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AUTONOMOUS VEHICLES: ACCEPTABILITY AND IMPACTS ON SOCIETY

PROCEEDINGS OF THE SEMINAR HELD
ON NOVEMBER 24, 2017

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D'AMÉNAGEMENT
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île de France

AUTONOMOUS VEHICLES

ACCEPTABILITY AND IMPACTS ON SOCIETY

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Note to the reader

The proceedings of the seminar are the retranscription of orally presented works. They are not a written production in any kind. This document is intended to reflect the rich presentations and exchanges which took place all morning.

Contents

Introduction

Autonomous vehicles are held to be the next shift in the automotive and mobility fields. By affecting the way we approach mobility, these vehicles are likely to have a broad spectrum of impacts on our society. For example, they are likely to reduce pollution and accidents on road and to redesign our urban landscapes by introducing new urban practices.

Still, many questions and hurdles pave the way to autonomous driving. They are technological challenges, but also regulatory, ethical, socio-economic and societal questions in the short and long terms, which need to be addressed in order to have a better understanding of that rising and global thematic.

The purpose of this seminar, held in the context of the European project H2020 CREATE, is to gather experts from different fields approaching these questions and challenges from different angles to fuel the debate.

PROGRAM OF THE SEMINAR
FRIDAY, NOVEMBER 24, 2017
15, RUE FALGUIERE, PARIS, 15TH ARRONDISSEMENT

MODERATORS
Charlotte Halpern, SciencesPo, Ecole urbaine
Tom Cohen, University College London

8h45
WELCOME AND OPENING ADDRESS
Sébastien Chambe, deputy CEO, IAU île-de-France
Dany Nguyen-Luong, director of the Mobility and Transport department, IAU île-de-France

9h10-10h40
GUEST SPEAKER SESSION
Paul Beauvallet, director of the Transport Pole at the Regional Council
Charlotte Halpern, SciencesPo, Ecole urbaine
Tom Cohen, University College London
Emmanuel Ravalet, researcher in mobility and transport, LaSUR, EPFL (Switzerland)
Jaâfar Berrada, PhD student in mobility and transport, LVMT/VEDECOM
Questions

10h40-10h50
COFFEE BREAK

10H50-12H30
PANEL SESSION
Clemence Cavoli, researcher in mobility and transport policies, UCL (UK)
Florent Anon, European projects manager, MOV'EO
Sina Nordhoff, researcher in behavioural science and cognitive psychology WZB Berlin (Germany)
William Payre, research in human factors and transport, Coventry Univesity (UK)
Questions

12h30
CLOSING REMARK

12h45
NETWORKING LUNCH

Welcome and opening address

Sébastien **CHAMBE**
Deputy CEO at the IAU

You are here in the biggest city planning agency in Europe. We are 220 people working in the fields of transport, of course, but also economics, housing, urban planning, health, security, sport… it's very diverse.
At the IAU, we work at the regional scale. That's important, because we are convinced that all the mobility issues should be considered at this scale, and not only the core of the agglomeration, but all the 12 million inhabitants who live in this area.
Today, we are gathered to speak about transport, mobility and more specifically autonomous vehicles.

Dany **NGUYEN-LUONG**
Director of the Departement of Mobility and Transport at the IAU

This conference is organised in the framework of a European project H2020, called CREATE and which topic is road congestion.
Today's topic is about acceptability and the wider impacts of autonomous vehicles. There was a recent survey in France about autonomous vehicles. One of the question was "Will you get into a driverless car, one day?" Most people answered "Yes, why not". And a second question was "Will you leave your kids get into a driverless car, one day?" The same people answered "No. Never!". That's why we have to think all together about the question of acceptability.

Guest speaker session

Paul BEAUVALLET, Director of the Transport Pole at the Regional Council of Ile-de-France

Transport in the Ile-de-France region faces two main issues. Over the long term, first; to remain environmentally sustainable, and second; to contain congestion.
We expect a sharp increase in the transport demand: the Government estimates it to a 15% increase by 2030 and a 30% increase by 2050. So we do many things to tackle this.

First of all we invest massively in railroads which is not our topic this morning but which is at the heart of the public policy in transport. We have invested more than 3 billion euros over five years to complete new metro lines, new tramways and new trains, let apart the "Grand Paris Express" project which is the biggest transport project in Paris, up to 30 billion euros in fifteen years. We invest in new trains as well. More than 700 trains for an investment of 10 billion euros over fifteen years. We invest in buses. By 2025 we have to renew every bus to be ecological: so electric, gas or hydrogen powered.

We do have a new approach to road infrastructure. Today, it still carries three quarters of the citizens of Ile-de-France. We adopted an "anti-congestion" plan that includes 200 million euros on works and 60 million euros on work innovation.

Because we do believe that there is much innovation in roads and in vehicles in the future years.
Actually we think that infrastructure itself will not be enough. We think that in spite of all these billion euros injected in the region, we will not be able to carry the 30% more people by 2050.

We anticipate an increase in congestion both in trains and on the roads. This is where autonomous vehicles might help.

There is still a reservoir of capacity in roads which are actually full of cars, but which are not full of people. We estimate that 1.2 people are in each car. With two or more people in each car, we could suppress every congestion now in Ile-de-France. And this is very important to us because it may not require all these billion euros of investment and it could be very powerful. But the whole question is: how? How do we change behaviours? How do we manage to put more people in every car? There, we need to understand how behaviours can change with autonomous vehicles as well. Because autonomous vehicles can change minds and the way people approach cars.

In that vein, many trials of autonomous vehicles are led in the Ile-de-France region. We had one on the bridge Charles-de-Gaulle in Paris. We currently have one in La Defense. Last week we inaugurated one in the Bois de Vincennes. There is also a project in Rambouillet and Rungis.
Now, all trials are based on the road traffic rules set up by the 1968 Vienna Convention. They can accommodate trials up to automation level 3 or 4, but not more. We don't have now level 5 trials which is full automation in a window of a real traffic. However users and wider public engagement are absent now in this development stage. These are mostly technical trials.

Apart from congestion, we also anticipate that improvement we call "inclusive mobility" for elder people, for disabled people, non-motorised people, etc.

Moreover, road safety will constitute maybe the primary benefit of the widespread use of automated vehicles. More than 1.2 million people are killed annually by road traffic incidents. And we may reduce them sharply with automated vehicles because more than 80% of them are because of human errors.

Other benefits may also include reduced energy consumption, improved air quality or better use of urban space because automated vehicles may be better shaped or better organized.
But now more uncertainties remain on the impacts of travel behaviour, car-sharing, travel time use. There are a lot of research on technical aspects, but less attention for behavioural issues now. So this is why understanding the attitudes, the behaviour and wider public acceptability of transport users will be critical to the success of this technology. It's vital that transport users, stakeholders and the wider public are at the heart of the design, development and deployment of automated vehicles.

Today we are interested in three topics: first of all, mobility impacts. Will AVs influence travel behaviour? How will it change travel time? Maybe will it change the value of time, itself? We observe what we call "a peak car" which is a reduction of car mobility in the dense areas now. Will automated vehicles change this? Will this imply a reduction of individual vehicles? Or maybe an increase? 95% of the time a car is parked, what impacts will it have on congestion? What will be the impacts on the deployment of parking lots? Will it change with automated vehicles? So we have to look into the demand side to assess the supply side more accordingly.

The second issue is the institutional impacts: what are the institutional aspects challenged by the deployment of AVs, especially for us, local authorities.

The third and final item is business impacts. Because business will also benefit through AVs: insurance companies, car manufacturers, logistics, all of these will be impacted by AVs. So all of this will lead to many scenarios (which are the key scenarios) required to encourage the deployment of AVs. What are the users' cases of AVs?

Charlotte HALPERN
Associate research professor at the Centre for European Studies and Comparative Politics, Sciences Po, Paris

I will introduce briefly the CREATE project, in order to put our discussion today about automated vehicles in the context of the work we have been doing so far with our partners. The CREATE project is an EU-funded project, under the Horizon 2020 programme. It is about congestion reduction in Europe. It is also a project for and with cities and regions in Europe. Five Western European metropolises are members of the CREATE consortium. The Ile-de-France region

represented by IAU is one of them, together with London, represented by Transport for London, Copenhagen, Berlin and Vienna. Five cities from Eastern and Mediterranean Europe, namely Tallinn, Bucharest, Skopje, Adana and Amman, are also part of the project. In total the CREATE project brings together 17 partners coming from 11 countries in Europe.

Our main objective in this project is to avoid repeating the mistakes from the past, in terms of the role that has been attributed to cars in cities. We want to learn from these past experiences in order to think about how to plan and develop urban transport in the future. Another way to formulate these objectives, is to quote Sorin Chirita, City Manager in the Bucharest, one of our CREATE partners, who made it clear during our last event in Bucharest, that his city "did not have the time to repeat the mistakes of the past". And another CREATE partners, Laurie Pickup from Vectos in London, also reminded us of the following quote by a very famous non-mobility related person, Albert Einstein, who said "We cannot solve today's problems using the mindset that created them".

