MAKING THE MOST OF CURB SPACES IN A WORLD OF SHARED AUTONOMOUS VEHICLES: A CASE STUDY OF AUSTIN, TEXAS

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ABSTRACT

With the recent developments of connected and autonomous vehicles (CAVs) as well as technologies in traffic and transportation systems, CAV applications will have the ability to radically change the urban grid system and challenge urban planners to repurpose existing public infrastructure. As CAV technology matures and accounts for higher proportions of the operating traffic, parking demands will be greatly reduced in central business district centers. Curbside parking spaces may be given back to pedestrians, repurposed for active transit users, or removed entirely to create additional roadway capacity.

This paper examines Austin’s parking supply and offers case study examples for curb-parking repurposing. It emphasizes how SAVs enable more utilitarian uses of curb-parking and offer an empirical study into repurposing this public area, providing municipalities the ability to develop the means to eventually liberate this public land from parked vehicles and repurpose it for a larger community benefit. The supply and demand for these alternative spaces is provided here for developing the decision support system, as well as their physical location, attributes, and pricing regimes. This analysis offers recommendations for future usage of existing curb spaces and ways to ensure curb-parking is ready for SAV-using settings. The suggestions offered here may serve as a model for other cities and may be valuable in long-term city development and planning.

Key Words: Parking Provision, Shared Autonomous Vehicles, Connected and Autonomous Vehicles (CAVs), Curb Parking
INTRODUCTION

The rapid urbanization and the desire for the urban lifestyle throughout age-groups have highlighted the need to provide a higher quality of life. Urban residents and their quality of life depend upon thoughtful urban planning and a transportation system to mobilize its citizens. Growing urban populations want streets to serve not only as corridors for the conveyance of people, goods, and services, but often as playgrounds and public spaces. Ideally, city streets are safe, sustainable, resilient, multi-modal, and economically beneficial, all while accommodating travelers. In response to these unprecedented demands, cities around the world are attempting innovative solutions through technology, automation and a shifting emphasis on active transit amenities.

Mobility is a key factor in urban quality of life and connected and autonomous vehicles (CAVs) have the potential to upend our current transportation system. CAVs are predicted to be one of the greatest technological advances in daily traffic service, with a promising future of safer and more convenient transportation (Fagnant and Kockelman 2015, Schoettle and Sivak 2014). CAVs are now within reach and may soon become a daily mode of transport for hundreds of millions of people (Bansal and Kockelman 2016). Many major companies, like Google, Toyota, Nissan, and Audi, are developing and testing their own AV prototypes (Anderson et al. 2014). Past transport transformations, like Henry Ford’s mass-produced Model T, helped shape our modern-day traffic systems. Our existing urban traffic systems are now being called into question, in terms of whether they can optimally support the needs and aspirations of a world increasingly dependent on more automated vehicles and traffic management systems.

Vehicle ownership costs and the freedom that SAVs offer travelers may lead to rapid adoption of shared autonomous vehicles (SAVs). SAVs, also known as autonomous taxis or aTaxis (Kornhauser et al. 2013), offer short-term, on-demand rentals with self-driving capabilities, enabling members to call up distant SAVs using mobile phone applications, rather than searching for and walking long distances to an available vehicle. SAVs may overcome the limitations of current car-sharing programs, such as vehicle availability, due to their ability to offer door-to-door service as well as effective connectivity to exist transit facilities. Therefore, one might expect the early integration of SAVs to cater to the shift in urban living where vehicle ownership is the most expensive and cumbersome. Martin and Shaheen (2011) estimate that 9 to 13 vehicles may be replaced for every non-automated shared vehicle. Burns et al. (2013) found that in mid-sized urban and suburban settings, each shared vehicle could replace 6.7 privately owned vehicles. Spieser et al. (2014) modeled a fleet of shared self-driving vehicles in Singapore in the absence of any private vehicles, and found that each shared vehicle can replace three privately owned vehicles and serve 12.3 households.

