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Driverless Cars — Another Piece of the Puzzle

The impact of driverless cars is being increasingly discussed, with numerous scholars and experts trying to predict the future of cities when this technology becomes widespread adopted. While driverless cars present, in several scenarios, some clear advantages compared to human-driven cars, they rise a number of challenges that should be faced carefully and objectively.

The article "Driverless Cars will Make Passenger Rails Obsolete" (Wiseman, this issue p. 22) predicts the replacement of passenger rails with driverless cars. Wiseman does not clarify the time horizon for this scenario to become a reality, but we believe it can only happen in the long term. First, "driverless cars" correspond to level 5 of automation, in which the car is fully automated under all roadway and environmental conditions that can be managed by a human driver. Most experts acknowledge that significant technical progress is needed before Level 5 automation is reliable, tested, and approved [1], [2]. Second, the term "passenger rail" includes all public transport running on rails. This comprises intercity railways (interurban, regional, and high-speed railways) and intra-city railways (light rail, tram, and metro). Whereas intercity railways involve higher speeds, longer routes, and lower frequency, intra-city transit involves lower speeds, shorter routes, and higher frequency. In such an audacious vision as Wiseman's, all public transport running on rails (and perhaps buses as well) will be replaced by fully autonomous cars.

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It is not possible to say categorically if this scenario is likely to happen, but in that eventuality, we should discuss the benefits and also the drawbacks of such a situation. Some experts are cautious, but many firms and companies make the most optimistic predictions regarding potential markets and penetration rates [3], [4]. However, it is essential not only to estimate the sales potential of driverless cars but also to debate how they will affect the society and cities' livability.

There are several reasons to be vigilant and cautious about the setting forecasted by Wiseman. He describes four main reasons that would imply a shift from the rail transport to driverless cars. According to the author, driverless cars would promote less congestion and fewer emissions, while increasing passengers' safety, convenience, and comfort. These features involve strong interactions between technological, sociological, and policy issues. Wiseman adopts a biased perspective without considering or analyzing the interaction between these various topics.

In this response to Wiseman's proposition, we assume a benevolent point of view and accept that all technological challenges are solved, with all driverless cars being safe, secure, comfortable, and emissions efficient. Based on these assumptions, we analyze the impact of driverless

Digital Object Identifier 10.1109/MTS.2019.2913070
Date of publication: 30 May 2019

vehicles on congestion, vehicle kilometers traveled (VKT), and travel demand. These strongly related concepts may help to understand that it is impossible to change one factor without causing an effect on the other. In his article, Wiseman seems to undervalue these interactions.

Impact on Congestion

Reduction in vehicle crashes, increased autonomous driving efficiency, enhanced vehicle throughput, and increased car and ride sharing are key factors affecting congestion in a scenario where driverless cars take the lead. At a first glance, driverless cars can remove a significant number of vehicles from the roads. The impact may be particularly important if car ownership declines and ride sharing increases. Martinez *et al.* [5] present a simulation considering a fleet of shared and single occupant driverless cars. This fleet does not consider additional travel demand (it should deliver the same trips as today in terms of origin, destination, and timing) and it should replace all car and bus trips. The authors concluded that a shared driverless car, combined with high-capacity public transport (train or metro) would need 65% fewer vehicles during peak hours. In this simulation, a single occupant driverless car without public transport would still remove 23% of the cars used today at peak hours.

However, the study does not take into account any new demand that could be induced by increased capacity. Hence, impact on congestion will only be significant if the movement and storage of vehicles is priced correctly.

Impact on VKT

Most modeling relating to the impact of driverless cars indicates an increase in VKT, even in scenarios assuming the availability of high-quality high-capacity transit [5]. The increase in VKT may result from self-parking trips, empty trips, or new demand from individuals unable to drive or who shifted away from public transportation [6].

Driverless cars can motivate empty car trips, for example, before picking up and after dropping off passengers, or while waiting to be called. Increasing driver convenience may encourage passengers to choose longer commute and errand trips, and more distantly sprawled households [7]. If no regulation or charging policy is implemented, VKT will certainly increase, since it will be cheaper for a car to drive around than to pay parking fees [8]. If VKT increases dramatically, the idyllic scenario of reduced congestion and of additional free space due to less parking cars would be an illusion. Similarly, emissions per VKT may decrease, but emissions throughout the day may actually increase. Environmental impacts are related to per-kilometer emissions and therefore will be dependent on the degree to which driverless cars employ more fuel-efficient and less polluting technologies [5], [9].

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Impact on Demand

Widespread adoption of driverless cars may have the same effect as adding lanes to the roads or highways. Such an increase in road capacity could decrease the internal price of the car travel, which in turn could increase the demand. Particularly during peak periods, the potential paradox of autonomous driving means that even if road capacity increases, average delay may not decrease substantially. Therefore, the challenge is how to keep demand at manageable levels. Congestion pricing may be the answer and the pricing level could be set in order to dissipate induced demand [10].

Traveling always involves costs and externalities, no matter the transport mode used. Roads can be seen as a common good integrated in a shared-resource system. Individuals acting according to their own self-interest will use the maximum available road capacity in order to meet their own goals. This behavior is contrary to the common good of all other individuals since it will drain that resource availability. Additionally, individuals tend to underprice their trips [11] and the lower cost of an autonomous vehicle trip may even aggravate this problem. Therefore, it is important to price road usage and parking spaces correctly, and to include externalities such as greenhouse gas emissions, congestion pricing, or VKT taxes. Such regulatory policies are not popular since they would increase the cost of owning and using a car. Unfortunately, without popular support, political support is very difficult to obtain. Only the collective awareness of citizens would allow the implementation of these type of measures.

In order to minimize the negative impacts caused by increased VKT and induced demand, which would mitigate the positive effects of driverless cars, there is also the need to promote attractive alternatives. High-capacity transportation methods, such as passenger rail, are an alternative transport mode, with high passenger throughput, particularly in dense urban areas. Passenger rail efficiently contributes to VKT reduction and, when integrated in a multi-modal transport system, is complementary to other transport services such as driverless cars or mobility-as-a-service solutions.

Negotiation, Regulation, and Management

A city is a very complex ecosystem, composed of many interacting organisms, each one having different goals and values. The balance and health of this ecosystem depends on negotiation, regulation, and management processes. In the future, driverless cars will be an additional organism in the city, and these vehicles will have to find their place without degrading the balance of the overall fragile city ecosystem.

Understanding the effects of driverless vehicles in societies is an active research field, and innovative and unbiased approaches taking into account the various components involved are required. Urban and transport planners, politicians and citizens now have a time window to discuss and design communities of the future. It is not futuristic to imagine liveable cities, walkable and less polluted, with wider green areas and parks, offering a diversity of high-quality mobility services, including driverless cars and passenger rails.

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Digital Object Identifier 10.1109/MTS.2019.2919045