

A.R.T. YOU READY?

**Towards a society in
which autonomous
vehicles are deployed
sustainably**

Discussion paper:
Autonomous road transport



Colofon ◀◀◀◀◀

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Summary

- How is automated road transport developing? It is a legitimate question now that the outlines surrounding automated vehicles are slowly taking shape. In non-urban areas, autonomous public transport can improve accessibility as an alternative to the private car. Autonomous shuttles can be deployed as a form of flexible pre-transport (first mile) or post-transport (last mile) for trips by bus or train. So, a less intricate public transport network can be amplified to provide better accessibility. The central question to this is: as a society, what do we want from our public facilities (public transport) in non-urban areas?

How is automated road transport developing?

It is a legitimate question now that the outlines surrounding automated vehicles are slowly taking shape. In non-urban areas, autonomous public transport can improve accessibility as an alternative to the private car. Autonomous shuttles can be deployed as a form of flexible pre-transport (first mile) or post-transport (last mile) for trips by bus or train. So, a less intricate public transport network can be amplified to provide better accessibility. The central question to this is: as a society, what do we want from our public facilities (public transport) in non-urban areas?

In the city, local authorities will have to start thinking about autonomous transport to come in around twenty or thirty years in reconstruction projects they are undertaking now. Because how do you create the right space now, which won't be needed until later? This is a difficult decision. It is not yet sufficiently clear what requirements the infrastructure of the future will need to fulfil. However, one thing is certain: the diversity of transport modes will only increase. Cities must ask themselves how

they are to integrate these different modes of transport with each other. A flexible layout of the space is also important, and that requires vision. Will each form of (autonomous) transport get its own lane, or do you opt for a distant view of mixed traffic? According to the STOP-principle, a Flemish principle for mobility management, smart technologies should not focus primarily on the car, but on pedestrians, cyclists and collective and shared transport. The car will not disappear from the city, although a 'small slice' will remain. Autonomous transport also requires a different perspective on parking in the city. Do you park autonomous vehicles in the inner city or do you create hubs on the outskirts? Fewer parking spaces and more greenery could make cities more habitable.

Autonomous road transport will have a long-term impact on employment. Jobs will certainly disappear, but the expectation is that also jobs will be created or be fulfilled differently. Autonomous vehicles are a double-edged sword in this respect.



The government must assume the steering role in the future of autonomous transport.

The risk of autonomous vehicles is that they are so convenient that the demand for transport increases. This can be avoided by making private autonomous transport more expensive, via the internalisation of costs. At the same time, mobility must be affordable for everyone. One potential solution is to make the cost price for the use of various modes income related. After all, cost plays a major role in the accessibility of a mode of transport.

The first forms of autonomous transport are based on caution and therefore come to a stop quickly in all sorts of potentially hazardous situations. Research shows that other road users therefore feel safe near an automated shuttle. The low speed of these shuttles contributes greatly to this feeling. Autonomous transport can make a major contribution to reducing road accident casualty figures. An important role is foreseen for intelligent and safe infrastructure in achieving vision zero (zero road traffic accident deaths in Flanders by 2020).

The government must assume the steering role in the future of autonomous transport. If the government assumes a compliant role instead of a guiding role, this may result in Belgium and Flanders excluding themselves from the sustainable development and implementation of autonomous transport. Furthermore, the danger of a government that remains on the sideline is also that automated transport will simply not be implemented. We are already lagging behind our northern neighbours, according to KPMG's 'Autonomous Vehicles Readiness Index'.

Eventually, four conditions apply to the transition to automated transport: technological progress, amended legislation and regulations, and partnership between the various stakeholders. A mental and modal shift are also essential to achieving the transition from trips with motorised private transport to sustainable (automated) journeys.

