

PAPER • OPEN ACCESS

## Impact of Automated Vehicles on Urban Form

To cite this article: E V Malysheva 2020 *IOP Conf. Ser.: Mater. Sci. Eng.* **753** 032013

View the [article online](#) for updates and enhancements.

You may also like

- [Design and implementation of obstacles detection in self-driving car prototype](#)  
R P Sari, I P D Wibawa and C Ekaputri
- [Speed and steering control system for self-driving car prototype](#)  
Rafsanjani, I P D Wibawa and C Ekaputri
- [Vision-Based Obstacle Detection and Collision Prevention in Self-Driving Cars](#)  
Y Sarada Devi, S Sathvik, P Ananya et al.



**ECS**  
The  
Electrochemical  
Society  
Advancing solid state &  
electrochemical science & technology

**DISCOVER**  
how sustainability  
intersects with  
electrochemistry & solid  
state science research

# Impact of Automated Vehicles on Urban Form

**E V Malysheva<sup>1</sup>**

<sup>1</sup>Samara State Technical University Academy of Construction and Architecture, 244 Molodogvardeyskaya St, Samara 443100, Russia

E-mail: mal-92@ya.ru

**Abstract.** Automated vehicles (AV) are a rapidly developing technology. It is expected that completely self-driving cars in the largest cities of the world will be by 2040-2050. All over the world technical, political, legal and economic issues of self-driving technology are being explored. Self-driving cars will not only affect daily trips, but also will change the appearance of cities. Automobiles — their size, accessibility, and environmental impact — are an important factor in urban planning in the last century. This article describes the problems of introducing self-driving cars and its impact on urban form and architecture. The technology of self-driving cars will change the urban environment. Those changes will be irreversible, so it is important to have an idea about the consequences of its implementation, in order to avoid negative developments and try to get the maximum benefit from the introduction of automated vehicles. Following the analysis of the scientific literature, two main scenarios for the introduction of automated vehicles according to the form of ownership — individual and public, including the system of a mass self-driving taxi — were considered. For these scenarios, the factors of spatial influence of AV on the urban form were combined into three groups of principles: the impact on urbanization; the impact on road infrastructure; the influence at the local level. The question of how the introduction of AV will affect the density and structure of the city, as well as the quality of human life. The problem of early obsolescence of infrastructure projects has been raised. Priority of an integrated approach is shown when choosing a strategy for further development.

## 1. Introduction

Transport has become an important part of human life, affecting all its aspects: work, leisure, education, services, etc. Therefore, movement takes a significant amount of time. Movement patterns have a significant impact on urban infrastructure, forming roads and neighborhoods. They also affect the environment through air pollution and noise; and on human health through the choice of passive (car) or active (bicycle) type of movement [1]. Comfortable transport infrastructure and a variety of types of movement around the city are important in the formation of a comfortable urban environment accessible to all social groups.

In an age of turbulent economic, political, social, environmental and technical changes, the life-cycle of urban infrastructure (engineering systems, roads, bridges, tunnels and buildings etc.) is becoming shorter, because the creation considers only current problems and their ways solutions [2]. Throughout its development, various forms of mobility had a direct impact on urban planning and space-planning and building planning, in particular. In recent years, there has been an active development of automated technologies. Various studies predict that by 2040 completely autonomous transportation systems will appear in biggest cities of the world. While the technological, economic



Content from this work may be used under the terms of the [Creative Commons Attribution 3.0 licence](#). Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI.

and legal aspects of the introduction of self-driving cars are intensively studied, the issue of their impact on urban planning and building planning remains unresolved [3].

## 2. Results

The emergence of self-driving cars is a reality of the next decade. All over the world, the technical and economic issues of automated technology are being studied [4]. However, the study of the possible impact on the urban form is not practically happening. The technology of self-driving cars will change the urban environment, and the changes will be irreversible. It is important to have an idea about the consequences of its implementation in order to avoid negative developments and try to get the maximum benefit from the introduction of self-driving cars.

