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Rethinking the Street in an Era of Driverless Cars

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URBANISM NEXT | RESEARCH

RETHINKING THE STREET IN AN ERA OF DRIVERLESS CARS

Global citizens get few moments to rethink streets and make decisions that will both serve the basic purposes of transportation and address urgent challenges like climate change, rising obesity, social isolation and conflict—all while expanding opportunities for general happiness throughout society. Such a pivotal moment is upon us, as autonomous vehicles represent a potentially disruptive technology that can re-make the city for good or for ill. City planners, policy makers and community residents have a unique, and immediate, opportunity to rethink their streets with purposeful and creative consideration about how this critical public good may best serve the public for generations to come.

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> Planners and policymakers can seize the potential of autonomous vehicles to accelerate the transformation.

PURPOSE OF TRANSPORTATION

The next wave of transportation technology is coming quickly – the autonomous vehicle (AV) or driverless car.[1] This is the moment for all levels of government to revisit the fundamental purposes of transportation, to take stock of our transportation systems and policies, and attempt to do transportation better.

In particular, autonomous vehicles present new and unique opportunities for fresh thinking about how streets are used – by whom, how, and to what ends. The bulk of transportation planning over the last half-century has conflated the basic purpose of transportation – providing access to destinations – with the simplistic goal of moving motor vehicles at high speeds with limited impedance.[2] Streets have been designed and prioritized for movement of cars, with other road users treated as an afterthought – if at all.[3]

As evidence mounts and consensus gathers that there is no way to build our way out of congestion, cities have begun to rediscover the benefits of walking, biking, and transit.[4] They also have begun the slow process of re-arranging land uses and updating zoning codes to promote the fundamental purpose of transportation through these non-auto modes.[5] The general shift toward urbanism underway across the U.S. is making walking to many destinations easier, more enjoyable, and more widely accepted as natural and beneficial.[6]

At the same time, progress to date towards sustainable transportation has been slow. In this paper, we show how planners and policymakers can seize the potential of autonomous vehicles to accelerate the transformation.

History tells us that a concerted effort will be needed to channel the potential of autonomous vehicles towards sustainable transportation.[7] The last major technological revolution in transportation – the rise of the motor car – saw parked cars spread out to fill every corner of public space, and a rising death toll as cars sped down streets that were historically places for walking, children's play and social interaction. Enormously high rates of death and injury from automobile crashes and the allocation of vast amounts of land to move and store vehicles continue to dominate life and urban form throughout most communities today.

Autonomous vehicles offer an entry point into society-wide conversations about transportation, the functions of cities, the use of streets, and how all this impacts equity, environment, social cohesion, happiness, economic health, resiliency, and more.[8-13] As a new

transportation technology, AVs are likely to disrupt long-established patterns of urban development, transportation choices and the use of streets. Cities wield the power—most critically, by regulating one of their largest assets, the street—to channel this disruption in support of wider social, environmental and economic goals. The choices that cities make over the coming years will set the terms of the sustainable transportation debate and establish priorities and practices of society for generations to come.

FOCUSING ON THE RIGHT-OF-WAY CANVAS

This policy paper focuses on the primary concept of the street as space that can be repurposed – real estate that can be allocated in similar or different ways than done currently. Cities generally refer to this publicly owned and regulated space from one side of the street to the other as the right of way (ROW). Our focus is on the centrality of the ROW in dictating many other community functions and values – transportation and otherwise. And our particular bias is to focus on the opportunities that AV technology is likely to create to rethink how the ROW is allocated, so that our communities can meet their substantial and unique environmental, social, and economic challenges. This perspective is distinct from many other current publications and reports that have expounded on transportation innovations or revolutions that are occurring in parallel with the evolutions of autonomy and artificial intelligence.[14-24]

Focusing on the ROW allows us to avoid some of the speculation about vehicle sharing and the possible over-optimism among many city planners about the extent to which a shared-use model will supplant private car ownership (25), because the ROW will be impacted in either case. Further, questions of buying vehicles or buying rides are largely out of the control of cities and in the domain of auto makers (sometimes called OEMs, or original equipment manufacturers) or transportation network companies (e.g., Uber and Lyft).