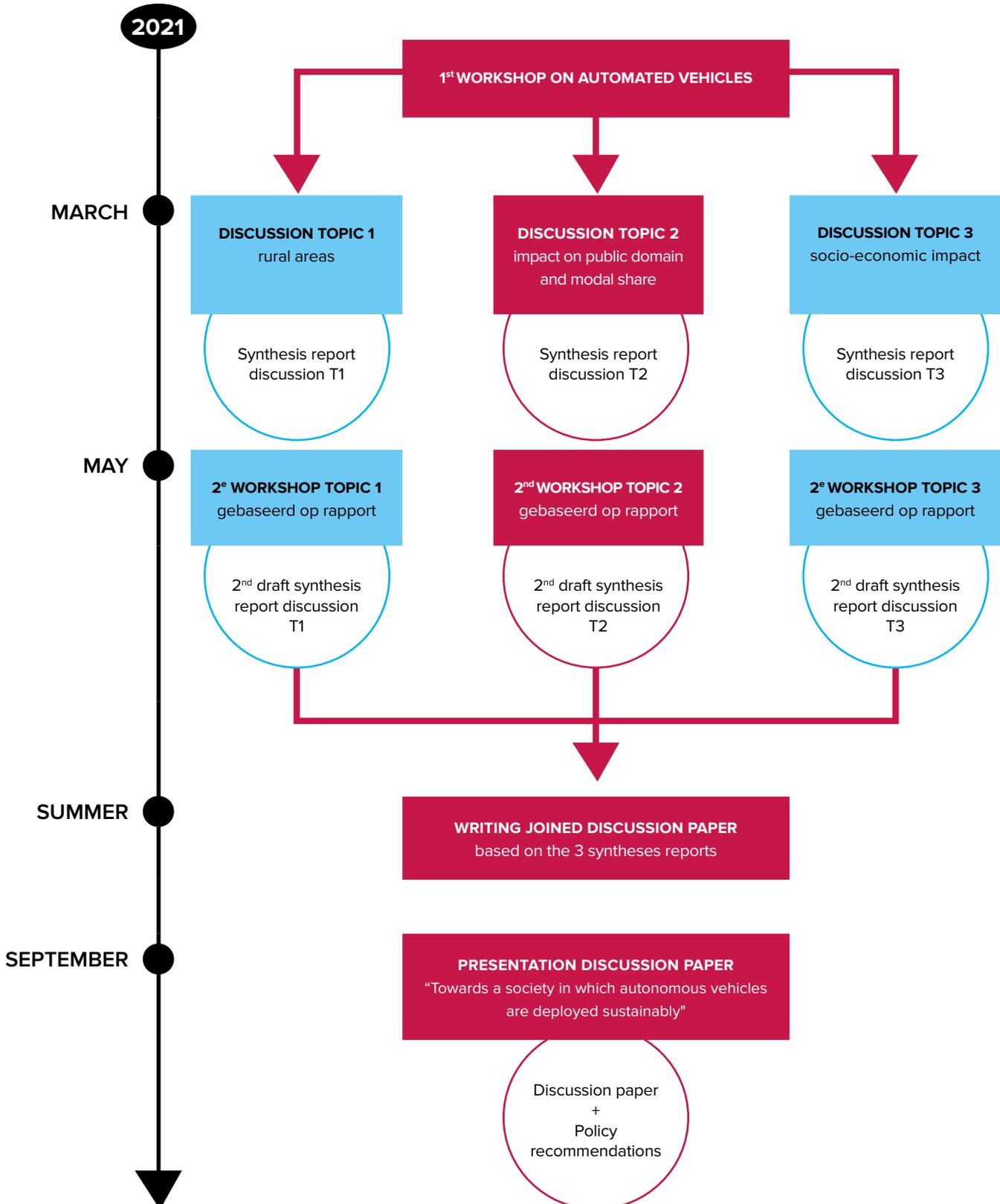


Contents

1	Aim, scope and working method.....	6
2	Problem definition.....	8
3	Positioning.....	10
3.1	Autonomous road transport in non-urban areas.....	10
3.2	Impact of autonomous transport on public space and the modal shift.....	12
3.2.1	Investment in autonomous driving.....	14
3.2.2	Parking.....	15
3.3	Autonomous transport and its socio-economic impact.....	16
3.3.1	Employment market.....	16
3.3.2	Cost of autonomous transport.....	16
3.3.3	Accessibility.....	17
3.3.4	Road safety.....	17
3.4	The changing role of government.....	19
3.4.1	The new role of government.....	19
3.4.2	The future begins now.....	21
3.5	What is required for the transition?.....	22
4	Conclusion.....	23
5	Policy recommendations.....	24
6	Abbreviations and glossary.....	26
7	Acknowledgements.....	27

SCOPE

The discussion paper focuses primarily on private & public passenger transport, with an occasional mention of goods transport. Autonomous transport will nevertheless have a major impact on how we transport our goods from A to B.



Autonomous transport and its socio-economic impact

If a truck travels autonomously, is the driver no longer required, or can he or she undertake other tasks? And so, it also appears that the taxi, bus and train driver will lose their jobs if automated transport goes ahead. The question however is whether so many jobs really will disappear, or whether they will be fulfilled differently. An operator or guide will still be needed for a long time to come. In addition to the impact of autonomous technology on the employment market, within the socio-economic aspect it's also about road safety and access to autonomous public transport.

The changing role of government

