK): The key principles of vehicle cyber security for connected and automated vehicles. <https://www.gov.uk/government/publications/principles-of-cyber-security-for-connected-and-automated-vehicles/the-key-principles-of-vehicle-cyber-security-for-connected-and-automated-vehicles> (2017).

²² Federal Ministry of Transport and Digital Infrastructure (Germany): Report of the Ethics Commission on Automated and Connected Driving, p. 12, Ethical Rule 14.

²³ Federal Ministry of Transport and Digital Infrastructure (Germany): Report on the Implementation of the Automated and Connected Driving Strategy. http://www.bmvi.de/SharedDocs/EN/Documents/DG/report-implementation-of-acd-strategy.pdf?__blob=publicationFile (2017).

²⁴ Regulation (EU) 2016/679.

context of CAD. Thus, the analysis performed under the European Commission's initiative entitled "Cooperative Intelligent Transport System (C-ITS) Platform"²⁵ was based on the GDPR. The next steps resulting from this analysis, including conducting a data protection impact assessment, have been initiated by the European Commission. The German Ethics Commission on Automated and Connected Driving also dealt with ethical issues concerning data protection and highlighted among others the importance of data sovereignty of road users²⁶ in its report.

Next steps concerning cybersecurity

The modern automotive industry is a global one. Products are increasingly designed to be sold in multiple markets, and there is a trend towards global products, which can be sold in any market. The CAV ecosystem is analogous to a modern global IT system, with not only products but back-end services like data centres, spread across a wide geographic area. For these reasons, it is appropriate to set the agenda for the industry on matters of cyber security and data protection at the global level. Thus the work on data protection and cybersecurity started at the UNECE, Working Party 29, is a key policy area which needs broad involvement of Contracting Parties/ EU Member States.

Nevertheless, individual countries can take steps to raise awareness and capability concerning cybersecurity. For example, the UK government has set up a cybersecurity information sharing forum, where government security experts can discuss the latest intelligence with members of industry in a secure setting. Similarly, industry participants can share their experience of developing products and responding to threats.

Next steps concerning data protection

The principles of data minimization and data avoidance which are enshrined in European law need to be appropriately reconciled with road safety requirements and the need for the development of business models and fair competition. In this context, it is necessary to ensure "data protection that is conducive to innovation and innovations that are conducive to data protection".²⁷ This balancing test will prevent on the one hand limitless data processing possibly leading to complete surveillance of road users and on the other it will prevent the creation of unsurmountable barriers for the deployment of this new technology.

The issue of data sovereignty is particularly important, both from a data protection and from a public acceptability perspective. Vehicle keepers and vehicle users should be free to choose whether they want to participate in the system and to decide whether their vehicle data are to be forwarded and used or not.²⁸ Applying this fundamental approach whilst designing frameworks for data processing within CAD would not only ensure data protection, but will also send a reassuring signal to the public that personal autonomy is being respected. This will positively influence how people feel about this technology.

The principle that technology users are free to decide has been incorporated in the GDPR in the form of the concept of "consent"²⁹. The (technological) challenge of allowing users to give specific, free and informed consent in the context of CAD has to be addressed primarily by industry.

Inherent in the concept of consent is the idea of choice. The Ethics Task Force discussed the impact of choice in the context of CAD. For example, choice over data sharing could mean that safety is compromised, as without certain

²⁵ European Commission: https://ec.europa.eu/transport/themes/its/c-its_en; Further reference is also made to European Commission/ Article 29 Data Protection Working Party: Opinion 03/2017 on Processing personal data in the context of Cooperative Intelligent Transport Systems (C-ITS). http://ec.europa.eu/newsroom/article29/item-detail.cfm?item_id=610171 (2017).

²⁶ Federal Ministry of Transport and Digital Infrastructure (Germany): Report of the Ethics Commission on Automated and Connected Driving, p. 12, Ethical Rule 15.

²⁷ Federal Ministry of Transport and Digital Infrastructure (Germany): Report of the Ethics Commission on Automated and Connected Driving, p. 25.

