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Automated cars: utopia or dystopia?

While automated car driving may bring important benefits in terms of traffic safety, we should not be blind to other effects: full automation is likely to lead to increases in car traffic, mostly for transport that is not related to commuting. This is likely lead to further reductions in road speed in the areas that already suffer the most from the congestion.

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What is at stake?

Less than two decades ago, driving road vehicles was considered out of bounds for computers. But then, around 2010, combined breakthroughs in sensor technologies and artificial intelligence changed the rules of the game. On the one hand, an ever-increasing number of new car models included partial automation, hand in hand with increased connectivity (this is, the capacity to "communicate" with both infrastructure and other cars). On the other hand, some firms started extensive field trials with fully self-driving cars.

Even if not all the hype has kept its promises, societies need to reflect on the likely consequences of full automation. Some transport specialists think that the potential implications of automation are huge, given the combined emergence of vehicle electrification, automation, and shared (on-demand) mobility, and the interaction between the three.

This article discusses the results of first simulations with the Belgian national transport demand model, PLANET, which has been developed by the Federal Planning Bureau. The key question addressed here is: if the Belgian car fleet would be composed entirely of self-driving cars, how would this affect overall passenger transport demand and road congestion? Given that the final impact depends on numerous parameters whose future evolution is highly uncertain, this analysis should be understood as a technical exercise, with as main objective to understand the relevant underlying mechanisms, and to develop an idea of the order of magnitude of the consequences.

Why should car automation affect mobility?

Full automation is expected to affect transport demand through at least three channels.

First, self-driving cars are expected to improve the fluency of traffic, for instance thanks to the shorter reaction time of self-driving cars (compared to human drivers), shorter headways between vehicles, a reduction in the number of accidents, a better distribution of the traffic over the network, a better synchronization with traffic lights and a higher stability of the traffic flows.

Second, in fully automated cars, humans will no longer need to pay any attention to traffic and will be able to use their travel for work or leisure. People will no longer feel that their travel time is "wasted" (or, at least, less wasted than in a car trip where they must pay full attention to the driving task). To represent by how much people feel their travel time in cars is wasted, the concept of Value of Time (VOT) is used: a VOT of 1 EUR per hour, for instance, means that people would be willing to pay up to 1 EUR to reduce their travel by 1 hour. Studies show that the VOT for driving by car ranges from 9 EUR per hour for leisure trip to 31.2 EUR per hour for business trips. If time wasted in a car is less a concern, the VOT decreases and car travel becomes more attractive.

Third, full automation is expected to lead to changes in the monetary cost of transport by car. Three components of the monetary costs are involved: the purchase cost of cars, energy efficiency and insurance costs:

- The purchase costs will increase because vehicle automation and connectivity require investments in additional equipment, including LIDARs and video cameras for monitoring the vehicles' surroundings, ultrasonic sensors for monitoring close objects, odometry sensors for distance measurement, connectivity features to exchange information with other cars or infrastructure, on-board computing systems, etc.
- The impact on energy efficiency is the net effect of two countervailing forces. On the one hand, more fluent traffic flows and automated eco-driving are likely to lead to an improvement in the energy consumption per kilometre. On the other hand, the additional equipment needed for autonomy and connectivity will require higher auxiliary power from vehicles and could alter vehicle aerodynamics. If automation leads people to

spend more time in their cars, the demand for comfort and convenience features (tables, beds, docking stations) would increase, leading to increased weight – and thus also to a higher energy consumption.

– There are also two countervailing forces for the impact of automation on insurance premiums. On the one hand, vehicle automation can lead to drastic improvements in safety, especially at high penetration levels (and *a fortiori* when the fleet is completely automated). On the other hand, automated vehicles are likely to be more expensive, which leads to an increase in the value that is to be insured.

How is car automation likely to affect the mobility system in Belgium?

The impact of each individual channel is first described (i.e. holding the other parameters constant). Then, the impact of the combination of the last two channels is discussed.

Through the first channel, improved traffic flows increase the attractiveness of private cars as transport mode, and this, in turn, leads to an increase in transport demand by car, but one that is small at the national level (at the very most around +1%). The improvement in traffic fluency dominates the increase in car traffic, and the average speed of cars on the Belgian road network increases by 1.5%. The main reason for this extremely small effect is that almost two thirds of traffic in Belgium is not subject to high levels of congestion in the first place. Improving traffic flows in areas or periods of the day with low traffic is unlikely to change the demand for private cars. However, this small impact at the national level goes hand in hand with non-negligeable changes in some specific areas. For instance, in some highly congested zones (the areas surrounding Brussels and Antwerp), speed increases by around 5 to 10 % (compared to average speeds of less than 60 km per hour in a scenario without car automation).

Through the second channel, the decrease in time cost (and therefore in the generalised cost of travelling by car) results in an increase in car vehicle kilometres by around 18 to 23% compared to a scenario without car automation. This leads to a drastic reduction in the road speed in the areas that already suffer the most from congestion – even up to -37% in the zone delimiting the Regional Express Network surrounding Brussels (compared to a speed of 56 kilometre per hour in a scenario without car automation).