Fair is fair: for decades society has moulded itself around the car. The government has followed ever since. It is clear that with the rise of autonomous transport, it will have to play a different role. More specifically, that of a director. Detachment on the part of the government may lead to Belgium excluding itself from the sustainable development and implementation of autonomous technology and transport. Our country scored low in the 2020 KPMG 'Autonomous Vehicles Readiness Index' in 21st place out of 30. The risk of a detached government is furthermore that automated and autonomous transport is not implemented correctly and opportunities are missed to resolve current traffic congestion or to implement the STOP principle.

What is autonomous transport?

An important starting point is to clearly identify precisely what we mean by Autonomous transport. An autonomous vehicle is a fully automated vehicle equipped with technologies that takes over all driving functions without human intervention. An autonomous vehicle can therefore drive, brake, accelerate and navigate the route without the need for a driver. An automated vehicle on the other hand is a vehicle in which technology assists the driver.

Country or jurisdiction	RANK		2020 score
	2020	2019	
Singapore	1	2	25.45
The Netherlands	2	1	25.22
Norway	3	3	24.25
United States	4	4	23.99
Finland	5	6	23.58
Sweden	6	5	23.17
South Korea	7	13	22.71
United Arab Emirates	8	9	22.23
United Kingdom	9	7	21.36
Denmark	10	n/a	21.21
Japan	11	10	20.88
Canada	12	12	20.68
Taiwan	13	n/a	19.97
Germany	14	8	19.88
Australia	15	15	19.70
Israel	16	14	19.40
New Zealand	17	11	19.19
Austria	18	16	19.16
France	19	17	18.59
China	20	20	16.42
Belgium	21	n/a	16.23
Spain	22	18	16.15
Czech Republic	23	19	13.99
Italy	24	n/a	12.70
Hungary	25	21	11.66
Russia	26	22	11.45
Chile	27	n/a	11.28
Mexico	28	23	7.42
India	29	24	6.95
Brazil	30	25	5.49

Scores KPMG-index 2020



We must ask ourselves what is desirable from the point of view of public space, instead of what is possible in terms of technology.