²⁸ Federal Ministry of Transport and Digital Infrastructure (Germany): Report of the Ethics Commission on Automated and Connected Driving, p. 12, Ethical Rule 15; European Commission/ Article 29 Data Protection Working Party: Opinion 03/2017 on Processing personal data in the context of Cooperative Intelligent Transport Systems (C-ITS), p. 10.

²⁹ Article 6 (1) (a) General Data Protection Regulation.

data essential capabilities or learning opportunities might be denied. Equally, a system that does not provide users with the possibility to choose has an impact on civil liberties and human rights. This itself may risk deterring people from using CAVs, which would mean that the potential safety benefits could be missed. Against this backdrop, it seems that neither a system that is solely based on free choice, nor a system that does not permit choice is desirable.

For this reason, in the context of CAD, future discussions could also include whether or not data processing could be – under circumstances yet to be defined – based on an appropriate and balanced (EU wide) legal instrument.³⁰

5. Socio-economic Implications

A major ethical concern of CAVs which is rarely discussed consists in some major or even disruptive changes for some business models and consequent socio-economic implications. Especially in the sector of goods and passenger transport, CAVs have the potential to completely change the existing business models and therefore it is crucial that we take on our ethical responsibility as a society for restructuring this branch. CAD is foreseen to create many new opportunities, new businesses and new revenue streams. However, there could also be challenging socio-economic implications involved in deploying this new technology of which potential job loss³¹ is among the most striking ones.

Potential Job Loss

In the short term, it seems obvious that the haulage industry will be among the earliest users of different levels of automated driving as these companies continuously seek to improve transport efficiency. At first, truck platooning will free drivers from the task of driving and will probably lead to longer turns and thereby further decrease the costs for road haulage. If no further actions are taken, this will probably further decrease the competitiveness of rail freight. Eventually, when fully automated heavy goods vehicles (HGVs) become a reality, many HGV driver jobs will be eliminated, since this will enable road haulage companies to further lower costs and thereby result in an increase of goods carried by road. In general, much fewer professional HGV, public transport and taxi drivers will be needed and those who remain will probably rather monitor the operation of fully automated driving systems, become technical staff or offer other added services related to the carriage of goods and passengers.

One business segment, which will be affected heavily by this transition, is the automotive industry. Clements and Kockelman³² estimate that, although car sharing services and fully automated shuttles may reduce private car ownership dramatically especially in urban areas, the overall automotive market will likely expand as the vehicle distance travelled increases for a wide range of users. Elderly people, persons with disabilities, or simply people travelling long distances will probably enjoy the convenience of fully automated driving without having to physically drive and spend time doing something else. However, even if the vehicle distance travelled increases, fewer collisions will lower demand for car repair, traffic police, medical, insurance, and legal services. In this context, an analysis of possible implications of CAD technology specifically on European economy and

³⁰ As suggested in European Commission/ Article 29 Data Protection Working Party: Opinion 03/2017 on Processing personal data in the context of Cooperative Intelligent Transport Systems (C-ITS), p. 9 and Federal Ministry of Transport and Digital Infrastructure (Germany): Report of the Ethics Commission on Automated and Connected Driving, p. 25; Highlighting improved traffic management as a potential purpose for data processing: European Commission: Communication, On the road to automated mobility: An EU strategy for mobility of the future. https://ec.europa.eu/transport/sites/transport/files/3rd-mobility-pack/com20180283_en.pdf (2018), p.13.

³¹ Nedelkoska, L./ Quintini, G.: Automation, skills use and training. OECD Social, Employment and Migration Working Papers, No. 202, OECD Publishing, Paris. <http://dx.doi.org/10.1787/2e2f4eea-en> (2018), p. 34.

³² Clements, L. M./ Kockelman, K.M.: Economic effects of automated vehicles. http://www.cae.utexas.edu/prof/kockelman/public_html/TRB17EconomicEffectsofAVs.pdf (2017).

society has recently been published by the European Commission.³³

The socio-economic implications need to be tackled as early as possible, e.g. by reconsidering education and employment models.³⁴ One of the issues to be discussed in this context could be whether or not companies should be mandated to re-skill workers displaced by CAD.

