

# Cities and the invasion of the autonomous vehicle

**Jean-Pierre Orfeuil**, Scientific Adviser to the City on the Move-VEDECOM Institute, Emeritus Professor at the Paris Institute of Urban Design (Université Paris-Est)

With the collaboration of **Mireille APEL-MULLER**, Director of the City on the Move-VEDECOM Institute

## *Preamble*

*We position ourselves here in a hypothetical context where:*

- The autonomous vehicle has achieved level 5 in the international automation taxonomy, in other words full autonomy in all circumstances, from city streets to freeways, and it is on sale at prices that make it attractive to individuals or companies.*
- Electric powertrains with rechargeable batteries have become standard on these vehicles.*
- These vehicles are connected to telecommunications networks that are necessary not only to their operation, but also to the leisure activities of their passengers, who no longer have any driving tasks to perform.*
- So the vehicle is an autonomous, connected, electric (ACE) vehicle, which we will refer to as an autonomous vehicle (AV) in the rest of this article.*

“Technological progress is shifting the boundary between the *possible* and the *impossible* and requires us to redefine the boundary between the *desirable* and the *undesirable*.” CNIL, 2017

“Artificial intelligence is the big myth of our time (...). Technology crystallises a power of projection into the future that is sometimes lacking in our political imagination.” Isabelle Falque-Pierrotin, President of the French data protection agency (CNIL).

## **Abstract**

The autonomous vehicle is shortly set to burst into the streets of our cities and into our lives. Its qualities will ensure that it spreads rapidly and massively, like the smartphone before it. The transition from the old world to this new world is inevitable...

This article will focus primarily on the links between the arrival of these vehicles, territorial action and urban planning. It will approach these questions from two main angles, corresponding to two moments in this revolution: the first, not far off, relating to the conditions in which the use of these vehicles emerges; the second, further ahead, relating to the consequences of the use of these vehicles on the production of space.

## Introduction

The autonomous vehicle (AV)<sup>1</sup> is shortly set to burst into the streets of our cities and into our lives. Its qualities will ensure that it spreads rapidly and massively, like the smartphone before it. In fact, it will come to heel at the simple blow on the whistle, carry us to our destination while we enjoy our favourite activities, and will go and park or perform other tasks that we cannot even manage today, without the need for us to do anything about it at all. The ancient link between the words “travel” and “travail” will be severed.

The promise of accident-free travel, without driving stress and without pollution,<sup>2</sup> will be enough to convert the public authorities and users. It will take over automatically, without resistance, and without financial support from governments. The most they will have to do is to tidy up a few old rules made obsolete by technology – such as the requirement to have a driver responsible for the safe operation of the vehicle – and to be open and welcoming to the protagonists of this smooth revolution.

The transition from the old world to this new world is inevitable. The territories that choose to be early adopters will be the first to benefit from the local advantages offered by the new ways of travelling (fewer accidents, less congestion, less pollution, more opportunities...). Moreover, they will attract and retain the cream of high-tech to carry out their pilot projects. For the early adopting territories, these pioneering operations will bring high media visibility and an image of modernity. This will gain them comparative advantage in the global competition that is the unavoidable reality of the modern world, and will position them as attractive destinations for a knowledge industry that is the prime driving force of modern development.

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<sup>1</sup> For the sake of simplicity, we will use the term autonomous vehicle here to refer to autonomous, connected, electric vehicles that use the road infrastructures, classified level 5 in the international taxonomy, in other words able to operate driverlessly in all circumstances. On the other hand, these vehicles may differ in their carrying capacity (from personal to public transport vehicles), in their status (personal vehicles, self-service fleets, shuttles operated by a transport firm, etc.), and in their primary function (people transport, freight transport, locations for mobile activities, etc.).

<sup>2</sup> One estimate among many, by A.T. Kearney (2016): “Imagine a world with fewer accidents, fewer traffic deaths, greater energy efficiency, and lower insurance premiums. This is the world of autonomous driving. Expect the following benefits to be especially powerful: reduce traffic accidents by 70 percent, lower vehicle service costs by 35 percent, cut energy consumption by 30 percent, reduce insurance liability by more than 15 percent.