The purpose of the study is to predict the degree of change in the qualitative and quantitative characteristics of the urban environment as a result of the introduction of self-driving cars.

In the work, based on the analysis of scientific and applied literature, certain principles of the influence of automated vehicles on the urban form are revealed.

Automated vehicles have both advantages and disadvantages. The main benefits include increased mobility, access to areas of cities that are currently not served by public transport. One of the main advantages of self-driving cars is to increase the safety of movement. Self-driving cars can be used by wider groups of the population, including the elderly and people with disabilities. It is predicted that the widespread introduction of automated cars will shorten the trip time, due to: uniform speed of movement of all road users; faster passage of intersections (due to intellectual coordination of actions); automated selection of the optimal route using cloud technologies; eliminating the need to find a parking space. The use of public self-driving cars can reduce the need for parking. Also, the introduction of self-driving electric cars will significantly reduce the amount of toxic emissions into the atmosphere [5].

There are a number of predictable drawbacks. Firstly, the widespread distribution of self-driving cars and access to them by a wider range of the population may reinforce the current trend towards sprawling cities. If automated cars are privately owned, an increase in road traffic will block the time saving movement described earlier. The negative impact on human health is due to a sedentary lifestyle, if the priority of the choice of movement will be given to driving a car, rather than cycling or walking. The introduction of self-driving cars will require a review of the professions and infrastructure related to transport (truck drivers and taxis, gas stations and auto shops, traffic police, etc.).

At the moment there are several scenarios for the introduction of automated transport [6-8]. Depending on the form of ownership, there are two fundamentally scenarios:

- private ownership of the vehicle, divided into controls without the external environment and with the help of the autopilot integrated into the general urban information environment.
- public form of car ownership, divided into the system of mass network taxi and autonomous driving in the public transport system.

These types of self-driving cars will affect different forms of the urban environment in different ways, so the article will be considered separately.

In the first scenario, when cars will still be privately owned, global changes are not expected. In a private house, where a parking space is located on a plot near the house, an ordinary car is simply replaced by a self-driving car. In areas with a higher density, it can be assumed that during the construction of multi-flat house, priority will be given to detached garage cooperatives, rather than built-in underground parking, so there will not be need for parking. It will be possible to call the car from the parking through the application on the phone. A similar situation will occur with public buildings. Self-driving cars will park itself in a remote parking lot and will come back.

In the second scenario, a new type of movement appears - an autonomous taxi system. This type can be considered as a logical continuation of an already existing carsharing system. These taxis do not work on certain schedules or routes, but are focused on demand. In this case, the car is in constant operation, that is more efficient. The next stage of this scenario is the integration of such a taxi into the

public transport system, thereby solving the problem of the “last mile”. Public transport will move passengers over long distances to the hub, and a taxi will deliver to the destination. All this can lead to a radical transformation of the public transport system. There are various forms of ownership of an automated taxi: public or private.

This use of AV can significantly affect the urban environment. It will be necessary to completely restructure parking as there will be no need for them. Parkings near houses can be renovated into pedestrian spaces or bicycle lanes. In residential areas with more dense buildings there will be no need for parking. After the car takes the passenger to the destination, travels to the next passenger. A similar situation will occur with public buildings. Parking will exist as charging stations on the periphery of the city. Self-driving taxis can increase group travel. Thanks to a similar structure of public transport, it will be possible to increase the accessibility of all areas of the city and increase the density of urban space [9].