Mobility-as-a-Service

Concerning passenger transport, an even more disruptive change of the business segment is conceivable. Mobility-as-a-Service (MaaS), also known as Transportation-as-a-Service, describes a shift away from personally owned modes of transport, and towards mobility solutions that are consumed as a service. Users no longer have to privately own a vehicle, such as a private car, in order to be mobile, but will choose – depending on their needs and preferences – the mode of transport which best suits them, and will then pay for this service. MaaS schemes already exist in several European cities and the arrival of fully automated vehicles could be another massive enabler for this transition away from personally-owned vehicles. Especially in urban environments, fully automated vehicles will make it possible to foster on-demand transport services and to reorganize the public space³⁵. MaaS is not limited to individual mobility, since the approach can also be applied to the movement of goods, particularly in urban areas.

Thus CAD may also have a lasting and profound impact on the way cities are organised and the way public transport

enables citizens to move around between the centre and the suburbs. Those mostly in need of access to reliable and cheap means for moving around, such as the elderly or people with disabilities, are likely to be affected the most. It is therefore important that inclusive and attractive access to these new technologies is granted to those most likely to benefit from them.

Moreover, CAVs will probably increase the vehicle distance travelled and thereby imply a higher use of the public road infrastructure. As a result, maintenance costs could rise. In parallel to the transition towards CAVs, the shift towards low and zero emission vehicles will also have an indirect implication on the financing of road infrastructure and maintenance. In many countries, fuel taxation of vehicles still contributes directly or indirectly to road financing; however, the rise of alternative fuels and in particular electric mobility will probably reduce those revenues. In this regard, it could be discussed in the future how the reduction of those revenues could be managed.

Studies & Research

A specific study exploring the possible implications on employment of CAD as part of the Horizon 2020 Transport Work Programme 2018-2020, will be launched in 2018.

In June 2018, the European Commission will organise, in cooperation with the US Department of Transportation, an EU-US Transport Research Symposium on the socio-economic impacts of CAD. The aim of this symposium will be to discuss research needs related to the impact assessment of CAD on traditional economics, job markets, equity and social inclusion, land use, urban development, etc.

³³ European Commission: An analysis of possible socio-economic effects of a Cooperative, Connected and Automated Mobility (CCAM) in Europe. <http://publications.jrc.ec.europa.eu/repository/bitstream/JRC111477/kjna29226enn.pdf> (2018).

³⁴ See also European Commission: Communication, On the road to automated mobility: An EU strategy for mobility of the future, p. 15; World Economic Forum: Executive Summary, The Future of Jobs – Employment, Skills and Workforce Strategy for the Fourth Industrial Revolution. http://www3.weforum.org/docs/WEF_FOJ_Executive_Summary_Jobs.pdf (2016).

³⁵ National Association of City Transportation Officials: Blueprint for Autonomous Urbanism. <https://nacto.org/publication/bau/blueprint-for-autonomous-urbanism/> (2017).

6. Human-Machine-Interface (HMI) / Handover Procedures

CAVs could be deployed as mainstream products in the near future. Nevertheless, preliminary issues have to be addressed to provide confidence that CAVs are operated in a safe way. Foremost, there must be the possibility to distinguish between the use of a fully automated system or a system for which the driver retains a certain amount of responsibility (for example, acting as the fallback for the system).³⁶ In case of the latter it is necessary that it is clearly regulated and apparent where that (divided) responsibility of control lies at each point in time. In this context, a clear and understandable HMI is of paramount importance. This will be looked at in the following paragraphs in continuation of section 4 (“responsibility”) and the ethical questions raised therein. The issue of whether or not a human driver shall be held responsible and therefore liable in case of divided responsibility needs to be reflected further. Potential (external) HMI for fully automated systems will not be considered.

(Divided) Responsibility of Control

One of the crucial points of focus is on how the interaction between a human driver and the automated system will operate in a way that ensures that the vehicle respects traffic rules, that the driver is aware of her/his tasks and that the safe transfer of control between vehicle and driver is ensured.