The estimated annual savings for the United States alone are expected to be around \$1.3 trillion, with \$488 billion on the cost of accidents, 507 billion in increased productivity from autonomous cars, 138 billion from reduced congestion, 169 billion in fuel savings.” These savings equate to 7% of US GDP, the equivalent of total spending on transportation by American households.

This, succinctly, is the narrative touted to the public by today's mainstream press on this new transport revolution. Like all big narratives, it includes plausible elements, but glosses over other components that nevertheless deserve attention.

We will not attempt here to discuss either the industrial feasibility of autonomous vehicles, or their capacity to enter the market. We will imagine that they exist and that they can be used in real-world day-to-day conditions. We will focus primarily on the links between the arrival of these vehicles, territorial action and urban planning. We will approach these questions from two main angles, corresponding to two moments in this revolution: the first, not far off, relating to the conditions in which the use of these vehicles emerges; the second, further ahead, relating to the consequences of the use of these vehicles on the production of space. We will start with the longer term perspective. This choice might seem paradoxical, even counterintuitive, since this perspective is inherently more speculative. The reason for it is that the technological disruption brought about by autonomous vehicles can feed into two opposing visions of the mobility of tomorrow, each with very different territorial consequences.

In the first view, the use of autonomous vehicles is in continuity with the dominant uses of the car today (privately owned and used). Individual car use will develop further, and the dynamics of urban sprawl will gain pace. In the second view, autonomous vehicles will facilitate, support and add impetus to the early processes of behavioural change already observable today in big cities, in other words more multimodal practices, more shared mobility, with more on-demand transport in cities. Under certain conditions, they will be able to reduce traffic pressure in the city and help to revive the appeal of urban density.

History has not yet tipped one way or the other between these two models, and it is likely that territorial action will play an important role in their respective development capacities. It is therefore only after having explored these two scenarios that we will be able to tackle the first perspective, relating to the more immediate changes affecting planning, the city and its actors, which need to be implemented in order to allow one or other of these two models to develop.

## **I Two scenarios for the use of autonomous vehicles**

US urbanists have no hesitation in comparing the significance of the forthcoming transition to autonomous vehicles with the earlier period of massive automobile spread, followed by the equally massive implementation of America's freeway programme, with its unanticipated impact on city production and urban ways of life. Which is to say that this is a critical issue for cities. It is also more complex than it was in the past, because a single new object – the AV – can be the foundation of two very different kinds of practice, with highly contrasting urban effects.

### ***1.1 The privately owned autonomous vehicle***

According to current estimates, the cost of buying a mass-produced autonomous vehicle may be no more than €10,000 higher than buying a conventional vehicle. If that is true, it could become the personal vehicle for a significant proportion of the population.

Two different mechanisms will have the effect of reducing the generalised cost of transport (money + time). Freedom from the task of driving and the potential use of travel time for other activities will cut time cost. This suggests that Zahavi's conjecture about the stability of travel-time budgets will become obsolete.<sup>3</sup> In addition, automated driving will allow higher speeds, in particular on dedicated infrastructures, and will thereby increase the capacities of existing infrastructures and reduce non-recurrent congestion (if for no other reason than the reduction in the number of accidents). In all, therefore, travel times will be reduced and travel will be experienced as less tedious.

With time, however, it will be observed that the AV will not achieve its full potential as an integrated system (with generalised inter-vehicle communication) unless human-driven vehicles (and pedestrians), in short all the less predictable uses and users, are eliminated. During the previous revolution (the large-scale emergence of the automobile), Henry Ford's answer to those concerned that cars might frighten the horses was that this was unimportant, since horses would vanish from the roads, which is what happened. It is therefore possible that old-world uses will be channelled (clearly identified pedestrian passages, pedestrian precincts, etc.) or will

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<sup>3</sup> Yauco Zahavi, a World Bank expert, observed in the 1970s that when citydwellers saw an increase in travel speeds, they responded by covering longer distances, with the result that they spent just as much time travelling. From the 1960s to the 2000s, travel-time budgets did indeed remain stable, at around one hour a day (1.5 hours in cities with multi-million populations), in France and in most developing countries with reliable statistics.

disappear spontaneously, like telephone booths after the mass spread of mobile phones. Human-driven cars, which will only continue to be used by population categories with little influence, will also gradually disappear, either because incentives or prohibitions are introduced, or because AV will be the only technology available on the market.

