Outlook

The Shapes of Streets to Come – How New Transport Technology will Reshape Urban Space

By David M. Levinson and Kevin J. Krizek

Autonomous vehicles are coming. At their best, AVs are stimulating an impulse to drive genuine innovation. At its worst, they are a hubris that causes us to overthink the solutions to transport problems in cities.

Big changes are coming for how people will get around in cities across the globe. The most important change will hinge on the introduction of autonomous vehicles (AVs). Simultaneously, cities will witness the conversion of the vehicle fleet to being primarily electric-powered (from a grid rapidly converting to renewable energy and off-the-grid solar charging) and new ownership models like shared mobility become more common.

The overall pace of deployment of AVs and their effects will vary by the size of the city, the cost of labour, and the desire for politicians and their constituents to innovate. How all of these factors play out on the multiple stages and multiple scales (e.g. the neighbourhood, metropolitan, and national levels) will prove exciting to watch. The best part is that *you* not only get to observe how things will play out; *you* get to participate as well. We preview many of the prevailing tensions of this emerging landscape below.

Autonomous Vehicles

After decades of technological slumber in the automobile industry, self-driving cars are here. Rolling on the roads today in semi-urban environments are cars that can recognise speed limits and adjust their speed instantly. They can maintain a safe following distance from other cars, and brake when needed. They can even recognise the difference between cars, buses, and cyclists. The technology is at the cusp of being widely deployed, something that will take place over the next two decades. Significant *other* hurdles, however, lie ahead. These impediments include how cultures might adapt (e.g. how quickly will people surrender control, and their comfort with technology), legal regimes might change (e.g. standards, reconciling responsibility in crashes, the role of licensing), and street designs will be altered (e.g. the extent to which AVs will be apportioned separated lanes on different types of roads, and how soon human-controlled vehicles will be prohibited in places). We focus on the last hurdle here.

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One of the strongest but often unrealised arguments for the advent of AVs relates to street capacity. Where today a freeway travel lane is typically 3.6 meters wide, with AVs, a standard lane might only have to be 2 meters (just wider than the width of a full-size car or SUV). This alone nearly doubles capacity. Farther into the future, lanes might be dynamically resized rather than permanently fixed in paint. Being automated, these cars can trail one another more closely as well. Instead of following at two seconds or one-and-a-half seconds, they might follow at one second or less, increasing throughput.

Today the average vehicle carries only one or two people, yet the average vehicle has seats for four or six or eight passengers. The fleet is oversized, especially in the US. Americans have a propensity to buy large cars for the few times when they may need it. The extra seats, however, sit unused most of the time. Automation, combined with mobility-as-a-service presents opportunities for new vehicle forms.

New Types and Forms of Cars

Smaller one and two-person vehicles can be the new standard, and larger cars the exception, only summoned on demand when needed. In lower density areas, travel distances remain large, but the use of AVs will allow suburbs and small towns to wring out more road capacity, provide good arguments against road expansion, and claw-back space that has been given over to parking.

A city can start to realise large benefits because it can get more capacity out of that smaller vehicle, more energy efficiency, a greater range for the battery, and so on. One of the more noticeable elements will be a transformation of the shape of the car. Vehicles will begin to sport new designs whose markets will be defined by required use. Consider an enclosed motorcycle that's electric, quiet, safe, stabilised, and automated. It is safe because, not only is the vehicle designed well, with a roll bar and all that, and because it is

driven by a computer with nearly instant reaction times, but because all the other vehicles are also automated. Small cars require less space and it is easy to see how future cars will starkly contrast with their ancestors. Meanwhile, sensors and computers replace the human-facing control functions; electrification is changing the entire motor system, so future cars will be simpler to manufacture and maintain than the internal combustion engine.

Innovations in Related Modes
The complexity of how and when – not if – to accommodate AVs will be further complicated because other modes of transport are re-inventing themselves as well. Different types of mobility-as-a-service are coming on line. These include new forms of taxis and transit services that are both smaller and bigger than a standard bus. Taxis will be more extensively used because the vehicles are smaller and driverless, and so cheaper. In urban areas, there will be more frequent transit services in selected corridors, which will be less expensive to provide as labour is automated away. Elsewhere, today's infrequent bus and commuter rail services will be replaced by mobility-as-a-service type of options; instead of having a bus that comes once an hour, people will be using taxis - often single passenger taxis, maybe shared ride taxis. While the exact market configuration (who owns, who rents, who shares a ride, who rides alone) will be sorted out over time, it is clearer to see how, like today in Manhattan, people who live in dense cities won't be owning cars, but instead will subscribe to a service, buy the services on demand, or find it provided by the public as a "free" utility, like the elevator in an office building.