Although autonomous transport will relieve existing blind spots in the public transport network, several concerns remain. Those are:

- ▶ Autonomous transport still requires customisation which is costly. The debate must be held over what is desirable from the point of view of public space, instead of what is possible in terms of (transport) technology. As a society, what do we want from our public facilities (public transport)?
- ▶ Further research is necessary into the forms of autonomous transport that work best. There is a risk that autonomous transport will lead to more trips. It is already evident that if you replace a bus route with autonomous transport (and then mainly shuttle services), the number of vehicle movements increases. TU Delft calculated that the capacity of autonomous systems is many times lower than that of an average tram or bus route.
- ▶ It is important to realise that fully autonomous technology is not yet ready for application in practice. Pilot projects with collective transport in mixed traffic, cannot yet be implemented or appear not to have been sufficiently successful. Autonomous goods transport on water or via drones (e.g. urgent medicines) however appear promising.
- ▶ The transition to automated and autonomous transport must not lead to additional private cars on the road. Nor must journeys by private car become more attractive than they are today. That could generate a negative effect on spatial planning. The focus must be on the automation of public transport and on the shared use of the vehicles. Automation without sharing makes little sense.



Automation without sharing makes little sense.

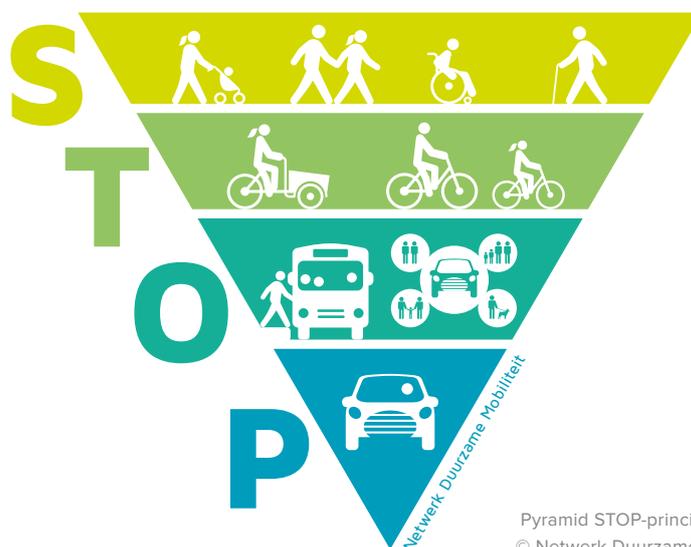
Separate lanes

But what you must take into account is the flexible layout of the space. It's important to have a vision of this (please note: on 9 July 2021, the Flemish government approved a future vision for mobility - the 2040 Flemish mobility vision - and also has a vision for 2030 with a look ahead to 2050 for intelligent transport systems). As a city, where do you want to go and where not? There will not be enough space to give each type of (autonomous) transport its own lane. Scarce open space will have to be protected as much as possible from ending up as extra lanes for automobility. This means that various types of users will have to share the same space. It will however be a long time before mixed traffic of autonomous and conventional vehicles and other road users becomes a reality, especially in non-urban areas. This doesn't leave out the option to consider a separate lane in very specific locations, for example for autonomous shuttles. Another consideration is to create separate lanes according to speed. This enables fast and slow traffic to be separated from each other safely.

“ Scarce open space will have to be protected as much as possible from ending up as extra lanes for automobility.

STOP-principle

In the pile of infrastructure amendments, it is important to keep in mind the STOP-principle. According to the STOP-principle, a Flemish principle for mobility management, walking ('Stappen') is given priority, then cycling ('Trappen'), followed by public transport ('Openbaar vervoer'), with a small place on the pyramid remaining for the private car ('Privévervoer'). The most sustainable and autonomous way to move forward is naturally on foot. Shared cars have a positive impact on both vehicle ownership and use and therefore have a place between the O and the P. Smart technologies should not focus primarily on the car, but more on pedestrians, cyclists and collective and shared transport. For example, pedestrians can be given a green light sooner when it's raining. During rush hour, cyclists can be given a longer passage. This will enable people to make the switch from car use to journeys on foot or by bicycle. Autonomous vehicles must also recognise pedestrians and cyclists as priority traffic, taking account of their greater vulnerability.



