ACCELERATED

A DRIVERLESS VISION FOR COLUMBUS

Autumn 2017


Photo Credit: Nextec

EXECUTIVE SUMMARY

Autonomous Vehicle technology has the power to radically transform our cities and upend the last 70-plus years of urban design and development practices. With rapid advances in data processing speeds, mechanical design innovations, and billions of dollars being invested across the mobility industry, the coming adoption of Autonomous Vehicle (AV) and Connected Vehicle (CV) technology is inevitable.

As we contemplate the possibilities, the promise of addressing many of planning's most stubborn problems is tantalizing. Reduced congestion, urban densification and walkable neighborhoods, better and more mobility options for underserved populations could result - and all while eliminating most of the now 40,000 annual roadway fatalities occurring in the US alone.

The danger is that this same technology, if unchecked by policy and planning, may also exacerbate these and other issues. Challenges could include increased sprawl, added congestion from a spike in vehicle miles traveled (VMT), real estate instability, degradation of urban form and equitable access to mobility.

For this studio, this group of students took on an exceptional challenge. Unlike most planning efforts that fundamentally rely on existing conditions and successful precedent; AV technology implementation has yet little concrete information. Using a combination of research, planning knowledge, stakeholder input, and informed extrapolation, the team developed a fascinating snapshot of the possibilities for downtown Columbus, Ohio. Taking this limited geographic area with its large economic reach, the class analyzed the potential development shifts and urban design possibilities. Coupled with a proposed a set of policy recommendations, this report illustrates both the rapid ways this city, and all cities, will change, and what initial steps planners must take to guide the coming revolution in transportation.

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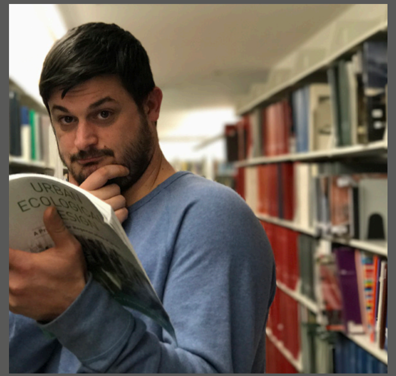

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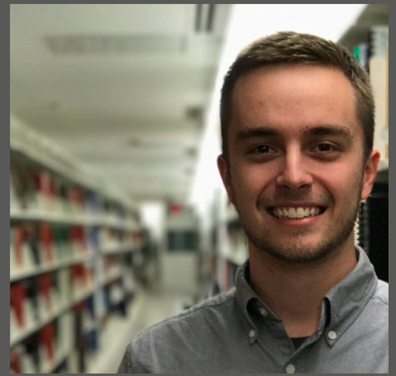

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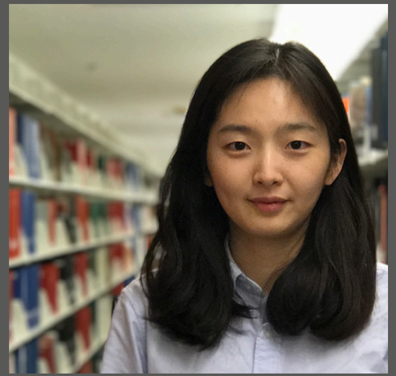

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INTRODUCTION

WHAT IS AN AUTONOMOUS VEHICLE?

Autonomous vehicles (AVs) come in a variety of forms, but they are all essentially vehicles that do not require a human in order to perform driving tasks.

GOAL:

Understand how autonomous vehicles could influence the course of development in Downtown Columbus in the next 15-40 years

OBJECTIVES:

- Understand the state of current AV industry progress to predict when and how quickly wide-spread use will be common.
- Understand current parking patterns in the Downtown district to determine how AVs are likely to affect future parking planning. This will include recommendations on the changes to future demand of spots and suggestions on future development of unnecessary parking.
- Understand current traffic patterns in the Downtown district to determine how AVs are likely to affect future traffic planning. This will include recommendations on changes to street configuration and the number of lanes needed.
- Determine what effect AVs will have on public transit and how the City can best utilize the technology to improve the transit network.

General advantages of AV

Our current local transportation system in Columbus, which mostly relies on cars and trucks on roadways, is adequate but lacks efficiency. Traffic congestion, the need for large parking infrastructure, and human error, to name just a few. The implementation of autonomous vehicles (AVs) is an advancement that will easily succeed due to the fact it improves many elements in transportation, and eliminate some of the issues. In general, improvements resulting from an AV system include[1]:

PARKING

This is the significant factor. Parking requires many resources and has many negative impacts on a city. With large-scale adoption of AV, parking can be reduced and cities can begin reclaiming land and streetspace. All of the extra parking space that becomes obsolete can be redeveloped into more productive space. Significant time is added to commutes in the name of parking, significant land and portions of streets are needed to provide parking spaces, and parking garages are massive structures that are generally used for the one purpose.

ACCESS

There are many people that are not able to drive due to factors such as age and disability. These residents would have access to transportation with AV, which would bring increased social equity.

SAFETY

Humans error is the cause of many accidents, but we tend to view this as an unavoidable cost of getting from point A to point B. There is a better, safer world on the horizon; a world of self-driving vehicles. The technology will always have proper reactions, at a much shorter time than humanly possible.

COMMUTE

Commuting in a driverless world will be more efficient in several ways. The time in the vehicle can be spent doing something other than driving, for one thing. A fully AV system will also require less time in a car, because optimal roadway efficiency can be achieved.

SPACE

The potential environmental impact of this element is exciting. AV have the potential to make ridesharing cheaper than ever. If ridesharing services became cheap enough, the number of solo-occupant vehicles on the road will decrease. impacts of less total cars could include no need for certain lanes, a system of optimal efficiency without compromising commute time, etc.

COST

As with any technology, cost will decrease with time. The certain future embracing electric vehicles goes hand in hand with their inevitable autonomy. Electric cars are more efficient to create and fuel, and are expected to become cheaper for consumers. In addition to this, ride share systems, and the possibility of less car ownership could drive prices down.

Levels of autonomy

1 FUNCTION-SPECIFIC AUTOMATION

Automation of specific control functions, such as cruise control, lane guidance and automated parallel parking. Drivers are fully engaged and responsible for overall vehicle control (hands on the steering wheel and foot on the pedal at all times).

2 COMBINED FUNCTION AUTOMATION

Automation of multiple and integrated control functions, such as adaptive cruise control with lane centering. Drivers are responsible for monitoring the roadway and are expectedto be available for control at all times, but under certain conditions can disengaged from vehicle operation (hands off the steering wheel and foot off pedal simultaneously).

3 LIMITED SELF-DRIVING AUTOMATION

Drivers can cede all safety-critical functions under certain conditions and rely on the vehicle to monitor when conditions require transition back to driver control.

4 SELF-DRIVING UNDER SPECIFIED CONDITIONS

Vehicles can perform all driving functions under specified conditions.

5 FULLY SELF-DRIVING AUTOMATION

Vehicles can System performs all driving functions on all normal road types, speed ranges and environmental conditions.

From NHTSA[2]

Models of adoption

1 PERSONALLY OWNED

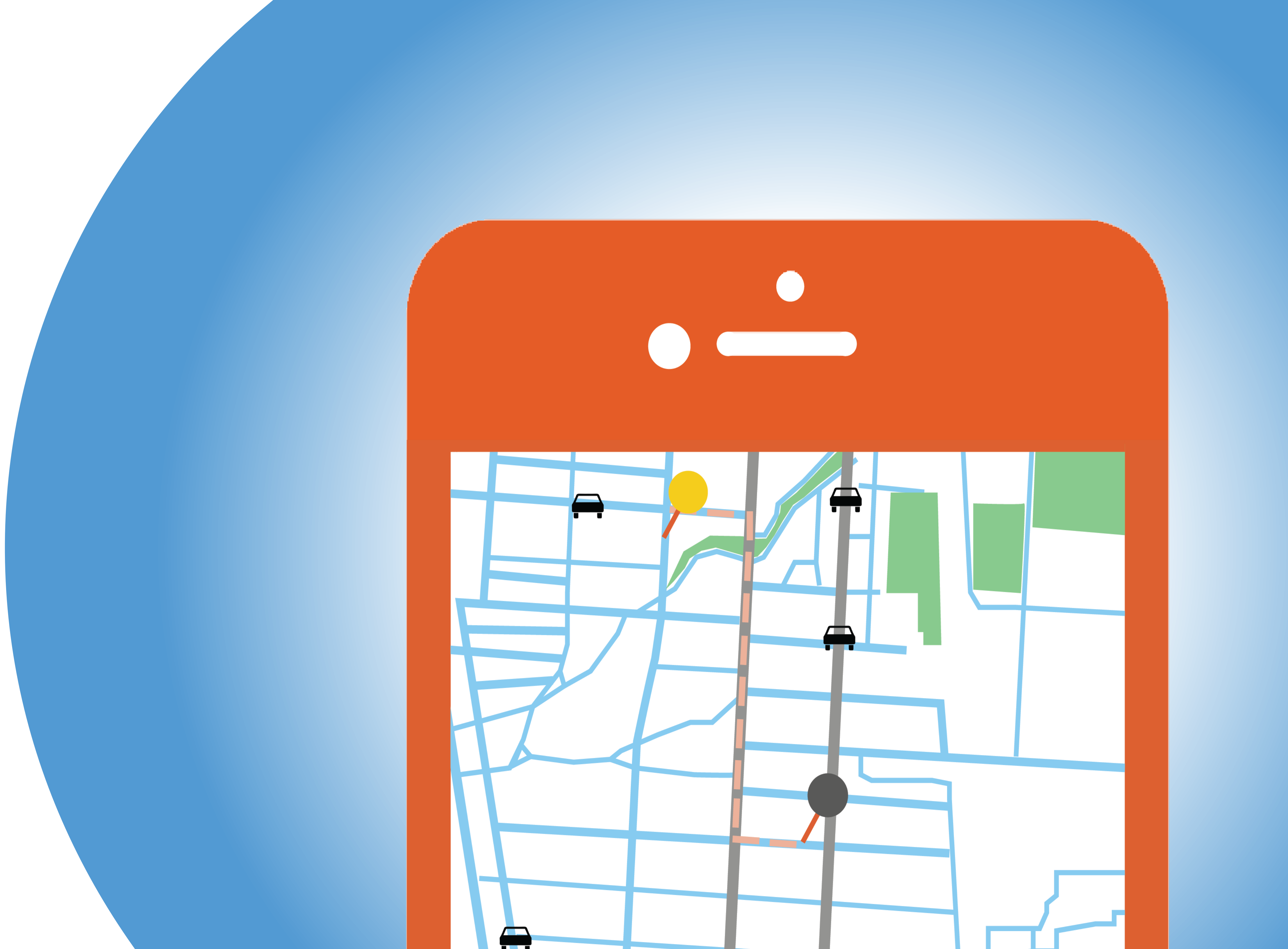
Under this model, individuals would purchase their own AV for personal use. The main difference between this model and the current non-AV model is that parking would likely shift location. With the vehicle being able to drop its occupant off at the door, it could park itself outside of the downtown area. Potentially, the vehicle could even drive itself home after dropping its occupants off at their destination.

2 SHARED

This model works with the assumption that AV technology would make transportation as a service (TaaS) very cheap, since most labor costs are removed. If TaaS becomes cheap enough, downtown residents and workers may not have to purchase their own vehicles and will instead share vehicle ownership. For example, once a vehicle drops an employee off at work, it may redirect and pick-up a student who is traveling to school. Under this model, parking in the downtown would be less necessary because the vehicles would ideally be in use throughout the day. Another major benefit of the shared model is that many people who currently do not have access to a vehicle for their own use, whether due to finances, age, or disability, would gain access to mobility.

3 SHARED AND POOLED

This model is very similar to the shared model, except that people would actually ride with each other. This model would have all the benefits of the shared model, but could also reduce Vehicle Miles Traveled (VMT). VMT could reduce due to the total number of vehicles on the road being decreased. In addition to all the benefits of a shared model, a shared and pooled model would decrease traffic congestion and cut down on pollution. However, it is also noteworthy that each individual vehicle would be traveling more which could shorten the lifecycle of a typical vehicle.



STAKEHOLDER INTERVIEWS

The team undertook a series of stakeholder interviews, which contributed to many of our assumptions about the future of Columbus and the resulting ideas put forth in this plan. Each of the following interview summaries provides a list of key points the team took away from speaking with each stakeholder.

Tyler Steele *General Property Manager of the Huntington Center*

With a thorough knowledge of buildings and leasings in downtown Columbus, as well as their connection to available transportation options; Mr. Steele provided insight into a vision for the future of AVs as they relate to transit and large business centers.

KEY POINTS

- The Huntington Center has about 1 million square feet and 3500-4500 people who need to get into and out of downtown every day. With 1300 parking stalls; 1/3 of workers there can get a parking stall, and they pay $200-300/month for it. However, four tenants of the Huntington Center relocated to the suburbs, Easton, home officing, and/or co-working in the last few months because employees were tired of traffic.
- AVs solve the parking problem, but don't solve the problem of traffic. To fully make use of a new system, and make travel more efficient, mass transit must be a part of the equation.
- AVs are best suited for first and last-mile use. Getting to or from a central transit location but not as the primary transit option for the entire trip.
- Wants to redesign Huntington Center to be more friendly in appearance.
  Building would have more places to intermingle and wait. These places could be useful for people waiting to be picked up by AV.
- Pickup-drop off facilities could take on several different forms:
  - Loading docks
  - Pedestrian malls
  - Valet areas
  - Corridors in back alleys
  - Parts of parking garages (all-enclosed for inclement weather)

Chris Hermann *Principal at MKSK*

He is well-versed in the nexus between land use and transportation and how AVs are a game changer for development in Columbus. Mr. Hermann's poignant questions helped guide our thinking as the team considered potential impacts of AVs on downtown in particular.