The concept of control is the underlying principle to ensure the necessary level of road safety as it is stipulated in the Vienna and Geneva Conventions on Road Traffic. In various manifestations, control is assigned to the driver who must operate the vehicle safely. In this context, non-distraction rules are included in the (national) legislations. In certain cases, a human driver is no longer required to operate an automated vehicle or to supervise the driving environment at all times as long as the automated system operates the vehicle. However, automated vehicle systems

may not be capable of operating the vehicle for the entire journey. If system limits are reached, the driver will be required to take over manual control of the vehicle and perform the required driving tasks.

To comply with the necessary standards for road safety, it is fundamentally important to create a reliable handover procedure ensuring the necessary control over the vehicle while the driving task is transferred between the human driver and the automated system.

Handover Procedure

Situations where the human driver has to intervene, take over and transfer the driving task from the automated system may differ widely. In general, a distinction between planned and unplanned take-over situations could be made.

A planned take-over situation may take place while the vehicle is operating within the system limits. For instance, if the automated vehicle is going to leave a geo-fenced area (e.g. highway section) in which it can be operated by the system, the driver will be expected to take over. The handover procedure can and should be planned and designed in a predictable manner, allowing sufficient lead time for the human driver.

An unplanned take-over situation may typically take place outside of the system limits of the vehicle. For instance, the automated system can fail to perform the driving tasks in an unplanned way because of various unexpected situations, such as the unlawful behaviour of other road users, the fact that the vehicle’s sensors have exceeded their limits due to weather conditions or in the presence of insurmountable or unforeseeable conditions. In these specific cases, the system should also be able to initiate safety manoeuvres.

In any case, the handover procedure should be designed in such a manner that the system allows for sufficient time in which the driver can safely and comfortably assume control over the vehicle. In this context, various conditions will influence the reliability of the take-over-request (TOR) and the entire handover procedure to assume control over the vehicle.

³⁶ Federal Ministry of Transport and Digital Infrastructure (Germany): Report of the Ethics Commission on Automated and Connected Driving, p. 13, Ethical Rule 16, p. 21.

Amongst the issues to be considered are the following:

- a. First of all, the system should be equipped with technology which ensures that the system limits are detected;
- b. The system should provide a clear signal (acoustical, visual, or otherwise perceptible) to the human driver with the TOR for manual driving;
- c. The complexity of the situation in which the driving task will be handed over to the human driver should be considered;
- d. The personal conditions of the human driver should be taken into account, in particular, whether the human driver is tired due to a monotone driving experience or is highly distracted, whether physically or cognitively. Against this backdrop, it is significant which side activities (other than driving tasks) are performed by a human driver while driving in an automated mode. Therefore, the vehicle should ascertain “that the driver is ready to take over when required by the system, this includes driver availability, engagement, and attention to the road and traffic situation”³⁷;
- e. “If the vehicle determines that the human is not able or willing to resume control when required to do so, it should take appropriate action. Depending on the level of automation, the vehicle should warn the driver and/or perform a minimum risk manoeuvre³⁸ in which it secures as little danger as possible to the vehicle occupants and other road users”³⁹.

³⁷ European Commission: Final Report of the High Level Group on the Competitiveness and Sustainable Growth of the Automotive Industry in the European Union. <https://ec.europa.eu/docsroom/documents/26081> (2017), Annex 3, p. 2.

³⁸ It should be noted that it may be more appropriate to refer to achieving a ‘minimal risk condition’. This may or may not involve manoeuvring, depending on the circumstances and operational design domain.

³⁹ European Commission: Final Report of the High Level Group on the Competitiveness and Sustainable Growth of the Automotive Industry in the European Union (2017), Annex 3, p. 2.

To mitigate and counter the risk that drivers are confused by different HMI designs across vehicle makes and models, the major information and interaction features of the HMI “should be designed in a way that allows intuitive and easily accessible control of the vehicle’s functions and must have a high level of commonality for drivers among models and brands, and when crossing borders”⁴⁰.

The main tasks of legislators, researchers, and industry stakeholders will be to consider these issues and to define a framework at the UNECE for determining an appropriate warning period to handover the manual control of the vehicle to the human driver.