In brief, CREATE analysed why and how these cities started thinking differently about mobility. This shift is very much the result of an evolutionary approach, which we documented precisely over time by looking at transport behaviours and policies across five Western European cities.
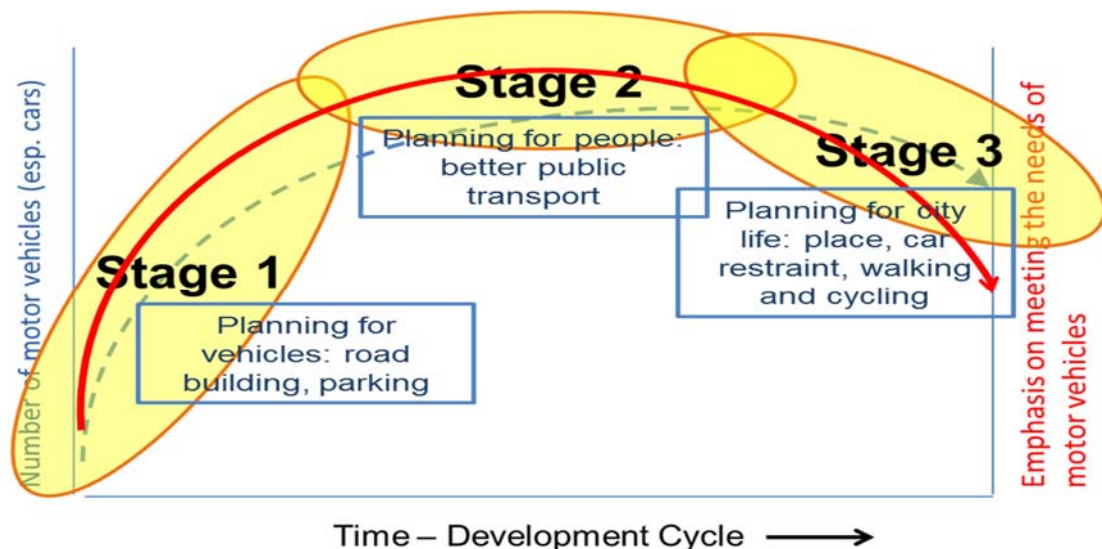
Source: Charlotte Halpern's presentation

We departed from the following assumption: in a number of cities in Europe, the following evolution took place: during the 1950s, there was a "first stage" during which cities mostly tried to plan for vehicles: developing and building road infrastructures, parking and making more roadspace available for cars. We can see many examples of this "planning for vehicles" type of thinking in Paris and the Ile-de-France region, such as the Boulevard Périphérique for example.

In all of our cities, this led to some demonstrations, strikes, and demands related to safety, noise pollution and the dismantling of old neighborhoods. This turning point, which very much is the situation we now observe in the Eastern and Mediterranean cities that are part of CREATE, highlighted the negative impact of car use. It fostered the development of a "stage 2" type of policies, in which transport is increasingly about mitigating car traffic, and mostly by developing public transport alternatives. And most of the western European cities in CREATE already had pre-existing public transport networks which were considerably enhanced ever since.

As part of CREATE activities with our partner EUROCITIES, we have seen some similar developments taking place in a number of cities across Europe, not just the very large ones, but also medium-sized cities which

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invested and developed public transport alternatives, favoured an integrated between transport modes, and planned a number of services around it.

Finally, in the five western European cities in CREATE, in Paris and the Ile-de-France region, in Copenhagen, Berlin, Vienna, and London, we've also witnessed the development of a "stage 3" type of transport policies in which transport is more and more about planning for city life. What does it mean?

Transport is not only justified anymore in the name of economic development, of the city's need to modernize, it's not only about moving flows and moving people around, but more and more as a contribution to city life, to wellbeing in these cities and in these regions. Transport and mobility planning is considered instrumental in better organizing the way through which cities are planned, with a growing focus on place-making, on walking, on cycling, on new softer modes of mobility.

Amount of space required to transport the same number of passengers by car, bus or bicycle.

Car?   Bus?   Bicycle?

(Poster in city of Muenster Planning Office, August 2001)
Credit: Press-Office City of Münster, Germany

Source: Charlotte Halpern's presentation

By now, most of you must be wondering about the next steps in this evolution. What is coming next? What would possibly be considered a 'stage 4' type of policy? This is a hotly debated topic in all our cities and in CREATE, and parts of the answer has been to organize workshops such as the one convened today by IAU with Tom Cohen (UCL) about automated vehicles in order to start thinking about possible futures in transport.

But for the vast majority of cities in Europe, including our Eastern and Mediterranean cities in CREATE, and for a number of cities located in the periphery of large metropolitan areas, the key issue is not just about "Stage 4", it is also about whether or not this learning process could be short-circuited. Most of these cities are still very much planning for cars, or at best, seeking to mitigate the negative impact of car traffic, and they are looking for ways to avoid the mistakes from the past.

So coming back to the question "What is stage 4?", what can we learn from the past?

The work done in CREATE shows that car use reduction was achieved by shifting priorities, by adding successive layers of transport policies and developing a more integrated approach to plan and develop transport, by combining a large diversity of transport solutions, in which road infrastructures and cars are only considered one possible solution among others. In this multi-layered context, some elements of stage 4 types of policies already are visible, with a growing focus on technologies, of course but also governance, on forms of coordination and some controversies about how to include the platform economy.

In all our CREATE cities, transport developments also raised major governance issues, in terms of defining collective goals, ensuring coordination between the public and the private, between levels of government and so on. In all these cities, the challenge now is to expand those transport developments that have been taking place in the urban core towards the periphery, to reduce socio-spatial

inequalities related to transport and mobility, and to adapt these policy solutions to areas with lower levels of density. And over time, in all these cities, transport developments were strongly related to capacity-building and developing additional capabilities at city or at region level.

As a conclusive remark, I would argue that the work done in CREATE suggests that there will always be new technologies in transport, such as automated vehicles, but the big challenge for our societies in Europe today is how to regulate them, how to integrate them in old urban environments, how to avoid them becoming a factor of new or growing inequalities. This is very much the debate we're now having as part of the CREATE project and the focus of today's workshop.

Tom COHEN
Senior Research Associate, Centre for Transport Studies - University College London, UK

The term "automated vehicles" can mean different things to different people. And, in order to have a meaningful conversation today about AVs, it is necessary to agree on meanings. In English, things are made more complex because both "autonomous" and "automated" are used. For the sake of clarity, a shared understand of this and associated terms is needed. This is helpfully done by using three axes: connectedness, automation and autonomy/control.
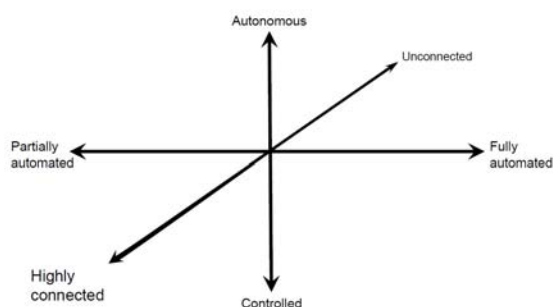
Source: Tom Cohen's presentation

Some vehicles are "unconnected". They travel through the network without communicating with either other vehicles or the static infrastructure. In contrast, there are some vehicles that are highly connected and they communicate extensively with fixed infrastructure and, to an extent, with other vehicles. Hence the concept of a "connected vehicle". A connected vehicle may still be entirely in the control of a human driver but this driver may be benefitting from information collected by the vehicle, such as downstream traffic conditions. But, as the driving task becomes automated, connected vehicles are widely thought to promise safety and other advantages over their unconnected equivalents.

"Automation" is the term used in English to describe whether the vehicle can carry out the driving task. This is widely explained using the SAE levels 0 to 5. A vehicle may be partially automated, in which case it can perform some of the driving task(s). There are partially automated vehicles on the network today: this is seen in adaptive cruise control, automated parking,
 etc. But a "fully automated vehicle" is one that can perform the driving task in its entirety across the transport network. If this is some way off, a "Level 4" vehicle is perhaps a more realistic prospect, being a vehicle that can carry out the entire driving task in certain defined parts of the network, outside of which some human intervention will be necessary.

Finally "autonomy". This is the least widely used of the three concepts. An autonomous vehicle makes its own decisions. It gathers information about its environment and makes a journey through the network accordingly. A fully autonomous vehicle may be unconnected, in that it is not communicating actively with the static infrastructure or with any other vehicle.
At the other end is a vehicle which we shall describe as "controlled". This is best illustrated by thinking of air traffic control: the pilot of a civil aircraft states the destination and desired travel time and then is assigned a flight path. That path is calculated with reference to the travel demands of the various other aircraft in the area. The autonomy/control axis is important to thinking about automated vehicles because it is quite possible that the collected decisions of a number of "autonomous" automated vehicles could lead to significant congestion.If many

vehicles have similar origins and destinations but are not communicating with each other or receiving instructions from a central control, they may converge on a single "optimal" route with unfortunate consequences. But the current narrative about automated vehicles does not include much discussion of the "controlled" model of operation; rather, the prevailing assumption seems to be that automated vehicles will use the network in much the same way as manually driven vehicles do today.

Download Tom COHEN'S presentation

Emmanuel RAVALET, Researcher in Mobility and Transport, Mobil'homme, LaSUR (Urban Sociology Laboratory), EPFL ENAC, Lausanne, Switzerland

Working on the future and working on prospective works is very difficult and can be tricky. Through my engineering background, and even more my research background, I've learned to prove with scientific methods, with precise data what I'm demonstrating. It's not really the case here, but I will try to be the more objective as possible. So prospective work necessitates specific methods. And I would like to add that it necessitates probably modesty and working with the DOT to stay as objective as possible.

The sources of my presentation come from several recent researches we made in laboratory of urban sociology of EPFL and with the consulting firm I created two years ago with Vincent Kaufmann and Stéphanie Vincent-Geslin, which is named Mobil'homme. So these researches were financed by two car manufacturers, a French one, Renault and a Japanese one, Toyota, two railway operators in France and in

Switzerland, and one bus transport operator in Switzerland.

Part of these researches are directly aimed at studying autonomous vehicles or autonomous cars. Some of our prospective works concern the future of mobility (in general) and territories in which autonomous cars have a very important part of course. And even if the subject was large, at the end of the research, each time we met our partners to present a result, the major part of the discussion concerned autonomous vehicles. Concerning the resources, they are more precisely literature review, creativity workshops, interviews with experts, etc.

After that brief introduction, let's talk about the SAE levels. You probably know these levels but it's important to present them because it just allows us to precise the conditions for these vehicles to circulate. I won't come back on each and every one of them, but just to say two things according to experts. Level 4 vehicles are not far from circulating on roads, they even may be coming this year. But level 5 vehicles won't come before 2040 or 2060 depending on the experts consulted.

