

Introducing the 21st Century Boulevard: A Post-COVID Response to Urban Regeneration of Main Road Corridors

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Abstract

As city leaders contemplate the post-COVID-19 urban regeneration, Parisian Boulevards from the 17th Century provide inspiration, from their combination of mobility with pedestrian, nature and place-based qualities. This paper proposes a new concept called “21st Century Boulevards” to support local and regional authorities in achieving urban regeneration using such qualities together with new technology. Four approaches are recommended to create 21st Century Boulevards: 1) enhancing road-based shared transit systems such as electric trackless trams; 2) embedding micro-mobility and autonomous shuttles for end-of-trip integration at stations; 3) adopting new precinct-scale technologies that enable Net Zero outcomes for station precincts such as renewable energy recharge hubs, and 4) implementing a smart cities-based demand management system. The human qualities of boulevards are outlined using new planning and design approaches. A key indicator of success would be to measure the extent of a new parameter called the “Busker Factor”. The integration of new technology and new planning to achieve centuries-old urban qualities is a regeneration opportunity with multiple benefits for the main roads of all cities.

Keywords

Boulevard, Smart Technologies, Net Zero Corridors, Trackless Trams, Busker Factor

1. Introduction

The Boulevards of France, such as the Champs-Élysées, are famous around the

world as a historic planning tool used to regenerate declining parts of cities. Using nature as a feature and visual frame, Boulevards provided new space in crowded cities that could transform urban economies, allowing room for greater commerce and urban activity, alongside a range of cultural activities. They were used primarily to allow greater mobility in the city; however, the real economic impact came from their popularity as a place to spend time at cafes, retail outlets and cultural performances. Boulevards quickly became “the place to be”, to experience a fusion of activity, nature and culture right in the heart of a city. The earliest Boulevards in France were built as far back as the late 1660s and since then many have been redeveloped, refurbished or extended every few decades given their popularity. The “Boulevard du Crime” became famous as the setting for multiple outdoor theatre performances with many displaying crime scenes that dramatized Paris life with great cultural significance (Girouard, 1985; Kostof, 1991).

When traffic engineering through “freeways” and “motorways” descended on cities as the essential infrastructure for economic performance in the 20th Century, existing Boulevards were seen primarily as traffic corridors and pressure was applied to reduce the sidewalk space to allow for greater throughput of vehicles. This was prevented in France due to powerful community processes that treasured walkable Boulevards. In 2020, the need for social distancing and resurgence of active modes of transport in a post-COVID-19 world has seen attention turn back to the amenities of Boulevards which are now seeing road space being converted into space for walking, cycling, and shared transit services. Furthermore, local urban nature has re-emerged as a valuable focus for mental health and wellbeing (Newman, 2020a).

What makes a “Boulevard” different from a “Main Road” (*i.e.*, a primary transportation corridor) is that along with providing “movement”, a Boulevard also provides a “place” that people want to walk through and spend time in. An effective Boulevard provides enhanced accessibility for locals and visitors, blended with the best of urban development. Along a Boulevard there can be a number of different precincts that provide different functions and mixes of activity, with all precincts having in common a strong sense of walkability and vibrancy. A key element of an effective Boulevard is the use of architecture and landscape design to create beautiful and functional spaces. This includes for example connecting people to adjacent pocket parks that offer oases of protected urban space and quiet reflection, despite being in the hustle and bustle of a vibrant city. Another key element is the creation of spaces that permit cultural activity in ways that encourage visitation without compromising traffic flow. This includes informal entertainment that we now call “busking”.

This paper explores the question of how applicable the Boulevard concept is to 21st Century cities that are currently dominated by cars. The impetus for this exploration comes from two global drivers. The first driver is the global imperative to address the United Nations Sustainable Development Goal 11 (SDG-11)

“Sustainable Cities and Communities” (SDGs) in relation to reducing carbon emissions and improving quality of life in cities, also reflected in the Intergovernmental Panel on Climate Change (IPCC) urgent calls for decarbonization (IPCC, 2021). The second driver is the post-COVID-19 economic recovery process, wherein there are opportunities globally to embrace new 21st Century “smart technology” to provide revitalized mobility and new economic, social and environmental opportunities in betterment initiatives (Newman, 2020b). Responding to these two drivers, we asked: “how can we blend the best of traditional Boulevard design with the latest 21st Century technologies in mobility, communications, sensors, data analytics and artificial intelligence”.

The paper begins by examining the history, function and design of Boulevards to identify and understand key factors that have made them popular. The paper then examines specific examples of 21st Century technologies—including trackless trams, micro-mobility, recharge hubs, and smart technology precincts—to consider how they can enable a 21st Century Boulevard that is a model for post-COVID-19 urban regeneration. The paper provides an overview of how urban planning and transport planning has begun to address the need for such 21st Century Boulevards, and discusses how success might be evaluated by decision-makers.

2. The History, Function and Design of Boulevards

2.1. The Origin of the Boulevard

The earliest mention of the term “Boulevard”, in reference to a particular type of road, was in Paris when Charles V built a wall along the northern limits of Paris in the 14th Century and called the flat walkway along the top a “Boulevard” (Merriam-Webster, 2020). It is believed that the French borrowed the word from the Dutch word “Bolwerk”, composed of “Bolle” meaning tree trunk and “Werk” meaning structure, which was believed to refer to the wooden structure used as part of the wall. In the 17th Century, Louis XIV decided that the wall was no longer necessary and it was demolished, replacing it with a wide tree-lined promenade as it had become a favourite place for the public to stroll. The French therefore named these roads a Boulevard characterised by wide, tree-lined spaces especially used for promenading (Girouard, 1985).