In this scenario, the spread of the autonomous vehicle simultaneously plays the role of a higher-quality infrastructure (like freeways compared with roads, by reducing mental load) and of an additional infrastructure that enhances travel speed. In addition, the need to provide transport for those not legally allowed to drive (e.g. the suburban “parent taxi”) disappears. Travel demand (which increases when the generalised cost of transport falls) can increase, along with the time spent in cars, while for people with children there is less advantage in living in areas with conventional transport services. In addition, the balance between modes that already allowed selective use of travel time (e.g. regional trains outside peak hours) and the car, shifts in favour of the latter. All this facilitates more expansion in the spaces of everyday life, to areas without rail or school transport services, further contributing to the loosening of the urban fabric, at least the residential fabric (or better territorial distribution, depending on one’s point of view). In short, there are undoubtedly gains (in safety, somewhat more marginally in speed) per kilometre travelled, but the potential increase in the distances covered by car could cause new congestion that will justify further demand for road building.

This scenario is in line with certain *big trends* in our societies: *primacy of the satisfaction of individual expectations and interests over the collective expression of well-being*, quest for more spacious, less mixed, living places, in contact with nature, etc. However, today this prospect is still hampered by the lack of appetite among motorists for autonomous vehicles and their lack of confidence in the safety of these vehicles, commonly registered in surveys conducted around the world and in the US by firms of consultants (Deloitte, 2017, J.D. Power, 2017) and even by MIT (Abraham, 2017).<sup>4</sup> On the other hand, it is a scenario that is in conflict with *public objectives* that are quite widely shared, at least in European cities: enhancement of “the” city and public spaces to promote “living together” and serendipity, resistance to urban sprawl, refusal to develop new road infrastructures, discouragement of solo car-use, etc.

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<sup>4</sup> Looking at the MIT survey alone, 75% of drivers are satisfied or very satisfied with the technologies available in their *current* vehicle, 13% would feel comfortable with an entirely automated vehicle (compared with 24% in 2016), and 48% say that they would never buy a totally autonomous vehicle.

## ***1.1 The shared autonomous vehicle***

This scenario is first of all based on the growing intolerance for traffic pressure in the city and for traffic jams. It recognises the inability of mass transit networks to provide a global alternative to the car, but relies on these networks wherever they effectively meet a sufficiently mass level of demand. It draws on the idea that fleets of robotaxis (possibly operating as collective taxis) can provide the transport currently delivered by private cars and by buses operating in low-demand niches.

These fleets could operate under several business models, from the most conventional (a fleet run by an operator or local authority that owns or leases it), to the most innovative. For example, one might imagine that individuals could buy shares in SCPM (“mobility” investment companies) which will invest in vehicle fleet operators. Or one might imagine individuals, e.g. former taxi drivers, acquiring a number of vehicles, in the same way as people today place apartments on Airbnb, and moving their empty vehicles around to position them in high-demand zones with good revenue potential. J. Donath has an even more disruptive vision: trips in these systems would be free of charge, because they would be financed by local businesses, which would thereby gain a certain control over the route: you booked with your smartphone, your tastes and your needs are known. Your trip will be free if you agree to make one or two stops at the system sponsors. We will go via a McDonald’s and wait there until you have finished your meal.<sup>5</sup> Another possible model is one in which an institution (or a group of individuals) provides the vehicles and hands over all the management tasks to *blockchains* (Renouard, 2017). In principle, this model would avoid the potential for centralisation and monopoly, and open up the market to a large number of actors, according to the Toyota Research Institute’s Chris Ballinger, who is studying this solution. These different options shift the status of the car from a consumer good to a productive asset. Each raises specific and highly complex questions of legal guarantees.