Douglas (2015) uses Kornhauser et al.’s (2013) base model proposal to size an SAV fleet for a 5-mile by 5-mile subset of the New Jersey model and found that at least 550 SAVs would be needed to serve the trip demand with reasonable wait times. The International Transport Forum (2015) applied SAVs to serve Lisbon, Portugal, and found that with ride-sharing enabled, each SAV could be expected to replace approximately 10 privately owned vehicles while inducing about 6% more vehicle-miles travelled (VMT) than the city’s baseline. Without ride-sharing in Lisbon, each SAV was expected to replace about 6 privately owned vehicles but deliver 44% more VMT, which could easily gridlock that city. Fagnant and Kockelman’s (2014) 10 mi x 10 mi simulations of relatively short trip-making patterns indicated that each SAV may be able to replace 11 conventional,
privately owned vehicles, while generating up to 10% more VMT. When the simulation was extended to a 12 mi x 24 mi case study of Austin (Fagnant 2015), with relatively low market penetration (just 1.3% of all person-trips in early test scenarios), each SAV was estimated to be able to replace 9 conventional vehicles while generating about 8% more VMT (due to unoccupied travel). Chen et al. (2016) utilized 2009 NHTS trip distance and time-of-day distributions indicate that fleet size is sensitive to battery recharge time and vehicle range, with each 80-mile range SAEV replacing 3.7 privately owned vehicles and each 200-mile range SAEV replacing 5.5 privately owned vehicles, under Level II (240-volt AC) charging. With Level III 480-volt DC fast-charging infrastructure in place, these ratios rise to 5.4 vehicles for the 80-mile range SAEV and 6.8 vehicles for the 200-mile range SAEV.

In the forefront of these changes is a need to re-evaluate current parking provision. Its supply and demand will define new parking baselines alongside AV technologies. Parking analyses require data on existing conditions and how estimations of future demands will respond to the provisions available. Parking is not cheap, and is estimated to represent 15% of the total rental costs in central Seattle (Thompson 2016). Cities like Boston have increased parking charges, in order to promote greater use of multi-modal, public transit trip-making (Arnott et al.2006). Current parking studies have indicated that some current pricing schemes incentivize automobile travel and do not accurately internalize the external costs of parking in the downtown area. Despite this perceived parking shortage in some downtown areas, US parking spaces outnumber the number of vehicles by a factor of 4 (Thompson 2016). Parking seems to be in abundance by the staggering number of parking spots in the US, but the location of the supply does not always meet the demand within proximity, causing high parking costs and increased traffic associated with locating vacant parking. The impetus of high parking costs along with the advent of autonomous vehicles lead Fagnant and Kockelman (2013) to estimate a savings of $250 in parking costs for each new autonomous vehicle in the market, primarily through reallocating parking space from Central Business District (CBD) locations to more remote areas utilized in conjunction with ride-sharing. Zhang et al.(2015) estimates the potential impact of SAVs systems on urban parking demands under different system operational scenarios with the help of an agent-based simulation model. The simulation results indicate the potential for a 90% reduction of parking demand for clients who adopt the system, at a low market penetration rate of 2%. Hayes (2011) suggested that AVs can economize parking garages because they can park inches from each other since there is no need to open auto doors, assuming that the passengers will be dropped off before the AVs enter the parking facility. New mobile applications can serve individuals who participate in dynamic ride-sharing services by matching the nearest vehicle with the route that matches the users’ preferences. Such a matching system will serve several passengers at the same time by linking trips that have origins and destinations close to each other. Once the vehicle occupancy rate is improved, a greater reduction in parking demand can be achieved.