In the late 1800s Napoleon III instructed Georges-Eugene Haussmann to “bring air and light to the centre of the city” and to “unify the different neighbourhoods with boulevards, and make the city more beautiful”. Haussmann’s regularisation of Paris created hundreds of kilometres of paved and lit streets including a spine of “Grandes Boulevards” (Gold, 1998). These Boulevards cut-through the medieval city, setting a new standard for Europe and indeed any city, as they could supply rapid connection between the city centre and its outskirts, but most of all it attracted people of all backgrounds to enjoy the space. Haussmann created the now famous Avenue de L’Opera and the Boulevard du Crime that became the setting for multiple outdoor theatre performances with many displaying crime

scenes that dramatized Paris life with great cultural significance. The Haussmann Boulevards brought a special quality to Parisian life which remains to this day, based on vibrant pedestrian sidewalks that include opportunities for dining, theatres, buskers and window shopping, as well, of course, providing mobility corridors that included transit by carriages which eventually became trams and light rail.

The concept of a Boulevard quickly spread to other cities in Europe as they struggled to meet the demands of the industrial age, including: Lyons, Marseille, Brussels, Rome, Stockholm, Barcelona, Madrid, Washington, and Mexico City (Pinkney, 2019; Merriam-Webster, 2020). However, the concept of a Boulevard as a rich, vibrant space of mobility, diversity, and culture was largely missed when applied in the United States of America (USA) and other car-dependent cities as shown in the examples below. Although boulevards in Europe were associated with promenading and enjoying the street life of the city, in the USA, boulevards were often reduced to long thoroughfares focused on vehicles and large private homes, often set back from the street, and therefore did not create the attractive walking environments of European cities (Jacobs, Macdonald, & Rofé, 2002) (Springfield, 2007). These two forms of boulevards are discussed further in the following paragraphs, considering best outcomes for future cities.

2.2. Forms of Boulevards

The European Boulevard

The Boulevards constructed in many European cities consist of wide roadways with narrow median strips and wide tree-lined sidewalks along each side. This typology is intended to accommodate both private and shared vehicle movement (as seen in Figure 1 with a transit lane on the side of the roadway) and safeside



Source: Google Maps.

Figure 1. St. Michel Boulevard, Paris (a typical Parisian boulevard typology).

access, along with shaded walkable sidewalks with ample space for shops, walking, seated areas and space for many public activities such as entertainment like busking.

Figure 1 illustrates the development potential of the Boulevard, with intensive land development built right up to the edge of the walkable areas. Typically rising up to 6 - 7 stories, this form of continuous development frames the Boulevard, providing the source of activity and “eyes on the street” for safety and security.

The American Boulevard

Although similar to Parisian Boulevards, the American style of Boulevard typically involves wider road space to accommodate more private vehicles and the reduction of the footpath to accommodate car parking and bike lanes. Referred to as “Multiway Boulevards”, they often keep some of the Paris form in that they can have dense development on the edge with a protective local road and sidewalk in some parts but are not as extensive in such development. The Multiway Boulevard approach uses tree-lined areas to separate the high-speed traffic from the local slow-moving traffic on the edge that provides slow access to residences. However, Multiway Boulevards generally have at least four central arterial lanes for high-speed traffic often with a median strip in the middle given pedestrian crossing is unsafe without it. Hence the American approach is typically a wider roadway which loses some of the character of the European Boulevard through the sheer width and capacity of the road to accommodate high speed traffic. Of course, due to pressure to accommodate car dependence there are also examples in Europe of such Boulevards being designed in favour of vehicle throughput rather than pedestrian experience.

A study in 2020 of Multiway Boulevards in USA and Europe suggests that they can be vibrant and pedestrian friendly in zones with low intensity intersections given people can easily adapt to the slower traffic (Jacobs, Macdonald, & Rofé, 2002). The findings of the study also suggest that when comparing vehicle throughput Multiway Boulevards compare well to the freeways and expressways constructed from the 1950s to 1970s. As in the case of the Octavia Multiway Boulevard in San Francisco there are examples of reasonably dense development along the Boulevards, shown in **Figure 2**, but provision for transit ways is not often provided, which suggests that buses are typically part of the traffic rather than being allocated dedicated lanes.

The Ocean Parkway in New York (**Figure 3**) demonstrates the set-back along many Boulevards in the US and the majority of the road space provided for cars though in this case a cycleway runs down the middle.

Boulevards are generally therefore a better kind of road as far as pedestrian, nature and place qualities are concerned, than freeway-style road engineering. But in the present context of urban regeneration for a new future in cities post-COVID-19, there is a need to recapture more of the older European Boulevard qualities. There are many main roads in all cities that are dominated by traffic,



Source: (Greater Auckland, 2011).

Figure 2. Octavia Multiway Boulevard, San Francisco.



Source: (Greater Auckland, 2011).

Figure 3. Ocean Parkway, New York.

where pedestrian, nature and place qualities could be significantly improved, and where walkable, dense urbanism is more likely to be attracted if this happens. The paper therefore looks at how these qualities can be enabled through using 21st Century technologies along with urban planning approaches designed to enable this kind of urban regeneration.

3. Harnessing 21st Century Technology to Help Create Boulevards

This section explores the potential for advances in technology to enable the creation of 21st Century Boulevards. It shows why cities need to aim not only to re-

claim the idea of the Boulevard but to use it to help regenerate their cities in ways that are attractive, safe and sustainable. In particular, a number of innovations in both renewable energy (namely distributed solar energy and electro-mobility, both with battery storage) and smart city technologies that are being deployed now as a major part of Net Zero strategies, can be integrated into Boulevards as a major site for achieving multiple additional goals as well as reduced climate emissions. These types of technologies are now forming a cluster of innovations that are quickly becoming mainstreamed in cities, especially in a post-COVID-19 world (Newman, 2020b), but the application to Boulevards has not been a focus. They will need to be managed through urban planning innovations that are more pedestrian, nature- and place-based in order to bring out the old Boulevard qualities.