Pyramid STOP-principle
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3.2.2 Parking

Autonomous transport will generate a shift in which parking spaces in the city disappear and are replaced by drop-off points where autonomous vehicles will park at quiet times.

“ We must avoid ‘zombie vehicles’ driving around.

There is still a lack of clarity over what happens to autonomous vehicles when they are not being used. It is likely that they will be clustered close to locations where there is great demand during the day. It is not certain whether they will have to travel to suburban areas or will be stored in hubs or depots overnight. Perhaps their batteries will be used to supply energy at times when energy demand is high. What is clear however, is that cities and their inhabitants are paying more and more attention to the quality of life in neighbourhoods and autonomous vehicles should meet these standards.

As a result, the car is being allocated a different role. This is already being put into practice in the form of:

- ▶ Circulation plans
- ▶ Low emission zones
- ▶ Reduced speed zones
- ▶ Cyclist and pedestrian priority zones
- ▶ Road tolls

This policy will possibly cause disputes with peripheral regions due to conflicting interests. As a result of the reduction in parking spaces in the city centre, parking congestion may shift to outlying areas and municipalities. Non-urban areas must be safeguarded against additional (autonomous) vehicles. So-called ‘zombie vehicles’- self-driving vehicles without a passenger- driving around must also be avoided.

3.3.3 Accessibility

Autonomous travel for people in transport poverty

Users need to be asked about their wishes. What mobility solution exists for less mobile people to participate fully in society? What scenario must we absolutely avoid? There have been many predictions about the cost of a robotaxi (in Belgium the major tech players are busy with the first steps of developing robotaxis). This form of autonomous transport will be cheaper than a private car in the long term. Autonomous shuttles also have that potential. This provides positive perspectives for people in transport poverty.

3.3.4 Road safety

The creation of a feeling of safety may be a significant first step in the acceptance of autonomous transport. This could be promoted by restricting the speed of autonomous vehicles.

Autonomous transport and cyclists

There are various locations across the world where automated transport is driving around, some of them in pilot projects. What has this shown? The vehicles remain at a sufficient distance from other (vulnerable) traffic. American and Belgian research shows that other road users feel safe in the vicinity of an autonomous shuttle driving by. The low speed of the vehicle contributes greatly to this feeling. Good news, or so it appears, but it remains to be seen what the feeling of safety will be when various types of (autonomous) vehicles are crisscrossing each other. And there's another point: human faults are judged less strictly than the failure of an autonomous vehicle. Apparently, the implementation of robotised transport is expected to be virtually flawless. Nevertheless, the first experiences with automated transport are hopeful. Autonomous transport will have to fit in with other traffic (particularly cyclists and pedestrians) and not the other way around. The technology must comply with these conditions before it may be used in a city or municipality.

»» Suggestion for research

To what extent are people prepared to pay extra to own their own autonomous vehicle or to travel alone? This is an interesting question, to which there is no answer yet. Who will pick up this research gauntlet?

“Transport poverty is not just about money or the use of transport modes, but also about how safe the user feels.”

The automotive sector is constantly emphasising that its autonomous vehicles will significantly reduce the number of road accidents. It is therefore prompting that countries, regions and cities make major investments in infrastructure and want their transport systems to be adapted. However, commercial or unethical reasons may lurk behind these arguments emphasising increased road safety.

3.4 The role of the government is changing

What new role will the government have in the transition to autonomous transport? It is one in which it will take charge within a long-term vision, promote inclusivity and ensure involvement. Society takes priority.

3.4.1 The new role of the government

In the past, the government has had too little control over the development of new technology. It did not determine its direction but instead was pushed in a direction. This is how society committed itself fully to the car. With the advent of autonomous vehicles, that can, and must, be different. It is time that the government accepts its coordinating role.