Previous studies examined parking provision and policies (e.g., Brooke et al., 2014; Habib et al., 2012; van Ommeren et al., 2012), but theoretical studies on parking provisions vs. network are rare. Bifulco (1993) introduced several parking types, fees and average walking times to a static traffic assignment model to evaluate the efficacy of several regulatory parking policies in a general urban network. Arnott and Rowse (1999) assumed travelers’ choice of parking lot is uniformly distributed on the ring-road, and thereafter derived the expected parking time, driving time and cruising distance for the available parking search. Calthrop and Proost (2006) presented a spatially homogeneous model characterizing the steady-state equilibrium of on- and off-street parking, in
which the search cost for on-street parking balances the higher fee associated with off-street parking, but did not consider traffic congestion perse. Chester et al.(2010) develop five parking space inventory scenarios and estimated the environmental consequences from these estimated range of 105 million and 2 billion parking spaces in the US, and then, Chester et al.(2015) estimated how parking has grown in Los Angeles County (CA) from 1900 to 2010 and how parking infrastructure evolves, affects urban form, and relates to changes in automobile travel using building and roadway growth models.

This work relates to the investigation of the parking provisions in downtown Austin, which will shortly followed by the downtown Austin Alliances commissioned study. A basic spatial distribution for the environmental impact analysis of CAVs is postulated. This estimation model builds off additional works mentioned as well as incorporating CAVs technologies to repurpose parking amenities and capture the effect on traffic and commuting patterns. In summary, the contributions of this paper include:

- This is the first investigation on the real-time dynamic sharing of parking space investigation and analysis in downtown Austin. A basic spatial distribution for environmental impact analysis of CAVs is formulated within the paper.
- An estimation model is proposed, which calculates the updated parking provision to avoid affecting traffic and commute time. The re-configuration of the curb parking provision will greatly impact the already packed traffic in the urban core, which is an inevitable problem during the transition period from private-cars to shared-vehicles.
- Extensive research was carried out and the results validate that re-planning parking spaces improves both comfort and convenience of life downtown due to the implementation of SAVs.

The analyses conducted help to validate the repurposing of existing amenities to ease the stresses of the urban environment that have emerged. The value of curb parking for other utilitarian uses should encourage city officials to begin discussions about how to utilize emerging infrastructure to allow for dynamic changes.

**Spatial Model Analysis**

The following illustrates a spatially symmetric road network structure of Austin’s downtown area, and will highlight the benefits seen as urban environments expand. Thus, essential assumptions of this model are made, such that all transit has enabled CAV technology and all parking is on-street. All trips are the same, and entail driving a fixed distance over downtown streets directly to a destination, followed immediately by having the vehicle park if a vacant parking spot is available and otherwise will search until a vacancy is found. After a fixed duration of time at the destination the vehicle will exit the system. The demand for trips is inversely related to the full trip price, which includes time and capital costs. Downtown corridors and the adjacent parking provisions rely upon adjacent land-uses, street width, and the proportion of the curbside allocated to parking. Vehicular travel and the proportion of vehicles in transit searching for parking makeup a significant proportion of the travelling public in downtown areas when analyzing parking availability and turnover. Within the model, the drop-off and pick-up of citizens from vehicles present the biggest opportunity to improve traffic, as cars cruising for parking greatly slow down traffic. Traffic equilibrium conditions are also affected by policy decisions, including management and design pricing and the designated use of curbside parking.

Spatial symmetry is assumed to simplify the analysis. Blocks are square with sides of length $b$,
streets are of width $W$, and $P_{max}$ is the maximum possible number of on-street parking spaces per unit area. The paper ignores the complications that arise from the indivisibility of lanes. Figure 1 portrays the geometry of the Austin street network.

(a) Investigation of blocks and roads information in Austin's downtown

(b) Geometric model from road network

FIGURE 1 Geometric model of road network in downtown Austin.
Renewal of Parking Spaces

Emerging CAVs will grow out of a need to correct modern city car-sharing inefficiencies. The connected and autonomous ride-sharing service will create more-efficient travelling options for the public money while reducing the amount of traffic and burden on the environment. The research conducted strategically reorganizes the existing parking provision, aiming at reducing the need for land occupancy, which has significant potential to improve urban life.

