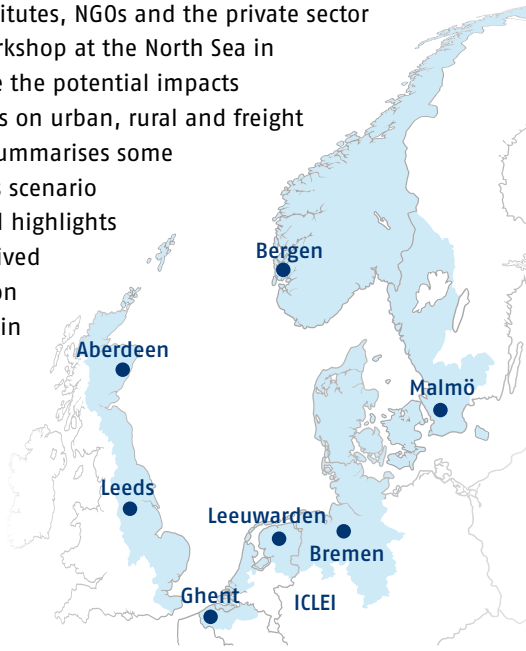
CARE-North plus

Autonomous vehicles – impacts on mobility of the future

A few years ago, the idea of driverless transport systems still seemed like part of a science fiction film. Now, as the technology begins to emerge and receive more media attention it no long seems like such a futuristic notion. Nearly every auto manufacturer is currently working on prototypes for autonomous vehicles and plans to introduce market ready solutions within the next few years. Investors and innovators outside of the traditional automobile industry are also hard at work: Google, for instance, has exceeded 1.1 million km of test drives with its driverless car, announcing its possible market release date between 2017 and 2020. Many autonomous technologies are also already in operation in some areas, such as autonomous vehicles in segregated areas (e.g. in harbours with automated van carriers or underground rail systems) or as features of conventional cars (such as a self-parking modus for private cars). As technological developments advance at exponential rates, it is easy for governmental policy, urban and transport planning to fall behind the times. Therefore, it is necessary to begin a debate about changing infrastructure requirements and social and economic impacts of autonomous vehicles now rather than when they become a part of daily transport on the road. How will the available technology be used? What kind of political decision making is necessary to take advantage of the positive potential? How can unwelcome side effects be avoided?

Today, transport planners and decision makers regard the technology without having a clear picture about what it may mean for the mobility of the future. That is why a dialog was begun in the CARE-North plus project about the questions above. Representatives from urban and transportation planning, research institutes, NGOs and the private sector came together at a workshop at the North Sea in January 2015 to explore the potential impacts of autonomous vehicles on urban, rural and freight transport. This paper summarises some of the outcomes of this scenario building workshop and highlights some of the input received from external experts on autonomous transport in the Case Study sections of the paper.



CARE-North plus
The Interreg IVB North Sea Region Programme
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Autonomous transport – A bit of background Information

There are three different types of autonomous vehicles: those with low autonomy, medium autonomy and high autonomy. The first category is taken by vehicles that operate in dedicated environments which are equipped with sensors and beacons to ensure functionality. These vehicles drive on determined routes and are not able to make any kind of intelligent decisions. They are predominantly applied in logistical areas but also in public transport routes such as the Copenhagen subway system. Other examples are the Personal Rapid Transfer (PRT) operating in London Heathrow Airport, Masdar City and the Group Rapid Transfer (GRT) at Schiphol Airport in the Netherlands. Medium automated vehicles also drive in adjusted areas but have an intelligent system on board which allows them to change their routes, for example, in the event the road is blocked. Highly autonomous vehicles are able to drive entirely independently in any kind of traffic situation. Highly intelligent sensor systems, instruments for navigation, vehicle-to-vehicle communication, and vehicle-to-infrastructure communication will ensure safe interaction with other traffic participants.

In general, autonomous vehicles have the potential to reduce the number of road accidents considerably, therewith reducing the number of people injured and killed in traffic accidents and the high costs (economic and social) associated with accidents. However, indirect effects of autonomous vehicles are also to be expected. The following sections will explore some of the potential effects or directions of development to which autonomous vehicles could lead in urban, rural and long distance freight settings as well as describe the pathway that must be laid out now in order for cities and regions to take advantage of possible benefits of autonomous transport and curb negative effects.