How exactly? De Lijn, the Flemish public transport operator, and the Department of Mobility and Public Works are conducting research into this. The interests are great. A detached government will exclude Belgium from the sustainable development and implementation of autonomous transport. Another risk of a reluctant role of the government is that private players will have a bigger share. The potential result is a focus that does not serve societal interests, but those of the private players. A study by the International Transport Forum, based on current mobility data from the city of Lisbon, shows that the greater the competition, the less autonomous vehicles will be able to comply with the requirements of passengers. The idea is that an oversupply of autonomous vehicles leads to a less efficient transport system.

PRIVATISATION

In general, society is undergoing a trend toward privatisation and liberalisation, in which the government shifts the responsibility for its tasks elsewhere. Before autonomous vehicles make progress, the government must prepare itself for its steering role. Fragmentation will also have to be prevented. An umbrella framework (including laws and regulations) could contribute to this.

INCLUSIVITY

For increased mobility, autonomous transport must provide for people who are currently excluded. The government and society must not simply allow changes to happen, they must determine those changes themselves, with the motto: the new autonomous (transport) system must be better, otherwise we won't begin working on it.

INVOLVEMENT

Public acceptance is of great importance. Pilot projects are an excellent means of achieving this, as long as they provide added value in terms of science and technology, compared to previous pilot projects. Although the government must take the lead in this, this process needs to take place democratically. That is to say, all stakeholders must be involved, including the end-users. It is also essential for people in transport poverty to be asked about their transport needs.

PARTNERSHIP

In the past, the role of the automotive industry in the layout of society was too great. The advent of autonomous transport is an excellent opportunity to redress this skewed balance of power. In Europe, it is important not to follow the United States too closely, where people are much more open to making public space available to the automotive industry. However, the automotive industry is not an enemy, but a partner. After all, the government needs the automotive industry, for example for the development of mobility services (shared car projects) in outlying areas. Partnership is essential, but one in which the government takes the steering role.

LONG TERM VIEW

In the run-up to the roll-out of autonomous vehicles, the government must steer how these vehicles are deployed. The government must also determine where it will permit autonomous vehicles and how it will promote their roll-out. The government must also respond to the requirements of users. A long-term vision is essential, in which the interests of society come first, rather than profit.

“ The new autonomous system must be better, otherwise we won't begin working on it. ”

3.4.2 The future begins now

Long-term thinking is important, but don't forget about today. There are at least four areas in which governments can already engage concerning autonomous vehicles:

1. Win back public space

Public space must be a place where the need for vehicles is low. Collective and shared autonomous vehicles can help to win back space, as shared vehicles are already creating a reduced need for parking spaces.

2. Think about the energy network

The mobility of the future is 'ACES': Autonomous, Connected, Electric and Shared (also referred to as 'CASE'). But how will we organise this electrification? Local governments must also seek answers to questions such as: should charging take place in large hubs (which requires a lot of capacity in terms of energy) or should this be decentralised? Do you take your energy from work to home? These are all questions that are not yet sufficiently in the phase of 'policy making'. A 'Clean Power for Transport'-vision 2030, already exists, alongside a draft memorandum: 'Charging infrastructure roll-out strategy 2021-2025'.

3. Allow legislation to evolve

A different method of transport and the layout of public space requires different laws and regulations. An example might be compulsory ISA (Intelligent Speed Assistance) in certain environments, or autonomous transport that is primarily used to resolve the first and last mile-mobility challenges. It is preferable to define these laws in advance and not after the event. The development of autonomous transport can be steered better if you have clear rules.

4. Keep up with current technology

The government (Flemish and/or European) must be the conductor. It must give clear instructions to the developers of the technology with definitive expectations and obligations. It must also remember that autonomous vehicles will not be here immediately, but that there will be technological interim phases during which the government can adopt a steering role. Intelligent Speed Assistance (ISA) is an example of this. This technology is necessary to achieve autonomous transport. But we can use this technology already in the area of road safety, even without autonomous vehicles.