This scenario draws on the hypothesis that the exponential growth levels that the operators (Uber, Lyft, and their imitators) of on-demand transport (ODT) have achieved reflect new expectations and attitudes that will continue to spread among citydwellers (less interest in vehicle ownership, increased use of mobility services, openness to sharing and variety in the

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<sup>5</sup> This disruption is also a return to the first free public transport systems, set up in Nantes 1827 by S. Baudry to attract customers to his public baths outside the city centre. It also recalls the practices of taxis or cars which give tourists the “benefit” of their knowledge of local restaurants, hotels, souvenir shops, etc. Often informal, this practice is legal in Las Vegas.

use of transport methods). Supporting this assumption is the fact that a vehicle that is unquestionably more personal than the car – the bicycle – is now available for sharing in big cities almost everywhere in the world, and that big carmakers – including premium brands like Mercedes – are showing strong interest in on-demand transport. It is then imagined that growth can continue until this system becomes the dominant way of meeting mobility demand, made all the easier by the fact that higher returns are built into the system, since the more potential users there are, the shorter the waiting times. The introduction of robot drivers will significantly reduce costs and make today's personnel problems a thing of the past.

Independent, good-quality academic studies carried out on different cities (New York, Austin, Lisbon, Singapore) have validated the concept in terms of its capacity to deliver mobility in cities. They show that urban mobility can be maintained in quantity (number of motorised trips) and in quality (transport times and costs) without personal use of the car, by generalising ODT, by opening it up further than today to shared practices such as Uber Pool, provided that the main mass transit services at least are kept in operation. From a public interest perspective, this different way of meeting mobility needs reduces the required vehicle stock by a factor of 10, almost entirely eliminates parking needs, significantly diminishes recurrent peak hour congestion, when pool transport is dominant, demands no public contribution to ODT, and is no more costly to individuals than the private car.<sup>6</sup> On the other hand, it may be expected that the competition between providers will lead to progressive rises in the brand status of vehicles used compared with today's owned vehicles, which might have a negative impact in terms of energy efficiency and greenhouse gas emissions.

This prospect is attractive for cities, where the primary scarce resource is available ground space. A study by the University of Florida, though admittedly somewhat simplistic, lists all the benefits that cities could gain from entirely autonomous traffic. They could eliminate ugly objects like traffic lights, reduce the number of signposts, design narrower traffic lanes, reduce the gaps between streets and shopping centres currently filled with ground level car parks, recover the millions of square metres currently used for streetside parking, devise new uses for planned parking and use this abundance of convertible space for shared projects with citydwellers. Cities and urban quality would emerge greatly enhanced from this scenario.

Moreover, it is in line with certain *big trends* in our societies, such as the need for sharing which – outside the mobility sphere – can be identified in the success of social media. It is in harmony with emerging mobility expectations and practices (less interest in car ownership, use

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<sup>6</sup> These studies assume constant levels of motorised mobility and no transfer from public transport to ODT.

of smartphones to organise mobility, intermodal agility...) that are particularly widespread amongst millennials. It is partially in tune with *public objectives*: collective uses of the car are welcome, provided that they detract from individual car use, not from the use of public transport. Studies conducted in New York and San Francisco suggest that this is not always the case in the real world. They do not condemn the concept, but show that systems *per se* do not necessarily support public policy objectives, and that mobility systems still need public regulation.

## II Urban action today: David against Goliath?

The faith in the inevitability of a disruption in mobility is apparent both in the stock valuations of the big players, even while they continue to suffer heavy losses, and in the considerable resources put on the table for the development of autonomous vehicles by the giants of the Internet or the automobile sector.

Relative to these giants, engaged in a merciless war for first place on the podium,<sup>7</sup> the world's big cities:

- Seem dwarfed,<sup>8</sup> mere spectators to a revolution that intimately affects them, but over which they have little control: together, the GAFAM represent market value of \$3 trillion, annual profits of 100 billion, R&D of 60 billion a year.