Currently, some major cities have started to convert formerly automobile-only spaces into multi-use spaces for public services, e.g., parklets, a bike lane, a bus-only travel lane, a general purpose traffic lane, extended sidewalks, multi-bus waiting areas, shared-car parking, EV battery charging, and truck loading zones. Major redesign of parking spaces requires a variety of considerations since not all streets are appropriate for specific rearrangements, if at all. Google Maps and ArcGIS were used in this paper to illustrate one possible way of identifying curb-parking suitable for this study. Additional streets may benefit from the replication of this method or may transform the criteria to account for different local conditions. Some of the ideal land use considerations include traffic flow, parking provision, minimized air pollution, existing pedestrian activity, commercial, high-density building and mixed-use areas. Other considerations include prioritizing parking spaces in rights-of-way, curb parking with low amounts of open space, high open space congestion and environmental transportation demographics.

- 1/4 mile (a 5 minute walk) is considered to be the maximum that most people would be willing to walk to reach a destination. Beyond this distance, people often bike, drive, take public transportation, or decide not to go to that destination (Nichols 2009).
- The re-plan of parking space prioritized commercial and high-density environments, followed by public service and non-profit institutions second, and lastly residential.
- Shared parking will be utilized primarily for adjacent trip attractors and neighboring commercial applications. Therefore, geocoding desirable commercial businesses (restaurants and bars, bookstores, theaters and music venues) and keeping the potential parking locations nearby (within 100 feet) are priorities (ASLA 2011).
- Most residences are within a 1/4 mile walking distance of current parking provisions. In addition, there is a great deal of variety in population density and size of available public space when considering the parking reductions due to the emergence of SAVs technologies. Therefore open space congestion was used (population density combined with open space acreage) as a metric.
- Environmental justice is a consideration in many areas of research, and currently no municipality other than New York City has made it a priority when implementing parklets. Ethnic minorities and those below the federal poverty line are historically disadvantaged populations in terms of open space-and therefore areas with a majority-minority population (>50%) and those with higher levels of poverty are prioritized (Sister 2009).
- Keeping parklets and bike lanes more than 300 meters away from highways is a priority (Brugge 2007) as active transit amenities should not be preferred nearby high speed vehicular facilities.

Replanning a successful parking provision for a CBD area requires a variety of considerations, as not all streets are appropriate for land use transformation planning. Certain streets and businesses have a higher propensity than others to support a modified parking provision. Along those streets, and despite certain throughput situations, specific blocks may warrant alternative uses, depending
upon adjacent land types and means of transportation to reach nearby destinations. The results of the GIS analysis may be used as a basis for discussion with city planners, businesses and residents to supplement parklet location decision-making.

**CASE STUDY**

A GIS suitability analysis is used here to demonstrate the above method. The downtown-parking provision data were collected from City of Austin files (as shown in Figure 3), and suggest significant potential for repurposing and reuse of existing spaces. This study seeks to anticipate how much curbside parking may be freed up by used of self-driving shared vehicle fleets, or SAVs. A shift to fleets of shared and self-driving vehicles may improve quality of life for downtown users and visitors, by facilitating all modes of transport by opening up land for more meaningful uses in this highly desirable and busy downtown setting. After conferring with design professionals, local businesses, residents, downtown workers, government officials, and other stakeholders, models of implementation can emerge.
FIGURE 2 Parking provision in downtown Austin.

When viewed in tandem with Figure 1, Table 1 values suggest that shared vehicles could save many more spaces in the downtown. Austin’s car-sharing companies (Car2Go and Zipcar) are well known to the public, with 95% of Bansal et al.’s (2016) respondents reporting familiarity.

| TABLE 1 Total Parking Spaces (Source: Austin Transportation Department, 2016) |
|---|---|---|---|---|---|
| Route | Meter Spaces | Paystation Spaces | Total Paystations | Total Curb Spaces | Location |
| 1 | 19 | 191 | 31 | 210 | Core |
| 1 CZ | 4 | 3 | 0 | 7 | Core |
Note: APD stands for Austin Police Dept., and MACC stands for the city’s Mexican American Cultural
Consider each of Fig. 1’s blocks in turn. When the parameter $t$ takes on different values, the spatial change rate of the in-transit street equals the entry rate, $D$, minus the exit rate, $E$. Thus,

$$S(t) = D(t) - E(t).$$  \hspace{1cm} (1)