Five key 21st Century technology systems are presented in the following paragraphs to show they can become part of a strategic transport planning approach to 21st Century Boulevards, namely: 1) Enhanced road-based shared transit systems; 2) Micro-mobility and autonomous shuttles for end-of-trip integration systems; 3) New precinct-scale technologies for stations; 4) Smart cities-based demand management; and 5) Reclaiming pedestrian, nature and place qualities.

3.1. Enhanced Road-Based Shared Transit Systems

Conventional shared transit along main road corridors is mostly dominated by buses with some trams still running that are effectively a left-over from previous eras, generally in conflict with traffic. In more recent times shared mid-tier transit options with dedicated lanes, such as Bus Rapid Transit (BRT) and Light Rail Transit (LRT), have increasingly shown that there is a role for road-based transit which has a lane of its own—providing mobility services for the equivalent of up to 6-lanes of car traffic (Vuchic, 2005). Increasingly these systems have improved their service quality (Hidalgo & Muñoz, 2014) through enhanced vehicle guidance, low floor disability access, and stabilization of sideways movement.

However, the return to electrification of buses and trams through the use of on-board batteries rather than overhead cables is set to revolutionise these modes. Not only does electrification reduce pollution and noise it can reduce the generation of greenhouse gases when charged with low carbon energy sources. Hence transit electrification projects can make 21st Century Boulevards not only a key part of the mobility of a city but a part of achieving the transition to zero emissions transit with associated technology built into station precincts. This also presents interesting opportunities to contribute to grid stabilisation in light of the proliferation of distributed energy generation systems, such as rooftop solar panels (as further outlined below).

After many decades of efforts to revitalise bus, tram and train systems road-based shared mid-tier transit was given a significant boost when a new transit technology was developed that we have called a Trackless Tram. In short, a Track-

less Tram System (TTS) brings together the best parts of high-speed rail, buses, and light rail to create a tram like vehicle that is ideally suited to cities, as can be seen in **Figure 4**. The vehicle runs on stabilized bogeys like high speed rail only with rubber tires, allows rapid boarding like a train or light rail, and is largely autonomous using a range of innovations (though not completely driverless), which allows it to move at speed down a road with the ride quality of a light rail, but without the cost of constructing rails (Newman et al., 2019).

Being electric through the use of on-board batteries and with no need for steel tracks, a TTS can be significantly cheaper and easier to implement than a light rail system, with comparable service and ride quality. Given the vehicle is no longer restrained to a track it can be directed around obstructions or even expanded or replaced on route. Despite advances in electric buses, as can be seen in **Table 1**, a Trackless Tram System is also much better than many rapid bus systems that have been deployed instead of costly light rail systems, and certainly better than standard bus systems, especially as a TTS can attract urban development around station precincts (Newman et al., 2019).

All of these innovations in mid-tier transit suggest that a Trackless Tram has made on-road shared transit systems more attractive to urban development partnerships—a critical factor in enabling the historic Boulevard to be a major city-building feature. It is not the only factor that will bring urban development investments along its corridors but a trackless tram system is the major infrastructure that can be supplemented with other planning tools. The different road-based shared-transit systems will require assessment in different cities but an approach is suggested below using key assessment characteristics which can identify the best approach to attract private development into precincts around stations. This enables a high-level approach to assess the potential to deliver very efficient



Source: Compliments of CRRC.

Figure 4. The trackless tram system by CRRC and demonstrated in Zhuzhou, China.

Table 1. Indicative comparison of characteristics of corridor based urban rapid transit systems.

| Characteristics | Assessment | Bus Rapid Transit (BRT) | Light Rail Transit (LRT) | Trackless Tram System (TTS) |
|---------------------------------------|------------|-------------------------|--------------------------|-----------------------------|
| Speed and Capacity | | √ | √√ | √√ |
| Ride Quality | | × | √√ | √√ |
| Land Development Potential | | × | √√ | √√ |
| Cost | | √ | × | √ |
| Disruption during Construction Period | | √ | × | √√ |
| Implementation Time | | √ | × | √ |
| Overall | | √ | √√ | √√√ |

Source: (Newman et al., 2019).

and effective 21st Century Boulevards along main roads that are presently dominated by cars and have few urban qualities in their associated land use.

3.2. Micro-Mobility and Autonomous Shuttles for End-of-Trip Integration Systems

Micro-mobility refers to a range of small transport devices, some old and some new, but all of which can be powered by batteries, such as: electric scooters, skate boards, bicycles, and auto-rickshaws. Micro-mobility provides end-of-trip integration with shared transit services and can work with autonomous small buses or shuttles to provide an integrated Mobility-as-a-Service offering (Glazebrook & Newman, 2018). Electric micro-mobility options are becoming a major part of the EV revolution (Ajao, 2019) however there should always be a focus on walkability given the associated health benefits. The growth of these modes in Chinese cities (Gao & Newman, 2018) and places like Delhi with the fifth biggest vehicle recharge system in the world in 2020 (StartUS Insight, 2020), is driven primarily by the need to reduce cost and air pollution, but they are also providing active transport movement (Stevenson & Thompson, 2019).