For the analysis of the impact of the third channel related to the monetary costs, several assumptions are required. Car automation is assumed to induce an increase in the purchase price of cars by 20%, a decrease in the energy consumption per kilometre by 10% and a decrease in insurance costs by 50%. Under these assumptions, the lower energy consumption per kilometre and the decrease in insurance premiums dominate the increase in acquisition costs, and average monetary costs per kilometre decrease. This decrease in the monetary costs of car travel leads to an increase in the demand for car travel. Taken in isolation, this effect remains relatively modest – an overall increase of around 2% compared to a scenario without car automation.

Although the impact of a decrease in time costs and the impact of a decrease in monetary costs are relatively small, the *combined* effect of both decreases is more important, as explained in the following. The impacts on the demand for transport per travel motive are summarized in Table 1 for private cars, and in Table 2 for all other transport modes (public transport, motorcycles, walking, cycling).

The impact of automatization on passenger kilometre is reported for a VOT of 6 EUR per hour (i.e. lower than in a scenario without car automation), in combination with the abovementioned percentage decrease in the monetary costs. Overall transport demand increases by up to 12.8 billion passenger kilometres per year (an increase of 19.8 billion passenger kilometres by car minus a decrease by 7 billion passenger kilometres for the other modes), compared to 162.7 billion passenger kilometre per year in a scenario without self-driving cars (133.6 billion passenger kilometre by car plus 29.1 billion passenger kilometres by other modes). The increase in car transport demand therefore exceeds the decrease in transport demand for other modes by a large amount.

For the travel motives “commuting to school” and “commuting for studies”, the small increase in the demand for transport by car is completely compensated by a decrease in the passenger kilometres of the other modes: this is purely a modal shift, without any induced transport demand. There is a small net increase in transport demand for the motives “commuting to work” and “business trips”, but most of the induced transport demand is for the "other motives" (such as shopping, leisure, family visits), where the increase in demand for transport by car is much larger than the decrease in travel by other modes.

Table 1 Changes in passenger km by car, per travel motive (2030)
Billion passenger km per year

Motive	Reference scenario	Changes for the self-driving cars scenario
Commuting to work	35.7	+3.8
Business trips	10.8	+2.0
Commuting to school	2.1	+0.3
Commuting for studies	0.8	+0.1
Other motives	84.1	+13.7
Total	133.6	+19.8

Source: PLANET

Assumptions for the self-driving cars scenario: increase in the purchase price of cars by 20%, decrease in the energy consumption per kilometre by 10%, decrease in insurance costs by 50% and a value of time = 6 EUR/hour

Table 2 Changes in passenger km for the non-car modes, per travel motive (2030)
Billion passenger km per year

Motive	Reference scenario	Changes for the self-driving cars scenario
Commuting to work	7.3	-2.8
Business trips	0.6	-0.5
Commuting to school	4.2	-0.3
Commuting for studies	1.8	-0.1
Other motives	15.3	-3.3
Total	29.1	-7.0

Source: PLANET

Assumptions for the self-driving cars scenario: increase in the purchase price of cars by 20%, decrease in the energy consumption per kilometre by 10%, decrease in insurance costs by 50% and a value of time = 6 EUR/hour

The impact on the speed on the road network is highly variable. During peak hours, the average speed in the Regional Express Network surrounding Brussels decreases by -28%, compared to an average of 56 km per hour in the reference scenario. However, outside the most congested areas (Brussels and the Regional Express Network zone, Antwerp, Ghent), the decrease in car speed does not exceed 5% compared to the reference scenario without car automation.

What additional elements should also play a role?

Of course, this first impact analysis is based on some simplifying assumptions – but many elements that are not accounted for in the analysis point to the conclusion that the increase in traffic volumes should even be higher.

For instance, self-driving cars can lead to induced demand by segments of the population that are not able to drive, such as children and mobility impaired people. The lower cost of driving is also likely to lead to the relocation of households and firms, resulting in urban sprawl or the creation of new centres.

Vehicle automation may also make car-sharing more attractive. Indeed, car sharing will no longer be constrained by the need to have cars available close to the customer as self-driving shared vehicles will drive themselves to the customer. Sharing of automated vehicles would also allow to spread the fixed costs over a higher customer base, making automation more attractive. In other words, automation and car sharing are two forces of mobility innovation that are likely to mutually reinforce each other.

Increased car sharing should reduce the need for parking space, but might also lead to additional trips, as empty vehicles waiting for new clients will reposition themselves. Moreover, even without formal car sharing, full automation could lead to an important increase in relocation travel, for instance because automation creates the possibility to reposition a single car to serve multiple family trips simultaneously. Also, in areas with little (or only expensive) parking facilities, owners could send their car to a free parking space within a given perimeter or let it drive around until called.