WHAT STREETS PROVIDE:

Transport – to move people, freight, information

Accessibility to goods, services, activities

Equity of access and impact – highways that disrupt vs streets that connect

Economic and social exchange

Space for community infrastructure, e.g., utilities and ecosystem services

Public and social space – plazas, boulevards, waterfronts

Cultural and artistic canvases

AVS AND THE OPPORTUNITY TO RETHINK STREETS

While safety is often cited as a primary anticipated benefit of autonomous vehicles, one of the other clearest socially beneficial outcomes is the potential space saved by smaller vehicles traveling more closely together and in service for more hours. Without delving into the details of how vehicle storage is likely to shift in space (to peripheral locations) and in time (based on peak hour needs), we can anticipate that AV penetration will free up street space in two ways:

1. **Lanes** – both *number* and *space* – may be reduced, as many AVs will be narrower, require less space between vehicles, and will be capable of sharing opposite-direction lanes as available. If the AV future is substantially populated by shared fleets instead of individual ownership, then the actual number of vehicles on the road may be substantially lower, with the follow-on effect of requiring still less lane space.

2. **Parking** *demand* on streets may be reduced by decreasing vehicle size, by ownership giving way to renting or sharing models, and by a shift to curb passenger delivery paired with remote storage. Parking *supply* may be removed by policy or by market mechanisms – reducing the need for on-street parking to store vehicles.

Reduced demand for both storage and travel space in urban areas presents a rare opportunity to reclaim physical space for other purposes. How might that liberated space be reallocated? Non-auto transportation, infill housing, small-scale retail and commerce, urban ecological corridors, recreation (active and passive), and other public and social purposes all merit consideration. Schools could extend their presence and activities into former parking or travel lanes; household gardens or community agriculture could fill small spaces; art or cultural activities – creation, performance, instruction – could find a platform. When given a newly blank canvas, our communities may be quite creative with imagining how to fill it.

This potential to reclaim public space currently dominated by the movement and storage of vehicles exists regardless of how AVs are fueled (electric, fossil) or whether they are individually owned, shared, or rented. At the same time, the ownership regime will dictate the kind and level of space savings to be reaped, with a shared model

offering more profound reductions in parking demand – making this a particular point of interest to planners and policy-makers in the run-up and transition to AVs.

With our focus on the ROW and possible alternative uses that may become possible with the rise of AVs, the following pages delineate a series of hypothetical street sections for both a prototypical urban and a residential street, and explores how this valuable real estate could be transformed in an AV future. The ReStreet design tool was used for the illustrations (26, 27).

URBAN ARTERIAL STREET DESIGN

Four-lane streets with on-street parking are a common urban street type. Such streets juggle the competing demand of moving large volumes of traffic, providing parking, and providing pedestrian access to local businesses. A typical design has two lanes for vehicles in either direction, on-street parking, sidewalks, and perhaps a center turn lane or some space for trees or other amenities.

A first, simple step is to reduce the widths of the lanes to 8' – a width that is easily navigable by autonomous vehicles and, at slower speeds, by human-driven vehicles. Meanwhile, the ability of AVs to park remotely means that less parking is required on-street. Simply reducing the width of the drive lanes to 8' and retaining one lane of parking yields 24' feet of ROW.

"Cities can be purposeful about how its public right of way serves the public; but if they are not – the AV technologists will do it for them. The time for cities to plan and act is now."

> A first, simple step is to reduce the widths of the lanes

Further reductions can be gained by removing a second lane of parking, as AVs can be automatically parked remotely (if they are individually owned) or may not park at all (if they are shared, and immediately depart to serve another user). Or, one additional travel lane could be removed, leaving one in each direction, along with a reversible or flexible lane that can be used for passing or peak-hour flows, easily navigable with AV technology. With either of these scenarios, another 8' of ROW can be liberated, creating a full 32' to reallocate.

The key question for cities is what should or could be done with this ROW opportunity. Should additional travel lanes be created in keeping with the current, albeit increasingly discredited, paradigm of expanding capacity to congested roads? Should space be dedicated to transit-only or protected bike lanes? Where will AV drop-offs take place? Should the pedestrian realm be enhanced? Or are there new opportunities to imagine, from infill housing to ecological corridors to new social spaces (parklets 2.0)?