The effective use of micro-mobility options and/or local shuttles will require appropriate management to ensure they enhance the accessibility of station precincts and replace the preference for car-dependent end-to-end travel (Currie, 2018). This would include how local shuttles (likely to be driverless electric shuttle buses that carry 8 - 12 people) can carry people to and from station precincts (providing first and last kilometre solutions) without ruining the walkability qualities of the area (Glazebrook & Newman, 2018). The focus would be to provide convenient access to station precincts to connect to rapid corridor transit options rather than replace car trips with taxi/rideshare/AV trips.

Studies suggest that rideshare services are actually increasing the vehicle kilo-

metres travelled, or VKT, rather than decreasing it as many had anticipated, causing greater congestion and accessibility issues (Schaller, 2018). On the other hand, membership of car-sharing services has been shown to reduce vehicle use, which may enable a balance to be achieved between demand-based systems like Uber/Lyft and autonomous vehicles (Calthorpe & Walters, 2017). Hence to counter this trend of individualised transit that is not suited to growing cities it will require a different approach to mobility, one that not only provides effective movement but also creates attractive places. This is the beauty of a focus on creating 21st Century Boulevards as they can harness new technology options that favour road-based transit and are integrated with appropriate end-of-trip options.

In many cities, the response to COVID-19 has seen an acceleration in the usage of micro-mobility options which is showing substantial health benefits by reducing car dependence (Stevenson & Thompson, 2019). According to a 2019 study, some 46 percent of car journeys in the US are just 3 miles long or less, many of which can be replaced by micro-mobility options (Ajao, 2019). Ridership on shared transit options like trains and buses were reduced significantly due to social distancing concerns during COVID-19, however private vehicle traffic also substantially reduced with people being asked to shelter in place or work from home. As such the growth of local walkability and active transport has been a global phenomenon with many cities now embedding these options into the core of their urban infrastructure (Davies, 2020; Harris, 2020, Laker, 2020). At the height of the COVID-19 pandemic in late April 2020, across Scotland the use of shared transport was down by as much as 95 percent and car use was down by 70 percent, while cycling was up by 120 percent (Transport Scotland, 2020). Some cities are featuring these qualities in their recovery plans (Earley & Newman, 2021).

The co-benefits of active travel, such as walking, cycling and use of micro-mobility options, are significant and along with improving air quality they also add to local economic development (Hargroves et al, 2018). Thus, providing cycleways that are suitable for all micro-mobility options is likely to be a high priority for the recovery of many cities around the world, such as London that has released plans to increase active travel ten times (Quinn, 2020). The Mayor of London, Sadiq Khan, working with Transport for London have release a plan to achieve a number of ambitious goals including:

- The rapid construction of a strategic cycling network, using temporary materials, with new routes, aimed at reducing crowding on public transport.
- A complete transformation of local town centres so that people can walk and cycle where possible, including widening footways on high streets so that people can safely queue outside shops.
- Reducing traffic on residential streets and creating low-traffic neighbourhoods.

The plan was given an immediate £2b on the basis that “when the nation gets moving again it does so in a cleaner safer way” (Walawalkar, 2020). The plan intends to also harness 21st Century technology such as: developing an app to help with transport choices; trialling e-scooters; providing extra charging points for EV vehicles of all kinds; and accelerating new rail projects (Sky News, 2020). Likewise, in Paris a commitment has been made to create a 15-minute city by 2024 based on bicycle access. As part of the plan it is intended for parking lanes to be reallocated as bikeways and passing lanes built into shared paths enabling more urban services to be provided locally (Reid, 2020). Such a move is designed to make Paris’s Boulevards even more popular and useful.

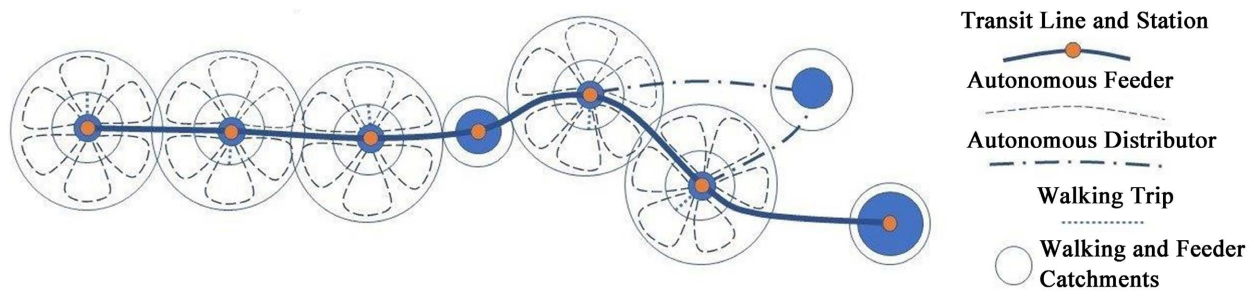
Combining advanced shared transport options like a Trackless Tram System with effective last mile services, such as walkability cycling or micro-mobility, is fundamental to ensuring cities have effective mobility but can also be attractive for urban development around this increased value. Thus, 21st Century Boulevards benefits can go well beyond that of just effective mobility. Trackless Trams can quickly fit into cities as they are road based and do not require heavy construction of rails and overhead wires, combined with a focus on attracting new development precincts around stations. Such a system combining a TTS with micro-mobility and urban development, will genuinely provide effective transit services, especially when linked to effective end of trip services, that run quietly and cleanly due to a lack of combustion engines. A TTS has the potential to replace the equivalent of 6 lanes of traffic along a Main Road, with subsequent urban regeneration contributing to the financing (see Section 4).

