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Autonomous vehicles in sustainable cities: Reclaiming public spaces for people

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Abstract: The advent of autonomous vehicles (AVs) may directly affect current trends in sustainable urbanism based on recovering the urban space for people, active mobility (walking and cycling) and chrono-urbanism. How will AVs affect the urban space and the mobility? How will they change the strategies of street and public space design? are relevant questions that need to be answered to prevent AVs ruling the city as the car has done. Decisions such as setting urban goals and planning ahead and encouraging shared used over ownership, will be crucial in guiding the AVs implementation and achieving the most desirable cities.

Keywords: autonomous vehicles; urban design and planning; sustainable mobility; public space

1. Introduction

Just as with the arrival of automobiles a century ago, the introduction of autonomous vehicles is expected to bring significant impacts in mobility and urban dynamics. These changes require urban planning and design actions to be undertaken now; however, they are not yet being included in urban plans. This is mainly because there are still few studies on the effects AVs will have on urban form, land use, the interaction with other modes of transportation and thus urban design, which makes them unclear to decision-makers. This article attempts to shed light on these issues, through the literature review of the relation between mobility and use of public space, the expected impacts of AVs on urban space, and the incipient proposals for design strategies for the driverless city, with especial focus on streets and active mobility.

2. Mobility and public space

The urban public space, central to urban life, is shaped by two characteristic elements, the square/parks and the street, which have competed over time for increasingly scarce space [1]. The square (and parks) is the exponent of the static dimension, aimed at the stay, recreation and social interaction of citizens. The street represents the dynamic component, which gives access and on which movements take place [2]. Cities were designed at human scale until the industrial revolution when new modes of transport were developed, and mobility began to take on greater prominence in urban design [3]. This is also when the segregation of space is introduced, distinguishing between people and vehicular space, and with it the separation of urban design from traffic engineering [4].

Between the 1920s and 1950s, the development of the automobile brings about one of the biggest changes in urban form and structure in the history of cities, although differed between the United States and Europe. While Americans adopted automobiles immediately for all trips [5], the old continent, thanks to the compactness of its cities, continued to rely on walking and public transport. After World War Two, the automobile becomes the king of the city. Planning was devoted to achieving ever more efficient routes in terms of speed, so that urban motorways/highways and more traffic lanes appear [6],

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along with the need and demand for parking, however pavements, the space for people, was reduced to a minimum.

Currently, we are seeing a call for the reconquest of the city as a response to what Gehl and Gemzøe [7] call the car-invaded and even abandoned city. This reconquest seeks a return to the traditional citizen-dominated city, centred on reclaiming public space and the street. This is embodied in new urban models that have been greatly recently due to the COVID-19 pandemic. One of these models is *superblocks* launched in Barcelona (Spain), whose aim is to group adjacent blocks into a superblock defined by the perimeter roads where vehicle circulate, and whose internal space is freed for other uses, such as green areas and small squares [8]. Another one corresponds to *chrono-urbanism*, the *15-minute city* or *20-minute neighbourhood*, of which one of the most emblematic advocates is the city of Paris. This model is based on the idea that most daily basic activities should be accessed within this timeframe, either by walking or cycling in the European context [9] or including public transportation or transit in the American one [10]. Another major contribution is *tactical urbanism*, low-cost temporary interventions that show the benefits for citizens and boost public acceptance [11] of actions such as replacing traffic and parking with new public spaces. These interventions have generated a large and positive social impact in cities such as Berlin, New York, Amsterdam or Bogotá [9] and can play a very important role in demonstrating how AVs can improve cities and people's lives [12].

2. Expected impacts of AVs on urban space

The effects that are expected to generate the greatest opportunity for redesign in the city are those related to the reduction of the parking space and the space dedicated to vehicular traffic.

In large cities, between 15% and 30% of urban space is devoted to parking, either on-street or off-street [13]. The arrival of AVs could lead to an overall decrease in parking demand between 67%, in case private AVs are encouraged, to up to 90% when only a 2% of shared AVs are implemented [14], also considering that most of the parking would be relocated to large peripheral areas [15]. This means, that in large cities between 10% to 27% or urban space could be released. However, these benefits will not be as significant in peripheral areas, where only 50% of trips are expected to be shared (compared to 90% in cities) [16] or in rural areas, where there are only 2.2 parking spaces per vehicle compared to 4 in urban ones [17].