Driveways also can be expected to decline – in number and in size – as the need to accommodate building-adjacent parking drops substantially. Driveways will likely be used primarily for freight/goods access, with attendant decreases in frequency and increases in flexible control over use. One result of a driveway decline would be the significant enhancing of any pedestrian and bicycling environment as significantly fewer vehicles will cross their paths.

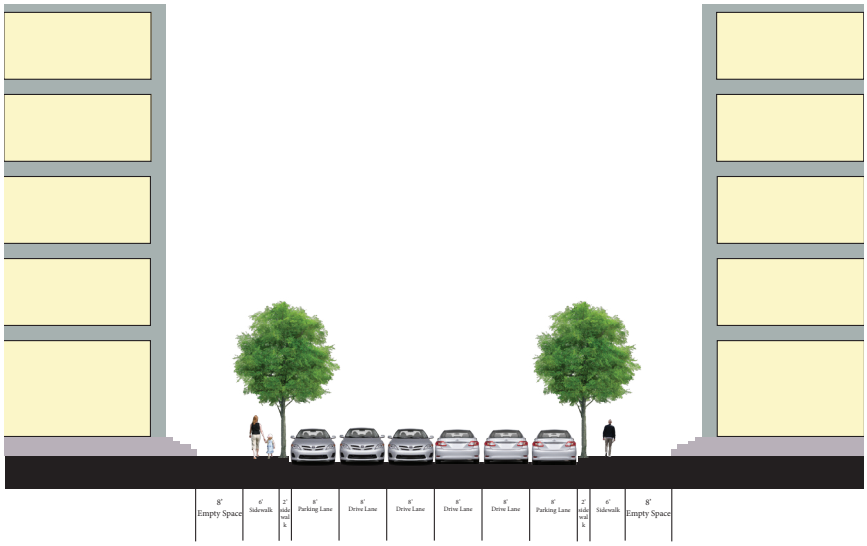
It is clear that streets may evolve to become very different from their current form. But doing anything different than the status quo requires a purposeful approach toward taking advantage of this unique moment of ROW liberation. We suggest that cities use this opportunity to flip the paradigm from the car as the most important actor on a street, to walking and biking holding this prime status. Thus, the order of priority we suggest when re-purposing ROW for transportation purposes is as follows:

- Sidewalks and paths
- Protected bikeways
- Transit lanes
- Curbs and other edges for transit stops and drop-off zones
- Vehicle lanes—travel and parking

Integrating these elements in this priority ranking may be a good way to begin planning for streets that accommodate AVs but at the same time prioritize sustainable transport. The following images are a stepwise progression of possible ways to rethink urban ROW in an era of autonomous vehicles.

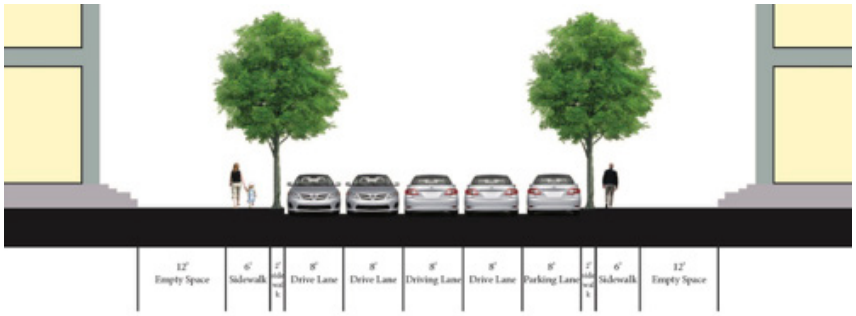
STEP 1: THIN THE LANES – GAIN 16'

The first step is to reduce the travel lanes to 8' each, which can be navigated by AVs and at slower speeds by human-controlled vehicles.



STEP 2: REMOVE A PARKING LANE – GAIN 8' MORE

The next consideration is to reduce on-street parking by half, which might be a continuous lane on one side of the street, or a design that alternates parking from side to side along a corridor.