- Have difficulty in defining visions and setting strategies: being themselves engaged in global scale competition, they may be prompted to accept conditions to ensure that some pilot or rather is conducted in their perimeter rather than in a rival city, with longer term consequences.<sup>9</sup> Whatever the domain, they do not have the same grasp of the issues as their the entities they are dealing with, nor the same capacity for anticipation.

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<sup>7</sup> Not just rivalries like that between Alphabet and Uber, but also GM's attempts to have the right to experiment restricted to automakers alone.

<sup>8</sup> There is probably no clearer example of the asymmetry in power between the Internet giants and territories than the responses to Amazon's call for proposals from regions to become the site of the company's second head office. 238 bids have been received. Most offer significant material advantages (including free land), despite being in a country where unemployment is low (compared with France). Chicago proposes redirecting 50 to 100% of the income taxes incurred by employees back to the company (described by the press as "*paying taxes to the boss*"); Stonecrest, Georgia proposes re-christening the future location "Amazon, Georgia"; and Fresno, California, proposes retaining only 15% of the taxes collected on Amazon's activity under unrestricted municipal management, the remaining 85% being assigned to projects chosen by Amazon, labelled "This project brought to you by Amazon".

<sup>9</sup> "Cities need to be careful about signing contracts that will limit their future ability to shape incentives and disincentives to fight congestion". L. Nisenson, Alta Planning, 2017 APA Conference, New York City. For example, the Mayor of Pittsburgh, very disappointed in his partnership with Uber for the deployment of a fleet of

- Resemble tortoises, compared with the hares of Silicon Valley: the speed of technological innovation is in contrast with the slowness of municipal action,<sup>10</sup> which is legitimately dependent on deliberation, itself rendered more complex by increasingly fragmented centres of power and legitimacies.

- Have not been sufficiently wary of their supposed friends, central governments. Governments, and supranational bodies, have proved very open to the arguments of the leaders of disruptive industries and to their needs for markets that are as uniform as possible, and not very attentive to the needs of territorial authorities.<sup>11</sup> For example, the “Autonomous vehicle start bill” currently being debated in the US Congress includes a clause that “prevents States and cities from providing surveillance, public information or political direction when AVs are travelling on their roads”. Noah Siegel recalls that the prohibition on American states regulating home deliveries by FedEx and other courier firms dates back to 1994 and comes from the last 3 words of a clause in an *air cargo* deregulation bill which states that no State may “enact or enforce a law, regulation, or other provision having the force and effect of a law related to price, route, or service of an air carrier when such a carrier is transporting property by aircraft or *by motor vehicle*”. He jokes that “it is a good rule of thumb that for every person dreaming up good policy at City Hall or an academic think tank, there are ten industry lawyers thinking about how to eliminate their authority”.

And yet, they are beginning to speak up: Airbnb is having to negotiate with the cities, Uber is no longer welcome everywhere, São Paulo is proposing a mileage toll for private-hire vehicles, Chicago has placed a tax on ODT services which goes to support public transport, Pittsburgh has declared itself very disappointed in its experience with Uber. True, these attitudes are reactive rather than proactive, influenced by the historical players (hotels, taxi

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autonomous vehicles, recognises that he cannot force Uber to sign the memorandum drawn up by the city to ensure that their presence is beneficial to the people of the city, and can impose neither regulations nor penalties if Uber refuses them (Aupperlee, 2017).

<sup>10</sup> In a recent paper (Aggarwala 2016), R. Aggarwala, who was New York City’s planning chief and is now one of the directors of Sidewalks lab, an Alphabet think tank, sees the urban dynamic as the product of dynamic imbalances between the advantages of density (less use of resources, better exploitation of collective infrastructures, higher frequency of physical interactions) and the costs of density (dependence on centralised systems, need to build trust, requirements for coordination and negotiation). He notes that the technologies currently being developed reduce the downsides of non-density *rapidly*, whereas the costs of density, in particular those associated with problems of governance, decrease only *slowly*.