So there is time. And my point this morning is to say that it is a chance to have that time because we are not ready. And when I say "we", it concerns politicians, researchers, planners, pretty much everybody. I propose to start assessing the effect of the level of autonomy driving to talk a little about autonomous driving in public transport. Level 3 or level 4 autonomy technology is sufficient to allow such vehicles to circulate. Automatic subways, for example, as they circulate in closed environment, are easier to implement. Some metro lines are already automated all around the world. For train, trams or buses it is of course a little bit more complicated. But if they are supposed to circulate on support lanes it can also be implemented much earlier than autonomous cars.

So what opportunities are linked with autonomous driving in public transport? It can allow more flexibility and reactivity in operational processes. It can facilitate an increase in the frequencies, and can also help limiting emergency brakes, which is a way to ensure more comfort for passengers and less use of energy. And such an innovation finally is an operational innovation to improve the offer, but on the demand side it doesn't

change many things. It makes no real difference.

On an urban planning point of view I think this is good news because the efficiency of public transport is very important of course and especially when we want to articulate urbanism with transport planning, or making a transport oriented development.

On the left, a temporary shuttle stop post. The shuttle is functioning as a regular service, serving each stop.
© Cédric Cariou

On the right, the SmartShuttle, a Navya autonomous shuttle tested by CarPostal in the historical centre of the city of Sion. (Switzerland).
© Cédric Cariou

Autonomous shuttles are vehicles that we can already observe now, quite everywhere: in France, in Switzerland, everywhere in Europe or North American cities. You can see them in Sion, in Switzerland for example. What is especially interesting in Sion is that the journey is long and difficult, and it's quite impressive: the shuttle circulates through narrow places and streets, with the traffic etc.

This kind of offer can of course complete the public transport in places where offer doesn't exist or in time period too expensive to operate with a conventional public transport vehicle. We can also think about the 'last mile' offer. Autonomous shuttles could replace in the future services like "on demand" services, which sometimes are very expensive. We could for example imagine in some suburban neighborhoods, autonomous shuttle services to join a mass public transport network.

Autonomous shuttles can be especially adapted for people with disabilities or reduced mobility. But these few elements allow us to see that, to my mind, and, in link with what we've heard with the experts we met, autonomous shuttles are relevant as transport service only in some specific areas,

only at certain time period, only for certain persons. It's not something that should be generalised. And I think there is a risk to see such shuttles to be generalised because every city will want to have its own shuttle and there's a risk that such vehicles will replace, for example, walking trips.

Public transport autonomous vehicles can play an interesting role in the near future, by making sure to articulate new services with the previous offer. There is a need to equip pathways to allow such vehicles to circulate. And I think it gives to public authorities a very interesting power to orientate and to impose a specific use of equipped pathways and of equipped roads. This question is far more urgent than the question of autonomous cars that will appear after public transport autonomous vehicles, because these vehicles can circulate with the technological autonomy level 4, and not 5 for cars.

Let's now talk about autonomous cars. When we listen to somebody talking about autonomous cars, quite often, you will see that people make a link between autonomous cars and shared services. I will make my presentation in two parts. The first one will be:

perhaps autonomous cars will be shared? So what would be the consequences? The second part of my presentation will be about non-shared autonomous cars. As a matter of fact, we tend to be optimistic concerning the possibility of autonomous cars to be shared, because of the development of shared services not only in the transport field, but also in other fields. And in this configuration, using autonomous cars is very interesting for many reasons. Especially to better organise the vehicle fleets. We know that the time spent by conventional cars parked and non-used is quite high, around 90 percent of the time, and sharing vehicles tend to allow limiting this time and one shared vehicle replace several non-shared cars. With autonomous cars in shared services, the possibility to develop large scale autonomous shared service could free an impressive amount of space dedicated today, to parking places.

In city centres, for example, this opportunity could allow planners to transform these areas to green, public spaces or else. It's something quite important. But articulating a car-shared service with a transport public offer is not as obvious as we could imagine. We worked on this specific thematic with the city of Grenoble and it appeared very difficult to organise or to think about how to organise services that would not be used, for example, to travel from A to B, if there is a bus or metro line to make the same trip. Let's ask to somebody what characteristics, what features the car-shared service should have: the answers correspond exactly to what is a car.

People want a flexible, fast, and convenient service. Something they can use when they want, where they want etc. That's a car! So it's very difficult to think: okay, we want to develop a car-sharing service but we don't want this car-sharing service to replace public transport services that we already have and that we don't want to lose. Some experiments are needed to work especially on the way to organise together car-sharing services with a classic public transport service and not only experiment on autonomous shuttles. In fact I have to say I'm not sure that autonomous cars will be shared.

Autonomous cars could also not be shared. It will depend on many things of course. It would depend on the price: car manufacturers can't sell such cars if it's very expensive. We

can imagine a private person couldn't afford this kind of cars or a very little proportion of the population only. But if it's not the case, I'm not sure people will choose using such vehicles only in shared services, and I think that's important. It makes me being cautious on the perspective of necessary shared fleets. At this date, even if efforts are made, car manufacturers know how to sell cars but they don't really know how to sell mobility services. Many improvements have to be done.

What could be the consequences of the development of an important individual autonomous cars fleet of level 5 autonomy? The first thing would be to sweep parking policies. There is no need to park the car anymore. So the effects of such policies become irrelevant. Pricing policies, regulation policies of parking would not be efficient anymore as car could be in level 5, find a place elsewhere, and if necessary they could come back home during the day and make the trip in the evening to fetch the owner of the vehicle. That leads to the second effect, which is that the average occupancy rate could decrease. It could even decrease below one person per vehicle. That's quite worrying, even if the vehicle is electric, I'm not sure that this is good news for the environment to have cars circulating empty. An autonomous car takes the same place as a conventional car. So in terms of space consumption, this is not good news of course.

And last but not least, autonomous cars allow freeing some travel time. But let me remind here what Jacob Zahavi demonstrated in the 1980s. He said that, thanks to important investments in public and private transport services we can now travel faster than before. But what people decided to make with the freed time? Working, sleeping, playing games? No, they decided to travel more. So time they earned was reinvested in distance. That's what we call "la conjecture de Zahavi" in French. So autonomous cars would generate in this case a big induced traffic. That is what I may call "Zahavi 2.0".

What can we do? In this presentation I don't want to say that we have to avoid autonomous vehicles as much as possible. It's not at all my point of view. But I argue in favour of a regulation of autonomous vehicles. I argue against any technological illusion or any blindness induced by a fascination of

innovation, even if I was fascinated when I first got into an autonomous shuttle. I think it would be easier to find a solution in urban areas, perhaps if we decide to seriously work on it. Individual cars for example could be banned.

We could imagine a tax, or largely tax individual cars to avoid them in these areas and users impose to use public transport or shared autonomous cars. But it's more complicated in rural areas.

Autonomous car-sharing services are less relevant in rural areas. Too many people at the same time in the morning to go from home to work and evening to come back, and not enough in the rest of the day. For the moment I consider that matter as something very difficult to develop, something that could be sort of "shared-car pooling services".

So autonomous vehicles have to be organised to complete a public transport. Considering what I've heard and understood on autonomous vehicles, public transport will continue to shape our territories. Mass public transports are important. They have a role in our cities and we have to avoid this role to be spoiled.

Download. RAVALET's presentation

There are many expectations associated with autonomous cars, especially the fact that they could become a shared mode of transport. But autonomous cars could also be not shared… Both models imply different impacts. Source : Marc van der Chijs, google.com/selfdrivingcar/where/

Tom COHEN
This presentation of the possible advantages and disadvantages of AVs echoes a piece of work by the International Transport Forum (OECD International Transport Forum, 2015)[1], where they imagine the future of shared *vs* personally-used AVs in Lisbon. The study

concluded that, if everyone shared, there would be a significant reduction in the number of vehicles in the fleet. This points to the need for society to decide what it wants from automated vehicles and for governance to be designed accordingly.

[1] OECD International Transport Forum (2015) Urban Mobility System Upgrade. How shared self-driving cars could change city traffic. Paris: OECD. Available at: http://www.itf-

oecd.org/sites/default/files/docs/15cpb_self-drivingcars.pdf (Accessed: 28 February 2017).

Jaâfar BERRADA
PhD student in mobility and transport,
LVMT/VEDECOM

I will talk about Modelling Transport Systems involving autonomous vehicles. And I will present some results from other existing studies. We observe, today, an emergence of autonomous cars and hundreds of kilometres have been travelled by AVs as tests. Also, several operating companies have joined the quest to build the perfect autonomous cars' systems in parallel of car makers, and governments of developed countries that have engaged policies to deploy AVs.

As a result, several research topics have emerged and have been motivated by this background related to (1) the social and urban impacts of the deployment of AVs, (2) the commercial success of business models based on AVs and (3) the coexistence of AV-based services with existing modes. The objective of my presentation today is to propose a classification of services based on AVs which are more some use cases based on existent methodology.

Then I will present the developed models briefly. And I will finish by the findings of these models. Let's start by the different categories of business models based on AVs. There are two types of existing models: the spatial or geographic models which are based on the technical performances of AVs and simulation/ socioeconomic models which are based on the interaction between AVs and users.

There is a classification of product-service systems applied to autonomous vehicles. From left to right we have business models based on the pure product where the value is mainly in product content and in the right the model based on the service where the value is mainly in the service content. And between the two of them we have business models which are based just on the use of the service or of the product. To be clearer I will present each one. I'll present some examples.

Categories of business models based on AVs

Based on the product Value mainly in product content	Based on the use/ function of the product or service Value mainly in the use of the product (product-service systems)			Based on the service Value mainly in service content
	Product content (tangible)	Service content (intangible)		
Pure Product	A: Product-oriented	B: Use-oriented	C: Results oriented	Pure services
Selling products	1. Services oriented to AV	1. Renting/ Leasing	1. Activities management	Selling services
Autonomous vehicles (AV)	Maintenance and repair	Maintenance and repair of the provided product	Fleet management	Public transit
Equipments of AV	Consumables (batteries..)	Individual access without ownership	Parking places optimization	Goods deliveries
Software / models	Taking-back (end-of-life)		Charging stations	Feasability studies...
	2. Advices	2. ¨Product sharing	2. Fonctional results	
	Efficient utilization	Maintenance and repair of the provided product ensured	Parking places availability	
	Adaptation to the context	Shared use of the product at the same time	Charged vehicles availability	
	Operating standards		Reliability of the system	

The business models based on the product are the classical business models where the supplier produces AVs and/or fare AVs. To be more general, the supplier sells products. The economic profitability depends only on the number of unit produced and on the cost of the unit. For example it could consist on selling autonomous vehicles or selling automotive parts of AVs and/or to develop software or simulation models and to sell it.