Impacts on urban transport

In urban areas, a large variety of motorised transport modes is common. Cars, buses, underground railways and trams carry passengers; delivery services, postal vehicles and trucks transport goods. Service vehicles for street cleaning or winter service, etc. also contribute to urban traffic. In all of these modes of transport, a certain potential for automation can be implied. But at the same time, the technological requirements are extremely complex. A growing application of automated transport systems and vehicles could change our cities dramatically, especially with the ongoing trend of increasing smart mobility, where all modes of transport are

closely connected. Personal car ownership is the key question within the scenarios of automated transport and there is great potential for change. It is possible to imagine a city with much fewer cars, therefore less congestion, less occupation of space, less pollution, far fewer accidents and, in the end, much higher economic efficiency. An intelligent and integrated transport system could bring people quickly from one point to another and allow for more public space, more parks, more playgrounds and a safer environment due to the ability of vehicles to "store" themselves and the lack of necessity to park one's car in front of one's home (for example, a car that can park and retrieve itself is always "in front of the door" when one needs it). This positive scenario is one of large-scale collective mobility, where only "last mile" journeys are conducted individually. To make this vision come true, cities would require target-oriented concepts for the inner city mobility of the future and need to push developments towards creating sustainable cities offering a higher standard of living. Today's public transport would be able to develop into a more demand - based collective transport system of high convenience – well connected with automated 'individual' services and few if no empty journeys of buses or trams. A data-driven urban transport management system can help the process of planning and regulation. At the same time, predictive modelling of intermodal concepts can support finding the most efficient and economical transport system for the city.

Without the necessary guiding hand toward a scenario where autonomous vehicles lead to collective mobility and support a cities goal of integrative sustainability planning, a "business as usual" scenario could be expected that entirely contradicts modern goals for creating liveable, resilient cities. In this scenario, car owners may simply replace their standard vehicles with automated vehicles. Because traveling by car becomes more convenient due to the lack of necessity to drive oneself and because a vehicle is capable of storing itself, owning one's own car could become increasingly attractive and traveling with collective means could become decreasingly attractive. This could lead to significant increases in road traffic, increasing the energy demand and space consumption in cities. With this scenario, the chance for cities to transition to a low-carbon, more liveable.

Key Idea: If cities want to avoid such increase in individual motorised transport, they must prepare the technology and as well the built-up environment. The benefits of re-using today's parking space for better and more economically efficient purposes need to be demonstrated.

CASE STUDY:

The CityMobil2 Project – An Example of Autonomous Vehicles for Collective Transport

CityMobil2 is an EU project with 45 partners including twelve different European cities, coordinated by the University of Rome, working on fully automated urban road mobility. Their concerns are the creation of a common legal framework that covers autonomous transport, the implementation of real autonomous systems in cities and the socio-economic effects that come with vehicle automation. They have developed fully automated vehicles to be tested in public. So far, Oristano in Italy and Leon in Spain have completed small scale demonstrations and showcases of autonomous transport.
Here, the Automated Road Transport Systems (ARTS) were revealed and tested in public in the form of fully automated 10-passenger vehicles operating on pedestrian paths (at the moment the vehicles are licensed to operate on public roads in Greece and Holland).
Significant work has been put into risk assessment to make the vehicles safe for use in sometimes crowded areas. In Oristano, 3000 passenger trips were conducted by 1600 registered testers. No accidents happened over the range of 1100km and 91% of the testers would like to use the ARTS-bus again in the future. So far the buses operate at quite low speed of around 5-8km/h but the curiosity of the people in Oristano and Leon has established the idea that autonomous transport will be easily integrated with society.
A large scale demonstration is now operating in La Rochelle in France on dedicated lanes with intersections with conventional traffic.

Demonstration of driverless minibus in Oristano, Italy (July 2014).

Change in rural areas introduced by new mobility concepts

Generally, rural areas can be subdivided into different types according to their population density. There are the surrounding suburbs of big cities, towns, small towns, agricultural landscapes and isolated areas. Between these areas, one can find different transportation corridors ranging from national routes to minor roads. All of these can be affected by applications of automated transport.
The suburbs of big cities very often have problems with congestion during rush hours. Automated transport systems can combine collective and individual transport services – being an alternative to purely individual cars. The idea of automated cars alone may even increase the transport volumes – as it might become much more convenient to go by (automated) car.