URBAN STREET DESIGN SUMMARY:

STEP 1: Thin the lanes

STEP 2: Remove a parking lane

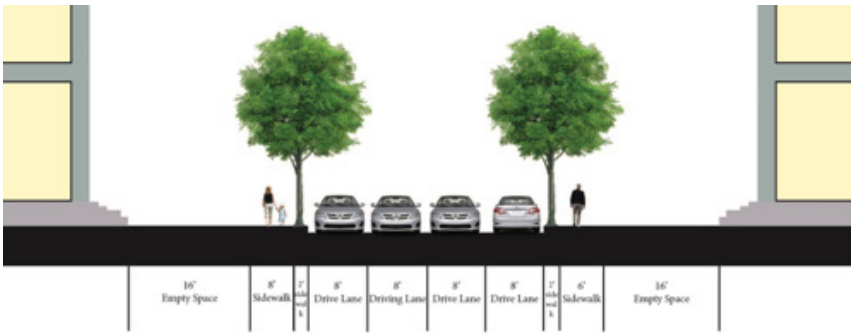
STEP 3: Remove another parking lane

STEP 4: Share travel lanes

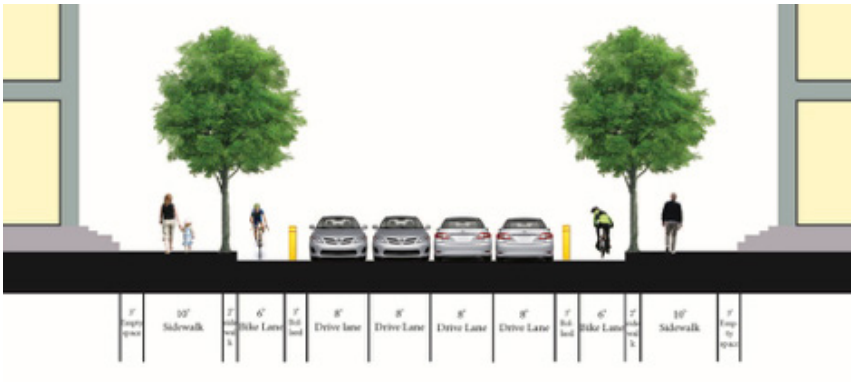
STEP 5: Rethink radically

STEP 3: REMOVE ANOTHER PARKING LANE – GAIN 8' MORE

Reducing an additional parking lane may be possible because AVs can be automatically parked remotely, could be put in continuous circulation by an owner, or could move on to provide a ride for a different passenger.



One option to begin utilizing the liberated space is to add modest, protected bikeways in both directions, which would provide the type of bicycle infrastructure that appeals to the greatest number and types of riders – and has the potential to recruit new riders.

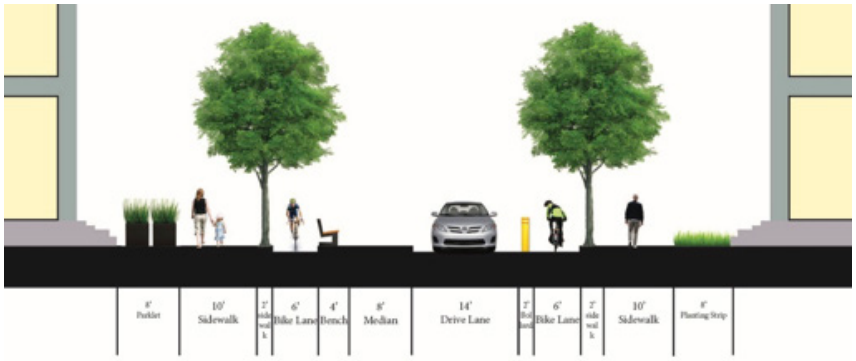


STEP 4: SHARE TRAVEL LANES – GAIN 8' MORE

Reducing an additional vehicle travel lane may be possible because AVs travelling in both directions can share a middle lane when space is available.

STEP 5: RETHINK RADICALLY #1

Under some scenarios (autonomous fleets) or in some locations (urban nodes), streets may be used completely differently than they are today. Combined lane and drop-off space may provide flexible AV and transit priority space, while allowing for robust space for walking, biking, ecological services, and social functions. The street could be 're-claimed' from a place dominated by the movement and storage of vehicles to one that preferences the movement and enjoyment of people.