As for traffic space, both the number and width of lanes might be reduced thanks to the decrease of the number of circulating vehicles (more shared AVs -SAVs), platooning and the implementation of reversible lanes [18]. Schlossberg et al. [19] indicate that, for example, for a typical four-lane arterial street with on-street parking, considering a feasible width reduction of the drive lanes to 8 feet (2,45m) and the elimination of one parking lane and one traffic lane, 40% of the space (32feet-9,8m) will be released. In general, releases of 15-25% of the street space could be achieved [13], which implies for a city like Lisbon, where 30% of its urban space corresponds to road infrastructure, a release of 6% of total urban space [20].

But AVs can also generate effects that may hinder the achievement of the city's reconquest objectives. Some authors point to a possible 26 and 20% reduction in the share of walking and cycling respectively in the case low-cost SAVs are implemented. However, if private AVs were banned or SAVs were operated at high costs, the walking share could benefit by 22-31% [21].

3. Design strategies for public space in the driverless city

The advent of AVs will present a major urban design challenge, and an opportunity to enhance a design based on the needs of people over vehicles, especially thanks to the reduction in car space. On the one hand, it would allow the widening of pavements to improve the pedestrian realm [19,22]. This proposal is taken up in most studies, despite

the potential expense of replacing the underground utility infrastructure [23]. On the other hand, it would create more dedicated lanes for public transport, as well as bicycle lanes and other personal mobility vehicles to travel short distances and their parking spaces [24]. Indeed, the possibilities for reuse are enormous, from increasing green areas to the configuration of social spaces (for social interaction/meetings), conviviality and leisure or the development of street commerce [25,2627]. Although some experts already point to the preference of green areas in large surface parking spaces and new cycleways in on-street parking areas [27].

Within the street platform, competition for space from various uses is anticipated to be particularly intense in the curb space, where in addition to traditional uses, new ones such as micro-mobility transit, and especially passenger boarding and alighting for on-demand mobility services and shared mobility and package and food deliveries, whose need is expected to increase significantly with the advent of AVs [24,25], need to be accommodated. The design of these zones should avoid conflicts between AVs and public transport by preventing vehicles from using bus stops to drop-off passengers [28], as well as obstructions, ensuring continuity of pedestrian and cycling routes [22]. The introduction of AVs can enable the design of flexible and dynamic spaces in these areas, where a variety of public and private uses can be developed according to the needs of the moment, and even vary throughout the day [26].

With regard to the specific proposals for redesigning the street and public space, logically, they vary according to the technical characteristics and functionality of these spaces. For example, depending on aspects such as the class of the street (local, collector, arterial, expressway) [20] or the speed and use intensity [12], the type or location of the space (city centre, suburban, neighbourhood) [13]. Other authors propose the gradual adoption of design proposals according to the degree of introduction of AVs [22], or "plug and play" solutions that are gradually implemented to form connected networks of public squares, pedestrian, commercial and green spaces [29].

4. Conclusion

In recent years, we have seen a push for new urban models that aim to recover public space for people instead of cars, laying the grounds for the urban planning goals that will guide the coming decades. The arrival of AVs can revolutionise the urban systems, causing effects that can help or hinder this sustainable path. The magnitude and final character of these impacts will depend on the type of settlement and critical decisions such as encouraging shared used over privately-owned vehicles.

In line with new trends, all emerging design strategies for the driverless city are based on the elimination or reduction of traffic space and parking lanes, and their conversion into spaces devoted to people, active mobility modes and public transport, while providing a high quality that attracts citizens, essential to ensure the use of modern public spaces [7].

This revision demonstrates the potential of AVs for transforming the urban environment, but also the vital need to start planning now for the cities we want, to establish and implement the most citizen-friendly urban design strategies that will commit us to the most win-win model of AV implementation.

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