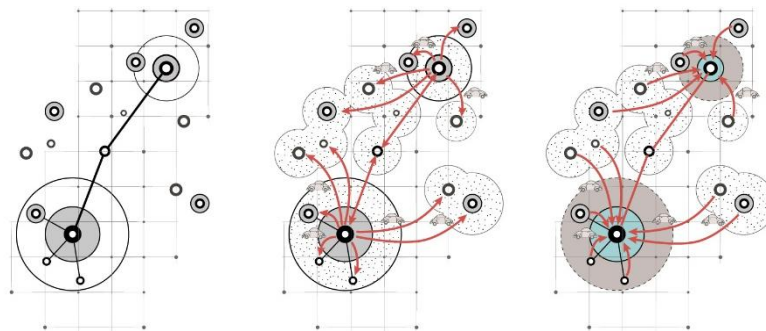
Common to both scenarios is the impact on the urbanization of the territory and road infrastructure. Some studies predict that with the advent of self-driving cars, interest in suburban residential areas will increase. Autonomous vehicles will give access to green areas with lower housing prices, but remote from the downtown, this can lead to the spread of cities and lower building density. All this creates additional costs for the maintenance of infrastructure. [10-20].

### 3. Discussions

According to the results of the study, three groups of principles of AV influence on the urban form can be highlighted:

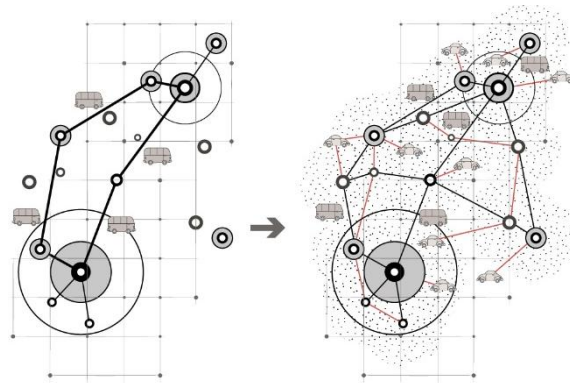
- Impact on urbanization.
- Impact on road infrastructure.
- Impact at the local level.

The first group of principles includes factors influencing the citywide structure. The introduction of AV can lead to urban sprawl and lower building density. On the other hand, AV can increase the density of buildings, making some areas more accessible (fig. 1).



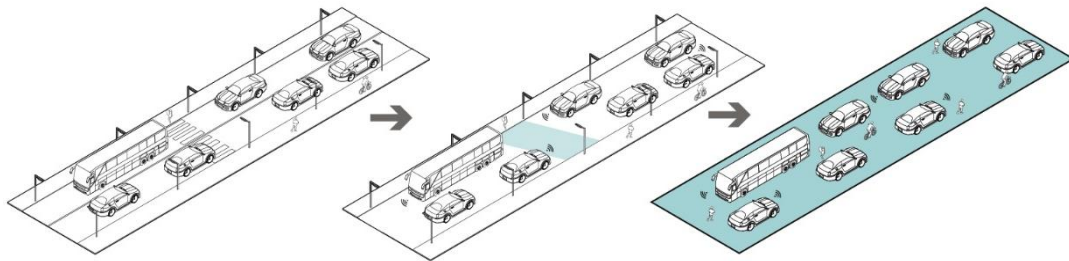
**Figure 1.** Effect of AV on building density.

AV can improve the public transport system, especially in suburban areas. With the formation of sustainable transport systems AV will solve the problem of the «last mile» (fig. 2).

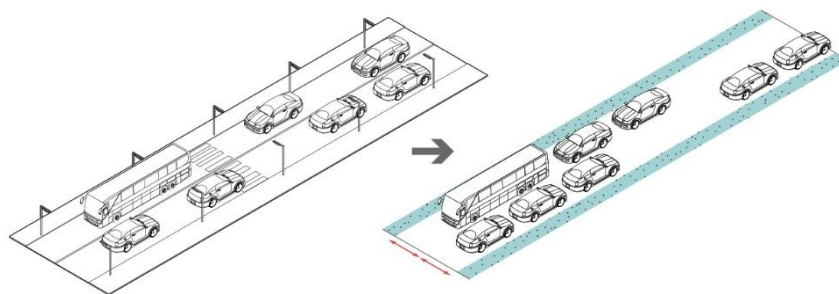


**Figure 2.** Effect of AV on the urban transport system.

The second group of principles includes factors influencing the use and physical change of street space. The introduction of AV will improve road safety and eliminate conflict between the driver and pedestrian (fig. 3). Complete replacement of conventional vehicles with AV will not only expand the sidewalks, but also completely eliminate the separation of cars and pedestrians on streets with low traffic. Uniform speed of movement and synchronized AV actions will improve traffic to flow without expanding roads. Also, the introduction of AV will reduce the width of the lanes and completely eliminate parking along the curb (fig. 4).