For business models based on the services, the operator or the supplier provides the service without any transfer of the ownership between the two. And for example that could be the transport of persons, the transport of goods, training, feasibility studies, and so on. Between these two, there are business models based on the use of the product or the service that depend on the presence of the product and the service. When the product is more present we have the product-oriented service and when the service is stronger, the result-oriented service. Between the two, we have the use-oriented service, which optimises the use of the product by an assessment of its function:

- For product-oriented service: the producer gives the product and also additional services or advice, which are required to the use of the products efficiently: for example, maintenance and repair, or advice for efficient utilisation.
- For use-oriented service there are two main categories: renting the product, or sharing it. For the two, the customer uses the product but doesn't own the product. And it's the supplier who is responsible of maintenance and repair.
- And finally for the result-oriented service. It can take place *eg* for outsourcing or to be engaged to ensure some functional results.

At VEDECOM we focus on the transport of people: autonomous car-sharing and non-shared autonomous vehicles. And we already started studying the transport of people as autonomous taxis and developing simulation tools to evaluate the impacts of models. As we are in inter-development, I will present the results of existing models, not our results. So a spatial model which is now well-known is the model of Fagnant and Kockelman which was presented three years ago and redeveloped then by other authors, and it

goes through several modules that takes into account several parameters that includes:

- A population generation: population is distributed along the territory depending on the existing density.
- Trips assignment (where each person goes) and the vehicle generation, depending on the trips' assignment and the population concentration.
- Vehicles movement, a module which depends on the constraints of the model and the constraints of the area.
- And, finally, a strategy of vehicles relocation aiming to optimise the fleet management.

That is the first version of the model, it was then developed by others. These evolutions were made to consider, for example, electric infrastructure and charging strategies, to consider users incomes, ridesharing strategies and also parking with different pricing strategies.

The second type of models are socioeconomic models. For socioeconomic models, there are two types of papers: technical studies and scientific papers. For scientific papers there are papers based on users' preferences, also papers based on mathematical estimation. Here I will present some results for market penetration. For some references, the results show that the penetration is estimated for 2050 or 2040. We see that it depends of the companies: one puts some target here, another puts some target there, and it's revised and changes continuously. Looking for the market saturation, scientific papers consider that the market saturation will be reached by 2060.

Concerning the results of users' preferences (potential customers): some papers think that autonomous vehicles would be more interesting for elderly people and people with disabilities, while more papers think that it's younger people who are more inclined to use technology and in particular AVs. Also, studies show that men will be more incline to use AVs as well as non-motorised people. And finally that it will be used more in urban areas and by people with higher incomes. About production costs: more studies are needed. For investment costs that I explored (estimated in the United States context), the purchase cost of AVs will be about $24,000-25,000 by 2025. While when I studied mobility in Singapore, they proposed another

estimation as we see. It's also related to the territory and to the local costs. About operating and maintenance costs, they vary from $0.2/km to $0.6/km.

To finish I will present the impacts of shared autonomous vehicles. They are the results of a lot of studies, led all around the globe. I will present the results for four types of impacts: mobility impacts, urban parking, accidents and environmental impacts.

Concerning the mobility impacts, the fleet size is reduced by 75% to 90% for a majority of studies, while the vehicle-kilometres travelled increase by 7% to 20%. So there is a really big issue about congestion. Will it really reduce the congestion? It is a big question and it's difficult to answer it for now.

For the urban parking, studies show that it is closely dependent on the market penetration. So if the market penetration is important, for example, if about 90% of all vehicles are autonomous, the space savings are interesting but when the fleet is not really big the space savings are not really interesting. Also there are suggestions to move parking to less dense areas. That suggests that will save more space in urban areas.

About accidents, there are no real simulation studies, but all say that technology could reduce accidents, that there will be more safety because most crashes are caused by the driver.

And finally about environmental impacts, we say that the fleet size will be reduced, so the pollution also will be reduced. As the vehicle will be more used the lifespan will be shortened, and they would be about one to three years, so that will allow changing vehicles, so have a better performance of the vehicles over the years.

And sharing vehicles will save about 5% of energy, but electric vehicles imply also high demand for electricity.

To conclude there are different forms of services based on AVs. Existing models focus on shared autonomous vehicles, which is the pure services type. They focus mainly on the supply operations without detailing the demand side. More detailed studies are required on the demand inclination and adoption, which is part of my work at

VEDECOM, and the urban and social impacts of AVs could be promising but we have to prove it yet.

Tom COHEN
More research is needed and this will be the case for automated vehicles for some time to come.
There is a question about whether automation will arise more from the world of the private car or more from the world of collective transport, with very significant consequences. Jaafar's initial comments about his modelling sounded like, on the one hand, *mobility as a service* to great extent and, on the other hand, the car manufacturers building these vehicles for individual owners as users. This could very much influence how the market develops.

Question and answer session with the audience

William PAYRE, Coventry University, Researcher
Actually I'm a bit curious about some of the slides you presented about the benefits of the so-called "autonomous vehicles". What about these benefits?

Jaâfar BERRADA
About these benefits, there is congestion, we don't know if it is going to be beneficial or not, and there is space saving which are the two biggest concerns. Some studies argue that, depending on the penetration of autonomous cars on the market, this could be beneficial or not. For now, some studies say that there are many benefits for urban planning, for the social impacts and for the safety etc. But as I said it's really linked to the penetration of autonomous cars, if it's "all autonomous" or not.

William PAYRE
Can we say that these benefits are, nowadays, still assumptions?

Jaâfar BERRADA
Yes.

Tom COHEN
Paul, do you feel as if you heard things which give you more confidence or give you cause for concern with regard to the future of automation?

Paul BEAUVALLET
Actually we heard both: pretty much bad news on one side and better news on the other side. We may expect lower occupancies on one hand, and higher traffic on the other for example. So basically we have the both sides of the same coin. I think that the research has to progress a bit further, because actually we don't really know what will happen.

Alain SAUVANT, Professor at École des Ponts Paritech (ENPC)
My question is about whether we have automatic benefits? Because, we could have also a lot of extra cars, a lot of empty cars as it was already said. What hasn't been modelled very much when I look at the detailed models that were published by ITS (OECD) on Lisbon or Helsinki recently is the role of the public authorities at both central or local levels, which probably will decide one way or the other, by instruments such as taxes, regulations and this sort of things. And we could have potentially, different models, in different countries, in different cities, just as the same way as we have different styles of driving, if we go in Switzerland or the South of Italy with the same cars, the same technology, but you can tell if you are in one country or the other quite easily. So maybe it's a feed for your research: what will central, local, regional bodies offer and how they can navigate with all these things so we can get more benefits than drawbacks?

Emmanuel RAVALET
Perhaps some elements. I'm not a specialist of that specific matter, but I think of course it will depend on what we want to do exactly. If we want to organise a car-sharing service it does concern the local authorities. But it's not something obvious. What do we want? Do we want a free-floating service? Do we want a station-based service? How do we articulate it with public transport services, etc.? So, it's a first point that, to my mind, concerns the local authorities and the place they want to give to autonomous cars in a sharing service. Today there are many other questions that concern the legal aspects, about the possibility that is given or not to circulate empty: we can imagine that autonomous cars with somebody in the vehicle is very different, because an autonomous car has the possibility to travel empty. So that is perhaps another question that concerns national authorities. But it's just, of course, a beginning of answer. I'm aware that it's very complicated and we have to articulate such different scales of governance.

Jaâfar BERRADA
I agree with you. Every region and every country will have its own policy and it's really dependent on the type of policy: policy of parking, policy of fleet management. If you prefer that vehicles run empty or search a parking. Also will there be a provided parking for these vehicles or will they choose just to let them run empty? That changes everything for the configuration of the urban planning. So it's a big issue. It depends on each configuration of the urban constraints. I presented some simulation's results for specific cities in the United States. And of course it's not the same thing for every country and every city.

Tom COHEN
So it would be fair to say that most jurisdictions are working at the moment to enable the development and the trialling of this technology and less on these downstream questions. So perhaps one of the things we can usefully do today is remind everyone in government that it is one thing to make the technology happen and another to make it happen successfully from the city's perspective.

David BÉTAILLE, IFSTTAR
I'm working on the issue of localisation for transport. We are projecting very far in the future in this discussion. Is there a step in-between? Can we imagine that the process will be "learning by doing", and what are your point of view about cooperative ITS (Cooperative Intelligent Transport Systems), "cooperative driving assistance", not only for car drivers, but also for truck drivers? Do you have also a measure about the reduction of accidents, or incidents, that automation would bring in this loop in this global system? Because we know that part of the congestion is due to accidents and incidents. Could those feared events be reduced, if, in a way or another, we put intelligence in the system? "Learning by doing", that is to say trying to define maybe more global "steps" in between today and 2060. Of course at different scales, I guess, not only technical, but also political.

"Self-driving car technology creates an opportunity to change, or at least to question the [relationship between pedestrians, cyclists and motorised vehicles]" (Gareth Sumner, TFL). This could change the way cities are shaped.
© Paul Lecroart / IAU 2018

Emmanuel RAVALET
Just a little reaction. I agree with you that working step by step is important. Because we know that in the next few years, perhaps in 10 or 20 years, we'll have part of the fleet that will be automated, and a part which won't be automated. So we can imagine that automated vehicles allow less accidents because they can communicate between them and with the infrastructure.