With saturated parking, the spatial scale rate of the cruising-for-parking block, $C$, equals the entry rate into the cruising-for-parking block, which equals the exit rate from the in-transit block, minus the exit rate from the cruising-for-parking block, $Z$.

$$C(t) = E(t) - Z(t).$$  \hspace{1cm} (2)

In the steady state, the exit rate from the in-transit block equals the block size divided by an individual’s time in the block, and the exit rate from the cruising-for-parking pool equals the exit rate from parking. Let $S$ be the pool or stock of individuals per unit area in transit to their destinations, $P$ is the stock of on-street parking spaces per unit area. $S/mt$ denotes the exit rate from the in-transit pool equals the pool size divided by an individual’s time in the pool, so that combination of Eqns. (1) and (2) delivers the following results:

$$D = \frac{S}{mt}, \quad \frac{S}{mt} = \frac{P}{l}$$  \hspace{1cm} (3)

This pair of equations involves several parameters, whose values may be assumed as follows: $t = 2.0$ (i.e., in-transit travel distance is two miles), $l = 2.0$ (the average dwell duration of parked-vehicle visit length), $f = 1.0$ (so the price of on-street parking is $1.00$ per hour), $\rho = 20.0$ (the value of parking search time is $20$ per hour), and parking is provided on just one side of every block (not on both sides).

Such computations offer planners a conceptual framework for recognizing on-street parking provision and rearrangement of parking spaces under shared-fleet conditions. After a thorough investigation of Austin’s downtown blocks and road structure, as illustrated in Figure 1, the block spacing, $b + w$, is found to be 110 m (361 ft.); the road width, $W$, is 10 metres (33 ft); and parking spaces typically measure 2.76 metres (9.1 ft.) wide by 6.1 metres (20 ft.) long, on average, with allowance made for crosswalks (2.45 metres or 8 ft.) at the ends of all blocks. As shown in Figure 3, there are 3 types of parking used along downtown Austin’s curbs: parallel parking (the most common design), inclined parking, and bay parking. These three types can contain up to 15, 22, and 10 cars, respectively, in a single, average block. Curbside parking on both sides of each block suggests 30, 44, and 20 cars can be parked per block under the 3 parking designs, respectively.

![FIGURE 3 Three types of parking in downtown Austin.](a) Parallel parking  \hspace{1cm} (b) Inclined parking  \hspace{1cm} (c) Bay parking]

The next thing to consider is the amount of roadway surface available for parking space allocation when shared parking is provided for residents, visitors, and businesses. Figure 4 presents the current spatial layout of curb parking spaces in downtown area. A study by Fagnant and Kockelman (2015) indicated that one SAV may be able to replace up to 9 conventional vehicles in the core of a region like Austin, suggesting that the need for any kind of parking spaces may eventually fall by 89%, if all those currently driving shift to SAVs. If one applies this percentage
to just curb spots (as listed in Table 1), this liberates 6426 parking spaces, or 0.042 sq.mi (roughly 4 percent of the core downtown’s 1.0 sq mi land area), which can be re-purposed for an extra lane of traffic, parklets, bike use, and other public facilities. With this decrease in parking demand, the rational reuse of parking spaces will become an important part of more sustainable transportation system designs.

As part of the future urban development, a new parking provision plan, which propose a classification method to redefine prioritized modes of transport for each street (e.g., pedestrian, bicycle, transit and vehicular). This plan should be implemented on the basis of existing street design and operation, and should continue to be updated as specific projects are funded for design and engineering, and as further community input is considered.

The parking spaces can be constructed in a variety of ways based on different existing parking types. For example, delivery trucks and bus stops can be moved around to create entirely new bike or traffic lanes, using the space in between for parklets, bike storage, and car-sharing. The key goal is to improve access to, and mobility within, the downtown core, creating a more balanced dynamic-shared-parking system that supports growth and intensification, while fostering a high-quality, pedestrian environment.
As downtown land space becomes more expensive and sites become smaller and less efficient for curbside parking, there will be a need to rearrange the parking provision more effectively. The multitude of options and the arrangement of these amenities with regards to additional infrastructure along the corridor should be considered. Instead of single-purpose parking spaces for a variety of uses downtown, shared and dynamic automobile and bicycle parking facilities could reduce the costs and burdens of urban development and provide for a more intensive and sustainable use of urban land.