KEY POINTS

- Without transit being a significant share, AVs could erode improvements that have been made to downtown. For example, skyscrapers that need pickup-drop off space facilitate this now via stacked levels of garages; with AVs, this may need to happen on the street level. It is unclear how much space will be needed.
- Some people will be hesitant to participate in a shared model, making parking a necessity to a certain extent for the time being. Determining the percentage of people unwilling to use the shared model will demonstrate how much parking is still necessary.
- There is concern that AVs will lead to greater separation between cars, bikes, and pedestrians. Predicting the manners in which different road users will interact will be vital moving forward.
- AVs improvement of street efficiency assumes there are adoption rates of greater than 90%. Mixing with manually driven cars will not improve efficiency and safety in the system. Yet manually driven cars can't be banned until there is guaranteed access to AVs for everyone.

Thea Walsh and Hwashik Jang

Transportation Systems & Funding Planners at MORPC

Ms. Walsh and Mr. Jang contribute to transportation plans for the Central Ohio region. Ms. Walsh helped lead the MORPC team in their Hyperloop proposal, and Mr. Jang works in the realm of Intelligent Transportation Systems (ITS). Both are forerunners in innovative transportation and their perspectives lent a better understanding of where Columbus fits into current and future transportation trends.

KEY POINTS

- The technology adoption curve gives a good idea of what the adoption of AVs will look like. Such as early adopters at front end, a gap in adoption, the curve peaking as people get on the bandwagon, and skeptics on the tail end. This puts full deployment of level 5 vehicles in about 40 years and a world without parking 30-40 years away, but we can already be thinking about adaptable uses.

- ITS is a good starting point for developing connectivity.
  - The goal is decreasing congestion without huge physical interventions like lane additions to the road system through the efficient use of corridors and notifications to drivers about congestion.
  - US 33 Smart Mobility Corridor: Connecting roadside units of fiber optic cables and monitoring traffic to use as a simulated model of connection between autonomous, or otherwise connected, vehicles. The challenge here is a lack of good testing data.

- The market is being envisioned as CASE/ACES (connected, autonomous, sharing-based economy, electric) with conectivity and autonomy working like the chicken and egg debate.
  - Being connected makes autonomous work better, so this will come first and be more powerful in denser locations whereas mixed environments will need to be more on the autonomous side.
  - Maintaining redundancy will be important in the short term, but may completely go away in the longer term.

- Designated lanes for AVs only make sense in dense environments.

- AV will be implemented in transit first in order to increase its efficiency.

Dan Dunsmoor *Senior VP, Colliers International*

Recognized as a market leader in the Central Business District, Specializing in Class A and B office space. Mr. Dunsmoor has built a loyal client base through landlord representation, tenant representation, and investment acquisitions. He has been involved in over 400 commercial real estate transactions valued in excess of $300,000,000 accounting for over 3,000,000 square feet of Class A and B office space.

KEY POINTS

- A firm belief in parking as primary concern when leasing in downtown Columbus. Businesses are looking for ways to have a higher density in their buildings to accommodate more employees with less space. Parking alone needs a significant portion of the lot and is the biggest obstacle with development. The new tower being designed in the downtown by Colliers will include a drop off zone at the base of the building, designed with AV in mind to hopefully alleviate the need for parking.

- By increasing the capacity of The Brewery Tower on 500 S Front Street from around 70-80% to 100% its value was doubled.

- Young professionals may be more than willing to use a shared AV model in a way that their privately owned vehicle could be rented out for rideshare while at their own day jobs. The car could effectively be paying for itself.


RESEARCH

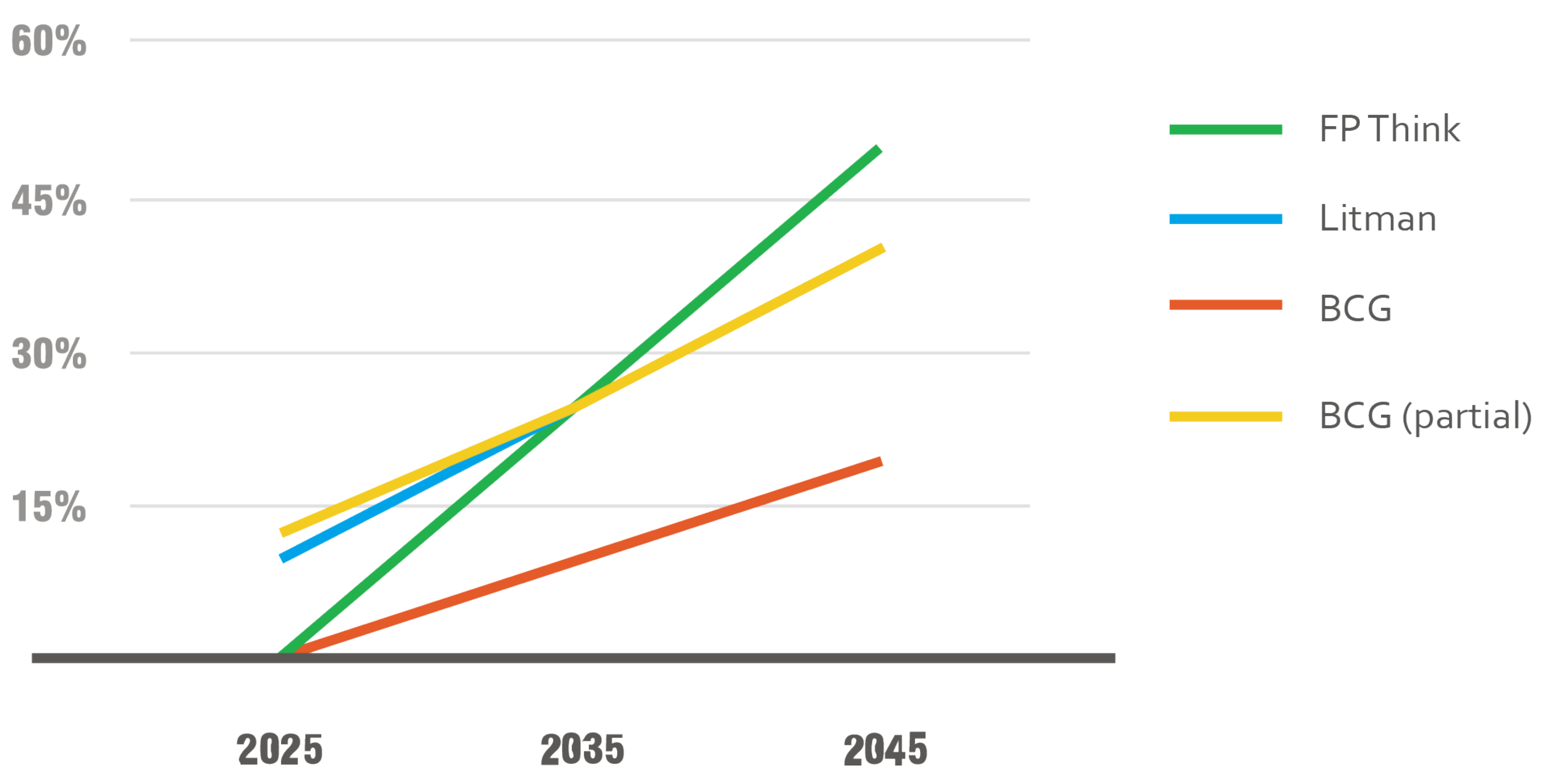
Adoption Rates

Background research for this report consisted of three different areas. First, we looked into the rate of adoption for AVs. The rate of adoption would affect the number of parking spaces needed downtown, as well as the potential traffic patterns.

The first article found set the projected rate of adoption at 22–90% by 2050 [2]. With the adoption rates having such a wide range of percentages the study was not directly helpful. However, The study did have links to 15 other studies on the subject. After reviewing those 15 links and a few other studies, 5 of the studies that were the most thorough and relevant to our project were selected.

For our final adoption rates, multiple approaches taken by these studies were used. One approach that the Litman study employed was to analyze the adoption of other vehicle technologies and use it to project the adoption of autonomy[3]. Another method applied by the Boston Consulting Group (BCG) used current and past vehicle turnover rates, as well as vehicle pricing to estimate the rate of adoption[4]. Based on the studies chosen, a graph to visualize the percentage of the fleet that will be autonomous by 2025, 2035, and 2045 was created.

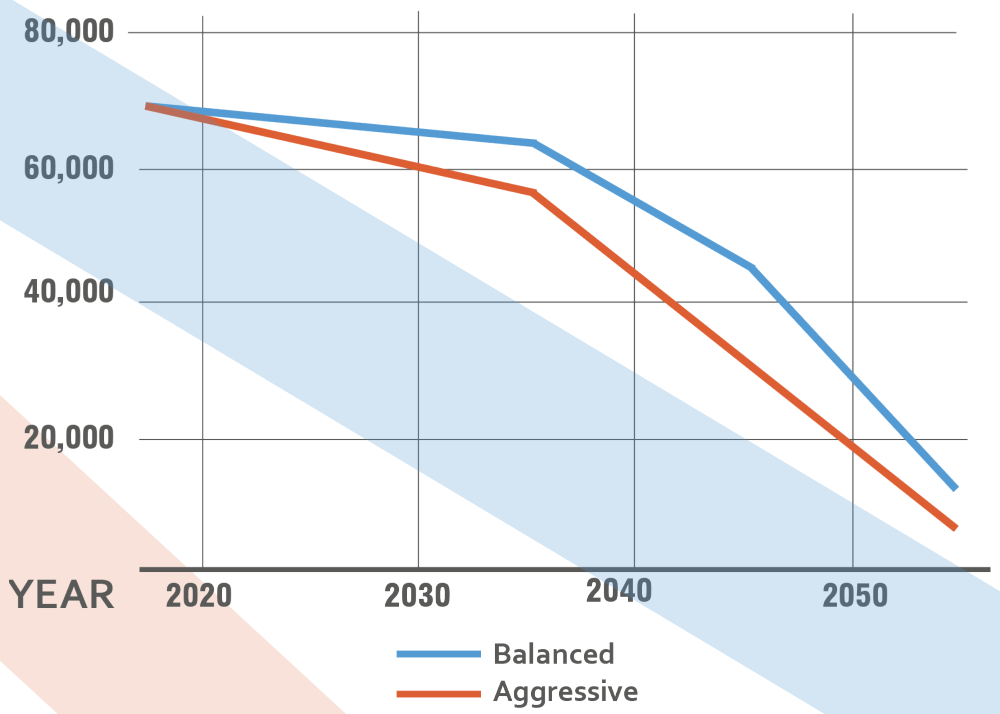
Adoption Rates by Research Report



Parking

The graph (below) was created using a number of different assumptions made by the studio team about the speed with which autonomous vehicles will be adopted for everyday use. Assumptions were made at 10-year intervals beginning in 2035 and ending in 2055. The scenario is broken down between a balanced adoption trend and a more aggressive adoption trend. An expected percentage of the overall autonomous vehicle adoption at the time was chosen for both trends at each year. Both balanced and aggressive adoption trends are then broken down into shared, owned, and transit adoption models. Shared, owned, and transit are also given an expected percentage range of adoption.

NUMBER OF PARKING SPACES NEEDED



Furthermore, an anticipated demand for Downtown parking percentage is assigned to each of the three models (as shown below, right). Individuals who own their autonomous vehicle would be expected to have the highest demand throughout the adoption period and are given the highest percentage of spaces still needed. Likewise, transit would be expected to need little to no parking. All percentages for a given trend and model are combined together to determine an expected number of spaces that will no longer be needed for parking in Downtown. As the overall adoption rate for autonomous vehicles goes up, the amount of unneeded spaces rises dramatically as more and more people don't need to own and park their car in the Downtown all day. Conversely, as overall adoption rises and more redevelopment can take place, the demand for parking could increase making the lower end of the unneeded parking range more likely.

Surface parking lot at Third St & Spring St

There are multiple ways that AV will reduce the need for parking downtown. If the cost of ride sharing services becomes cheap enough, some downtown commuters will choose to forgo driving their own vehicle. Even if people choose to drive their own vehicle, it may be cheaper to send their vehicles back home to park. Either way, the total number of parking spaces in the urban core can be reduced. Ideally, as the amount of parking spaces decreases and redevelopment begins, the surface lots will be the first to change in order to maximize the newly available land.