Automated (driverless) public transport services may operate with lower costs than buses today, due to lower costs with regard to driving staff as well as the possibility to provide a demand responsive service. It is also a chance for rail corridors in rural areas to be used by driverless rail vehicles, which, in terms, of technological capabilities has the potential to be seen in practical operation on a broader scale soon.

Today many rural areas have lost their attractiveness as a place for younger people to reside, due to the concentrated location of work places and services in cities, often leading to degradation and disregard of whole towns and villages. Living in rural settings has become increasingly difficult for the elderly, for example, because of the necessary car dependency in these areas (due to longer distance to places where necessary services can be acquired). The elderly often become isolated here when they are no longer capable of driving a car. With autonomous vehicles, this age-related transition would be much easier and it could significantly increase the possibilities for social inclusion for many isolated elderly people. Autonomous transport has the potential to counteract the degradation of rural living areas. On the other hand, autonomous transport also has the potential to refuel the suburbanisation process, which many European regions have recognised as being detrimental to the environment and the liveability of regions as well as to regional resilience in the face of an impending energy crisis. By improving the convenience of commuting through automated technology – travel time could be perceived no longer as lost time if your car drives you to and from work – living long distances from one's place could become increasingly attractive again. This so-called "house-at-the-lake syndrome" could only strengthen urban sprawl

and/or the energy demand of transport as traveling long distance on a regular basis no longer poses a burden on the driver.

Key Idea: There are risks that automated transport systems may lead to an increased transport volumes and related problems of infrastructure capacity, especially related to peripheral urban areas. Again, the question of privately owned vehicles versus the benefits of wide-scale collective transport is a key for the overall efficiency of transport systems with autonomous cars.

Smart Mobility

Smart mobility is seen as a path to sustainable cities. This does not cover only autonomous transportation but also involves intelligent infrastructure and the integration of social and political aspects. The flexible and efficient use of all modes of transport is a key factor. Therefore, a shift has to take place from a mono-modal transport system, where passengers use either car, bus, or bike, to a multi-modal system, that allows the flexible use of all modes of transport where required. If mobility turns more towards being a service, integrated

Freight transport – High efficiency includes possible rebound effects

In long distance freight transport, two areas are likely to be automated in the near future: the transportation of goods by rail and transportation by road. In the former, we find that the personnel needed for operating trains has already slowly decreased over the years and the path to automation is quite short. For road transport, several different concepts can be imagined which all show a great potential to decrease the amount of trucks on roads and for creating a more efficient, more environmentally friendly and safer transport sector. With trucks driving in convoy (or "platooning"), the lack of a need for necessary breaks for the driver or the idea of hybrid trucks being supplied with electricity via overhead wires, revolutionary changes to the way long distance freight transport is managed and carried out are possible.

It is possible to imagine trucks like pearls on a chain using designated lanes, all traveling at a speed adapted to environmental needs (noise protection) until they leave the motorway at their respective destinations. Only the last few kilometres of the journey would be powered by their fossil fuel engines. In this way, transportation would become less energy consuming, less polluting, reduce noise and much safer. Like in the inner city or rural areas, the freight sector will also need the right investments in order to benefit from automation. Even more than with passenger traffic, freight transport is highly influenced by economic driving forces. Here, we find the economic model of constant growth as a beneficiary. This could lead to unwanted rebound effects, where a very efficient transport system exists but still does not gain ecological sustainability because it only triggers an increase in the use of transportation modes in general. Also, the currently increasing amount of consumers that prefer to "consume locally" and the development of more localised production (e.g. through the abilities of 3D printers) may result in a reduction in the use of transportation in the near future, as the demand long-distance journeys decreases. Society and policy makers will have to make a decision about what kind of future is desired and what mechanisms are necessary to steer carefully so that newly engineered technology will be used to ensure sustainability.