**Designating a Preferred Mode of Transit along Each Corridor**

The availability of public land associated with the reduction in parking provisions due to SAVs presents an exciting opportunity to further promote specific modes of transit along corridors. For example, Guadalupe street is a corridor in which the local transportation authority, Capital Metro has invested in improved bus facilities for a variety of routes, not to mention the newly installed bus rapid transit line. To further promote multi-modal transit and a level of service improvement for the transit system, the current parking on this corridor can be converted to a hybrid of services to promote public transit. These amenities could include an extension of the existing bus lane, increased bike and car share locations which can promote public transit and additional queuing spots for buses to prevent traffic buildup during vehicle alighting. Selection for the preferred mode of transit correlates to the neighboring characteristics which could include:

- Adjacent land-uses and their parking needs
- Access to highway facilities
Existing modes of transit currently along the corridor

Presence of high trip attractors

Usage of the corridor during major city-wide events

Refuge for pedestrians and active transit

Current daily traffic counts versus improved daily traffic counts

Usage of shared facilities

The following indicates the empirical analysis taking into consideration the above characteristics.

Rio Grande (Average Daily Traffic (ADT): 2,730-2,830 vehicles per day, on average) - Bike corridor – This corridor runs through downtown to west campus and consists of low traffic neighborhood tree-lined streets. The current corridor has a bike route in place and could be suitable for additional bike traffic. Additional emphasis on this mode of transit would enable other corridors to focus on high capacity transit options. Meanwhile, this street still serves local traffic effectively and presents an aesthetically pleasing area for pedestrians and active transit users.

Lamar Street (ADT: 32,670-38,480) - SAV preferred corridor - This corridor connects areas of Austin that have been developing rapidly, and the same can be said for the growing transit opportunities along this corridor. Due to the limiting ROW constraints, this corridor would be suitable to encourage high occupancy SAVs to improve and economize the existing infrastructure and serve the multitude of communities adjacent to Lamar Street.

Congress Avenue (ADT: 7,340-23,260) – Hybrid of amenities for all modes – Congress Avenue has a wide number of bay parking spots that have already been converted to parkelts where additional pedestrian amenities are needed. Currently, bicycle traffic is mixed in with vehicular traffic decreasing potential throughput capacity. During city wide events and most weekends, large events are planned near the paramount theatre and a dynamic setting to accommodate the stresses of additional pedestrians in the adjacent area should be considered. Additional downtown developments are planned which do not provide parking amenities for its patrons and therefore shared amaneities and transit should be considered around this new development.

San Jacinto Boulevard (ADT: 4,230-5,980) – Multi-modal transit – San Jacinto Boulevard connects a major university and growing medical center and has high amounts of student traffic on buses, foot, and bike. With the additional roadway space and more centralized parking, more feeder buses should be considered to serve commuters to the university who may park further away. Additionally, to promote active transit and to provide a firmed berlin environment for the multiude of events and football games in the area, increased pedestrian and cyclist shade and refuge will help to promote these environmentally friendly forms of transit. Current vehicular access is restricted at most areas of San Jacinto so it is not recommended to encourage additional vehicular traffic.

Brazos Street (ADT: 2,880-3,840) and Colorado Street (ADT: 3,780-4,530) – Shared-parking environment – This corridor is designed to provide shared parking amenities for downtown destinations. This re-designed space allows for quick queuing and alighting times and a space for carpooling and queueing for these vehicles. Current street configuration promotes active transit with newly created pedestrian space and this shared parking environment is already enabled with current bike sharing infrastructure. Additional pedestrian space can be created with this shared-parking environment to relieve some of the urban stresses related to additional density. Neighboring streets with pedicab access should be considered for a pedicab queuing area as well. These streets have a high amount of off-street parking and vehicular traffic should be preferred for these corridors.
Electric Drive – Transit-oriented development through SAVs – Newly installed EV infrastructure has created “Electric Drive” in Austin’s evolving Seaholm EcoDistrict. Increased high-density urban development has created this highly sought after urban district, which is generating and attracting new vehicular (and non-motorized) traffic. Utilizing underused public spaces is one of the avenues towards implementation of a shared vehicle system. Shown below, current Seaholm SAV station design example exists underneath a Union Pacific rail line, opening up underutilized land for some meaningful (SAV storage) development. This station can increased and promote a shared parking environment which can become a first/last-mile effort parlayed with public transportation.