ADOPTION RATES AND REQUIRED DOWNTOWN PARKING %

2035		
BALANCED SCENARIO 25% AV		DOWNTOWN PARKING REQUIRED
SHARED	30-55%	65%
OWNED	30-60%	80%
TRANSIT	10-25%	0%
AGGRESSIVE SCENARIO 50% AV		DOWNTOWN PARKING REQUIRED
SHARED	50-75%	65%
OWNED	10-40%	50%
TRANSIT	10-25%	0%

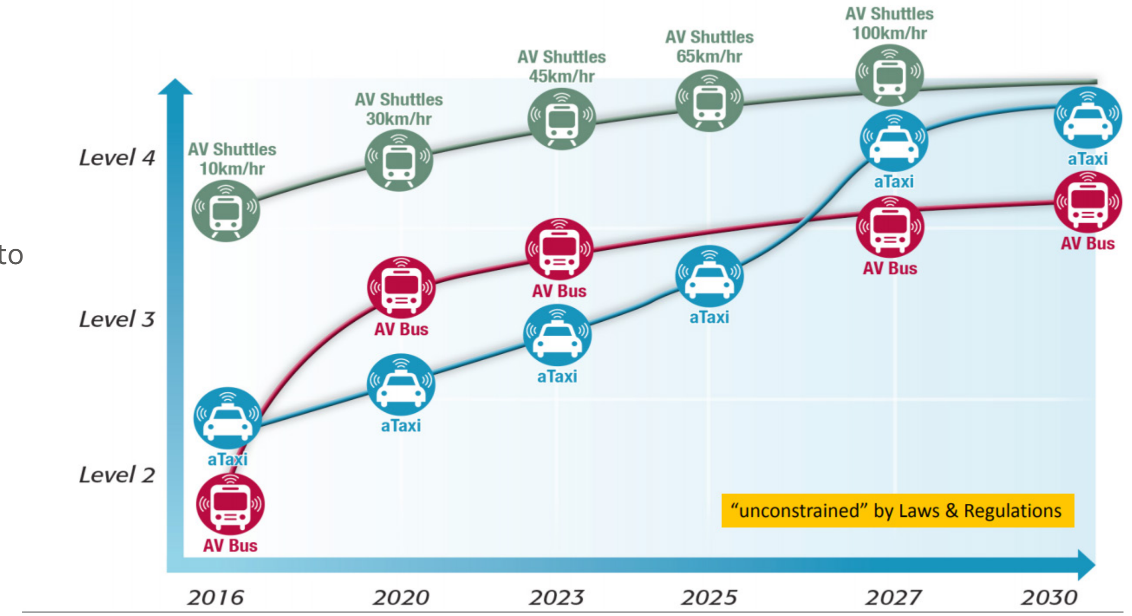
2045		
BALANCED SCENARIO 50% AV		DOWNTOWN PARKING REQUIRED
SHARED	50-70%	35%
OWNED	10-25%	50%
TRANSIT	20-25%	0%
AGGRESSIVE SCENARIO 75% AV		DOWNTOWN PARKING REQUIRED
SHARED	60-75%	35%
OWNED	5-10%	40%
TRANSIT	20-25%	0%

2055		
BALANCED SCENARIO 90% AV		DOWNTOWN PARKING REQUIRED
SHARED	75-80%	10%
OWNED	0-5%	40%
TRANSIT	15-20%	0%
AGGRESSIVE SCENARIO 100% AV		DOWNTOWN PARKING REQUIRED
SHARED	75-80%	10%
OWNED	0-5%	40%
TRANSIT	15-20%	0%

For example: In balance scenario 2035, 25% of all vehicles would be fully autonomous. Out of that 25%, shared vehicles would account for 30-55% of AV, owned vehicles would account for 30-60%, and transit for 10-15%.

Transit

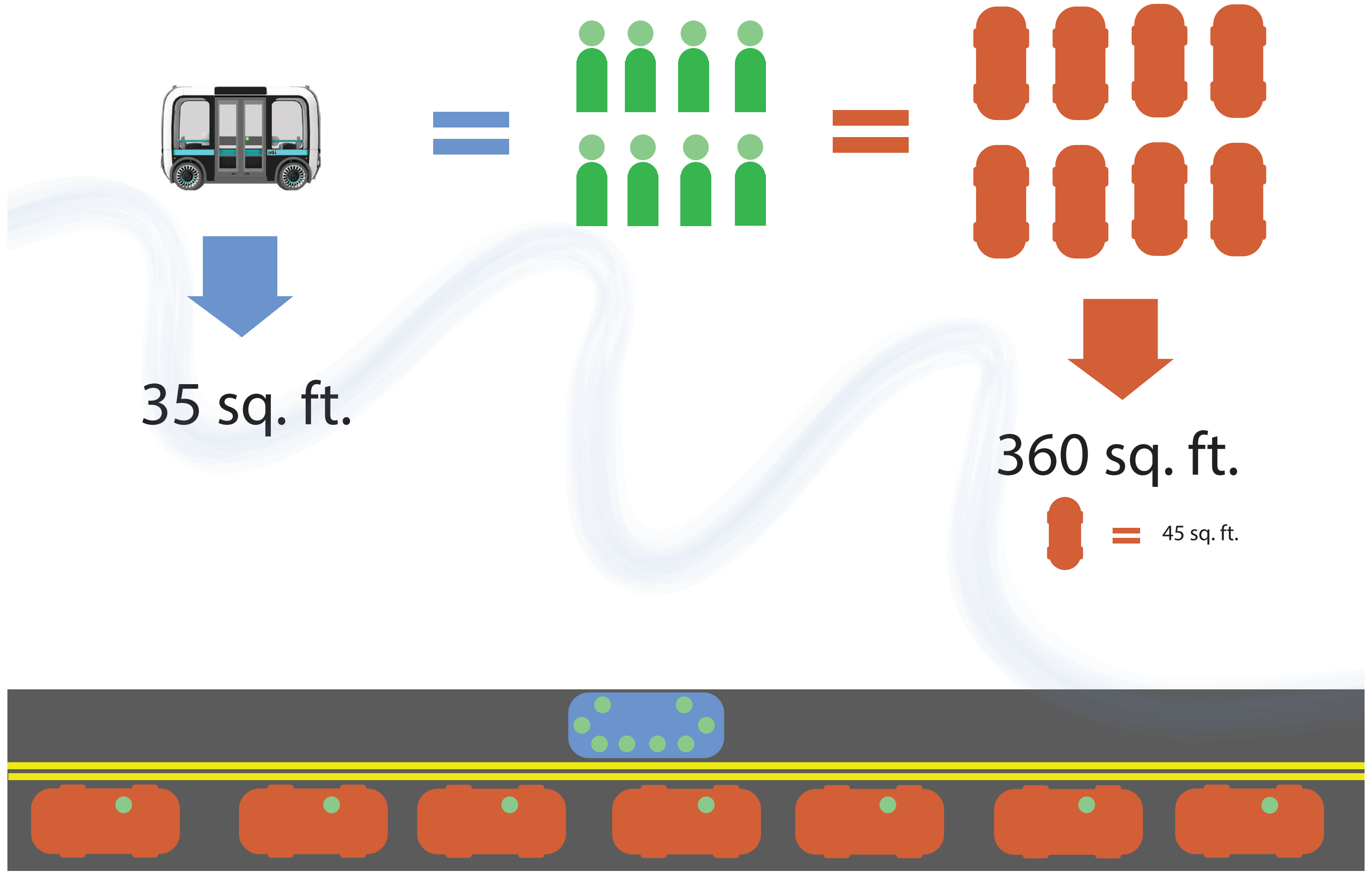
The nexus between automated vehicles and transit as well as its impact on VMT is a key consideration in determining what assumptions can be made about the future of downtown Columbus. The applications of AV technology are far-reaching, and transit vehicles will not be untouched. In fact, many point to transit as the perfect starting point for early adoption.



Application of AV Technology to Transit Over Time

The Transportation Research Board has put forth the following timelines for the application of AV technology to transit [6]:

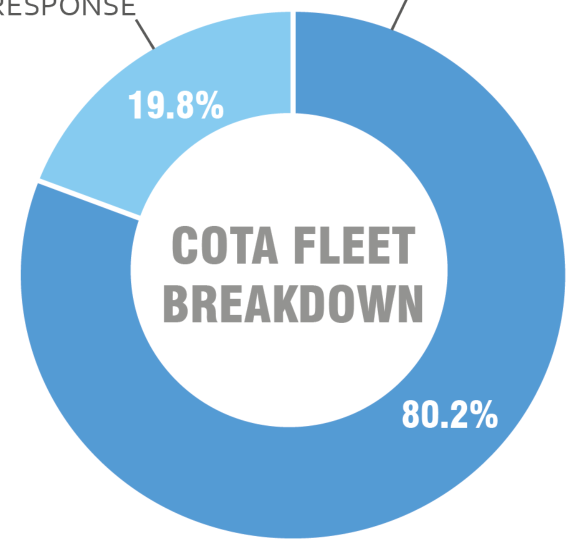
NEAR-TERM (5-10 YEARS)	MEDIUM TERM (10-15 YEARS)	LONG TERM (15-20+ YEARS)
Level 3 Bus Rapid Transit (BRT) transitways and High-occupancy Vehicle (HOV) lanes, Level 4 operations in campus environments.	Level 4 operations in BRT/HOV and low speed in mixed traffic on city streets.	Levels 4 and 5 operations in all environments with fully automated transit systems.



Here the disparity in the amount of space used between eight autombiles can be seen when compared to an autonomous Olli transport. Utilizing such modes of transit will help to decongest roadways and further reduce parking needs.

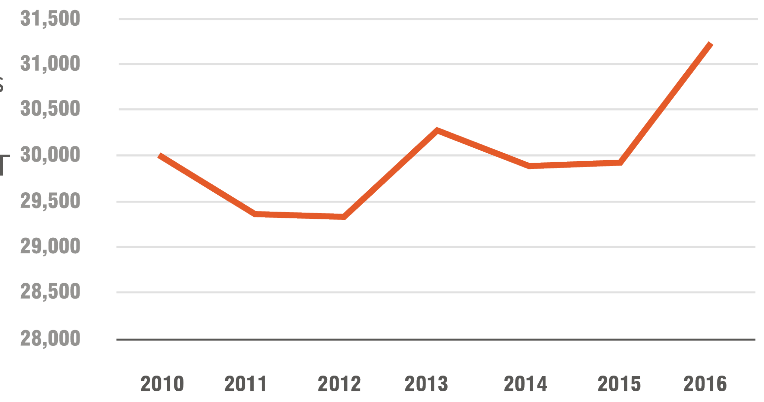
Two different future transit models arise from these assumptions. In the near term, Columbus' transit system could include more demand-respondent buses and shuttles, like the ones being employed at Easton as part of the Smart Columbus initiative [7]. In 2014, COTA's fleet included 68 demand-respondent vehicles [8]. This number could greatly increase; working to "taxi-ify" the current system. In the longer term, lower-occupancy autonomous vehicles could adhere to a first mile/last mile concept, tying into a larger fixed-route transit system.

FIRST MILE/LAST MILE CONCEPT

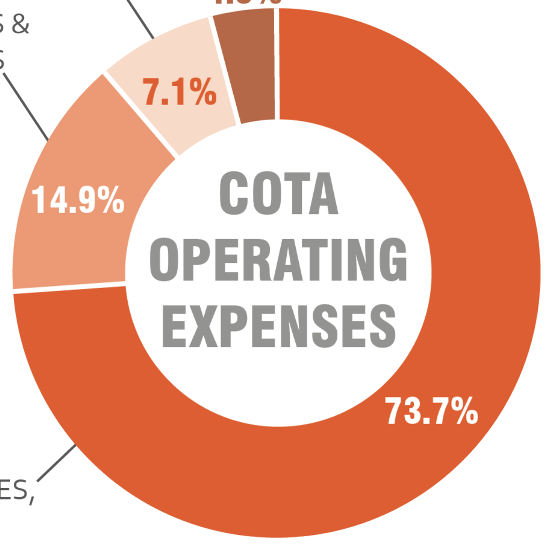


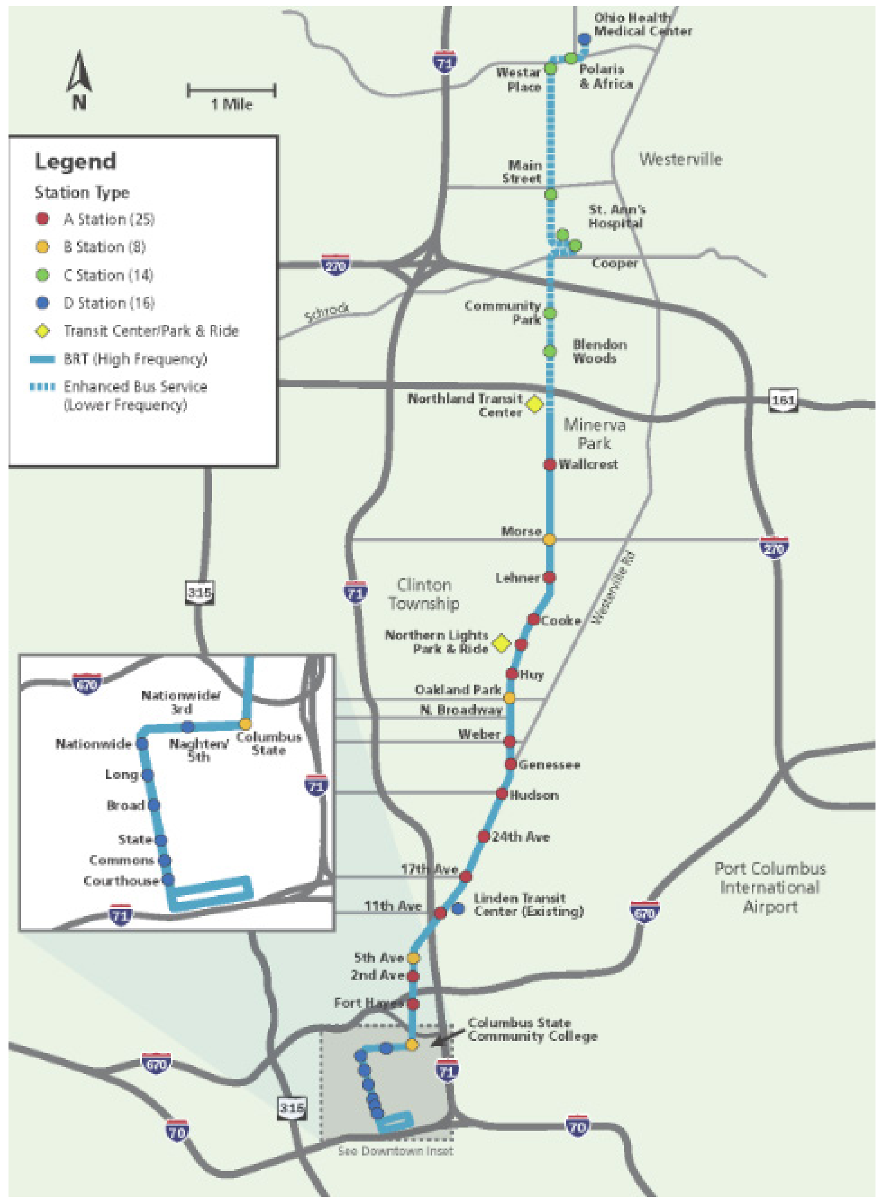
Columbus is already seeing an uptick in VMT; see the Franklin County Urban kDVMT graph which shows how many thousands of miles were travelled daily on urban Franklin County roads since 2010[9]. The spike in 2013 coincides with Uber launching in Columbus[10]. The addition of autonomous vehicles into the system, both privately-owned and shared, could actually cause VMT to skyrocket and contribute to a congestion nightmare for Columbus. This, however, does not include the pooled model. Today, the vast majority of commuters ride into downtown by themselves in private motor vehicles; 87 cars commute downtown per 100 workers [11].