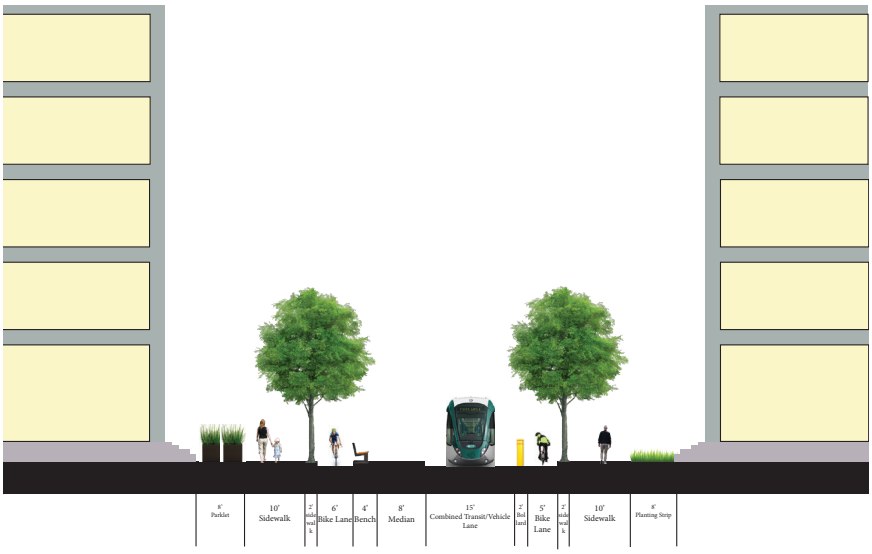


> **Combined lane and drop-off space may provide flexible AV and transit priority space.**

> Residential streets offer even more exciting possibilities to repurpose street space

STEP 6: RETHINK RADICALLY #2

In higher-density corridors, transit will remain a space-efficient form of transportation, and re-allocating street space and dedicating some to exclusive transit use will only enhance its efficiency. Driverless transit will also significantly decrease operational costs, allowing for transit vehicles to run for more hours per day and more frequently, further enhancing the quality and efficiency of transit in particular corridors.



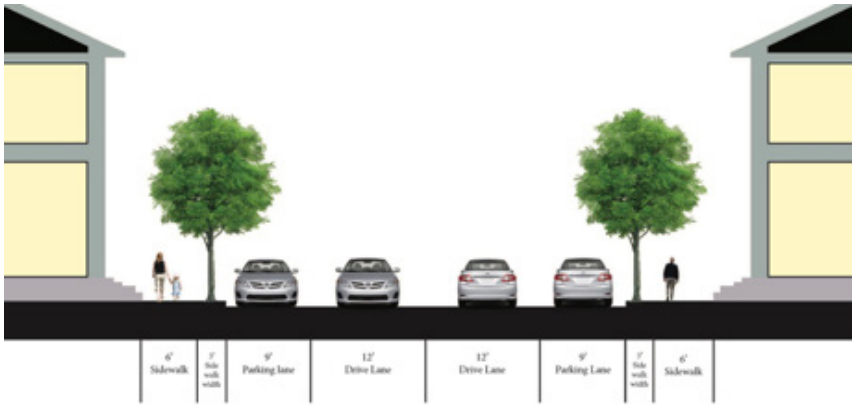
RESIDENTIAL STREET DESIGN

Like urban streets, residential streets in some neighborhoods have the potential to be completely different in the future. Reducing and combining lanes has the potential to make the public right of way safer and accessible to more people for more uses. Sidewalk- or bikeway-adjacent lanes, which previously may have served as parking lanes, may be repurposed for other uses – or they may serve as intermittent catchment zones as AVs move through and respond to the environment, and need extra space to load, unload or pass.

Thus, residential streets offer even more exciting possibilities to repurpose street space, given that the primary purpose of such streets is usually access, rather than through movement. Similar to the urban prototype, as space previously allocated to lanes and parking becomes free, it can be apportioned to other travel modes. Parking needs in residential areas also can be expected to decrease, and may result in re-purposed private driveways and garages, while former on-street parking becomes publicly available for re-use.

TYPICAL RESIDENTIAL STREET CROSS-SECTION

A typical residential street cross-section includes on-street parking on both sides of the street and usually enough street width to accommodate three lanes of moving vehicles, although only a single 'lane' in each direction is used. In most residential streets, it is a rare event to have two opposite-moving vehicles pass each other on any given block. Moreover, since most properties are required to have off-street parking, most residential streets can already be considered significantly overbuilt in terms of vehicle infrastructure. The rise of autonomous vehicles will only make this mismatch between supply and demand more apparent, raising opportunities for creative retrofit.