Role of Walking and Bicycling
Amidst this uncertainty, bicycling and walking will thrive for shorter and medium distance trips. These might be trips where people yearn for physical activity or just want to be outside. Their use will continue to be constrained by weather and hills, though e-bikes, with electrical pedal assistance, will mitigate some of that. This is one of the reasons we will likely see an increase in the attention devoted to physically powered movement for next few years. It is green and energy efficient. It makes many people feel better. Most importantly, bicycling and walking are modes that are relatively known and proven in selected markets.

All of this is to say that traditional modes, bicycling and walking will continue to exist and begin to thrive even in the US. This owes to increased population densities in central cities (and trip distances therefore decreasing), increased safety because AVs are less likely to kill them than human driven vehicles are, and a growing inclination to more fully connect with others and their environment.

Infrastructure Needs and Who Gets What Space
How will street space be appropriated in a manner that will allow multiple modes to harmoniously co-exist? Answers to this questions will play out differently between and within cities. Fundamental geometric limits ultimately dictate the usefulness of these improvements. Where the intensity of development is higher, several modes will compete for the same space. Different modes can safely mix in the same shared space at slow speeds, as is now found in historic sections of many European cities.

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Photo courtesy of the author
Kevin J. Krizek

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Further away from these cores in lower density areas, where space allows, the infrastructure provision for modes will be more segregated.

Typically, local municipalities operate the local streets and state or regional agencies maintain the connecting the backbone. On the backbone, we envision special (managed) lanes for automated cars for a period of time, just as today we have express, HOV, or high occupancy/toll lanes. It may even be the same lanes will benefit all users, as separated lanes will allow reaping the benefits of closer following distances than possible with mixed (human plus automated) traffic. As all vehicles become automated, all lanes will be managed.

Shapes of Streets and Shapes of Cities

The ability for cities to dynamically reconfigure lanes and repurpose streets will be the central challenge. The speed and manner in which cities and regions respond to the onset of these big changes will vary. Some places will move quicker than others. Politics and openness to innovation will be important. But ideas are light baggage, and successful policies will be quickly copied and emulated.

Shapes and patterns of development of communities determine how most people get around. The size and nature of buildings and roads are important. The prevailing perspective is that cities have evolved under different technological and political regimes; they therefore embody the DNA of their continents. Granting exceptions, North American cities have a DNA that is distinct from their Asian, European, or Latin American counterparts. Cities in Europe are smaller in size, they were mostly formulated in an era prior to automobile, and their networks for movement are more multi-modal. It's sometimes easier to get things done without a car, automated or not. Hundreds of European cities already have an extensive track record severely limiting automobile traffic in historic districts. The Italians call it the ZTL (Zona a Traffico Limitato). We expect European cities will be keener to take back even more street space from the new AV, and use it for landscaping, linear parks, cycle tracks, and high-frequency transit services. Places in other parts of the world will follow suit.

AVs and the Future of Cities

At their best, AVs are stimulating an impulse to drive genuine innovation that will make lives richer and more connected, faster and safer, and more productive. At its worst, they are a hubris that causes us to overthink and over-engineer the solutions to transport problems in cities. Either way, AVs are coming. It is just a matter of when and how.

Political and legal systems in cities will be forced to play catch up with technological systems. The cities that do will win the 21st century. The others are building unnecessary capacity justified by extrapolating the exhausted trends of the past. The aim of transport should be ensuring people and goods can reach their destination safely and efficiently. This requires focusing on what will improve access tomorrow, not what might have increased access yesterday. ▣

David Levinson and Kevin J. Krizek are the authors of *The End of Traffic and the Future of Transport*, available on Amazon Kindle and Apple iBooks.

David M. Levinson is Professor in the Department of Civil, Environmental, and Geo-Engineering at the University of Minnesota and will soon be joining the University of Sydney. He holds the RP Braun/CTS Chair in Transportation.

Kevin J. Krizek is Professor and Director of the Environmental Design Program at the University of Colorado-Boulder. He also serves as the visiting professor of "Cycling in Changing Urban Regions" at Radboud University in the Netherlands. Krizek was a 2013 fellow of the Leopold Leadership Program and was awarded a 2014 US-Italy Fulbright Scholarship.