Franklin County Daily Vehicle Miles Travelled



This commuting pattern is unsustainable and will only become more unsustainable with the adoption of autonomous vehicles. Focus needs to be given to the development of an effective mass transit system into which first-mile/last-mile trips by autonomous vehicles can feed. COTA recently developed a non-designated infrastructure bus route called CMAX to address the transportation needs of underserved populations[12]. The CMAX line is a small step in the right direction. However, further changes to the system are greatly needed to make it at least as efficient at moving people as private motor vehicles are right now. These changes will no doubt be expensive, but the automation of the driving task opens up opportunities for human capital and investment to be reallocated to other aspects of the public transportation system in order to increase its efficiency and, therefore, ridership. In 2014, COTA spent nearly $79 million on salary, wages, and benefits alone, accounting for almost 3/4 of its total operating expenses[13]. In the near future, this kind of spending could change drastically and allow for greater investment in transit routes themselves.





COTA CMAX ROUTE

Likelihood of Redevelopment

The Traffic Analysis Zone (TAZ) map scores city blocks based on four categories: historical value, street frontage and plan, height and building mass, and condition/age. Our group included an additional category we call "specialty use" to identify land/buildings that are particularly immune to future redevelopment These scores were derived based on the research conducted of susceptibility to change with adoption of autonomous vehicles. The scores are useful for visually displaying what sections of downtown will change based on the aforementioned categories within the upcoming 15 to 20 years. The downtown TAZs are overlaid with each city block's respective building footprint, with the darker footprints being more susceptible to change and the lighter footprints less susceptible to change.

(Ranked on a scale from 1 to 5, 1 being the least likely to change and 5 being the most likely):

HISTORICAL

1 - Indispensable "cultural treasures" (ex: LeVeque Tower)
2 - More indispensable than disposable
3 - Right in between
4 - More disposable than indispensable
5 - Disposable (ex: Ohio Chamber of Commerce building)

SITE PLAN

1 - Pedestrian-oriented design that encourages use
2 - More pedestrian-oriented than car-oriented
3 - Right in between
4 - More car-oriented than pedestrian-oriented
5 - Car-oriented, parking dominated, suburban character

CONDITION

1 - Newly constructed or renovated, almost no wear and tear
2 - Newer and less worn down
3 - Right in between
4 - Older and more worn down
5 - Old, abandoned, obvious dilapidation

MASS/HEIGHT

1 - Tall, highly utilized, taking up multiple blocks
2 - Taller and wider
3 - Mid-rise, taking up about one block
4 - Shorter and narrower
5 - One to two stories, only taking up part of a block

SPECIALTY USE

1 - Highly specialized and highly demanded
2 - More specialized and more highly demanded
3 - Common/mixed use
4 - Less specialized or less highly demanded
5 - Highly specialized use that is becoming obsolete

TAZ SCORE KEY
Sum of 5 criteria scores

5-7 [Unlikely to Change]
8-11
12-16
17-21
22-25 [Likely to Change]

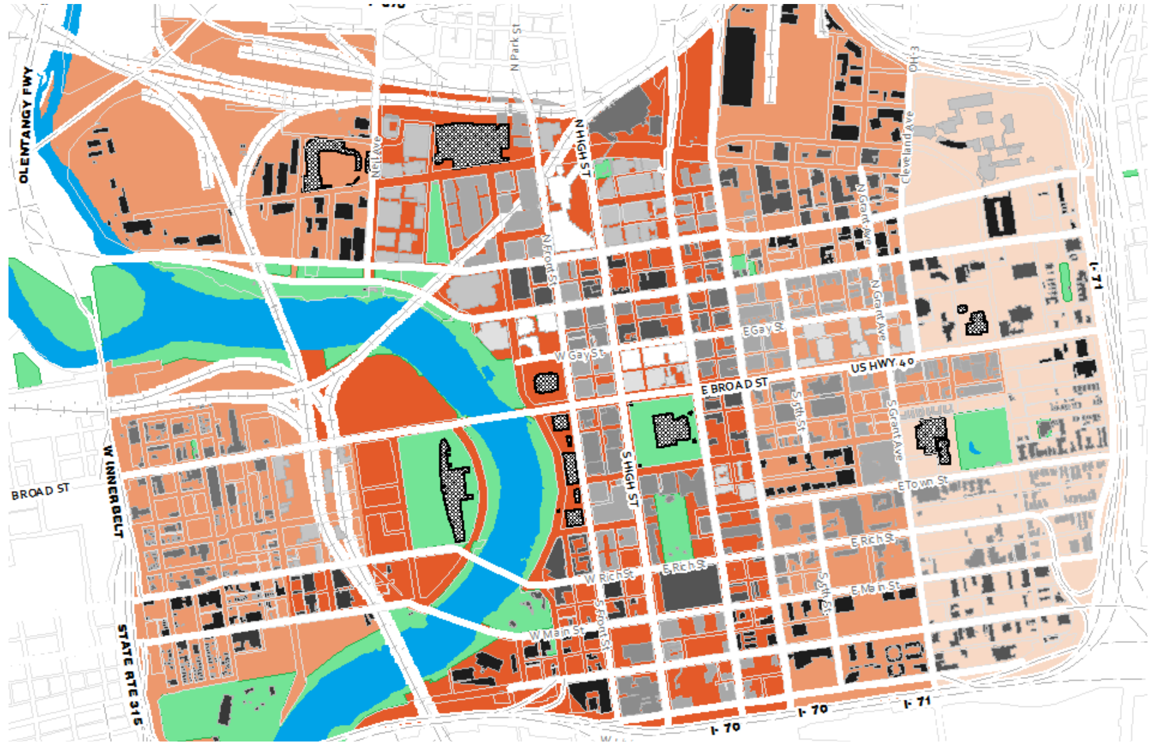
Specialty Use

Traditional Thoroughfares

LIKELIHOOD OF REDEVELOPMENT MAP

Development density

The density of development analysis, visualized as a map below, is a projection of building density based on the current conditions of the study area and the TAZ score evaluation. In this analysis, the study area was divided into 3 zones based on their projected level of development density which were then categorized as "low", "mid", and "high". Each zone has a projected maximum and minimum building height, based on current conditions and the zone's TAZ scores, and an estimate of building heights based on the longevity of the development. The criteria for each zone is as follows



Low Density Criteria
Max Height: 10 Stories
Min Height: 2 Stories
Short-term Typical: expected 3-6 stories
Long Term typical: expected 5-10 stories

Mid Zone Criteria
Max Height: 25 Stories
Min Height: 6 Stories
Short-term Height: expected 6-8 stories
Long term height: expected 6-20 stories

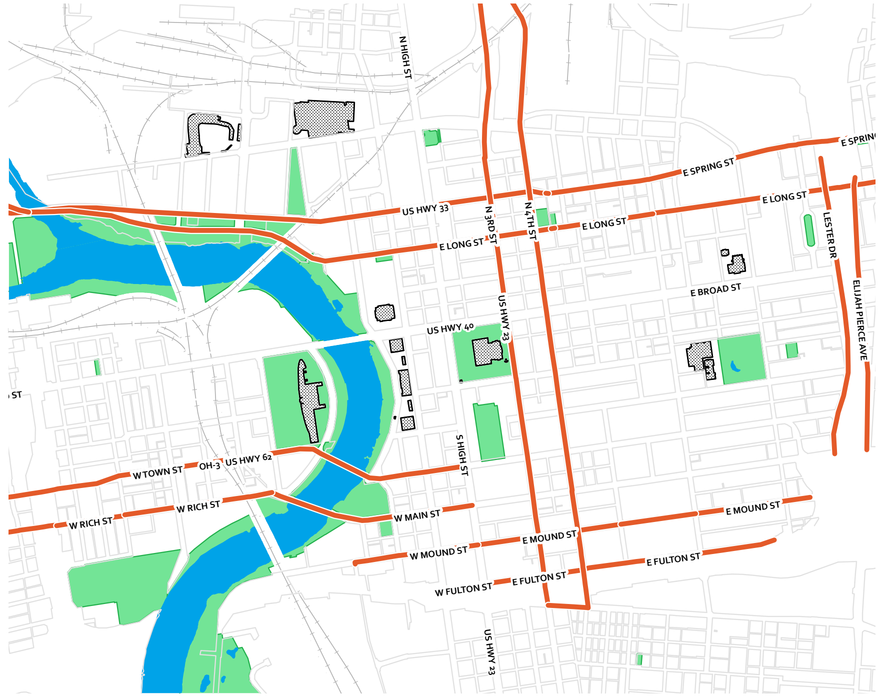
High Zone Criteria
Max Height: 40 stories
Min Height: 8 Stories
Short-term typical: expected 8-20 stories
Long-term typical: expected 18-30 stories

Comparing the Likelihood of Redevelopment and Density of Development maps can give insight into what the landscape of Downtown may look like in coming years. Looking at the "High" density zone and comparing with the TAZ map, there are around 200 acres of land within our likely to redevelop rating. That would mean 200 more acres of development between 8 and 40 floors. It is important to remember there will still be parking demand during the transition to AV and redevelopment can drive up this demand. A balance will be needed to continue to provide enough parking, but this clearly indicates the development possibilities that will exist with autonomous vehicles.

ROAD HIERARCHY

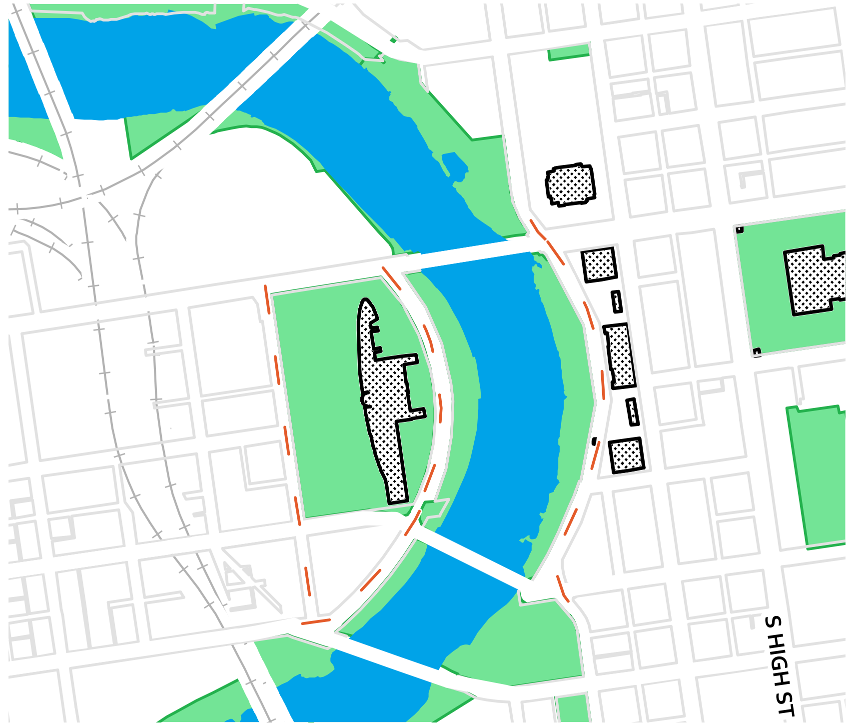
In order to identify how downtown Columbus' road network might change in the next several years with the adoption of autonomous vehicles, the team developed a road hierarchy which categorizes different thoroughfares into a series of classifications.

ONE-WAY HIGHWAY CONNECTORS



Circulate traffic into and out of downtown via their connection to highway exits and on-ramps.

RECREATIONAL THOROUGHFARES



Low-capacity roads providing access to downtown Columbus' main recreational area.