3.3. New Precinct-Scale Technologies for Stations

Precincts around stations are necessary for 21st Century Boulevards, and will be very attractive to developers because they are value enhancing and risk-proof investments with a new iron-clad ability to raise finance as they can be Net Zero Developments (see Climate Action 100+). New precinct-scale systems are the best way to introduce the modular carbon-reducing technologies like solar, batteries, new small scale water and waste systems, and new local electric transport systems (Newton & Taylor, 2019; Thomson, Newton, & Newman, 2019).

One of the most important integrative features of these new urban systems is that each precinct/station can become a recharge hub for the Trackless Tram and the micro-mobility which will provide a clear destination point along the Boulevard with people feeding into and out of the station from around the precinct (Newman et al, 2018) (see Figure 5).

In practice such a Boulevard will allow electric private cars to move down the central lanes (with the Trackless Tram operating in a dedicated lane), and when nearing stations private vehicles will be required to slow down to enable the integration of the walkable environment adjacent to the station precinct. A Boulevard can have a chain of precincts along the corridor that all use these new technological advancements for regenerating a city’s infrastructure and buildings.



Source: Amended from (Glazebrook & Newman, 2018).

Figure 5. A diagrammatic representation of accessibility of a 21st Century Boulevard.

Given the interconnected nature of a Trackless Tram style Boulevard, different station precincts along a corridor can have their own distinct amenity and purpose, such as a focus on health care, education, dining, entertainment or offices. This special quality of place-based urbanism is fundamental to any urban regeneration as will be the need for the integration of nature (both as part of urban design and for aesthetics), effective waste management (such as waste minimisation and enhanced collection of recyclable items) and green buildings (Caldera et al., 2019).

But most importantly the necessary uplift in value that can release the funding/financing of a series of urban regeneration precincts will only happen if there is a strong and competitive transit system feeding the residents, workers and visitors to the precinct. Each precinct will therefore be an opportunity to show how they can use new technology in their project and most importantly how they can link into innovative transit systems. It is clear that all forms of vehicles will soon be electric, both private and shared vehicles, including those used for last mile linkages. Thus, this presents an opportunity for each of the precincts to provide on-site energy generation (likely using solar technology), storage (likely using battery technology), and charging infrastructure. Thus, this shifts the focus of the Boulevard from simply a transport route to being a key part of the surrounding electricity grid, presenting both challenges and opportunities.

The understanding that very soon vehicles will be a key part of the electricity grid has given rise to the concept of “Vehicle-to-Grid” or V2G, which describes a system where electric vehicles are connected to the grid for mutual benefit. (Uddin, Dubarry, & Glick, 2018). Once connected, a range of services can be designed to allow electric vehicles to contribute to storage and grid stabilisation, increasing grid efficiency, stability and reliability (Yilmaz & Krein, 2012). The physical connectivity between vehicles and the electricity grid will likely allow for discharging of power from transit and other vehicles when not in use, to respond to times of peak demand, referred to as “peak shaving”. (Ehsani et al., 2012) provide six potential services that electric vehicles will likely provide grids in the future ranging from peak shaving for between 15 minutes to 2 hours, down to assisting the starting of electric motors that require high-intensity electricity for a short period of approximately 15 seconds. Moving from theory to practical ap-

plication in this area is still a focus of research and demonstration efforts.

What this adds to this grid-support literature is the potential innovation to create “Recharge Hubs” at station precincts which support urban regeneration as well as grid stability. These will be able to help all kinds of electric vehicles recharge, especially micro-mobility feeding into the electric transit that is suitable for constrained spaces. The new precinct developments can be built with solar PV on roof and wall space and extend out as far as is needed to ensure sufficient power can be provided locally. All forms of electro-mobility need recharging and in cities these can become part of Recharge Hubs at station precincts that are managed strategically to support the grid to ensure universal access and resilience. These Recharge Hubs can be available to the multitude of micro-mobility vehicles that can be supportive of local economies, and also provide the last-mile linkages for electric transit as it services a corridor of economic development.

Electric micro-mobility can also develop a range of new functions relevant to local centres (a growing focus for the new economy), which could include local delivery of parcels and take away food. For instance, the rapid growth in parcel delivery vans has been a major part of growing traffic in the US (Schaller, 2018) which could be mitigated if parcels were delivered locally by small electric vans. They can be delivered along the corridor by Trackless Trams (potentially with a dedicated carriage) providing parcels to station precincts where local delivery vehicle hubs can be located.

All of the innovations outlined above—solar, batteries, electro-mobility in vehicles of all shapes and sizes—have two key characteristics of relevance to this paper: they work best as localised systems as they can create local economic multipliers; and, they work even better as consumption of fossil fuels is reduced, along with the associated noise and pollution as well as enabling cities to have greater resilience to global warming impacts (Newman, 2020a; Newman, 2020b).

3.4. Smart Cities-Based Demand Management

Smart Cities is an agenda which has rapidly grown in the 21st century and involves the application of technologies such as big data analytics, artificial intelligence, and digital commerce based on data collection from sensors, cameras and mobile devices. The smart technologies can help integrate all other infrastructures together so that solar/batteries/electric vehicles/water/waste, can be enabled to work together like an ecosystem (Newman, 2020b). There are a number of controversial aspects when “smart” technology is simply used for surveillance and traffic congestion management (largely failing due to the rebound effect which continues the problem of car dependence, see (Creutzig, et al., 2016). Beyond these typical applications, transport systems can use a range of new “smart” technologies, especially as part of station precincts (Allam & Newman, 2018). Thus, it is very likely that smart city type technologies will become a key part of cities in the future, especially to provide valuable platforms to operate and manage distributed energy generation and storage options along with the charging of all sorts of ve-

hicles at station precincts to create high-quality urban development.