Assessment of the current situation

The automotive industry is a global one, and many of the fundamental decisions regarding its future are taken at UN level. Work is on-going at the UNECE to adapt relevant regulations for automated systems and side activities. Here, the work carried out by UNECE Working Party 1, known as the Global Forum for Road Traffic Safety, is essential and must be considered carefully.

UNECE WP.1 agreed on two fundamental principles in this context:

“When the vehicle is driven by vehicle systems that do not require the driver to perform the driving task, the driver can engage in activities other than driving as long as:

- **1: these activities do not prevent the driver from responding to demands from the vehicle systems for taking over the driving task, and**

⁴⁰ European Commission: Final Report of the High Level Group on the Competitiveness and Sustainable Growth of the Automotive Industry in the European Union (2017), Annex 3, p. 1.

- 2: these activities are consistent with the prescribed use of the vehicle systems and their defined functions.”⁴¹

Next Steps

These principles should be recognized and supported by the EU and Member States who should continue to actively engage in the ongoing work to this end within UNECE. Moreover, it is necessary that the above-mentioned fundamental observations are incorporated in the further development of these two principles and that the HMI is designed in a way that it supports compliance with these principles.

7. Additional Ethical Considerations

The Ethics Task Force considers several ethical issues to be important which have not yet been addressed in one of the previous sections. These issues are briefly set out in this section for future consideration.

Right of citizens

One of the concerns (see section on public acceptability and participation) around CAVs relates to the right of citizens to benefit from these technologies. Multiple questions arise regarding the right to “opt-in” and the principle of non-discrimination. What happens if certain CAV operators or a specific CAD software impede the operation of fully automated vehicles in certain areas? Should CAV operators be given the power to discriminate between customers based on a differentiated treatment of data? Should regulators, carmakers, fleet operators and software developers agree on a set of principles for “technological neutrality”, similar to the ones envisaged for Internet service providers?

Given the high expectations for drastic road safety improvements once a critical mass of CAVs are on the roads, there could also be an ethical aspect of not bringing CAVs to the markets.⁴²

Artificial Intelligence (AI)

Considering ethical issues of CAD in the broader context of AI is of paramount importance as well.⁴³ Self-learning systems are designed to operate – in a certain way – comparable to human intelligence. There are different forms of self-learning systems developed and available in the market for road traffic. AI has been used in this context for object recognition in cameras for driver assistance systems since the early nineties. Recently, the focus is more on the question of how AI functionalities could support/ take over the decision- making process determining how the system in the CAV shall manoeuvre (e.g. braking, turning to right). When considering ethical aspects of AI within CAD in the future, it could be discussed whether deployment of self-learning systems should depend on their ability to comply with safety requirements.⁴⁴

Considering cross-sectoral exchanges on how to address ethical issues, e.g. with the health and aid sectors, could also prove helpful and enriching.

⁴¹ Global Forum for Road Traffic Safety (UNECE): Report of the 75th session. http://www.unece.org/fileadmin/DAM/trans/doc/2017/wp1/ECE-TRANS-WP1-159e_new.pdf (2017).

⁴² Report Ethics Commission on Automated and Connected Driving, June 2017, p. 13 (Ethical Rule 6), p. 11.

⁴³ The European Commission underlined the necessity to deal with ethical questions in the context of AI and announced that draft AI ethics guidelines will be developed by the end of 2018, European Commission: Communication, Artificial Intelligence for Europe. <https://ec.europa.eu/digital-single-market/en/news/communication-artificial-intelligence-europe> (2018); The European Group on Ethics in Science and New Technologies (EGE) highlights the need for a common, internationally recognized ethical framework for AI and proposes a set of basic principles and democratic prerequisites, European Group on Ethics in Science and New Technologies (EGE): Statement on Artificial Intelligence, Robotics and ‘Autonomous’ Systems. http://ec.europa.eu/research/ege/pdf/ege_ai_statement_2018.pdf (2018).

⁴⁴ Report Ethics Commission on Automated and Connected Driving, June 2017, Ethical Rule 18, pp. 13 and 30.

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