FURTHER ENHANCEMENTS IN THE URBAN SPACE

Curb-parking epitomizes wasted space and represents areas within our urban network which can be repurposed to promote a higher quality of life for the community. Parking spaces have responded to the stresses of the urban environment through the installation of parklets, providing much needed amenities for the community (Koue 2012). Cities have been able to partner with non-and for-profit businesses such as Zipcar, to implement these infrastructure improvements, serving to increase the efficiency of the current systems. A closer examination at the underutilized public spaces in the CBD has led to grass-roots movements such as the growing parklets phenomenon in San Francisco. These forms of mobility for communities should be quantified so municipalities can evaluate which forms of shared mobility will be integrated within their system. Alleyways are another example of underutilized space. Once the home for lively community activities, much of this vanished when many municipalities began wholesale adoption of alleys as a form of the waste refuse process (Chan 2015). Coordination of the newly adopted pedestrian alleyways can become integrated into the decision process of parking revaluations to give more room for the outflow of pedestrians in the environment.

In addition to promoting underutilized spaces through tactical urbanism, coordinating and incentivizing public transit through this initiative must also be considered. Currently, the City of Austin has recently devoted a lane of travel for the newly installed bus rapid transit system. This system and the continued adoption of public transit will only be developed if it can provide a high level of service. Coordination between these systems and private car sharing systems will allow for a more effective downtown environment. Last mile efforts such as biking and walking will allow for more multi-modal trips.

CONCLUSIONS

Self-driving technologies may make SAVs a highly competitive mode alternative for many, most, or nearly all person-trips. Around the world, car-sharing is becoming a viable alternative to privately owned vehicles, which helps reduce parking requirements in settings that offer storage for shared fleets. A basic spatial distribution for the environmental impact of SAVs is postulated, liberating curb-parking for other uses. If one SAV can replace 9 conventional vehicles, it seems reasonable to expect that 90 percent or more of Austin’s current downtown curb spaces may be easily liberated (especially since off-street parking can be more challenging to repurpose). That space constitutes about 27 acres of land (or 4.2% of total land) in Austin’s 1.0 square mile downtown, could be re-purposed for other public uses. This paper provides a variety of re-use suggestions along major corridors, ensuring provision of truck delivery spots and transit stops, while adding bike lanes, extending sidewalks, and providing more general purpose traffic lanes to facilitate various forms of travel and leisure along north-south routes. The goal of this research is to improve access to, and mobility within, a downtown core, creating a more balanced and dynamic...
shared-vehicle and shared-parking system that supports regional and local growth and densification, while fostering a high quality of life for all those destined to and/or residing in the downtown. As part of any city’s long-term planning efforts, a new parking provision plan, recognizing SAVs’ potential impacts, should emerge. As in this paper, such plans may do well to redefine each street’s objectives and priorities (e.g., pedestrian, bicycle, transit and vehicular), to support more active modes, more meaningful land use, and safer and more efficient transport.

Parking provision is a principal factor in shaping the form and character of downtowns everywhere. Although a major goal of many cities is to create sustainable, pedestrian-oriented downtown districts, the lack of many highly well connected, very frequent, and popular transit routes and transit-supportive land use patterns across Austin requires that adequate levels of automobile parking continue to be provided in this particular case study until there are more viable alternatives. SAVs may be the breakthrough that cities like Austin seek, though their overall impacts (on travel distances, location choices, and traffic congestion) remain to be seen.

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