The power of new smart cities technologies includes an ability to enable a system to learn and optimise itself through artificial intelligence (AI) or machine learning. Many functions of AI have been envisioned to help the Zero Carbon agenda (Rolnick et al., 2019) but there is one that is just emerging which can assist urban regeneration of precincts along a 21st century Boulevard. As new suburbs, new industrial estates, new office blocks, new residential villages are built or refurbished, they can be enabled through a microgrid and sensors to manage their energy, water, waste, transport, to be continuously learning from their users and the wider system (Saldaña et al., 2019). The centres become something like a set of neural networks that are constantly improving the ecosystem in which they operate. The roles of Recharge Hubs and Delivery Vehicle Hubs can all be optimised along with many other new localized services along any Boulevard to enable job creation through enterprise facilitation in local communities (Sirolli, 1999; Sirolli, 2012). Localised smart systems can be managed to provide different solutions for the different kind of places across a city and as part of a 21st Century Boulevard will demonstrate how the best of both new and old approaches can be harnessed to deliver flourishing and vibrant cities.

3.5. Reclaiming Pedestrian, Nature and Place Qualities

A key benefit of adopting a Boulevard approach to designing for urban regeneration, is the inherent appreciation of the importance of place and locally meaningful qualities for users of that place. Understanding the urban fabric of each place is critical, involving a unique set of spatial relationships, typology of buildings and specific land use patterns that can then be mapped to appropriate transport infrastructure priorities (Newman, Kosonen, & Kenworthy, 2016; Thomson & Newman, 2018). A previous study into sustainable urban renewal using Urban Fabric Theory distilled a set of seven core principles; in **Table 2**, we have summarised 21 associated core practices to ensure urban design for pedestrians, nature and place are addressed alongside infrastructure development priorities. These new planning and design approaches are all building on the history of urban design as demonstrated in the Boulevard tradition.

These principles align well with the earlier Boulevard discussions, and the practices point to existing tools and methods that are associated with achieving the underlying qualities of a Boulevard. In summary, for any 21st Century Boulevard, the design drivers would need to include: specifying quality transit corridors that reduce car dependence, transit node locations (stations) that emerge from redevelopment opportunities, and place-based design that uses amenity opportunities to create value along the whole corridor.

What isn't covered in **Table 2** is the importance that a 21st Century Boulevard project would place on the cultural elements that enables informal street-based entertainment and engagement of locals and visitors. We propose that an associated

Table 2. Core principles and practices for pedestrian, nature and place outcomes.

| Core principles | Core practices |
|--|---|
| 1) Precinct safety and accessibility: the development should be safe and healthy for people waiting to access transport nodes | <ul style="list-style-type: none"> • Human centred design • Walkable urban design • Place and movement design |
| 2) Carbon neutral—positive approach: the development should aim for carbon positive, being at least zero carbon, in both power and transport | <ul style="list-style-type: none"> • Solar passive design • Solar active design • Carbon neutral analysis |
| 3) Local shared mobility: the development should encourage diverse local modal services to access the transit service, with defined spaces | <ul style="list-style-type: none"> • Local mobility design • Feeder transport design • Mobility as a service |
| 4) Property diversity: the density and urban mix should contribute to urban regeneration | <ul style="list-style-type: none"> • Community engaged planning • Agglomeration economy analysis • Financial modelling |
| 5) Property affordability: the development should include diverse property options to provide affordable living as well as affordable housing | <ul style="list-style-type: none"> • Social housing analysis • Life cycle assessment • Sustainability operational analysis |
| 6) Nature-loving and biodiverse spaces: the development should include and connect biophilic and biodiverse greenspaces, supporting endemic species and habitat | <ul style="list-style-type: none"> • Biophilic design • Water sensitive design • Landscape oriented design |
| 7) Inclusive, integrated place-based planning: planning, design and implementation (operation, maintenance) should involve diverse stakeholders and all tiers of government to provide an integrated place-based approach | <ul style="list-style-type: none"> • Joined up governance analysis • Partnership analysis • Procurement option analysis |

Source: (Caldera et al., 2020).

design metric could be the “Busker Factor”. It would be designed to assist in evaluating the “cultural” success of urban regeneration initiatives. The need for inclusive spaces that assist communities in celebrating their cultural context and story-telling are fundamental for SDG-11 and also good health and wellbeing (SDG-3) but the need for a popular cultural dimension to place would seem to be rather obvious though rarely does it seem to be built into main road projects. Creative street artists would seem to be an important component within a successful 21st Century Boulevard that enables pedestrian, nature and place qualities to thrive. Cities that can develop a Busker Factor that is measurable and managed as a part of future transportation and infrastructure projects can improve the documentation of their betterment journey—and their appreciation of outcomes from 21st Century Boulevard efforts.

All of this design will need to be enabled and managed to achieve these goals, requiring appropriate planning and transport tools. These are discussed in the following section.

4. Planning and Transport Tools to Support 21st Century Boulevards

A defining factor in the success of cities in the 21st Century and beyond will be if they are able to provide high quality shared mid-tier transit that is well integrated into urban regeneration around stations. Rather than doing this piecemeal the renaissance of the Boulevard concept provides the blueprint to integrate a number of elements into a coherent system based around an electrified mid-tier corridor transit system, such as a Trackless Tram System. Such a system can provide fast and efficient access along corridors and, when linked, across cities they become embedded in high quality walking environments around stations.