<sup>11</sup> For example, the Bloomberg Philanthropies report notes that “Cities around the world are tightly constrained by national policy on AVs. But action has been sporadic and not particularly sensitive to cities’ concerns. In the United States, for instance, transportation regulators issued a landmark set of AV testing policy guidelines covering safety, reliability, data standards, and privacy. While directed at state governments, the report mentioned cities exactly twice in 116 pages.”

firms) more than by a vision of the future, but these reactions constitute a breach in the nebula that prevailed in the relation between the platforms and their customers.

This passivity should only be temporary, if we can believe the Bloomberg Philanthropies report: “Throughout the long incubation of AV technology, national governments have led the way by funding basic research, organizing pilots, and updating policy and regulation in transportation, telecommunications, and insurance. However, as the transition to AVs gets underway, cities will play a larger and more pivotal role.(...). City type will replace country or region as the most relevant segmentation dimension that determines mobility behavior and, thus, the speed and scope of the automotive revolution.”

So far, this is no easy matter At present. For Bruce Schaller, former New York City transportation chief (Schaller, 2017), “Public officials don’t know what policies are needed for technology that doesn't yet exist”. Things are no less difficult on the citizen side. For J. Sadik-Khan, “There's a lot of interest and people tend to get distracted by this shiny new toy. Let’s make sure that is the focus – creating the city that we want to have – and not looking at the technology as the be all and end all.”<sup>12</sup> In short, one has to be convinced, and to convince both citizens and governments, that the idea that autonomous vehicles are good in themselves is naive, and that their deployment will only bring benefits if we steer them in that direction.<sup>13</sup> As we will see, there is no shortage of subjects.

### **III What should be the focus of tomorrow’s urban action?**

Here, we will move from the more general to the more specific, drawing on different American articles, on the exercise conducted by the Boston Consulting Group (2017) in Île-de-France, and on a recent senatorial report (Sénat, 2017).

*The first challenge concerns the governance of the real-life arrival of autonomous vehicles, with at least four issues:*

The issue of the close involvement of cities in the deliberations and decisions, notably on the approval of vehicles, of supranational bodies (EU) and national governments,<sup>14</sup> so that

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<sup>12</sup> J. Sadik-Khan In L. Laker, Street war 2035, The Guardian, 14/06/2017. She was New York City Transportation Commissioner and is the author of “*Streetfight: handbook for an urban revolution*”, Viking, 2016

<sup>13</sup> P. D. Norton, University of Virginia in BLOOMBERG PHILANTHROPIES, 2017

urban priorities are taken into account more than they have been in the past, notably with regard to cyber-security (how would Paris or Barcelona function with a few thousand AVs frozen and jamming the city following a cyber-attack?) and terrorism (no need for suicide bombing any more...).

The issue of designating a leading authority (probably an intermunicipal body for well structured cities) for each big city region to talk to all the stakeholders.

The issue of establishing consultation bodies to work with the public on the benefits of this revolution, its requirements, its (contrasting) consequences on the choices made depending whether the emphasis is placed on individual or more collective visions, on the conditions of transition...

The issue of forming a pool of legal expertise or expertise across multiple authorities to ensure that the contracts signed with companies bedecked with highflying legal advisers and capable of structuring a highly complex deals, actually match the intentions of local authorities, and include the get-out clauses that are inevitable in a democratic context where the future is necessarily indeterminate.

*The second challenge concerns the business models of transition.*

Before tackling this challenge, it is worthwhile reproducing an extract of the recent Senate report in order to get an idea of the purely economic issues: “The revenue collected from road mobility will essentially go to those who have developed effective artificial intelligence systems for the safety of travellers and pedestrians, to those who have succeeded in imposing their protocol for communications between vehicles and infrastructure, and finally those who offer the best IT tools to organise traffic flows in order to avoid the delays too often experienced in large-scale urban zones. Relating simultaneously to all the problems inherent in artificial intelligence and robotics, driverless motoring is the epitome of an issue which, once technically mastered, will have critical consequences for the geo-economics of the 21st century.” With regard to the financing of mobility, we will add a remark by G. Plassat (2017): “For the first time in the history of transport, we are going to be able to think about taxing every journey, which changes everything.”