“ Even without autonomous vehicles, we can use current technology already to have safer roads.

3.5 What is required for the transition to autonomous transport?



Autonomous transport is coming. That appears certain. It is not yet clear when, and to what extent we will have to deal with self-driving cars and autonomously operating public transport. The following 4 aspects determine development to a significant degree:

1. Technological progress

In recent years there has not been a great deal of technological progress in the development of autonomous vehicles. We are therefore 'stuck' in a phase of trial projects with automated shuttles and vehicles that are not being upscaled. Manufacturers are working on a generation of level 4 vehicles. Level 4 autonomy is defined as fully automated driving, whereby the vehicle is equipped with a steering wheel, so that a driver can intervene. Level 5 requires no steering wheel or driver and the vehicle drives entirely autonomously. We are still far away from that, but how far is not yet clear. The question is in fact whether level 4 autonomy will be possible in the city. There are supporters and opponents of this. Further research will help to determine the right direction.

In addition to the technological progress of the vehicles, it will be necessary for the 5G network to be rolled out to enable superfast communication between vehicles and between vehicles and the infrastructure.

2. Legislation

In 2021, the German federal government adopted a 'law on autonomous driving'. In doing so, Germany is the first European country to introduce legislation on permitting level 4 self-driving vehicles on the public highway. Flemish and Belgian legislation does not yet exist. The discussion is mainly about who is responsible for what.

3. Interests

Several players, each with their own interests, are involved in the transition to autonomous transport. This transition will take place if the interests of several players are served and if autonomous mobility is feasible and scalable. The sustainability objectives formulated at EU and UN levels are of major influence. Mobility will naturally take shape within that framework.

4. Modal & mental shift

The transition to autonomous transport is more than a question of providing the technology, the transport systems and the vehicles. People need to be convinced that they can travel from A to B in a sustainable way. The desired modal shift (leaving the car at home and choosing another mode of transport, or a mix of modes) is therefore strongly linked to a mental shift: a change in mentality.

4 Conclusion

Current mobility problems - road safety, traffic jams, air pollution, climate impact, accessibility, parking problems, transport poverty - will not immediately disappear if autonomous transport is introduced on a large scale. However, if it is managed properly, autonomous transport can be part of the solution. If electric, collective and shared autonomous transport were integrated within a stronger, enforced modal shift, we could overcome the above problems to a great degree.

The development of self-driving technologies is progressing gradually, as a result of which it will be decades before autonomous transport makes the steering wheel redundant. In the meantime, various vehicles with different degrees of automation will exist alongside each other during a specific transition period, whereby it is likely that they will make use of the available space through each other rather than alongside each other.

Before autonomous transport gets a place in our society, various hurdles will have to be overcome. First of all, technological progress must lead to transport devices that are level 4 or 5 autonomous. And in which also kilometres can be driven without the presence of a driver. The arrangements surrounding autonomous transport must be laid down in laws and regulations. In addition, the interests of various players must be in line with each other, in which European and global sustainability objectives will be definitive.

Finally, the transition to self-driving vehicles requires a change in awareness: a mental shift. Above all, the government must assume a coordinating role. It must bring the most important parties involved in autonomous transport around the table so that its inclusive nature is ensured and that it connects to the needs of users.



Current mobility problems will not disappear if autonomous transport is introduced on a large scale.

existing technology. Governments can already take significant steps, on the one hand by adapting the regulatory framework and on the other by clarifying the signalling and communication structure.

7 — Be open to research

Who will organise autonomous shared vehicles? Will it be the mobility providers who do so on behalf of the government, or will it be by private initiatives? And what is the situation regarding partnerships between stakeholders? These models require further research. It is important to facilitate research and create the conditions in which research can easily be conducted. Of major value is research into the transport method selection process. What will entice people away from constantly reverting to the car, when more sustainable alternatives are available?