**Figure 3.** Transformation of roads and sidewalks in the implementation of AV.

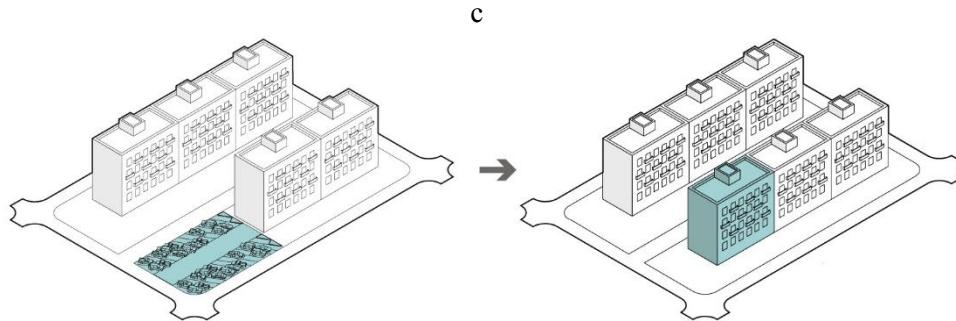


**Figure 4.** More efficient use of the roadway when implementing AV.

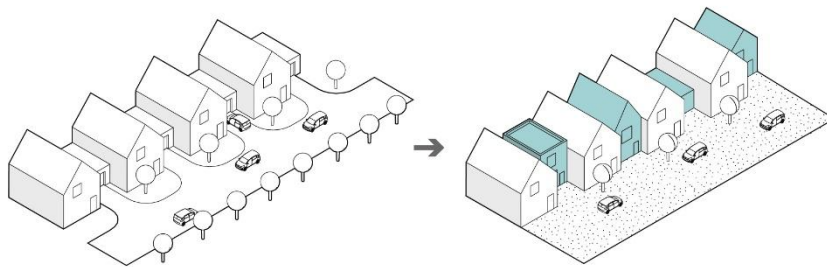
The third group covers more local changes: the impact on residential development at downtown and suburbs. With the advent of AV to reduce the need for parking, existing parking will need to be adapted to other functions (fig. 5). Renovation of parking in residential areas will increase the density of buildings. In the central areas of the city, parking can be converted into offices, housing, retail



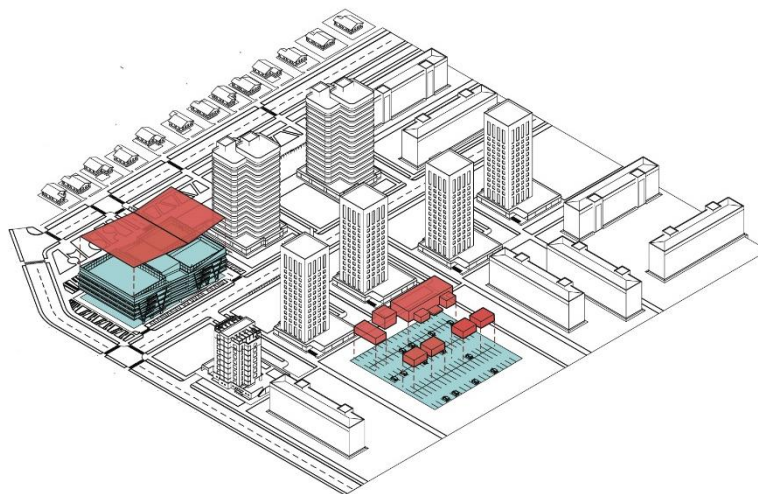
spaces or recreational spaces. It will be necessary to change the infrastructure related to the car: salons for sale, auto shops, and various services, gas stations, etc (fig. 6).