But what will be the reaction of "humans"? Our reaction with automated vehicles around us? So in this case, what will be the consequences on accidents? Perhaps these elements would be useful to think about in order to build "steps", "to test" many things, and perhaps we will define after each step what to do, how to react, how to allow certain things or not, etc.

Jean-François JANIN, URBA 2000

A question for Jaâfar especially. You do mention "social acceptance", "social impact" of the different scenarios, but you didn't describe any means to measure employment that could be created or destroyed by those scenarios.

Do you accept the hypothesis that automated vehicles will destroy employment? Could it be likely that some of the scenarios could create employment?

Jaâfar BERRADA

A good question. I don't have the answer. I didn't investigate about jobs and "employment". It's really interesting.

Tom COHEN

It is fair to say that more generally there's an on-going debate about automation and its impacts on the economy.

There are enthusiasts who say we have lived through industrial revolutions before: there is a change, a period of transition, and then things settle down into a new order. This will be just another of those.

Then there is the more pessimistic view that large proportions of the population will be workless.

Jaâfar BERRADA

The models I'm working on are just simulation models. It's more the impact on mobility, more than the impact on the global economy of the cities. But it's a good question!

Veronica REYNOLDS, Vectos

I just want to know to what extent the panel "agree or disagree" with the point made earlier that we need some governance (if we are to avoid the situation outlined earlier that we could end up with vehicle occupancy rates of <1).

Perhaps the main driver will be economic forces: the fact may be that transport will become so affordable, and personal car use is declining in many cities anyway.

Do you think that the need for governance will be overridden by the fact that market forces will be the main driver for change?

This and high levels of adoption of (these mass transit AVs) would be such that we won't really be in a situation of vehicles having an occupancy of less than one because mass transit in autonomous vehicles becomes an increasingly cheap way of moving around and much more desirable than spending money on a car.

Tom COHEN

We may therefore not need governance because the market will sort it out.

Alexandre SANTACREU, ITF (OECD)

My biggest fear with autonomous vehicles is that they bring more traffic on the streets: not only will people travel longer distances more comfortably, we can also fear that vehicles will run empty. By the way, there are already empty vehicles nowadays, taxis roaming for customers on the streets. The use of the vehicle is "zero". So that exists already. My question is what could we do to prevent excessive use and additional mileage? Is it road pricing? It's not very popular. Does the panel believe there are other options than road pricing or should we get ready for road pricing? And London has road pricing, but it's per day, which doesn't prevent a vehicle from roaming. Would we need to charge vehicles per kilometre or per minute?

Tom COHEN

So the unpalatable prospect of road user charging, which hasn't been popular so far as a transport policy. Any prospect of it in the Ile-de-France region, Paul?

Paul BEAUVALLET

Not yet. Actually congestion is already a charge. We already have that kind of phenomenon we just have to model it: why do you take the RER instead of your car? Just because it takes too long with the car, because it is congested. And if you relate money to time you spend in traffic, you already have a strong toll. So I think we can include this in current models just to understand how it works now, which is a point to us, if we mean to lower the congestion. Actually the mechanism puts more cars on the roads, because if we see congestion as a process you can't aim at suppressing congestion itself because it's part of the mechanism.

Emmanuel RAVALET

I agree with that, and I just think about what would be the consequences of the freed time. That is to say, you can use it doing something else when you're in a traffic jam. You can work as if you are already in your workplace because you're connected with your team and working is possible. So it's not a problem to be stuck 3 hours on the roads: because you can make a use of that time. You are not at home or else, but, it's quite nice, quite

comfortable, so not a problem. Perhaps you will be 3-4 hours at the office during the day and the rest of the day you'll be between your home and the office. Of course it's pessimistic! It's voluntarily pessimistic but it is to illustrate that the problem with traffic jams is just about the time lost and the uncertainty (concerning when you will arrive), but if you use your travel time differently, the problem is totally different. So I think we have to think about how to regulate and to try to avoid people using their car and travel just when, where and how they want. And it's of course on a political point of view very difficult, but I think it's very important to consider travelling as a cost. "Price and space" and it has to be consider.

There will always be new technologies in transport, such as automated cars, but the big challenge for our societies in Europe today is how to regulate them, how to integrate them in old urban environments, how to avoid them becoming a factor of new or growing inequalities.? (Charlotte Halpern, SciencesPo, Paris) © Paul Lecroart, IAU 2018

Charlotte HALPERN
I have heard two interesting points in your questions, which we may investigate further in relationship to the urban dimension of automated vehicles. Jaafar mentioned that we could see more of these automated vehicles being sent to park somewhere else, outside very busy cities.

One of the findings from the CREATE project is not to further differentiate or create new inequalities between very dense urban centres and their peripheries. I'm certain that municipalities at the fringes of metropolises' areas won't be too thrilled at the idea of becoming massive parking areas for automated vehicles that would then travel back to city centres in the morning in order to take in new passengers. And a second point, to answer Veronika. Drawing on the work we did in the CREATE project, it won't just be market forces driving the process, it could

also be public authorities seeking to brand their cities as a haven for automated vehicles or whatever new technology might be introduced in the future. However in terms of governance, the introduction of automated vehicles also means the arrival of new actors, new entrants in this market, it will, very probably, disrupt current arrangements and create new needs for coordination.

Panel Session

Clémence CAVOLI
Researcher in mobility and transport policies, UCL, UK

"What are automated vehicles (AVs)?": Well, essentially, they are technological tools that we, human beings, are developing to serve our needs.
Now this leads to another question which is "Why are we developing those tools? Who is developing those tools? And what for?" That is when things get a little bit more complicated. Essentially it looks like different groups of people, different entities, are developing those technological tools for different reasons. So we see that there seems to be different drivers.

Somewhere between 20 or 30 years ago those tools started to be developed by military forces. The objective for them was to improve their military operations to create better vehicles, better weapons, and better tools for military operations. Then academic institutions and private entities started thinking about the potential of those technological tools in different contexts. That is when technology companies entered the market. But there is also traditional car manufacturers for whom those vehicles are a way to update current products. So depending on who develops those vehicles, objectives and needs can differ.

But how about public entities? There is an increasing number of public entities which start investigating in those vehicles. They have different objectives. And these objectives might vary from one entity to another, from one country to another, from one level of governance to another. To give you an example, in the United Kingdom, the objective is primarily a commercial and industrial strategy for the country. The UK government views those technological tools as a fantastic opportunity to stimulate the vehicle market and for the UK to become a leader on the international scene. So far this has been the main objective at the national level in the UK. In Singapore on the other hand, the objective is slightly different. It's not about stimulating the market and boosting the economy.

"By 2050 we anticipate an increase in congestion both in trains and on the roads. This is where autonomous vehicles might help" (Paul Beauvallet, Regional Council of Ile-de-France). ©Xseon/shutterstock.com

It is mainly about improving the efficiency of the transport system. The Singapore Government sees these vehicles as a tool to optimise the country's transport system. So different public entities seem to have different goals related to the development and use of automated vehicles. In some cases, different institutions might have contradictory objectives. That is where I think we need to be vigilant and to start engaging in a discussion between different actors. Different drivers could lead to different outcomes.

So where do local authorities stand in this puzzle? Where do they position themselves? Do they drive the development of AVs? To what extend do they influence these processes? Do local authorities lead the development of this technology to suit its needs, do they adapt to the demand, or do they react to changes? To me it seems that, especially in a country like the United Kingdom, and the USA, local authorities' agenda is being led by other actors. So far local authorities have been a mostly passive. They've been observing from a distance what is happening and they have not developed any strategy or any vision to integrate this disruptive technology in their agenda.

The technology is actually been developed rapidly: we might have some time to respond rather than to react, but we do need to start engaging now. In my opinion, it is time for local authorities to start getting involved in the debate. It is also time for national authorities to start involving public authorities in the debate, to start consulting them, to start framing and shaping the development of this technology called innovation in a way that really serves collective needs in a most efficient and smart way in urban areas.

NAVLY, the autonomous shuttle tested in Lyon (France) © Pierre Salomé / Aishuu

Florent ANON European projects manager, MOV'EO

Mov'eo is currently involved in two projects related to autonomous vehicles.
The first one is TEVAC, which focuses on Paris and Normandy regions. We are financed by the ADEME, Ile-de-France region and Normandy region. The idea within TEVAC is to provide a benchmark of all the stakeholders involved in the autonomous vehicle ecosystem in these territories. We are talking here about big companies, SMEs, public bodies, research institutions, and so on. The idea is to map the initiatives that have already been deployed in Normandy and Ile-de-France, to be able to position this area as a major player for the experimentation of autonomous vehicles.

The first phase of the project was the benchmark and mapping of the stakeholders, and the second phase, with which we are dealing with right now, concerns the development of use cases. The idea is to involve all the stakeholders to provide some testing ideas and to identify which experiments we could put in place to answer special needs of special communities in our areas. So, the idea here is to have a user centric approach and make sure that we not only experiment something; there are already plenty of experiments everywhere right now; we want to base the future experiments on specific needs of specific communities and try to involve all the other stakeholders that could answer these needs.

We are also involved in a second project: BRAVE. It is a European initiative (like CREATE project), funded by the European

Commission within the H2020 framework programme.

The idea of BRAVE was, similarly to TEVAC, to have a user centric approach. The objective is to identify the needs, the concerns and the expectations of users of autonomous vehicles to provide human/machine interfaces that will answer the concerns of the users. By saying "users", I intend to talk about:

- The driver (or car owner, who maybe won't be driving anymore),
- The other drivers dealing with autonomous cars in front of them,
- Vulnerable road users like pedestrians, cyclists, etc.

The objective is to try to identify and develop human/machine interfaces that will ensure that all the users and all the stakeholders involved will accept the autonomous vehicles, and will be comfortable with the concept. We are talking about means of communication between pedestrians and a vehicle that would be coming across, to ensure that both of them are aware that they have seen each other. We're talking about human/machine interfaces that would help switching from the driver being responsible of conducting the car, and the car taking over the control (and the other way round).

The final step is to develop some prototypes that will be tested. The purpose is to make sure that the human/machine interfaces we are developing are answering a special need and a real concern for the stakeholders.