Key idea: Automated long distance freight transport can drastically increase the capacity of the highway network. Today, strategic transport planning foresees further highway building and enlarging capacity. However, it may not be necessary to build roads for the future based on the calculations used for transport volumes today. The potential effect of the use of autonomous vehicles on road capacity in the future provides a chance to re-calculate the infrastructure needs and possibly to reduce the amount of resources invested in highway network expansion.

CASE STUDY:

The Flying Carpet Feasibility Study – Hanzehogeschool Groningen

The Flying Carpet project aims to facilitate the implementation of autonomous vehicles between Groningen's city centre and Groningen airport. So far, a feasibility study has been carried out that investigates technical, legal and economic feasibility. The "Flying Carpet" aims to be an autonomous vehicle, transporting passengers from their car to the departure and arrival areas. Numerous fully working autonomous vehicle systems, like in Masdar City and at Schiphol Airport, have shown that passenger transport using autonomous vehicles is feasible. With such an on-demand service, sustainable and improved accessibility to Groningen airport would be created. The new technology will catch the attention of passengers, a highly desirable quality for advertisers. There is, of course, also the desire to reduce costs in the long-run and since fewer bus drivers in the shuttle service will be needed, the running costs will be reduced. The study has come to the conclusion that the "Flying Carpet" is legally feasible if safety is guaranteed. This includes operation in private areas, a speed limit of 5km/h, safety sensors, camera systems, dedicated lanes and certified traffic control systems. It is economical so far only as a "test lab" where supporting the development of technical/legal knowledge and marketing outweighs the financial criticism. The technical feasibility was proved to be the lowest obstacle as existing technology can be implemented.

Demonstration of CityMobil2 driverless minibus on street space in La Rochelle, France (March 2015).

CARE-North *plus* themes for implementing and integrating autonomous transport into society

The impact that automated vehicles could have on future mobility is very complex subject to consider, with many unpredictable variables. There are many risks associated with the implementation of such technologies and unforeseeable variables such as the impact on employment, the economy as a whole, the degree of acceptance among the public and so on. However, the automation of vehicles can also provide many benefits, such as the increased efficiency and manageability of transport, improved road safety and increased accessibility to mobility for disadvantaged groups (such as the elderly or physically handicapped) and the increased comfort that could make journeys more convenient, for example, because passengers are free to conduct other activities while being driven to their destination. However, to achieve the highest benefit for society, future technological inventions and their implementation must not be driven by monetary profits alone and a "business as usual" model cannot be condoned. Risks and consequences of these developments must be carefully weighed along with potential benefits.

Automated vehicles may become a part of daily life and no longer a part of science fiction in the nearer future than some expect, therefore, a framework for action for cities and regions and how these developments should be taken into consideration for future planning is required today. This framework should include the following:

Participants of the CARE-North plus workshop on the potential and risks of automated transport systems (January 2015).

Political and executive leadership,

especially covering:

• Legal framework for the use of autonomous vehicles

This is essential to make autonomous vehicles legal participants in traffic and to cover the question of liability in case of casualties or damage.

• Data security

Autonomous transport combined with smart mobility will create another sector with associated personal data. Misuse and data theft must be prevented.

Responsible and target-oriented investments

Reasoning for funding can no longer be based on predictions drawn from past statistics. Recent developments that may have great influence in the future must be considered.

Listen to actual consumer demands

Sometimes market regulations fail when the essential needs of consumers are exploited by industries that push products through aggressive marketing and advertising. To create cities with high living standards, real people's dreams and desires should be the template to create the city of the future.

Finding solutions for changes in affected occupational areas

Automation of transport will lead to a society built on services rather than labour. People that lose their jobs in the process (this effect of automation and the consequences for society and the economy must not be underestimated!) must be reinstated in similar or related roles or compensated accordingly.

CARE-North plus Partners:

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Contact

Free Hanseatic City of Bremen
Ministry of the Environment, Construction and Transportation
CARE-North plus Project Coordination

Contrescarpe 72
D 28195 Bremen

Der Senator für Umwelt, Bau und Verkehr

Freie Hansestadt Bremen

Michael Glotz-Richter
Phone +49.421.361.6703

Rebecca Karbaumer
Phone +49.421.361.59427

Hendrik Koch
Phone +49.421.361.10455

Fax +49.421.496.59427
Email: CARE-North@umwelt.bremen.de
Web : www.care-north.eu

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