**Figure 5.** Effect of AV on residential areas.



**Figure 6.** Effect of AV on the suburbs.



**Figure 7.** Effect of AV on the downtown.

#### 4. Conclusions

AV can have a different impact on the urban forms, depending on the type and form of ownership. From the point of view of technological, legislative and economic changes, the first scenario is the easiest to implement, in which a simple car is replaced by an self-driving car. From the point of view of the urbanization of the territory, this study shows the need to promote the introduction of the second scenario, which will exclude private ownership of vehicles, which in turn will reduce their number. Self-driving technology will change the urban environment, and the changes will be irreversible, in order to avoid the negative consequences of the introduction of AV, we must now change the urban

infrastructure so that it meets the requirements of AV. Objects related to the transport infrastructure must be designed with the possibility of their further adaptation and reuse with other functions.

## References

- [1] UN-HABITAT 2015 Planning and Design for Sustainable Urban Mobility: Global Report on Human Settlements 2013 (New York City: Taylor & Francis Group)
- [2] Marshall T 2014 Future of Highways (London: ARUP)
- [3] Townsend A 2017 Taming the Autonomous Vehicle: A Primer for Cities (New York City: Bloomberg Philanthropies)
- [4] Corwin S, Vitale J, Kelly E and Cathles E 2015 The future of mobility. How transportation technology and social trends are creating a new business ecosystem (Deloitte University Press)
- [5] Heinrichs D 2016 Autonomous Driving. Technical, Legal and Social Aspects Autonomous Driving and Urban Land Use (Springer, Cham) pp 213-231
- [6] Mohamed A, Vitulli C, Slocum K, Herrero R and Zhu S 2018 Shifting Gears: An Urbanist's Take on Autonomous Vehicles (Watertown: Sasaki)
- [7] Isaac L 2015 Driving Towards Driverless: A Guide for Government Agencies (New York City: WSP Parsons Brinckerhoff)
- [8] Farah H 2016 State of Art on Infrastructure for Automated Vehicles (Netherlands: Delft University of Technology)
- [9] Van Acker M 2017 Highway x City: The Future of the Urban Ring road (Amsterdam: BNA Onderzoek)
- [10] Mearian L 2015 Computer World Researchers developing roads that charge your electric car while you're driving (<https://www.computerworld.com/article/2998356/researchers-developing-roads-that-charge-your-electric-car-while-youre-driving.html>)
- [11] McDonald S S and Rodier C 2015 In Road Vehicle Automation Envisioning Automated Vehicles within the Built Environment: 2020, 2035, and 2050 (Cham: Springer International Publishing)
- [12] Pandya S 2016 Adaptive reuse of parking garages (Alexandria: International Parking & Mobility Institute)
- [13] Jeekel J F 2016 Smart mobility and societal challenges: an implementation perspective (Netherlands: Technische Universiteit Eindhoven)
- [14] Mumford L 1958 The Highway and the City (New York: Harcourt Brace and World)
- [15] Roe Smith M and Marx L 1995 Does Technology Drive History? The Dilemma of Technological Determinism (London: MIT Press)
- [16] Jeekel J F 2016 Smart mobility and societal challenges: an implementation perspective (Eindhoven: Technische Universiteit Eindhoven)
- [17] International Transport Forum 2015 Urban Mobility System Upgrade: How shared self-driving cars could change city traffic (Paris: International Transport Forum)
- [18] Claudel M and Ratti C 2015 Full speed ahead: How the driverless car could transform cities (McKinsey&Company)
- [19] Henle S 2007 The Architecture of Parking (New York: Thames & Hudson)
- [20] McDonald S S 2007 The parking garage: design and evolution of a modern urban form (Washington: Urban Land Institute) pp 261-271