Both projects have in common the users' centric approach. We are not primarily dealing with technical challenges in those projects, but we need to deal with all the other aspects (road safety, legal, ethical, social, economic implications and challenges). We believe that we must answer all these challenges first, and that the technical challenges are only a part of the overview but are not the main concern right now.

Tom COHEN
We have two distinct perspectives:

- **A long term view**: what might automation bring and how we might try to ensure that it brings us what we want?
- And then, **the very practical view** which is today, with the technology as it stands

now, trying to see how it might work and trying to make it effective. We need to seek a meaningful dialogue between the technology as it is today and the tests that are being done now and this longer-term question. At the moment we are not successfully joining the two.

Sina NORDHOFF
Researcher in behavioural science and cognitive psychology, WZB Berlin, Germany

I will present the user-centred view and tell you about a pilot project involving an automated shuttle from Local Motors, which ran on the EUREF campus in Berlin from December 2016 to August 2017. The shuttle was moving at approximatively 8 km per hour at a maximum campus speed of 10 km/hr. We have been studying user acceptance by means of questionnaires or interviews ever since, surveying people after they took a ride in the automated shuttle. More is to follow since we received a new automated shuttle called Emily which represents the latest generation from Easymile.

First, one of the key lessons that we learned is that Olli has been positively perceived. Many people liked the idea of taking a ride in the shuttle and of using automated shuttles as feeder modes to public transport systems to bridge the so-called first or last mile. This idea was very well appreciated. Furthermore, people gave very high ratings on some generic aspects of the vehicle such as its usefulness and ease of use. But there are still many challenges at the moment.

We still have a lot of homework to do because the second key lesson that we learned from this pilot project was that people's expectations far exceeded the actual technological performance of the system. They had this fully automated vehicle in their mind which can drive on their own and does not need to be supervised at all by a driver or operator on board. Then they came to our campus with the highest expectations and met Olli.

Olli is a very cute prototype vehicle, but Olli runs at a speed of 8 km per hour and had a steward on board supervising the system to intervene when the system was not able to cope with some situations. For example, the steward had to intervene when a static obstacle blocked the path of the vehicle. Many people were quite irritated and confused about this particular type of driving behaviour, sometimes even describing it as the "opposite of automated driving".

This meant for us that we had to manage the expectations of the people in the sense that we had to explain the technology to users and also educate them about the system's limitations and capabilities. Therefore, one of the future tasks is to create more realistic expectations that are in alignment with the actual technical performance of the system as the creation of unrealistic expectations may be harmful for later acceptance.

Another key question is how can we investigate a technology that is still hypothetical and abstract to so many people? Automated vehicles of higher automation levels are not yet commercialised and automated shuttles are mainly tested in demonstration projects worldwide (e.g., WEpods, SmartShutle, CityMobil2). Hence, the public has limited experience with and knowledge of automated vehicles as these demonstration projects are not available to the main public.

Hence, our task is also to bring the technology to the attention of as many people as possible and test it under various complex and dynamic conditions in so-called living labs or even on public roads in unprotected areas. This would be even more exciting for us, but requires a bit more negotiation with relevant stakeholders as there are still some challenges to solve to make such kind of endeavor happen (*e.g.*, legal challenges). But I

am also very confident that we are getting there, slowly, but sooner than later. Furthermore, another challenge is to involve "ordinary citizens" so to speak who are not so much familiar with the technology.

At the moment, many studies mostly targeted potential lead users and early adopters and not people who may be a bit reserved or skeptic about this technology. For the success of automated vehicles, we need these people which is why we need to start involving them in our research and investigating their perceptions and attitudes as regards automated vehicles. For example, the campus on which the pilot test with Olli took place is a campus that does research and development on innovative mobility solutions. For example, we have an intelligent smart grid, many electric cars, many car-sharing vehicles and the people who work there are quite "technology oriented".

The question is thus how can we reach out to these citizens who haven't so much experience with this technology, who probably do not even have a smartphone, and to what extent does their opinion probably differs from the more innovative ones? We still need to do a lot of research to gain more knowledge of how we can successfully introduce this technology into our market, but we will make this happen.

William PAYRE Researcher in human factors and transport, Coventry University (UK)

Very recently, I saw a documentary called *Manufacturing Consent* about Noam Chomsky's work. It made me realised that all the studies I did about acceptability of automated vehicles and other studies that I saw were actually based on bias samples. When I saw that documentary about

manufacturing consent and positive attitude towards political opinion, I realised that what is presented in the media by the academics, the industries and the manufacturers are always about the benefits, and not about the disadvantages (even though these vehicles are definitely, in my opinion, political because of all the money that is injected).

Although autonomous vehicles are not manufactured yet, autonomous vehicles acceptability already is. It's a very different process between the theory and the practice. For example there is a massive media coverage about autonomous vehicles and you will barely see on papers, sometimes in the academics although almost never in the media, about the motion sickness issue, which is related to the conflict between vestibular and visual inputs. Basically, if you are reading the news for example, what you will probably do in a so-called 'autonomous car', you won't be looking at the road constantly. As a result, you will be less able to anticipate the trajectory of your vehicle. So what you see is in conflict with what your body is experiencing. It will result in motion sickness. And there are actually huge individual differences: it is estimated that maybe 40 to 50% of the population will experience motion sickness. So how come nowadays the light is shed mostly on the advantages, and why don't we talk more about the disadvantages? Firstly because it's very tricky to assess. And secondly, it's definitely a flaw in driving automation.

I would like also to address the bias regarding autonomous driving studies.
Most of the studies, even those I conducted, are based on tech and savvy people, and these people are very familiar with technology. I guess it's going to be okay in Paris, in the US, or in the United Kingdom but what about driving or being in an autonomous car in Mexico City? The way you drive is totally different. How does an autonomous car follow the legislation there? It's going to be very messy for the system to follow the rules.

There is also a distinction between acceptability and acceptance: acceptability is prior to experience whereas acceptance is post-experience. Acceptability is then based on not having any direct experience with the system. There are still a lot of assumptions towards this.

About the role of cities and of governments, I read a very interesting report by the House of Lords in the UK, in which they gathered a lot of human factors experts and asked them to what extent the government should invest in and develop autonomous vehicles. One of the experts, Natasha Merat from Leeds University said that, whether you like it or not, these vehicles are coming. We should definitely be careful about how it is coming to us and how the technology will be accepted, and how these vehicles will interact with their environment. She provides an example about complacency saying that maybe it's not about the people inside the vehicles, but also about people outside the vehicles, for instance road users, pedestrians, cyclists etc. Maybe these people will become complacent, because they will make the assumption that the vehicle will stop whatever happens. They might cross the road at any point or some people might even play with the behaviour of the vehicle.

We must take some distance with the studies that have been released so far and maybe we should reconsider the fact that autonomous vehicles are not so **autonomous** they are **automated first**. An autonomous car is a misnomer. So there is a confusion about the naming. I would actually call it "branding" because it's fancy to say it is autonomous instead of automated. They are automated, they are actually very depending on the sensors, they are depending on the environment (*e.g.* weather conditions), they are highly depending on the infrastructure, and eventually they are depending on the behaviour of the passengers.

Usually, it is said that one of the benefit of autonomous driving is to increase safety by reducing human errors. But what is a human error first? As far as I know, these cars are designed by people. So maybe in the design process, there will be also human errors: in the human machine interface, in the algorithm etc. The human error is not only about the use, it's also about the conception of the vehicle.

The average driver takes 45 seconds to get back to the level of attention required by the driving task after an emergency control takeover. "If people don't drive anymore, it might be very difficult to cope with the emergency situations" (William Payre, Coventry University). © anyaberkut/iStock

Finally the ethical considerations are outstanding. One survey[2] draw the attention on the following paradigm: you are in an autonomous vehicle and you have an accident. So you have to choose whether the passenger in your autonomous vehicle will be safe, or if the autonomous vehicle will make the decision to save the life of the road users. Respondents said they were keen to save the other road users. However, when they were asked "Would you use such a car and buy such a car?" They answered "no". It sounds like "Do what I say not what I do". We need to take a lot of distance, and keep on investigating with surveys, simulator studies and on road trials.

Tom COHEN

This chimes with the concept of hype cycle[3]. This is the idea that, as a new technology emerges, we go through a period of uncertainty, which is followed by a period of excitement about the technology. This excitement gradually diminishes as we become more realistic about what this technology might offer. Analysis by a technology firm indicated that we are at the very top of the hype cycle where automated vehicles are concerned (Gartner, 2016). This is an interesting point of view and probably explains a lot about what's going on.
Are there optimistic or pessimistic people regarding autonomous vehicles and why?

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[2] *The social dilemma of autonomous vehicles*, study led by Azim Shariff, Iyad Rahwan and Jean-François Bonnefon.
[3] Gartner (2016) *Gartner's 2016 Hype Cycle for Emerging Technologies Identifies Three Key Trends That Organizations Must Track to Gain*

Competitive Advantage. Available at: http://www.gartner.com/newsroom/id/3412017 (Accessed: 26 September 2017).

Question and answer session with the audience

Mohammed RAHAHLEH, City of Amman (Jordan)
From my point of view maybe autonomous vehicles will work in some cities, but not in other cities where the infrastructure, like the roads, are old. For example in Amman, there are places where the GPS locations are not accurate, hence we need much more time to navigate through the city. In many cities around the world, there is a need to work and to establish a good infrastructure! Because this kind of technology implies good infrastructure and everything that lies behind. Maybe the map shows a road ahead, but in fact the road has been deconsecrated some time ago! I think that we are assessing here about cities with complete infrastructure, complete roads, with good planning, and good zoning. But in most of the cities in the world it will take decades.

David BÉTAILLE, IFSTTAR
I am optimistic. One of the interest in putting technology in a car is that you can help the driver and improve the awareness of the situation, because you have a camera, because you have a dynamic mapping of the environment. So all those technological breaks needed for the car to be automated one day are interesting from the point of view of the safety in driving. So there are some products that will be available in between now and the next 50 years where maybe some cars will be automated. And those will be products to help you as a driver and prevent from accidents probably.