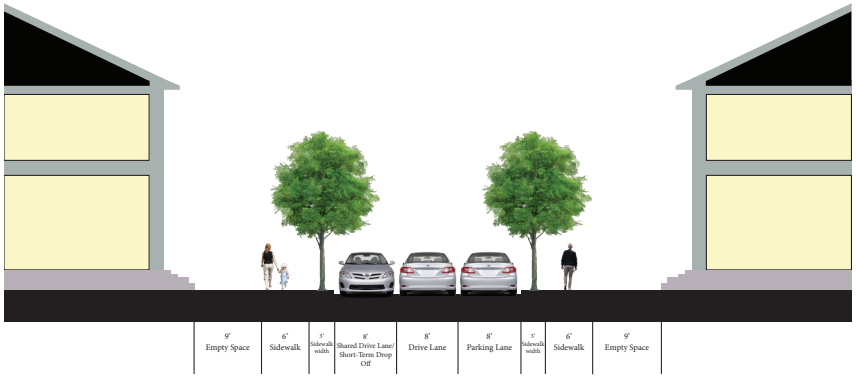


RESIDENTIAL STREET DESIGN SUMMARY:

STEP 1: Right size the travel space
STEP 2: Remove on-street parking
STEP 3: Remove a vehicle lane
STEP 4: Radical re-thinking

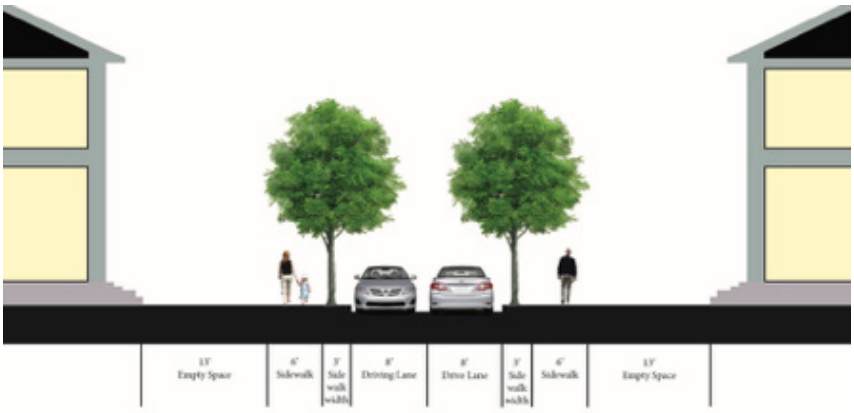
STEP 1: RIGHT SIZE THE TRAVEL SPACE – GAIN 18'

Given that most residential streets rarely have opposite-moving vehicles pass each other on a block and that most properties have off-street parking, the first opportunity is simply to narrow the streets for vehicles and increase the space for other uses. Similar to an urban street, this step is achieved by reducing travel lanes to 8' each, and reducing the parking by one lane – again whether one continuous lane or an alternating pattern. This change can happen now in many places, independent of any consideration of AVs.



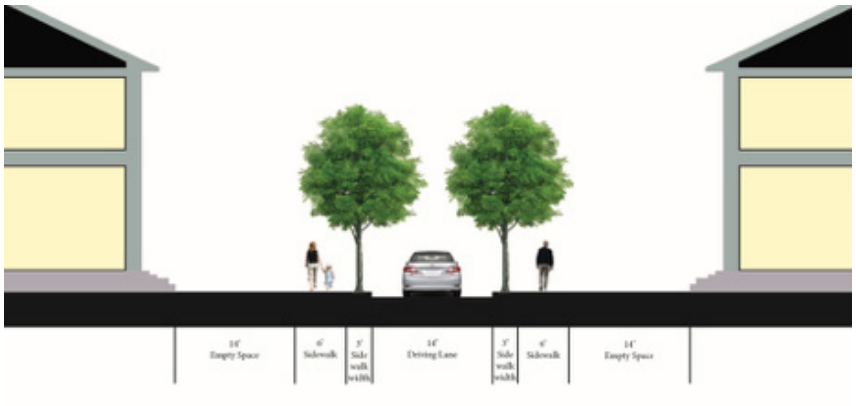
STEP 2: REMOVE STREET PARKING - GAIN 8' MORE

Reducing the lane widths to 8' and eliminating the remaining on-street parking recaptures a total of 26' of ROW. In residential areas, the driving lane can also be used for pick up and drop off, given that volumes are usually low and AVs (and human drivers) can navigate the ambiguous spaces created. Off-street parking could be used for short- or long-term parking, and any excess off-street parking may become a commodity for short-term rental (similar to an extra bedroom offered on AirBnB) or be completely re-utilized for non-auto use where individual auto ownership gets replaced with other transportation options. On busier residential streets, a different configuration may be more appropriate.