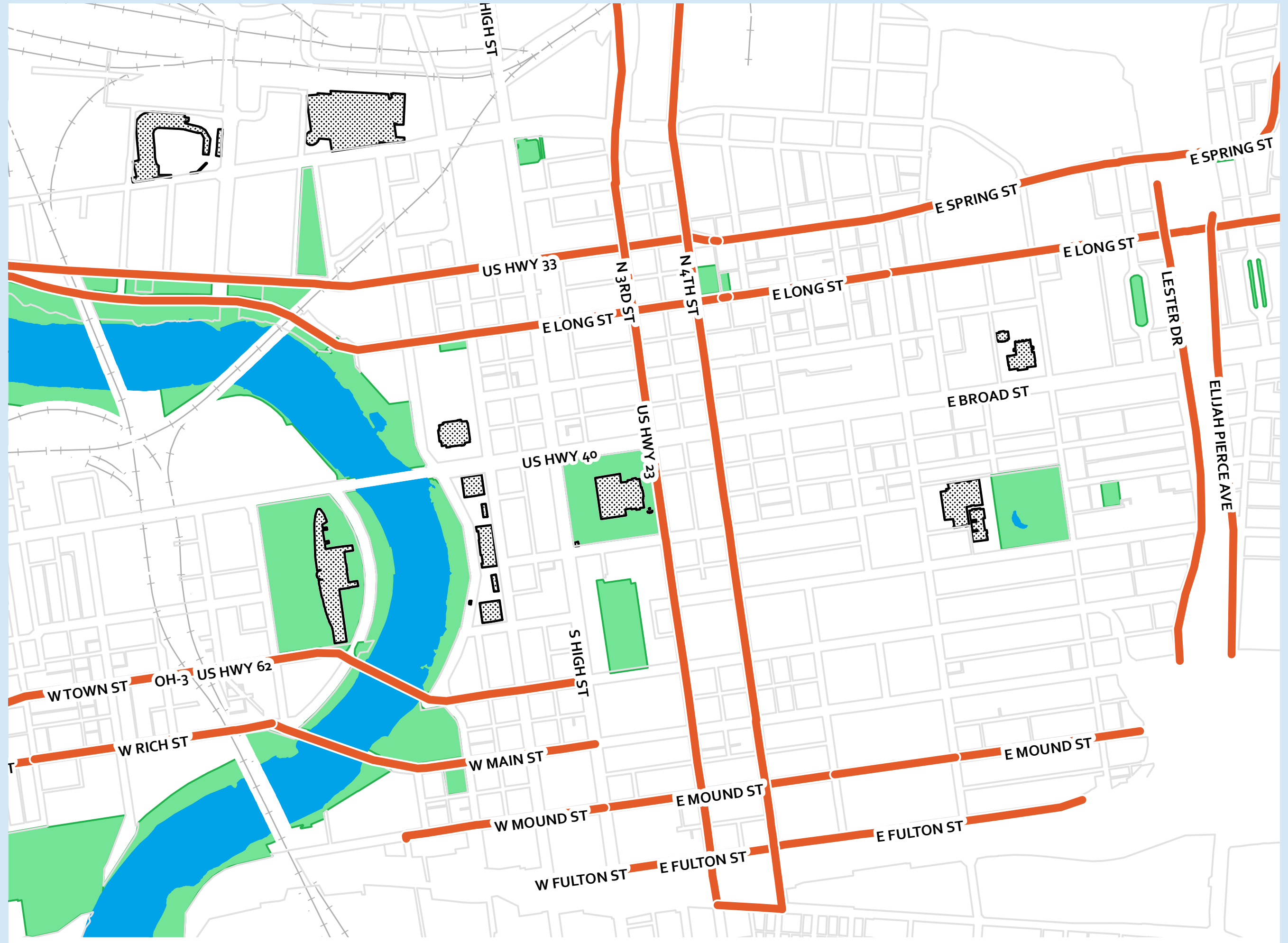
TRADITIONAL THOROUGHFARES

Main north-south and east-west roads which run throughout Columbus.

SECONDARY THOROUGHFARES

Feed traffic into and away from one-way highway connectors.

ONE-WAY HIGHWAY CONNECTORS



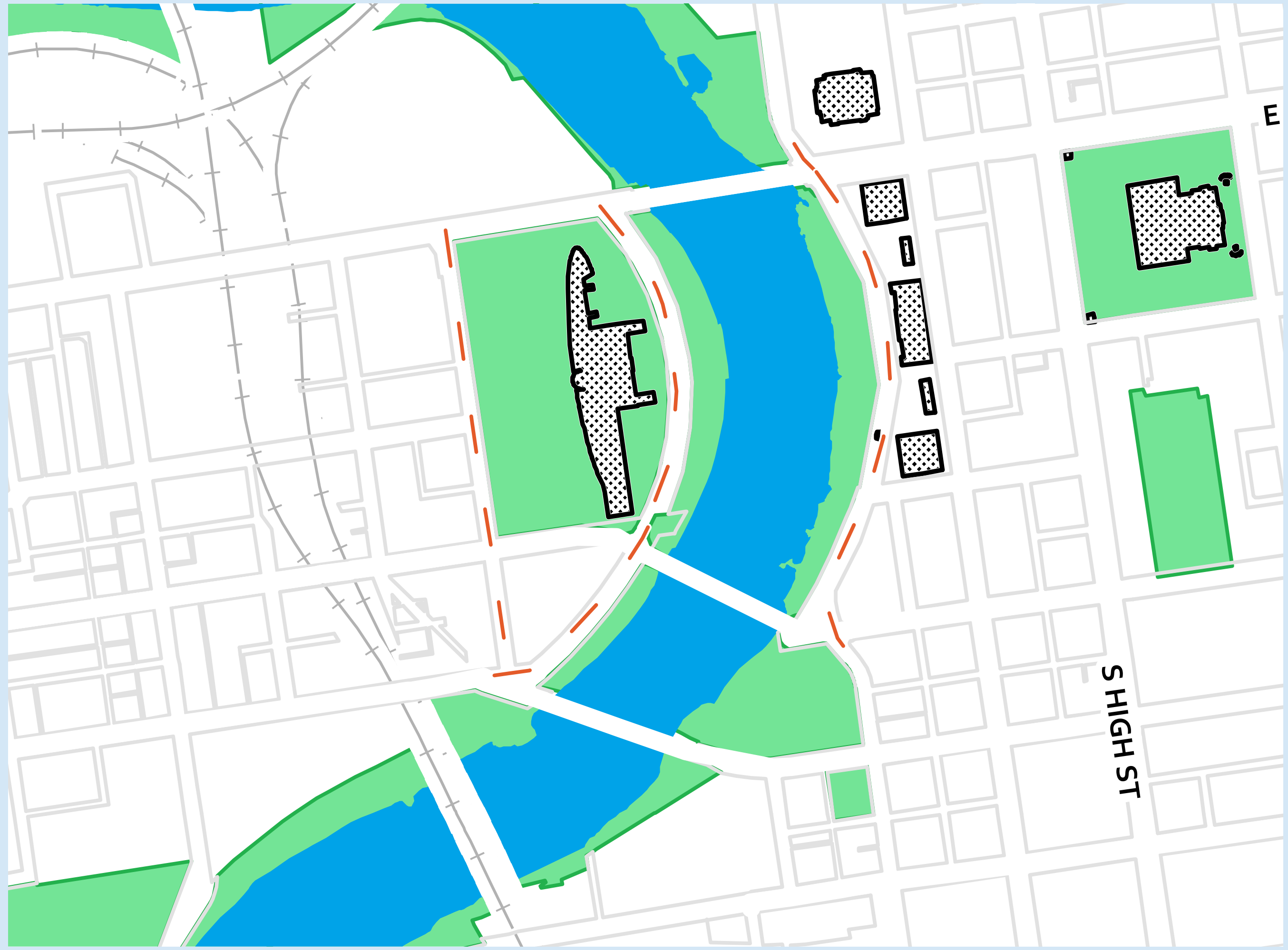
AV CONDITIONS

Designate and paint dedicated pickup-drop off areas for on-demand, self-driving cars where on-street parking currently exists.

Grant non-exclusive access to certain bus lanes for any providers of an on-demand, self-driving service.
Install bike lanes. In addition to promoting bike use, these create an easier and safer environment for self-driving cars.

Example: Third Street

RECREATIONAL THOROUGHFARES



AV CONDITIONS

Eliminate curbs.
Establish a schedule for use, install signage displaying that information, and enforce regulations.

EXAMPLE SCHEDULE

Morning: Freight deliveries, drop off, cafe parklet

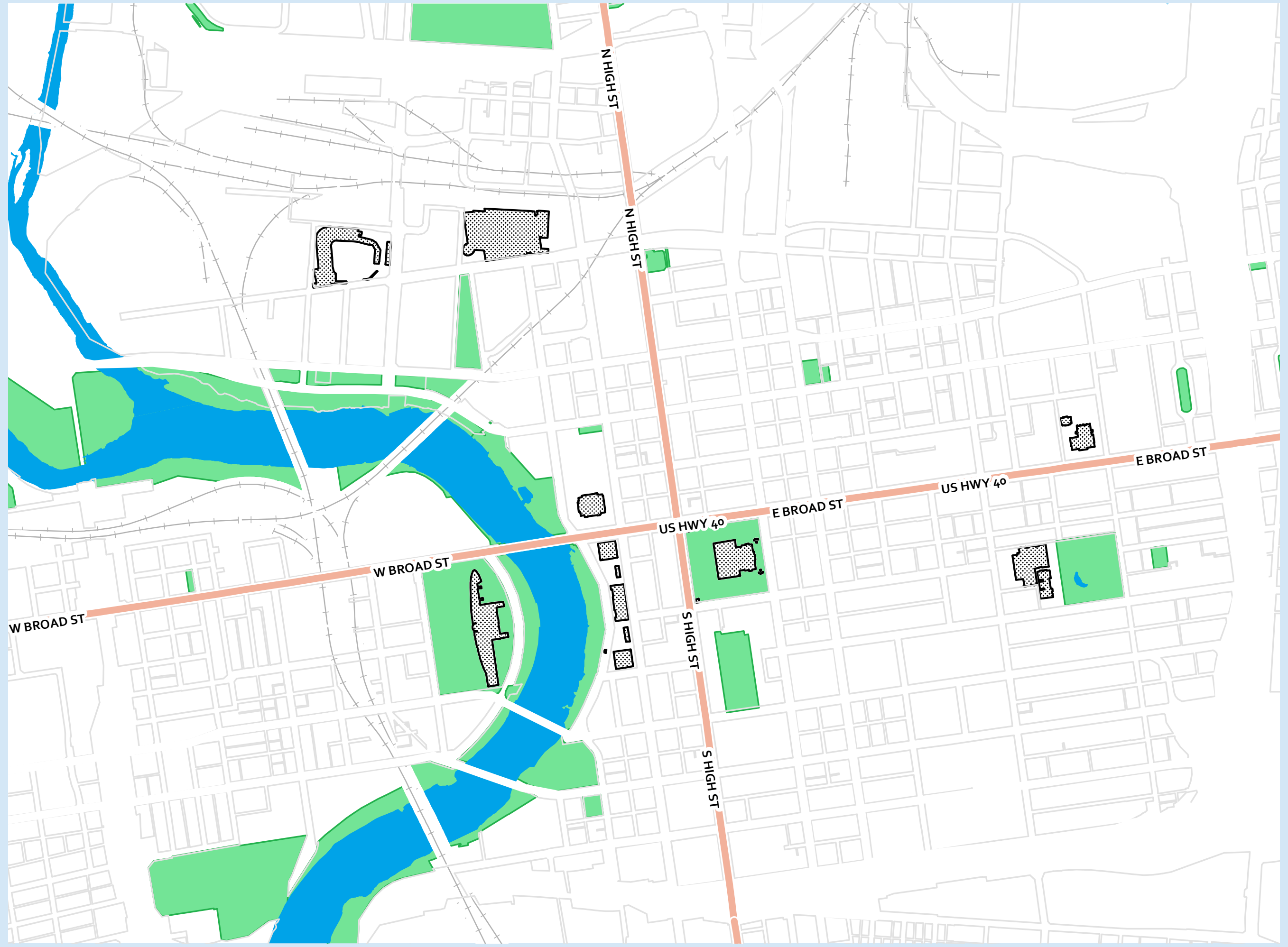
Mid-Day: Mail deliveries, street vendors, farmers market