There are at least four topics that we already need to be thinking about:

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<sup>14</sup> It is assumed here that these bodies have found a satisfactory way to settle data privacy questions.

The gradual replacement of fossil fuels with electricity (which will be catalysed by AVs) currently relies on massive subsidies for electric mobility (bonuses for vehicle purchases, subsidies for recharging terminals, exemption from parking charges, exemption from the existing fuel tax that goes to investment in and maintenance of roads and streets). All these advantages are justified as market priming measures. When will the market be considered sufficiently mature to withstand a cut in incentives, then a contribution to road investment and maintenance? If this did not happen, we would find ourselves in the unprecedented situation of providing heavy subsidies for automobile use. Conversely, this transition is an opportunity to introduce road contributions that are better suited to urban conditions, with tolls that simultaneously play a funding role (a replacement needs to be found for the TICPE domestic energy consumption tax, which will bring in less revenue as the stock of fossil fuel vehicles falls) and a regulatory function (varying in time and space to reflect congestion levels).

The second topic, linked with electric mobility, concerns finding a sustainable supply of this form of energy, which excludes thermal and nuclear power plants in favour of renewable energy sources. What mechanisms can be devised to induce sellers of cars (or batteries) to be active in this sphere and to use renewable energy to cover the power needs linked with the movement of vehicles and the associated communication systems?

The third topic concerns financing the (significant) investment in and operation of the communication networks necessary to the safe operation of AVs and to the leisure activities of their occupants (including the investments needed to duplicate highway signs with a communicating digital equivalent).<sup>15</sup> There are a number of possible business models, combining public funding, subscriptions and fees, advertising, etc. Cities need to be make sure that they will be able to choose their own model, and that this model can be adapted to their vision of mobility on their territory, in terms of traffic levels and intermodal share (nonmotorised modes, public transport, individual vehicles, shared vehicles).

The fourth and last topic tackled here, without claiming to exhaust the subject, is that of data, both the sharing of data in systems that are sufficiently integrated and open to allow multiple actors to use them, but sufficiently controlled to maintain confidentiality, and the sharing of the revenue associated with data. We are well enough aware today that the control and use of data is what makes Silicon Valley rich and reduces profits elsewhere, to realise that cities need to take a very close interest in the matter, and maintain legal links between the territories where

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<sup>15</sup> Intel has entered a partnership with Warner Bros to broadcast films and videos, Renault has purchased Challenges to offer it in AVs... It would seem that the actors believe that the brain time available on AVs will be of high quality.

business is done and revenues earned, and the territory where those revenues are declared.

*The third challenge concerns the planning and design of our streets and public spaces.*

Whatever the form in which the AV achieves its breakthrough (privately owned vehicles or fleet pools), it is likely that the hierarchy of norms for use of the highway or the street, and the rights and responsibilities of individuals, will have to change: we are not going to spend hundreds of billions of euros so that any pedestrian, even a child, has the power to stop an AV just by standing in its way... We can expect very tough discussions on the rights of use over public spaces, and even their rewriting.

The future in the event of a big rise in privately owned AVs is simple: there will be more traffic, on roads that will have to be better maintained. One can imagine more tolls to moderate the resulting traffic increases, or the start of a new cycle of roadbuilding. Fortunately, one might say, the possibility of malicious acts will perhaps restrict the right to private ownership.

The possibility of fleets of self-service robomobiles is in principle more attractive for cities: a smaller number of vehicles than the current stock (5 to 10%) should be enough to maintain a level of urban mobility comparable with the level currently provided by privately owned cars. In this way, the city could be relieved of its parking function. Some thorny problems nevertheless remain: what forms of incentive for individuals to give up their cars in the transition period, incentives that the AV actors will undoubtedly demand? What priorities for the design of station surroundings between AVs, buses and bicycles? How to make sure that these new services will not be more attractive to existing public transport users (or cyclists) than to motorists? Will it be necessary to set aside traffic lanes for these vehicles, as we do with public transport? Will these lanes will be closed to pedestrians, who will then be steered towards footbridges – known to be highly unpopular – as suggested in a proposal currently under discussion in New York (Schneider, 2017)? How do we ensure that AV delivery services do not develop uncontrollably and wipe out the expected benefits of reduced traffic pressure? These questions are already being asked. How can we avoid the situation described in this disillusioned observation by Tony Travers on London:<sup>16</sup> “London is close to proving that you can take away all the private cars and still have congestion.”