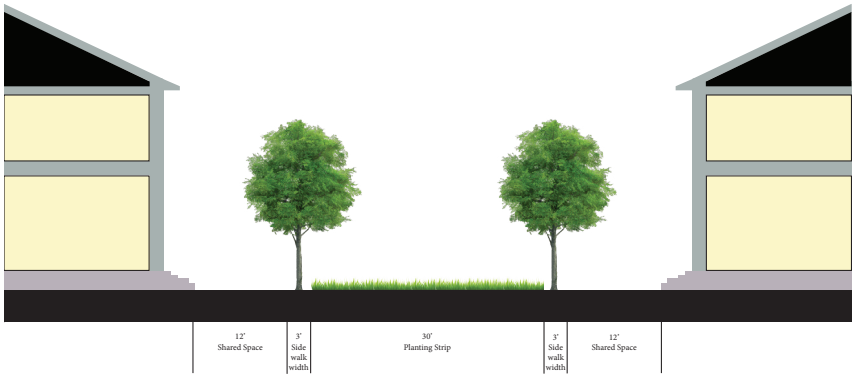
STEP 3: REMOVE ANOTHER LANE - GAIN 8' MORE

Removing an additional vehicle travel lane may be possible, if vehicles are able to yield to oncoming traffic. Such "yield streets" are already commonplace in European cities and many historic residential districts in the United States. Further, streets will likely begin to function as more of a network in an AV future, eliminating the need for two-way traffic. The street as well as the space liberated can be used for shared space for bicycles, pedestrians, and neighborhood amenities, including play areas and green space.