Evening: Pickup, cafe parklet

Late Night: Freight deliveries

Example: Washington Boulevard between COSI and Genoa

Traditional Thoroughfares



AV CONDITIONS

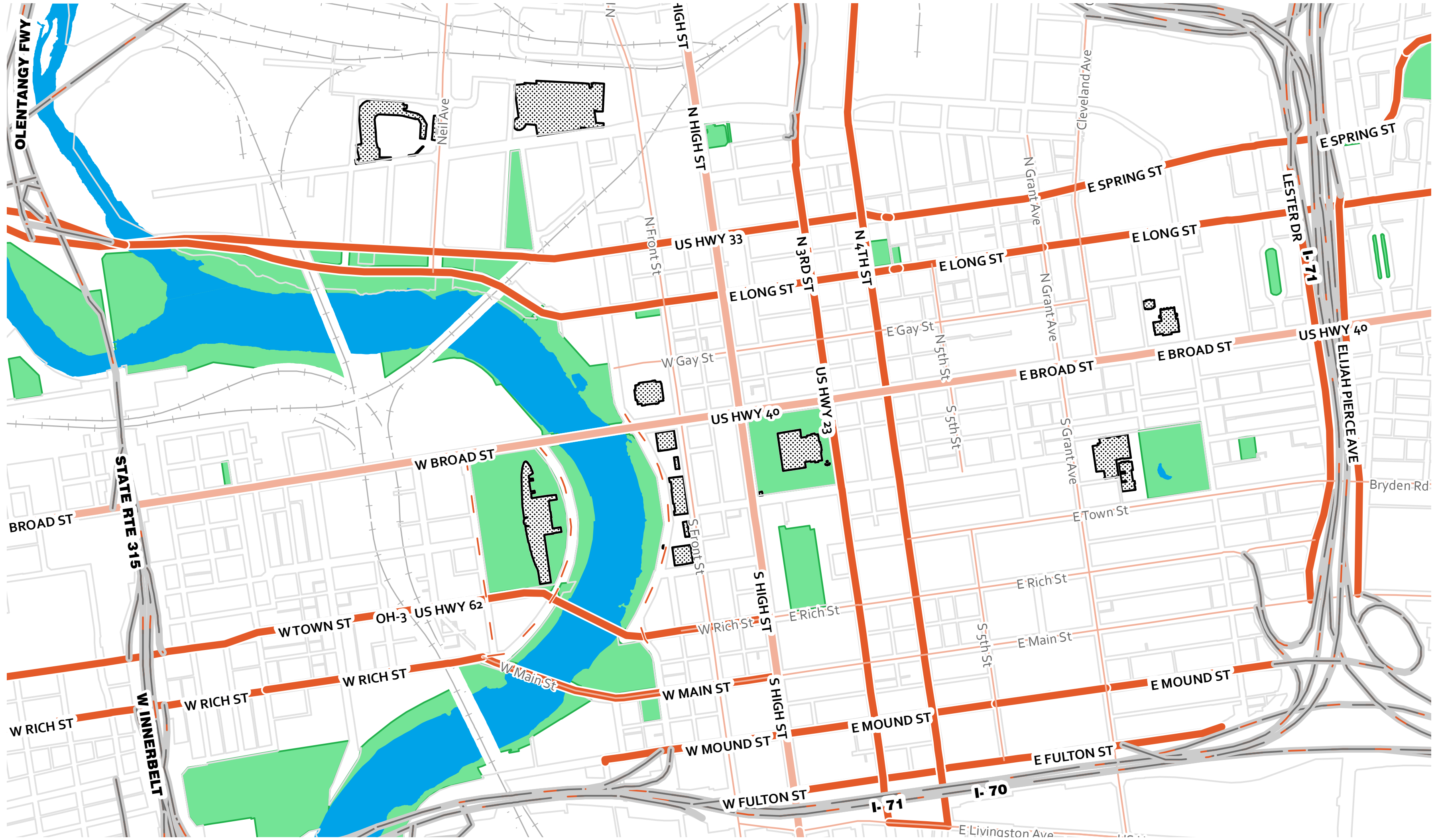
Designate and paint dedicated pickup-dropoff areas for on-demand, self-driving cars where on-street parking currently exists.

Grant non-exclusive access to certain bus lanes for any providers of an on-demand, self-driving service.
Install bike lanes. In addition to promoting bike use, these create an easier and safer environment for self-driving cars.

Example: Broad St

ROAD HIERARCHY

All road types shown



Traditional Thoroughfares | Secondary Thoroughfares | One-way Highway Connectors | Recreational Thoroughfares

RECOMMENDATIONS

Infrastructure Recommendations

SHORT TERM

Public Infrastructure

Maintain high visibility lane striping and pavement markings, highly reflective signage, and traffic control devices to a standard at which AVs can easily detect them[14].

Ensure effective snow removal, etc[15].

Establish controlled-access facilities as early locations for the deployment of automated vehicles.

Instrumentation for New Technology

Implement flow management of exiting traffic so increased volumes on expressways do not overwhelm surface streets with traffic[16].

Install DSRC (Dedicated Short Range Communications) equipment at all signalized intersections.

Speed Management

Limit vehicles to a maximum speed of 25 miles per hour in downtown.

MID TERM

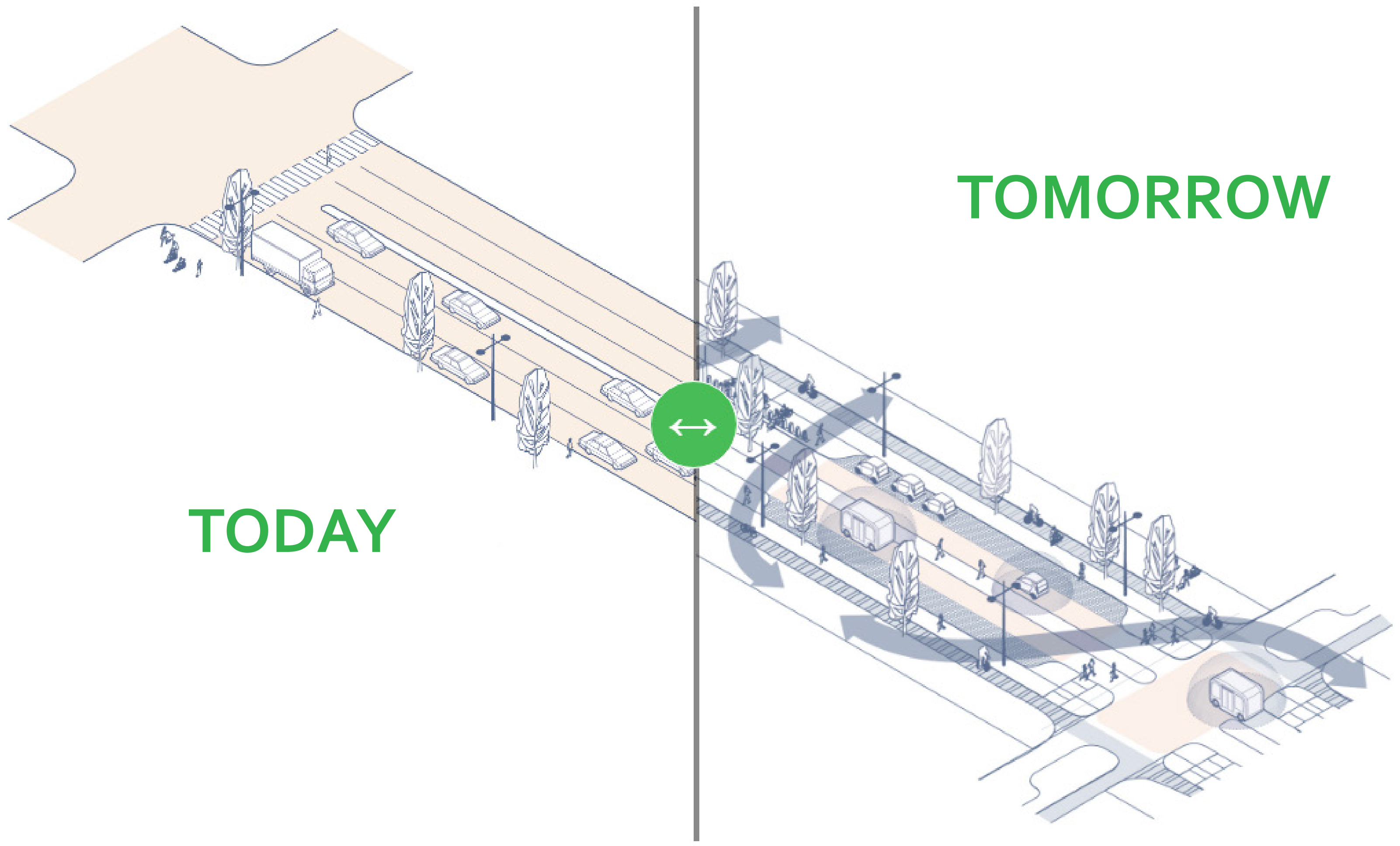
Anticipate different interactions between vehicles and other road users. Reconsider sidewalks and jaywalking to take more fluid street interaction into consideration[17].

LONG TERM

Prohibit non-AVs and/or ICE vehicles from downtown streets.

Establish intersection managers to schedule AVs' timeslots through an intersection[18].

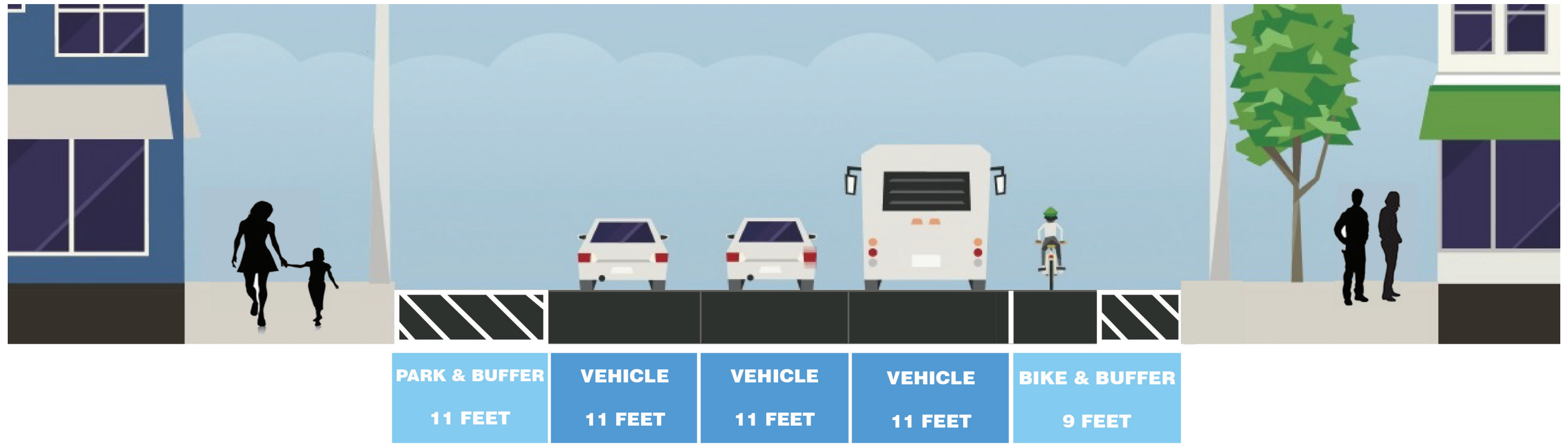
FLEXIBLE USE

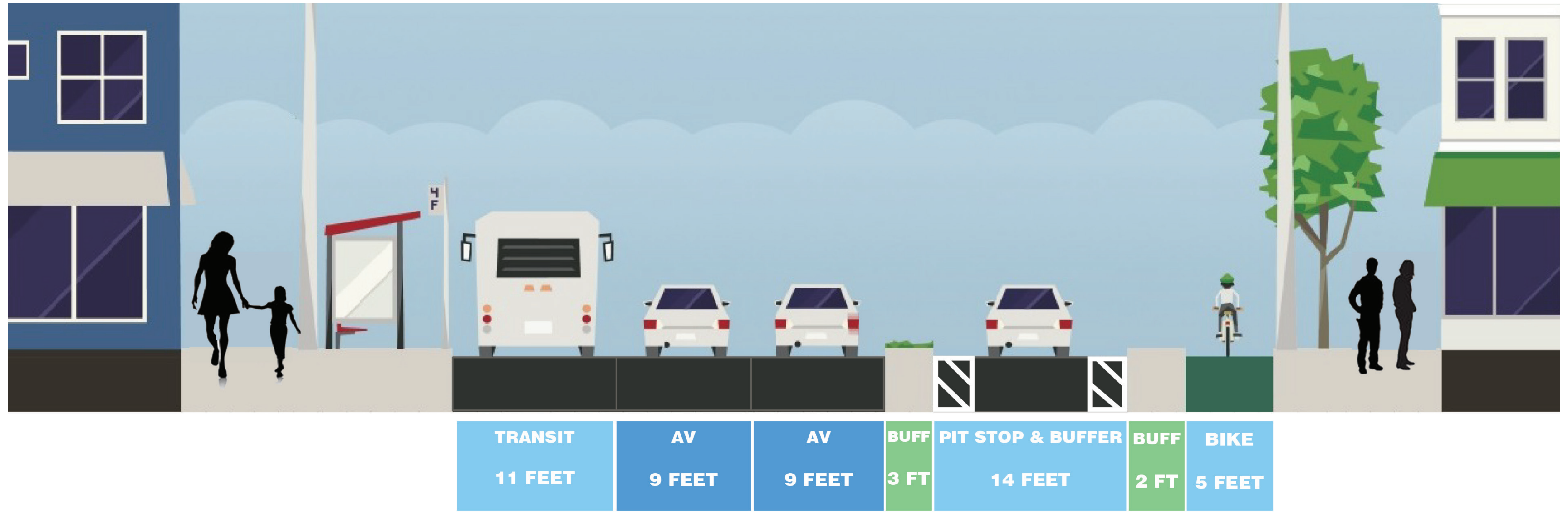


Pickup-dropoff zones could look different at different times of day and on different days of the week, dependent on the surrounding land use and pricing mechanisms[21].

THE STREET

THIRD ST AND FOURTH ST REDESIGN





Current conditions of Third and Fourth Street (Above), and future possibility (Below)

The major north-south passages through downtown, 3rd Street and 4th Street, will continue to serve as major vehicle-oriented roads which through Columbus from and by high volume areas (Ohio State campus to German Village). The segments which border these streets in our focus area include important features such as Columbus Commons, the Ohio Statehouse, Keybank Tower, Chase Tower, and several large parking garages, lots. The width downtown from curb to curb stays consistently at or slightly below 53 feet on both 3rd Street and 4th Street. Within each road lays three wide vehicle lanes, one buffer or park lane, and one bike or buffer lane (which also occasionally serves as a park lane).