8 — Take up your steering role as a government

The government must take control via co-creation (partnership with your stakeholders) and an emancipatory and empowering policy concerning private initiatives in the market. This should ensure that social interests prevail and are served. There may be scope for focus on profit, but this should not be the priority area for the framework surrounding autonomous transport. The government is responsible for the creation of a more active policy surrounding the currently abstract concept of autonomous vehicles. It could already be studying tangible situations and local mobility requirements. The government must take a proactive role in respect of new technologies and must function as a conductor, controlling the market for autonomous vehicles.

9 — Provide new jobs when old ones disappear due to autonomous transport

The automation of vehicles is now being seen from an economic perspective, as a cost-saving measure. It would be meaningful to adopt a holistic perspective, in which the focus is on the creation of meaningful employment for everyone. How can jobs that disappear be replaced by meaningful jobs?

10 — Put well-being before profit

In association with the eighth and ninth recommendations, the holistic perspective appears to be the way to look at the entire evolution of autonomous transport. Prosperity must no longer be the most important driving force in decisions to be taken, but well-being should. Put society's interests first.

11 — Ensure that autonomous transport is inclusive

Situate and visualise autonomous transport step-by-step within public space and in doing so, take into account inclusion and accessibility. Both in the city and in non-urban areas. In the future, autonomous transport can of course play a better role in access to these areas. Communicate proactively about the impact of automation. Participation and a social debate play an important role in this.

12 — Adopt the STOP-principle

Following the STOP-principle, smart mobility technologies should not focus primarily on the car. For example, pedestrians are given a green light sooner when it's raining. This will enable people to make the switch from car use to journeys on foot or by bicycle.

6 Abbreviations and glossary

Autonomous vehicle: a vehicle that is fully automated and equipped with technology that can take over all driving operations. Human intervention is redundant.

Automated vehicle: a motor vehicle that assists the driver in carrying out driving tasks.

ACES: the mobility of the future 'ACES', which is short for Autonomous, Connected, Electric and Shared. Or smart (connected) shared autonomous transport that is electrically powered. ACES, also referred to as CASE, is however not the only nomenclature. The acronym CCAM (Cooperative, Connected and Automated Mobility) is also used.

First mile and last mile transport: the first or last portion of a journey. This often refers to the part of the journey between the home/departure point and the station or MOBI point, or the last part of the journey from the station or MOBI point to the destination. Cities are aiming for an emissions-free last mile in which small-scale (in the future autonomous) electric transport travels from the edge of the city to the city centre.

Intelligent Speed Assistance (ISA): driving aid that reads the maximum speed limit and adjusts the speed of the vehicle accordingly. ISA is an existing technology that is seen as an important steppingstone to autonomous transport.

Intelligent transport systems (ITS): Intelligent transport and driving aid systems. These are applications of information and communication technologies in vehicles to make traffic safer, more efficient, comfortable, reliable and environmentally friendly (Source: SWOV, Nederlands Instituut voor Wetenschappelijk Onderzoek Verkeersveiligheid [Dutch Institute for Scientific Research into Road Safety]).

Level 4 autonomy: is defined as fully automated driving, whereby the vehicle is equipped with a steering wheel so that a driver can intervene.

Level 5 autonomy: level 5 requires no steering wheel or driver and the vehicle drives entirely autonomously.

Mental shift: a change in mentality. In this context: a change in mentality that lies at the basis of behaviour change which is required for autonomous transport to be accepted and used sustainably.

Modal shift: The choice for a new (mix of) transport methods to convey us from A to B. The shift from motorised to sustainable transport is central to this.

Mixed traffic: various forms of (autonomous) transport that criss-cross each other, without individual lanes for each type of transport.

Robotaxi: a self-driving taxi which in the long term will require no driver.

STOP-principle: the scheduling of mobility policy based on priorities. Walking is given priority, then Cycling, followed by Public transport, with a small place on the STOP pyramid remaining for the Private car.

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