Alain SAUVANT, professor at École des Ponts Paritech (ENPC)
With the decrease of experienced time value by the users of the cars, there will be probably more passenger-kilometres driven, and probably more miles driven by the cars as well. So it could end up with significantly more congestion. The other problem is an environmental problem that goes with AVs: people moving from public transport to cars, especially when public transport is not efficient. On the one hand it seems that it could be positive, but if you increase congestion even more, you may have a paradox where basically you try to improve something while you just worsen it in central cities. So there are many drawbacks.

Another thing that concerns me is the consequences on jobs. I understand there will be new jobs created but when you look in France how many people are driving as main job, it is about half a million: it's a lot of people! What kind of occupation will they have at a time where lots of other jobs with similar aptitudes will be gone as well? There is also the military use of autonomous tanks, vehicles and drones, which started to appear and could be quite a frightening use of this technology in local wars. So there are elements of negative aspects, I'm not sure they will happen, but one should be aware of them. It seems to me that public policies should be able to avoid the negative possibilities.

Tom COHEN
Let me come back to one thing which is about congestion, and it was raised by Emmanuel Ravalet in the first session. Does anyone else imagine that we might in fact "reconceptualise" the time we spend travelling?

Veronica REYNOLDS, Vectos
I have an issue with the idea of sitting in a vehicle for many hours. At least if you're sitting in an office you can get up and move around. I think the right to human movement is really important, which is why for me the whole debate really needs to centre around active modes with an interaction with AVs. And I think one of the great possible benefits on AVs could be the freeing up of more of the public round for active modes and for making these active modes safer. So if cyclists feel safer, then I think that's a wholly positive thing. We need to think more about the impacts on human health, on place making, on the design of our public realm to accommodate AVs, and active modes primarily and then look at the modes after that.

Clémence CAVOLI
I will come back to some principles we mentioned. First of all, acceptability. What is missing so far? In the context of our investigative work we have looked at the surveys that have been done to try to understand potential users' acceptability. What is missing is that we are not presenting users with different scenarios. We might get very different responses if we offer different hypothetical scenarios. We could give people an idea of the different futures which could

emerge with the arrival of autonomous vehicles, for instance a scenario where AVs lead to increased congestion, or a scenario where AVs improve public transport and optimise freight delivery. If we offer different visions we might get very different answers from potential users and that could, in turn, influence governance and government decisions.

Now, to address ethical issues, Germany is the first country that developed official guidelines in relation to ethics and AVs and I think this is urgently needed in other countries. Because so far the vehicles are being developed by programmers who are making subjective decisions when they are programming those vehicles. So we already need to have a debate on ethics, and how those vehicles should be designed. Acceptance of the technology is something that strikes me because in France we haven't really embraced automated gears. So we still have manual cars because we like our manual cars. In the US, now over 80% of the cars are equipped with automated gears. Maybe in some countries the manual cars will remain very successful, but there could be a situation where automated vehicles are much safer. Could the manual car drivers become like the smokers of today? Who would not be allowed to drive anymore because it is not safe, I think it is something interesting.

Another point related to kilometres driven. An interesting study has been done on Uber investigating the extent to which Uber has actually increased passenger-km driven in cities. Research findings suggest that Uber contributed to increase vehicle kilometre travelled by car amongst public transport users or pedestrians: and that is another worrying side. We are thinking about automated vehicles like something wonderful for the "last mile" because they could improve accessibility but, could they end up decreasing physical activity? Could they end up decreasing the use of other public transport modes? That might not be necessarily bad but it might be. All of that needs to be modelled and we need to be a bit more careful and to look at Uber and other companies as an example because they are the stepping stone to automated vehicles.

Tom COHEN
The trial in Berlin probably had that "last mile" character. What do we do to make that the

norm? What do we do to ensure that this is how AVs are deployed?

Sina NORDHOFF
I think it is very important to make an intelligent use of automated shuttles feeding the first and last end of public transport trips. For example, in Berlin we have a very dense transport network. The maximum distance to the next public transport stop is maybe 500 metres. So we are already well-served with buses, underground and car-sharing systems. Automated shuttles have a chance in areas where we have a lower-quality public transport system and where we can bridge the so-called "first mile" or "last mile".

If we intelligently implement automated shuttles where we actually need them, we will be less likely to face a competition between automated shuttles and more active transport modes such as walking or cycling so that people continue using these active and sustainable modes of travel to move around the city. And if we implement them in areas where public transport is low but car use is high, people might be inclined to switch from their cars to public transport in the long-run. This will not happen overnight, but in a longer transformation process.

To this end, we need to give them incentives or "nudge" them to adapt their behaviour by using their cars less and environmentally-friendly modes more. Given that our cities will continue growing, we need to find solutions to cope with increasing levels of urbanisation and traffic-induced problems such as environmental pollution and congestion. Automated vehicles will be one of these solutions to ensure that our cities remain to be liveable, especially for the next generations.

The last point I want to address is about a very important aspect, namely the pleasure of driving. For example, some of you may know that I'm from Germany and we have a very strong car industry there with BMW, Volkswagen and Daimler. At the same time, our cities are growing and changing and maybe it's not so fun anymore to drive in cities, because we will be constantly stuck in traffic anyway. However, we will not be able to convince people to switch from their cars to public transport if the quality of public transport does not increase on its own. Automated shuttles won't and can't be the

problem solvers for public transport, but public transport systems need to reinvent and improve themselves! They should become better than people's cars and offer the same or more advantages than individuals private cars.

What we should also not forget is that the idea of automated driving is not new, but it already dates back to the 1930s. Sometimes you can easily get the impression that it all started with Google's first self-driving pod-like car that was released in 2015. However, what has changed between now and then is the context in which the technology is now embedded. So while we are dealing with the same technological object -we are still dealing with automated vehicles- we are coping with differences in the technology or supply side because software companies such as Google or Apple are very influential in terms of really pushing this development and creating an innovation pressure to which we all must react. Furthermore, we probably have a higher level of political commitment to support eco-friendly mobility solutions such as automated and electric vehicles and we also have changing customer preferences. The car does no longer serve as status symbol, especially for the younger generations but may be replaced by the smartphones, mainly because people can order a car by just pressing a button on their smartphones' app and have it ready to go within five minutes.

Florent ANON
AVs as the "last mile" solution are very relevant to my opinion. With an autonomous vehicle we will be able to answer special needs that we would not be able to answer without it. Therefore, people who will access to these new services will get more comfortable with autonomous and automated technologies. We can take the example of the experiment held in Paris-Saclay, where they have provided autonomous shuttles by night and at the end of the day when transport systems stop working, to fill a specific gap in the transport network where regular transport cannot be provided. With autonomous shuttles for the "last mile", we will be able to make people aware of this emerging technology, and make people aware of its benefits.

William PAYRE
Actually you just said that autonomous vehicles could be a solution for "last mile"

mobility. On the other hand, and it's part of the result from the service, that people are actually keen to use such vehicles for parking, driving on motorways, and when there is congestion. Actually, there is a contradiction: manufacturers are developing pods and shuttles.
But when you ask people about their intention to use autonomous vehicles, they don't really want to use them in the cities and downtown, because I guess they realise that it is very complicated, there is a lot of interactions and the vehicle is somewhat unpredictable. As of now, people seem to rely more on their skills than on autonomous vehicles' skills. Most surveys show potential users would like to use such vehicles in other situations: motorways, parking and congested roads. So it could be a solution for the last mile mobility, but people are, according to the studies, and again it's not that reliable, not really keen to use pods and autonomous shuttles in dense areas. Still, there are such vehicles in la Défense.

Tom COHEN
With regard to the user and whether they embrace the technology or accept it only partially, is it too early to say whether we might want to retain some of the control that we currently have?

Sina NORDHOFF
It is of course a very nice idea to let go off the wheel when driving is stressful or monotonous and then take back the wheel when driving is fun. For example, driving on a curvy country road close to the beach in the sunshine with a nice car and your boyfriend, and then sitting on the driver seat of your automated car and reading your newspaper on dense, congested city roads. What a nice idea!

However, I think that a very tricky part of this whole development are exactly these transitions between human and automated control. Honestly, I'm not too optimistic about this because if this technology is implemented in our cars, we need to rely on the human driver in the most critical moments and studies show: Humans are very bad at monitoring for longer stretches of time! For example, if I am on the highway in my automated car, reading an email related to work. Maybe that email will make me angry. What if I need to take back control within a period of say three seconds? How can a "safe

take over situation" by the human driver be guaranteed if the driver was reading an email three seconds before and not any kind of email, but an email that angered him? Here we need to control the attention of the driver and his or her emotions. This is very, very tricky. I think that it is very difficult to keep the driver in the loop without compromising the benefits of using this automated system for the driver. For example, I do not know whether all drivers will like the idea of having cameras built inside the vehicle that monitor the drivers' gaze behaviour to make sure that

he or she is ready to take over when requested by the system. Google actually removed the manual steering mechanisms such as steering wheel, gas and brake pedals for this reason: Because they know that human drivers are not able to be attentive and aware the whole time and therefore it's better if we remove the steering wheel and other manual inputs too.

I think that the transition between human and automated control and the different states of the driver resulting from being in-the-loop and out-of-the-loop is quite a challenge.

"Perhaps just 10 to 20 years from now, part of the fleet will be automated. So we can imagine that automated cars will reduce accidents because they can communicate between them and with the infrastructure. But what will be the reaction of humans"? (Emmanuel Ravalet, Laboratory of Urban Sociology, EPFL ENAC). Shareway 2030/Winner of the Audi Urban Future Award 2012 – Rendering © Squared Design Lab, courtesy of Höweler + Yoon Architecture).