Supposing that all these questions find a satisfactory solution, cities will still have to devise new uses for sidewalk kerbs. There will be multiple options: recharge terminals, delivery points,

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<sup>16</sup> Teacher at the London School of Economics

self-service bike stands, drop-off/pickup points for private-hire cars... This is probably not the most difficult question in the absolute, but it will be a difficult question during the transition, since it will deprive residents of that little portion of public space that they slightly feel belongs to them...

We will add a final question, which so far does not seem to have been tackled. The model of the private car worked well because a single vehicle made it possible to meet urban, regional and long-distance travel needs: for most people, the car is only justifiable and viable because it is used for these three purposes. In collective terms, of course, this is not ideal (that is why urban traffic consists of vehicles with five seats, weighing more than a tonne and capable of travelling at 130 km/h, whereas the main aim in urban conditions is to carry one person at low speed), but in meeting the needs of cities it should not be forgotten that there are also needs outside the cities... So new solutions will also have to be devised for these mobility demands.

## Conclusion

We are living in a time of paradox, when tens of billions of dollars are being invested every year in technologies that seem to inspire in motorists more mistrust than interest,<sup>17</sup> when the power of the myth of autonomous driving is taking us back to the era when “what was good for General Motors was good for America”,<sup>18</sup> when Europe (and France) can only think about running ever faster to catch up,<sup>19</sup> forgetting important principles of their law.<sup>20</sup>

Technological advances are happening fast, and governments are urging them on. By contrast, they seem less ready to look at the consequences to themselves of this anticipated future.

The arrival of AVs on the market will disrupt the economics of the road sector (13% of GDP) and employment in the industry, and will impose massive conversion requirements. This is just

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<sup>17</sup> We nevertheless need to be cautious on this point, as evidenced by the success of the smartphone, for which there was no “demand”.

<sup>18</sup> With the understanding that the idea has gone global: the European Union and the big European states are on the same wavelength.

<sup>19</sup> The Fabrique de l’industrie (Houlé, 2017) report entitled “Véhicules autonomes : ne ratons pas la révolution” [autonomous vehicles: let’s not miss the revolution] is typical of this standpoint.

<sup>20</sup> For example, Article 10 of France’s loi Informatique et Libertés (1978) – data protection act – which prohibits a machine from being able to take decisions on its own (without human intervention) that can have crucial consequences for individuals.

beginning to be realised. The electrification of the automobile stock will sharply reduced revenues from France's domestic energy consumption tax (€28 billion in 2016) at a time when investment will be needed in road quality. No one knows what will replace it.

In the procedures for the approval of vehicles, software, services, the influence of the AV's sponsors risks being greater than that of local authorities, of ethics specialists, and of citizens, who from one moment to the next change role from idler, to pedestrian, to cyclist, to bus passenger, to motorist in a human-driven or driverless car... France's data protection agency has begun to explore the question of ethics in artificial intelligence and the algorithms that it uses, and has proposed design principles (fairness and vigilance) and engineering principles (intelligibility, human responsibility), as well as making recommendations, including the establishment of a national algorithm audit platform, while underlining the additional difficulties arising from the use of deep learning for automated decision making.

Big data will be collected on all citizens, which will pose a problem for the protection of individual freedoms, a problem of national sovereignty, and of course the question of the destination of the revenues that this information generates or can generate. Without a strict legal framework, it is likely that this mine of information, which is also a goldmine, will benefit the most technologically advanced actors more than the most politically legitimate, if strict rules are not laid down from the start.

Civil liability and insurance law will have to change. The same will be true for public space law, but this will evolve in multiple arenas of negotiation with little connection between them. It will undoubtedly be necessary to ensure that local authorities and citizens are better represented than they are today, and in particular that changes in the highway code do not take place without them.

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