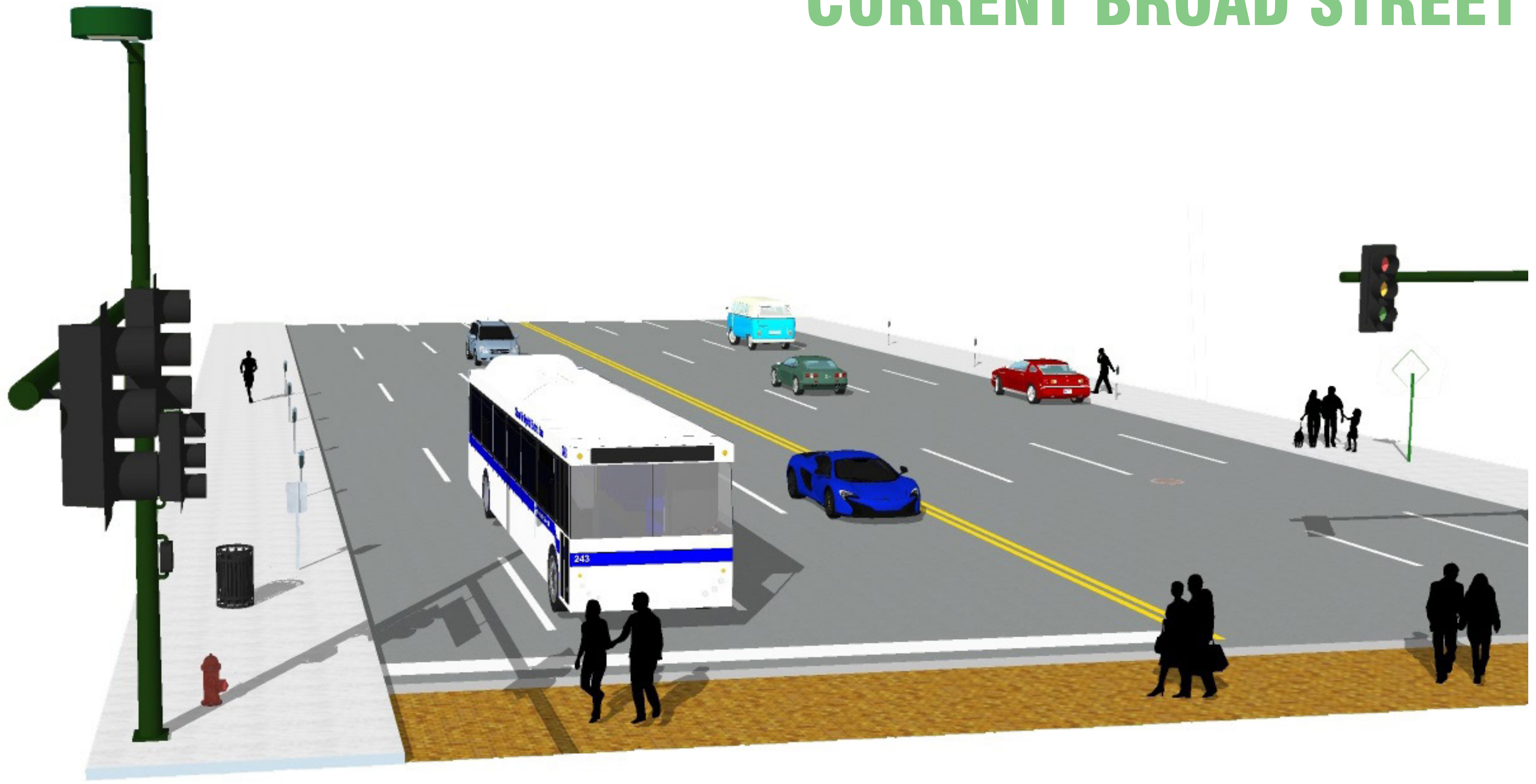
The elimination of street parking, which will be one of the first changes made during the transition to full autonomy, along with the ability to narrow lanes, makes room for several changes. From the viewpoint of 3rd Street going south, the left lane will be transit-centered. This will be used exclusively by high capacity vehicles (in this case meaning more than a standard 4-6 person car), perhaps an Olli or something similar. Here, the pit stop dropoff style will be implemented throughout much of the stretch on the far right lane, and it will double as a right-turn lane at several necessary points (At broad, onto Spring, into major alley drop off systems, etc. The middle two lanes will be typical travel, and just to right will exist several barriers that form the pit stop drop off, as well as protection for bikers and pedestrians. Physical barriers will be important for the safety of people who, at least initially, may not understand how to act with AVs as opposed to human drivers (or will directly obstruct them with the rational full confidence of the car stopping). It will also optimize the efficiency of the AV system if the unpredictable actions of pedestrians and bikers are kept physically out of the roadway.

The transit-oriented AV lane will be a long loop the runs with the flow of traffic up and down the length of the streets, and beyond our focus district to provide quick access to and from downtown. The simplicity and quick travel time of this route will be attractive to riders.

A curved turnaround at Engler St (and the adjacent parking lot) will include only the transit lane and two AV standard lanes will allow vehicles to quickly and efficiently switch from heading south to north (from 3rd St to 4th St) without disrupting other traffic patterns.

BROAD STREET REDSIGN

CURRENT BROAD STREET



A focus of our plan involves major changes to Broad Street, which hardly has use for its massive width. While the road layout has slight changes due to variances in sidewalk width, presence of a parking lane, and different turn lane styles, it generally is about 80 feet wide. The graphic above shows the current condition of Broad street.

A NEW BROAD STREET

This is what a Broad Street could look like during its transition to a fully AV system. A green spine replaces many of the lanes, and more emphasis is put on transit (both bus and autonomous vehicles).

BROAD STREET REDSIGN

CURRENT

AV TRANSITION

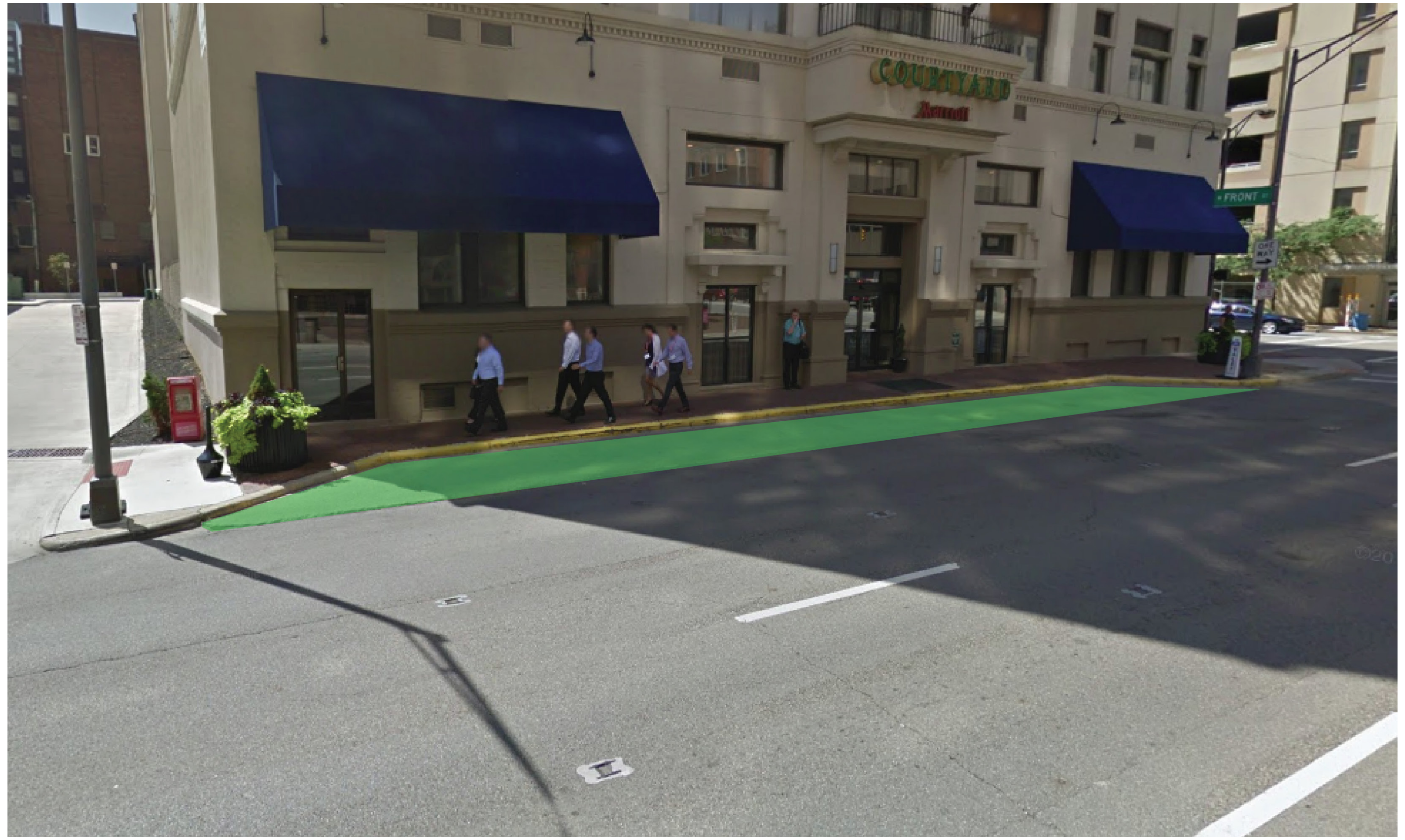
The green spine will create a park atmosphere and desireable major east-west connection that is currently lacking downtown (aside from perhaps segments of Gay Street). This is already a major pedestrian walkway, considering the bridge to COSI, the Scioto Mile, and Veteran's Memorial. The Broad Street park stretch will make the trip safer and more enjoyable for those jogging, walking, and running through Columbus without compromising much in terms of vehicle accessibility (considering there is no need for four lanes each way already). The fully AV model will look similar in terms of infrastructure.

The safe bike-exclusive lane in the green spine, along with the semi-exclusive east-west COTA route (the 10-Line), improve accessibility to downtown from areas that would benefit from these alternative transportation options. The bus lane is shared with AVs to minimize human driving error while interacting with AVs at first, as well as prvide incentive (in the form of faster travel) to ride AVs in Columbus. Dropoffs during transition would align with the existing bus stops, and "pit stop" style when necessary and possible (where larger setbacks allow it). Ideally, the bus/AV exclusive lane and safe bike access would stretch from Hilltop to the Franklin Park Botanical Gardens. It seems only feasible, due to street width, setback length, and desirability, that the green spine would stretch from Franklinton to near the Columbus Museum of Art.

Not only does this model enhance AV travel, geographic connectivity, street appearance, and pedestrian safety, but it also aligns with the goals of Blueprint Columbus. Plenty of impermeable pavement is replaced with greenspace, and rain gardens will be present within in the park to collect urban stormwater runoff.

PICKUP/DROPOFF ZONES

As rideshare systems have recently grown in popularity in cities, problems have arisen regarding the dropping off, and picking up, of passengers. Rideshare drivers are often not only dangerous when stopped at curbs, but also negatively impacting traffic flows. A few different models could address this issue:



Example: Spring St in front of the Courtyard by Marriott Hotel

CONVERTED ON-STREET PARKING

Downtown Columbus has several roadways with long stretches of on-street parking which may no longer be needed. These parking lanes can be designated and painted as dedicated pickup-drop off areas for on-demand, self-driving cars. Appropriate signage for these areas will also need to be implemented, especially if pickups and drop offs are only allowed at a zone under certain conditions.

EXISTING LOADING ZONES

Several spots around downtown Columbus already exist where vehicles can pull off of the street to drop off or load passengers. A prime example is in front of the Courtyard by Marriott hotel on Spring Street. These areas can continue to operate as they currently do, with anticipation of increased use.

PIT STOP

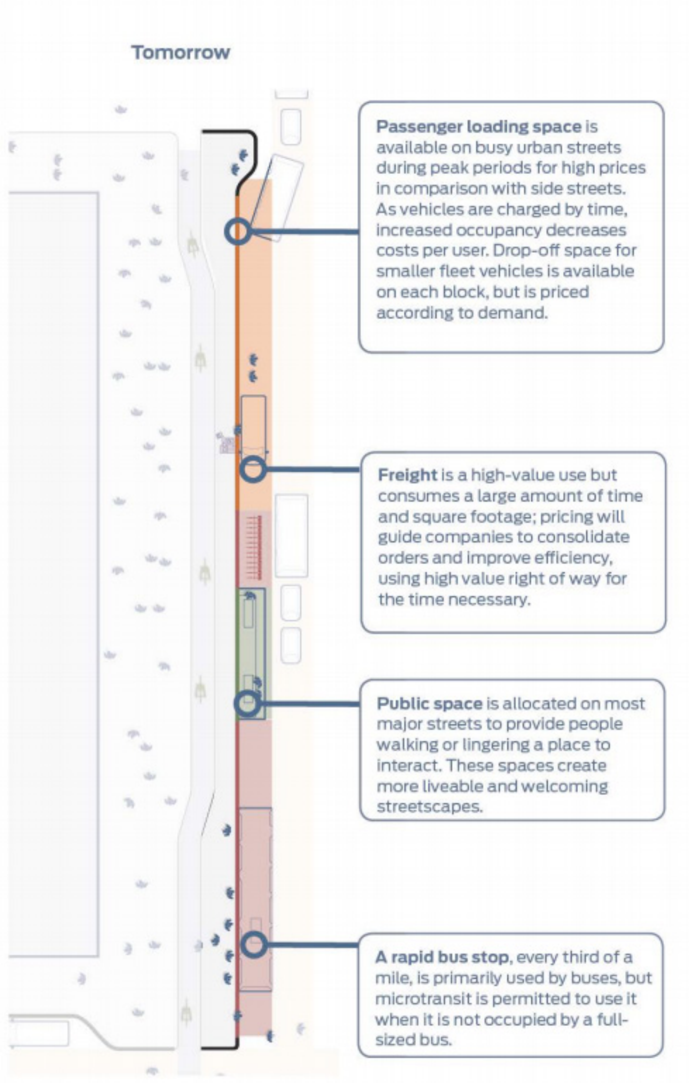
Another model is what the team will refer to as the "pit stop" dropoff. This will be a lane separated from the rest of the road by a physical barrier such as green space or a small concrete curb. The name is derived from this feature in racing tracks, where cars temporarily leave the main track (for maintenance) and re-enter after the task is completed. The task in our drop off, of course, will be picking up or dropping off passengers. The main two reasons for the pit stop dropoff are to avoid backing up cars on major roads while they stop at curbs in standard lanes, as well as providing protection for passengers in calmer traffic with physical barriers.