William PAYRE

Emergency situations are very important to assess. The first thing is to consider that if people don't drive anymore it might be very difficult to cope with the emergency situations, especially when they are unexperienced drivers. We can make a parallel with the aviation field. It's different but at the same time it's a bit similar, because they use automated planes. In 2014, a bit more than three years ago, the Federal Aviation Administration in the USA, provided a note to US flight companies, suggesting that pilots are strongly advised to operate manually their planes as much as possible to avoid a loss of skills. The point is that these pilots are professionals, trained all their lives. It's their job to pilot. So what will happen with

people who are not professional pilots or drivers?

Today, especially in France, when you get your driving license you're not taught about what to do in an emergency situation. Are you taught about how to brake properly when there are icy or circular roads? No you don't. What will happen when you will be in an autonomous vehicle? Maybe it will be "level 5" but maybe at some point you'll have to recover control in an emergency situation. You have not been trained to do so.

That is actually another question in terms of policies. I guess it follows the governments and local authorities to think on training people, at least make them understand the

underlying logic of such vehicles. What are their limits and their potential? What should you do in a case of emergency? Why is it safe? To what extent? They could actually be dangerous to travel with if you're not able to handle all the situations.

Tom COHEN
Florent, are you looking at both emergency and planned hand-back in the projects you're involved in?

Florent ANON
That is indeed one of the topics we are addressing. Switching between the driver and the car being responsible of the driving is a major issue, with wide implications (e.g. how to wake up a sleeping person and give him/her back the control of the car in an emergency situation). We need to develop ADAS (Advanced Driver Assistance Systems) together with all the stakeholders because, if we develop an automated system, it will have a lot of implications on the rest of the situation. We need, at every stage of the thinking process, to make sure that we talk with public bodies, with driving instructors, or with insurance companies (to name only a few), in order to make sure that everybody is in line with the same strategy, and that we will not just develop a technical tool which will not be able to be used on the roads because it does not really fit.

Tom COHEN
There are two broad schools of thought concerning the development of automation.
• The first is that we will gradually go up through the levels of automation: vehicle manufacturers are already giving us the lower levels of automation and they will simply carry on increasing the range of task that cars can carry out independently.
• And the other school of thought is based on the work of Google, Apple, etc. They have never made cars and have no interest in the conventional car. This is why they are working towards vehicles that will not have a steering wheel.
We may end up in quite different places depending on which of these trends turns out to be dominant.

So now are there people who are thinking about acceptance or acceptability? Whether this is a technology which needs to be "sold" to people, or is it something which is going to sell itself?

Veronica REYNOLDS, Vectos
I think there's a part of this about educating people to understand how the technology works. My understanding of these vehicles is that they are not so much 'automated' as they operate with complex learning algorithms. And I think that's a concept a lot of people don't appreciate or understand. So they just assume the vehicle is pre-programmed, and they go along the route, encounter an obstacle, they have a way of dealing with that. But actually they are becoming all the time much more sophisticated in their learning algorithm and learning in "real time". If they do encounter an unexpected obstacle they will have a learning algorithm to deal with it. It's not so much the automatic element which is what is in people's minds, as helping people to get over that to understand how learning algorithms in technology works. And I think that part of the task is to help people understand the technology better.

Tom COHEN
To follow that idea, let's suppose I am a typical citizen and now I understand that these vehicles learn quickly and that what one vehicle learns is taught to all of the other vehicles almost instantly. Am I, as a citizen, going to be happier or less happy about this technology?

David BÉTAILLE, IFSTTAR
I am happy if I can avoid a situation where an accident may happen. And for that reason it is interesting that cooperative vehicle sends me some information or that additional technology makes something for me as "Electronic Horizon", for example.

Emmanuel RAVALET
I was wondering about "happiness". I am not sure that it is the good notion. Perhaps it is something that could be just "functional". What can I do now that I couldn't do before? Where can I go? What are the possibilities? And on a functional way it could be something like the "utility" concept in economy perhaps, much more than happiness which is something on a long term, very difficult to describe or understand. But it is close to asking "what is my gain"?
That is why I'm probably worried, because I'm quite sure changes are driven by personal gains, and the question is to know, why/how

these personal gains will make a "collective added value"? That is just a question to think about.

William PAYRE
During the first study I conducted in a driving simulator, participants were interviewed and some of them told me "I don't like automated vehicles because I like to drive on my own. For me it's not a proper way to drive and I don't feel that I'm driving anymore".

If people behind the steering wheel consider that they aren't the driver anymore, it means that they are not expecting the system to give back control, so they might consider themselves passengers. In terms of use they might be very sleepy and not be able to recover control from the system. Some people might take some drugs or being drunk while using autonomous vehicles according to previous surveys. They will just call their car to get back home, like in the series Knight Rider for instance. One of the participant also told me: "If I'm going on a journey and I have to work or to read anything, or if I want to watch a movie, or to talk to my friends I will travel by train. They already exist, so what's the point of having an autonomous car?" That's actually a major point. You can already share a vehicle without having an autonomous car, and engage in a non-driving related task when commuting in public transport.

Finally, most of the cars nowadays, let's say autonomous vehicles, are designed around safety, but they are not really designed around "usability". Usability is an important dimension to consider when you design such vehicles. And it will definitely increase the positive attitude and also the efficiency of such vehicles.

Tom COHEN
So we may not be happy but we might nonetheless use the technology.
Would anyone like to talk about how automated vehicles might fit in the work they do? Can you give us a sense of whether you expect automated vehicles to assist you or perhaps make things more difficult?

Gareth SUMNER, Transport for London
Autonomous vehicles could present disruptive opportunities focused on walking and cycling; and what it will be like for people to walk and cycle near an autonomous vehicle. Over the

last hundred years, we have found that it is not great to be walking or cycling near to a vehicle (today's vehicle) with the relationship between the pedestrian (or cyclist) being controlled by the needs or the automobile not the pedestrian. Autonomous vehicles technologies create an opportunity to change, or at least question that. If we do this in the right way, we can change the way that vehicles interact with their environment and especially with walking and cycling, for the better. Right now are great opportunities to shape the technology and automotive industries approach to autonomous vehicles so that the relationship. As the public sector, we need to consider how this relationship should work so that it contributes to overall public benefit. This is likely to mean designing AVs so that they encourage walking and cycling as well as their own use.

Tom COHEN
It is worth mentioning the case of London and its Mayor's draft transport strategy. This document is quite tentative on the question of new technologies. It says Transport for London is going to watch carefully to try to make sure that new technologies develop in such way that London obtains the maximal benefit. But it doesn't say AVs should be used for one particular purpose or that their use for another should be discouraged. Nor does the strategy explain how AVs would be consistent with lots of walking and cycling.

We have discussed briefly about the possibility that the profession of driver is under threat. Do you think that automated vehicles are going to be economically beneficial in the long term? Or do you think that automated vehicles are going to be economically harmful in the long term?

Alexandre SANTACREU, ITF (OECD)
To me vehicle automation seems to be like all previous automations we've seen in history, as part of different industrial revolutions. We saw jobs replaced by machines but new jobs appeared soon after. Could it be just another one of those industrial revolutions?

Moreover, humans at the wheel make terrible mistakes: there are 1.2 million people killed every year in traffic. This situation has a terrible impact on the economy for two reasons. First, crashes have an obvious direct cost due to the loss of life, medical costs and lost productivity. Second, crashes create a

fear of traffic, whereby people don't walk and cycle as much as they otherwise would. If people walked and cycled more, they could have more reliable journeys, they would reduce congestion and pollution, they would reduce the medical cost of sedentary lifestyles… I'm hoping that machines will do fewer mistakes than humans do, leading to fewer crashes. For this precise reason, I'm optimistic about their benefits to society.

William PAYRE
It's another major concern for people who said that they will accept that technology, they also raised the issue of being hacked. So it's not only about safety, it's about security, and the security is about the hardware and the software which will be used in the car.

Also, autonomous and connected vehicles are about sharing data. For example the engine, the algorithm, the computing power, it is also the battle about infotainment. So what is going to be displayed in your vehicle?
If you don't have to drive anymore you will likely watch movies, use softwares, platforms and entertainment systems. For example Apple bought a lot of tracks in the US to conduct road-trials, they are not building autonomous vehicles, and they are trying to implement new softwares and interfaces in these vehicles because it will probably be a working station, if it is accepted.

Finally, a last point about the economic impacts. The first thing is that these vehicles will use the infrastructure and the roads should be very neat and clean and maybe we will have to add more sensors. Who is going to pay for it? Only the owners of these cars or the whole population? Actually I don't know to what extent jobs will be removed. I guess on the other hand it will create other jobs, for example, managing the fleets, etc. I don't know when where and how and I don't know if the trade will be actually interesting and who will take benefits of this trade, but there will be new jobs.

Charlotte HALPERN
We have seen some ideas in CREATE, especially in the case of "stage 3 policies: planning for a livable city" where it was no more question to plan cities and regions around the car: it is not about transport for transport, not transport for economic growth, transport for wider benefits, but transport in the service of a city urban life. Such thinking

could come into the way of automated vehicles.

One of them is reducing traffic speed, and we heard this morning that one of the rationale for having automated vehicles in the first place is to go faster, to avoid congestion, maybe to travel in the air and not necessarily on the ground.

The second thing we know from livable cities is that it encourages the development of other activities, of different ways to capture value and to avoid devoting so much roadspace to the circulation of cars in order to encourage having restaurants, transport, tourism, residential areas, playgrounds etc. Where do automated vehicles fit in this type of urban economy?

And a third point we could add is how to combine the use of automated vehicles with existing layers of transport policies? What is their added value? We hear this morning city centres are not where it is most needed, by contrast to the fringes of the metropolises where public transport is inexistent or insufficiently developed, or by contrast to specific timeslots, such as at night, when there is no or less public transport, and where people don't own a car. When applied to automated vehicles, these findings from the CREATE project highlight the need to better integrate this technology-driven approach to automated vehicles into a broader urban, social and political context.

Closing remarks

Dany NGUYEN-LUONG
I am not sure what will be the future of these vehicles but what I am sure of, is that when I see the youth of the speakers, the panelists, research has a future in this field.
I would like to thank you Tom for the quality of your animation, to have created fruitful exchanges with the audience and thank you Charlotte for your help.