The system would harness a range of new technologies to allow both movement along the corridor and seamless connectivity to station precincts, where walking, cycling and micro-mobility options including on-demand electric bus shuttles can connect people to the service and link to the surrounding activity centre (Newman et al., 2019). In order to provide effective corridor services however effective ways of making space in the existing roadway for such high-capacity transit will need to be explored with resistance likely to reduce once transit services deliver both congestion relief and development outcomes as promised. There are a number of other important policy related considerations and the following section outlines four key planning approaches that may underpin the development of a 21st Century Boulevard project along with the transport and development technological systems outlined above.

4.1. The Use of Strategic and Statutory Planning Mechanisms for People and Place

The use of strategic and statutory planning mechanisms can be very effective to secure specific transit corridors for 21st Century Boulevards and associated station precincts. Despite the more recent focus on servicing private vehicles in automobile dependent cities, the early train and then tram corridors in 19th and early 20th century urban history created the core structure of many cities around the world (Newman et al., 2016). These are now a highly sought-after urban fabric for living and working due to the ability to provide multiple accessibility options and mixed land uses. However, in many cities these train and tram corridors have been converted to main roads that are now dominated by traffic, and are largely reaching capacity. To either convert back or upgrade main roads to transit boulevards requires both strategic and statutory planning mechanisms, especially as there will be initial disruption to traffic conditions before the transit and development benefits are realised. In particular such a Boulevard will need structures to ensure the use of high-quality transit systems with the corridor declared or zoned as primarily for transit and dense urbanism.

Such an approach is being explored in various ways around the world, such as Transport for London's focus on "Street Families" (Transport for London, 2013) which nominates particular streets for transit priority and where density will be

given special encouragement. More generally the concept of “Movement and Place” has gained traction which recognises that streets are not only about moving people from A to B, but in many contexts also act as places for people and public life. As part of a “Movement and Place” Framework places can be prioritised for a focus on walkability and liveability along the corridor. AustRoads, the peak body for Main Roads agencies in Australia, has recently released a new study called “Classifying, Measuring and Valuing the Importance of Place in the Transport System” (Fooks & Zhao, 2020) that outlines how transport systems can not work unless they integrate place planning.

In Perth, an approach has been proposed to designate “Green Routes” that have a focus on prioritising transit services and integrated density along the route, delivered in a sustainable manner—ideal locations for 21st Century Boulevards. Increasingly in the UK and Europe there is a shift from traditional transport plans to what are being referred to as “Sustainable Urban Mobility Plans” (Twissee, 2021); **Table 3** sets out a comparison of key features developed in these plans, which provide the ideal basis for implementing 21st Century Boulevards.

A core part of designing 21st Century Boulevards will be a set of detailed design options for how a transit service could travel at speed down a clearway where possible, and then slow down when it enters a station precinct where the design and place focus would be on facilitating walkability and pedestrian activity. This would make it clear that dense urban development will be favoured as it would have a high-quality transit system linking it to the rest of the city and would have

Table 3. Comparison of primary objectives for traditional transport planning and sustainable urban mobility planning which would be needed for 21st Century Boulevards. Source: (Twissee, 2021).

| Traditional transport planning | Sustainable urban mobility planning |
|--|---|
| Focus on traffic | Focus on people |
| Primary objectives: traffic flow, capacity and speed | Primary objectives: accessibility and quality of life, as well as sustainability, economic viability, social equity, health and environmental quality |
| Modal-focused | Balanced development of all relevant transport modes and shift towards cleaner and more sustainable transport modes |
| Infrastructure focus | Integrated set of actions to achieve cost-effective solutions |
| Sectorial planning document | Sectorial planning document that is consistent and complementary to related policy areas (such as land use and spatial planning; social services; health; enforcement and policing; etc.) |
| Short- and medium-term delivery plan | Short- and medium-term delivery plan embedded in a long-term vision and strategy |
| Related to an administrative area | Related to a functioning area based on travel-to-work patterns |
| Domain of traffic engineers | Interdisciplinary planning teams |
| Planning by experts | Planning with the involvement of stakeholders using a transparent and participatory approach |
| Limited impact assessment | Regular monitoring and evaluation of impacts to inform a structured learning and improvement process |

a highly attractive urban design quality for attracting people-based activities in and as part of station precincts. This could be called a “70:20” strategy as the aim would be to bring the road-based transit down the corridor at speed (70 km/h max) and then slow down to prioritise walking (20 km/h max). This is a very different approach than on railways and on traditional main roads which separate out urban development from the mobility goals along the different modal routes.

The concept of “Place” is a critical function of a vibrant 21st Century Boulevard and will be a turning point in transport planning for road engineering if taken seriously in urban regeneration projects. Perhaps one way of assessing whether this place-orientation has been achieved would be to see if there has been a growth of buskers in the areas being created. A Busker Factor could be created to see if a place-based KPI with a cultural dimension could be part of any evaluation process. Such guidance will be needed in the detailed delivery of 21st Century Boulevards.

4.2. Incorporate Walkability and Sustainability/Net Zero into Station Precinct Design

Most urban planning approaches around the world now recognise the significance of the walking city fabric seen mostly in old city centres (Gehl, 2010; Newman et al., 2016). More recently they are being created as transit-oriented precincts along corridors following the old transit city urban fabric. These trends are being supported by a new dimension that focuses on sustainability, tapping into a range of new technologies for energy, mobility, and communications, to reduce environmental pressures. Such combinations of walkability and sustainability can now be a feature of creating 21st Century Boulevards.