Pickup/dropoff management

As demand for curbside space and other pickup-dropoff areas grows with the adoption of shared and autonomous vehicles, systems to manage and appropriately price these spaces will need to be established.

DEMAND PRICING

In order to prevent congestion and to efficiently distribute pickup-dropoff zones, prices for the use of these zones will need to reflect the demand for those areas. Uber already incorporates this into its pricing, charging more for a ride from Nationwide Arena at 10pm on a Friday night than the same ride at 2pm on a Tuesday afternoon, for example. For certain appropriate zones, an instant reservation system could be implemented so that specific vehicles can automatically reserve time slots a few minutes in advance of arrival at a site, paying for however long they use the space[19]. The cost would be determined by the demand for that space at that moment in time, facilitating an efficient balance between demand and supply. Regardless of whether a spot can be reserved or not, the price for usage of a pickup-dropoff zone should increase until the zone occupancy reaches an optimal level in order to ensure that it is neither underutilized or overcrowded. This concept, put forth by Donald Shoup, has been widely applied to parking, but could also have useful applications to pickup-dropoff zones in the future[20].

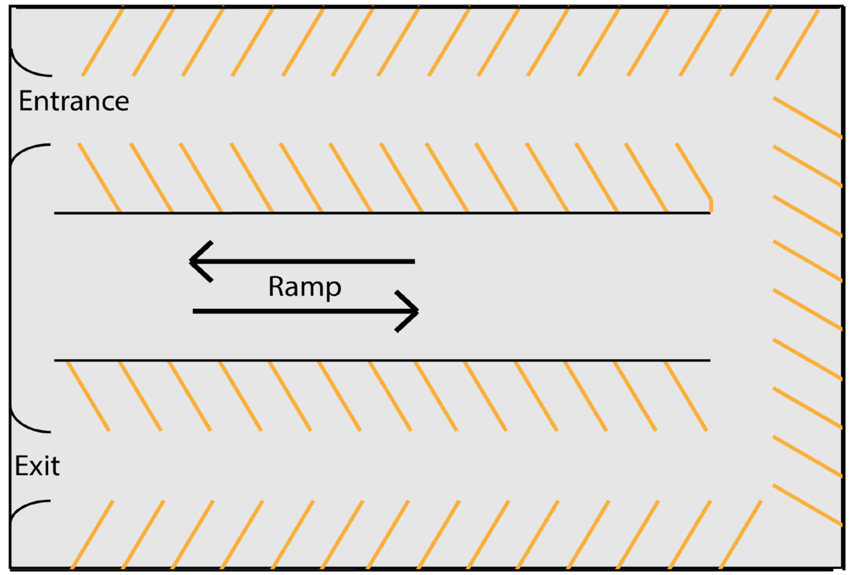


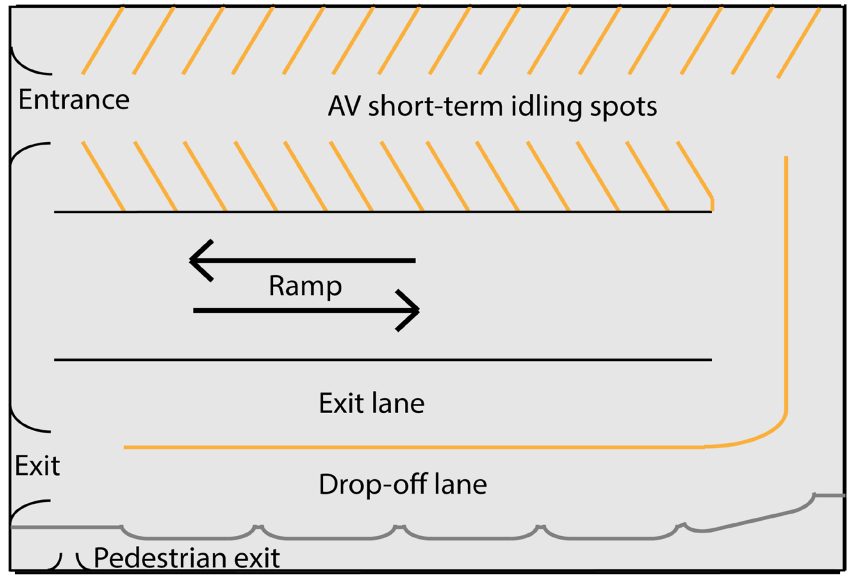
Seen here is a pick-up location for rideshare companies (Photo credit: The Points Guy 2016)

Garage functionalization

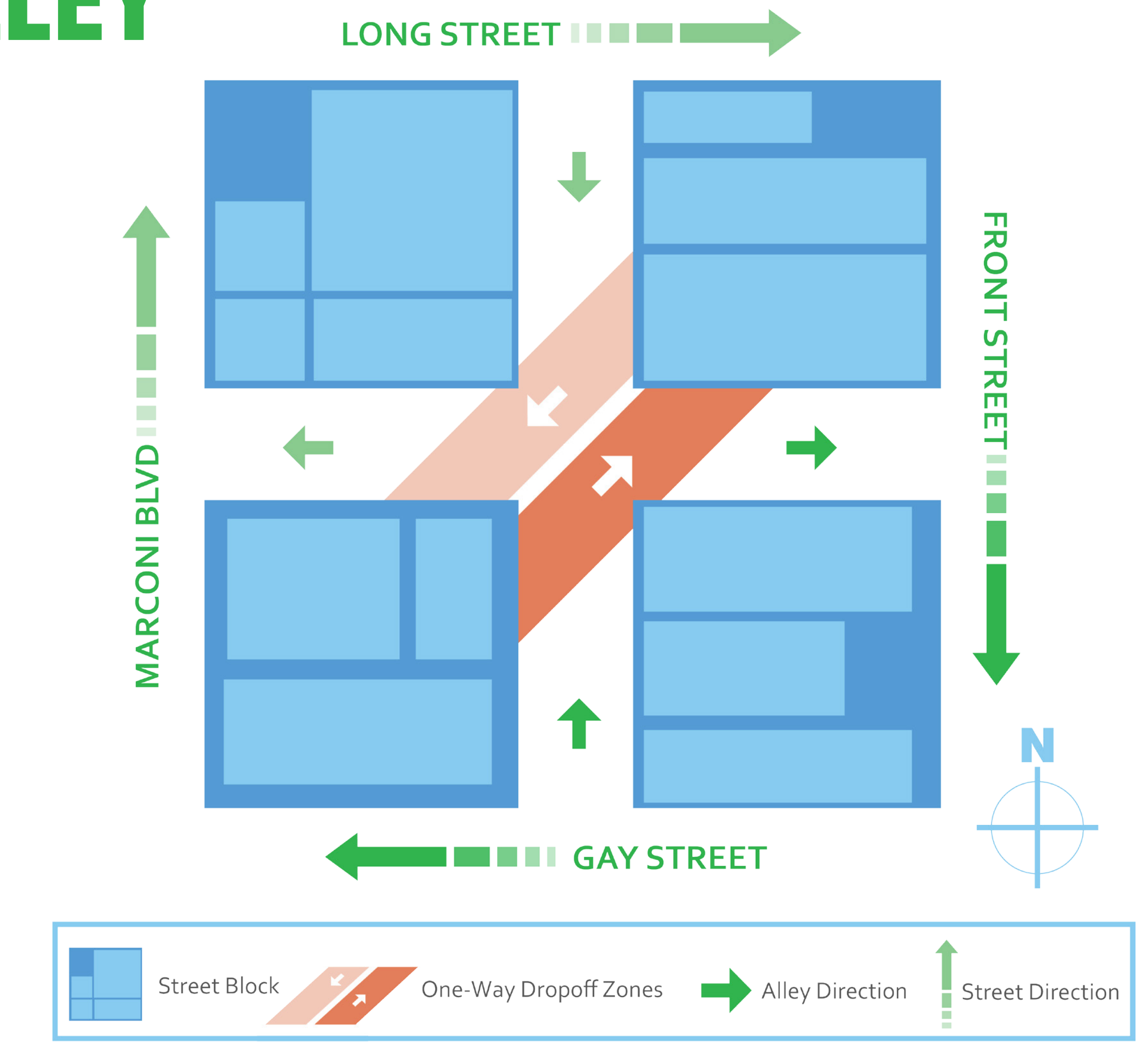
Repurpose bottom floors of garages,shown below, for pickup/dropoff. As the need for parking is reduced by increases in AV, parking garages will have to shift use to continue to be profitable. More drop-off space will be needed for AV in the city, and garages can adapt to fill the role. The bottom floor of a garage can be altered to facilitate the drop-off and pick-up of occupants. The spaces on the bottom floor could also be designated as short-term idling zones for vehicles that arrive before the passengers being picked up.

Repurposed alleys, shown to the right, can be used for pickup/dropoff to minimize the amount of other roadway space used for pickup-dropoff idling. Alleys are low speed and would be ideal for pedestrian drop-off. AVs can idle and stop in alleys without impeding traffic on a normal roadway.
Grant non-exclusive access to the bottom floors of parking garages for the staging of self-driving cars while they are awaiting dispatch.
Regulate the use of roadways by AVs that do not have a passenger by requiring staging in designated areas while awaiting dispatch.





The alley



Drop offs can occur in alley intersections, shown in orange above, via a system of exclusively right turns. This way passengers are safer when entering and exiting vehicles (as opposed to being adjacent to a busy Long Street), and cars can move more efficiently without waiting for the oppourtunity to turn left at intersections. (Note: This specific intersection is just an example; this is possible wherever these street directions can be established.)

Policy recommendations

Policy will be crucial in determining which AV model(s) are adopted, how quickly they will be adopted, and how smooth of a transition the adoption process will be. Some helpful policies have already been put in place, including the bus pass program with downtown employers which encourages commuters to take public transit and the payment alternative component of the Smart Columbus initiative which provides equitable access to transportation services for those without credit or debit cards[22]. The following recommendations are made with the purpose of building upon the successes of already existing policies, as well as mitigating the potential negative implications of AVs while taking full advantage of the technology's potential benefits.

SHORT TERM *Immediatly valuable implementations*

Do not continue to make expensive infrastructure decisions based on the current model (i.e. adding lanes, building parking garages)

Establish effective systems for information about work zones, roadway incidents, changes in pavement condition, etc. and create data-sharing requirements for automated vehicles[23]

Sourcing • Processing • Sharing • Maintaining

Expand broadband (ex: 5G Mesh Network - a cell network that can share large amounts of data[24])

Anticipate drastic changes to employment opportunities in the transportation sector and ensure that workers are equipped with the skills they will need to adapt to changing workforce needs

MID TERM *Facilitating a smooth transition to AVs*

Prepare for the possible influx of AVs with the sole purpose of advertising (automated versions of today's billboard-toting trucks)

Allocate space for charging stations

Implement dynamic pricing that takes the following variables into account[25]:

- Origin and destination
- Number of passengers
- Level of congestion
- Environmental impact
- Household income

LONG TERM *Capitalizing on full autonomy and repurposing the obsolete*

Establish an area/areas away from the urban core for cars to park when not in use.

Establish a hub for intermodal transfer between downtown transportation options and regional transportation systems (i.e. Greyhound bus, rail, Hyperloop - proposed mode of passenger and/or freight transportation using magnetic levitation technology to connect Chicago, Columbus, and Pittsburgh with vastly shortened travel times[26])

Repurpose abandoned parking lots, garages, and other obsolete uses for stormwater management, recreation, etc.

Amend zoning codes and establish municipal facilities to allow local power generation and prioritize a distributed power grid[27]

Last Word

The future of downtown Columbus in the wake of autonomous vehicles is largely uncertain, but what decision-makers choose to fund, implement, and encourage today will help determine what that future looks like. Efforts to gather as much information as possible right now are crucial for ensuring tomorrow's wise decisions. Just as crucial is ensuring that the public is well-informed about what is coming down the pipeline with autonomous vehicles and why this technology is relevant to them. AVs have the potential to drastically alter the most important decisions of people's lives: where they live and where they work. Citizens need to be equipped and enabled to help with decision-making in order to ensure that the future of downtown Columbus aligns with community interests, goals, and values. It would serve the city well not to get caught up in the "glitz and glam" of new technology and lose sight of community needs which AVs could meet in more economical, environmentally-friendly, and equitable ways.

Appendix can be found online at:

https://docs.google.com/spreadsheets/d/1hwc39Z7gQDkE_uT2zDCQsTEEfZoJOF4uFSCL0WXQEFQ/edit?usp=sharing

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