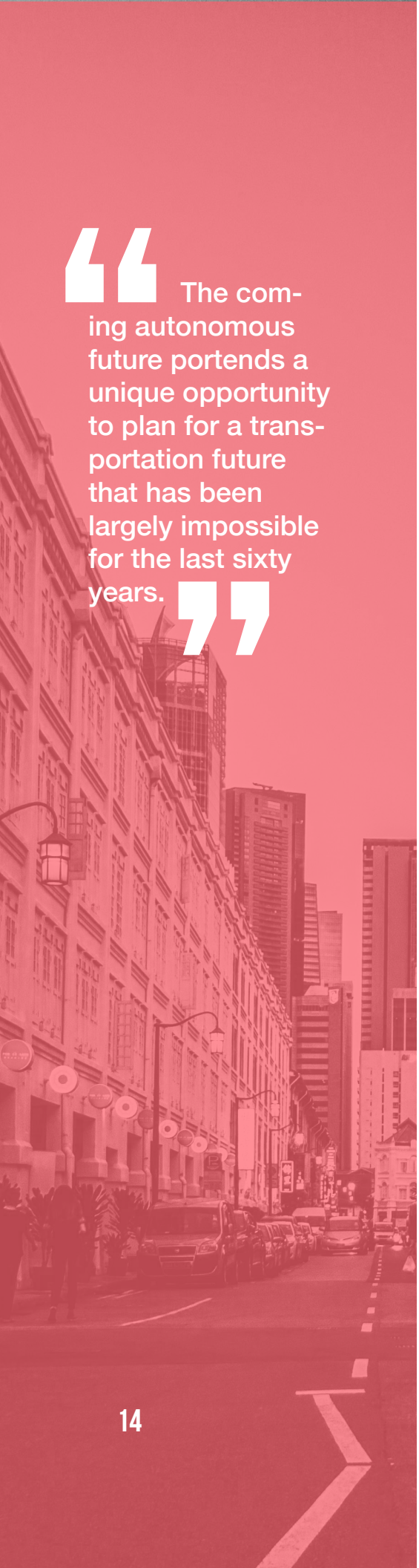
STEP 4: RETHINK RADICALLY #1

Residential streets will evolve alongside AVs and much of the existing public right of way may be available for uses that better serve the public at the neighborhood level. Eventually, reclaimed street "real estate" may transition to other uses, including open space for recreation (active and / or passive), infill housing and small-scale retail and commerce, public and social space. Already most residential streets are vastly overbuilt and underutilized and there is the danger that the AV future will only exacerbate this waste of the public's land. The image below essentially reflects an opportunity to 'start over' with residential streets. Residents or city planners offered such a blank canvas would not likely produce results that look like today's street cross-section, which reflect earlier decades of transportation and land use principles that no longer serve our needs and aspirations.



5 Principles for Street Design in an Autonomous Future

- Stop expansion and start deconstruction
- Rethink streets, again
- Prioritize human travel
- Price the street
- Experiment and start now



> The coming autonomous future portends a unique opportunity to plan for a transportation future that has been largely impossible for the last sixty years.

A TIME TO ACT

While AVs may not inherently change the layout of the street, they are likely to alter how space is allocated because of changing parking demand, possible changes in vehicle ownership rates, the increased efficiency of autonomous transit, and the increased space-efficiency of the vehicles and vehicle operations. The changes ushered in by these new and disruptive transportation technologies, and the anticipated ubiquity of AVs within ten years, present an immediate and urgent need for communities to clarify their values and ensure that the AV future enhances – rather than diminishes – those values. The city's largest public asset – the public right of way – is one of the most profound opportunities AVs present to reimagine transportation systems and rethink how the public right of way may best serve the public.

Because AVs are a new and captivating technology, they represent an important moment for educating and energizing public audiences on the topic of transportation. Planners and policy makers can – and should – harness this energy. Cities can take action now to accelerate progress toward their sustainable transportation goals while simultaneously planning strategically for an AV future.

What we want out of our streets has not changed – we want to efficiently, comfortably, and safely access the destinations we value, and to enjoy streets as public spaces as places to gather or play or build community. Rethinking our streets is not a radical idea, as observed in a broad movement in the last twenty years to improve streetscapes and make them more accessible for walking, biking, and transit use. However, AVs represent more than an incremental shift in how we consume transportation and use the land in our communities. As we have illustrated in our deconstruction exercise, most existing street design principles espoused by organizations like the National Association of City Transportation Officials or Institute of Transportation Engineers still hold in an autonomous future. What is qualitatively different? The coming autonomous future portends a unique opportunity to plan for a transportation future that has been largely impossible for the last sixty years.

Streets are complex systems that can evolve – and now is the time for this evolution to accelerate. Planners should not wait for certainty about how technology will develop, but deploy sustainable transportation solutions now. These may be either incremental or broad-reaching, but should push streets toward this evolved sustainable travel paradigm. Expending the effort to plan and strategize before AVs hit the streets is critical. Cities can be purposeful about how its public right of way serves the public; but if they are not – the AV technologists will do it for them. The time for cities to plan and act is now.

ABOUT THE AUTHORS

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ABOUT URBANISM NEXT

Urbanism Next is an applied research and policy program of the University of Oregon's Sustainable Cities Initiative and focuses on the impact of autonomous vehicles, e-commerce, and the sharing economy on the form and function of cities. Additional reports and related content are available at urbanismnext.com.

ABOUT THE APRU SUSTAINABLE CITIES AND LANDSCAPES RESEARCH HUB

This white paper was conceived of during an intense multi-day work session organized by the Association of Pacific Rim Universities (APRU) and the University of Oregon through the Sustainable Cities and Landscapes Research Hub at its first annual gathering in September, 2017.

The APRU Sustainable Cities and Landscape Research Hub was set up in response to the increasing concerns about the sustainability of cities given rapidly increasing global population and urbanization. The Hub engages with cross-disciplinary experts, government officials and external organizations to consider Asia Pacific cities in the context of their many landscape interdependencies, including services, networks and systems, and to initiate solutions and policy interventions.

Established in 1997 by the presidents of UCLA, UC Berkeley, USC and Caltech, APRU has over 45 research university members throughout the pacific rim. APRU brings together the region's leaders and brightest minds to address the social, economic and environmental well-being of the Pacific Rim, and is the only network of leading universities linking the Americas, Asia and Australasia.

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