In order to capture the real benefit of these new Boulevards the station precincts along the corridor need to be designated as dense and mixed use developments, rather than just parking structures, in the strategic and statutory zoning systems. There are a number of tools that have been created to inform the design of station precincts to ensure they are “inclusive, safe, resilient and sustainable” places. These include: walkable urban design, solar design, water sensitive design, biophilic design, affordable housing design and most of all integrated design (Caldera et al., 2019). For instance, there are a number of detailed manuals from the Congress of New Urbanism that set out best practice in these areas (Tachieva, 2021, and the tools at <https://www.cnu.org/resources/tools>). Such guidance now needs to be reflected in statutory requirements for station precinct developments along transit corridors and wherever possible updated to include, or at least allow for, new technology options as outlined in this paper for 21st Century Boulevards.

The most significant new technology for station precinct design would be to make it part of the Net Zero agenda (Seto et al., 2021; Newman, 2020a; Newman, 2020b). This requires not just solar-based power on the rooftop for all new build-

ings with batteries that can enable sharing across a microgrid, but a recharge hub that can assist all the transit and micromobility to be serviced from this power. The new Internet of energy systems that can integrate these innovations and manage them locally, including the vehicle-to-grid balancing services, will enable such developments to be not just meeting the Net Zero agenda, but also the need to make the project affordable. The Net Zero microgrid can then extend back into the housing and businesses around the precinct, hence enabling tentacles of decarbonised growth to spread across the city.

4.3. Create New Governance and Partnerships from the Start

Unlike traditional transport and development projects that are handled by the respective parts of government the responsibility to enable 21st Century Boulevards would require multi-purpose governance that brings these departments together. Perhaps an agency, or cross-agency group, could have both responsibility for delivering transit and delivering urban regeneration. Thus, roads chosen for this category would shift their priority for providing mobility services for “through traffic”, to a focus on how they could enable quality transit and urban design along the corridor that delivers value to both developers and the community requiring mobility along the corridor and beyond. This would mean more of a focus on accessibility, liveability, sustainability, and equity. The key is that car dependent cities are reaching their capacity for vehicle throughput anyway and especially at peak times, thus it is time to build a shared mid-tier transit corridor with their ability to carry the equivalent of 6 lanes of traffic (Newman et al., 2019). This will not only ease congestion issues but the greater accessibility it provides will see increased activity at station precincts along the corridor assuming they are well designed and provide services and amenity that attracts people. This will need to be done in partnership with the developers building the station precincts as part of their associated urban regeneration.

One of the central functions of a 21st Century Boulevard governance structure would be to help facilitate new forms of partnerships. Building such Boulevards into cities will require partnerships between public, private and community interests just as good planning outcomes have always required. What differentiates such a project is the fact that the development of such partnerships begins with early engagement to explore the vision and priorities for land interests, communities, local authorities and financiers—which could be done proactively before the project starts or as part of the procurement process. The key is to have partnerships formed early, especially with developers and financiers, rather than after the transport part has already been planned and built. In the case of private funding and financing of urban projects like 21st Century Boulevards, stakeholders are often able to reach agreements around the distribution of benefits and costs more easily if they are working together in partnerships from the start (Zhao, Das, & Larson, 2012). The role of the community in enabling long term benefits is also critical and appropriate to be built in at an early stage.

These partnership-first approaches have been growing rapidly around the world in recent years, taking the place of siloed professional practice (Clark & Clark, 2014; Clark, 2016; Newman & Kenworthy, 2015). For cities and infrastructure, this partnership approach has sometimes been called a “City Deal”, and enables a mostly bottom-up approach to infrastructure planning and provision. These new approaches will be important for involving private funding to help fund the capital costs involved in quality transit and development projects (Newman et al., 2019). The Australian Federal Government has followed the success of the UK City Deal policy and has created a program based on this concept to encourage urban renewal (Commonwealth Government of Australia, 2016). The City Deal program includes requirements to enable:

- An agreement between the three tiers of government, setting out a plan for the City Deal to accomplish innovation, affordable housing and sustainability outcomes;
- Greater community involvement and support for any projects;
- Involvement of the private sector, including innovative financing that integrates transit and land development, and with supporting funds from local and state government, with the Federal Government providing a risk guarantee.

Another key feature of the City Deal approach is it provides an effective mechanism to align the policy intent of the different tiers of government. This provides greater clarity to the private partner, reducing risk, and facilitates co-ordination with other government programs. City Deals are well-suited to facilitating 21st Century Boulevards, as they can provide increased regulatory certainty or guidance by aligning the objectives of the different tiers of government, which is a key consideration for the private sector to obtain finance. Agreements can also be reached with multiple levels of government to provide associated public infrastructure work such as recharge services for stations where electric battery recharging is needed. All of this is likely to increase value in projects.

5. Conclusion

This paper has suggested that the historic idea of a Boulevard that creates high-quality urban development with strong accessibility can now be repackaged into cities by harnessing 21st century approaches (such as partner-first approaches) and technologies (such as solar energy, batteries, all kinds of electro-mobility including new mid-tier Trackless Trams and micro-mobility), all monitored, managed and able to learn through smart systems. However, such Boulevards will need to be delivered using new 21st century planning tools as well, including:

- Developing strategic plans and statutory regulations that specify where Boulevards should go and how they can prioritize transit and dense urbanism along Main Road corridors including the new place and movement strategies;
- Creating walkable and sustainable station precinct designs including the new Net Zero agenda as well as bringing in a new Busker Factor to evaluate a cul-

tural dimension to the place-qualities of the associated Boulevard;

- Creating new governance and partnerships from the start that include communities who belong in the new place-based boulevards and precincts.

Some of this preliminary work has been done but now it is time for high profile demonstrations of 21st Century Boulevards, showing how the best wisdom of the past can be merged with innovative technology and design, to deliver vibrant, productive and effective for 21st Century cities.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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