Rethinking Public Transport Accessibility: A Scenario for Decentralized Melbourne

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Abstract: Cities worldwide and particularly Australian cities are facing the imperatives of population growth and low-carbon future. Re-thinking car-oriented urban morphology through transit-orientation has shown to be the essential step for effective public transport along with social, economic and environmental performance. This paper aims to develop a scenario to rethink Melbourne public transport through a case study in Footscray. The existing public transport infrastructure in Melbourne is not as efficient as it could be because it channels all the flows towards and through the city centre. This has been widely contested by local experts, academics and residents; however, for almost a century this radial network morphology has had little change. In this paper, we are looking at a new public transport scenario for facilitating a more effective access within Melbourne. This scenario is focused on providing high-volume lateral links across middle-ring suburbs that might complement the existing public transport infrastructure and provide a more convenient access. These accessibility scenarios are a part of broader multi-scalar research tackling the way in which urban diversity, amenity, flows and processes emerge from connections and interdependencies between different aspects of urban morphology. While the original research considers multiple scales and morphological aspects, this paper will only explore large-scale accessibility in Melbourne. This is not an attempt to advocate an ideal network proposal for Melbourne. The aim is to explore the redevelopment potential of the existing public transport as a discursive framework that would challenge car-dependency.

1 Introduction
Cities worldwide are facing the problems of car-dependency, urban population growth and segregation of land uses that are increasingly causing environmental, social and economic issues. Research has shown that transit-based urban intensification has the capacity to overcome these issues by focusing on mixed use, densities, people, activities and flows around public transport (Dittmar & Ohland 2004; Calthorpe 1993; Calthorpe & Fulton 2001). This process is extremely complex and multidisciplinary, involving multiple stakeholders and multiple scales.

The issue of car-dependency is most widespread in North American and Australian contexts, however it occurs in cities worldwide, including European and Asian cities that are proven to have the highest densities and least carbon emissions (Newman & Kenworthy (1989) 1998). In other words, the problem outlined and tackled in this paper is universal to all contemporary cities.

Plan Melbourne (2014) outlines that the projected population of Melbourne will reach ten million by 2051. If we are aiming for improved social, environmental and economic performance, such projections call for a serious rethinking of ways in which the city should operate. Plan Melbourne further advocates the need to consolidate growing population around nodes of public transport. While it is clear that this strategy is based on best intentions, there is a question of how this might work. According to Mees (2008, p. 5), Melbourne public transport is increasingly overcrowded as it is, which is not strange since “[t]here has not been a new suburban railway built since the Glen Waverley line opened in 1930”. If we already have overcrowded railways, how will public transport operate when the population and job densities increase around railway stations? Plan Melbourne calls for strengthening of tram and bus lines, but without any substantial improvement in high volume public transport a considerable share of commuters will end up driving. This is now a conundrum as more cars on roads is a nightmare to imagine given the current state of congestion in peak hours. The proposal for Melbourne metro rail connection (MMR 2015) is yet another rail line that links to the city centre at a high capital cost, and it’s construction would leave no resources for new suburban connections or increase service provision that might facilitate the problem of overcrowding (Mees 2008). Considering all the facts, there is an imperative for a more sophisticated scenario that focuses on quality over quantity.

Contemporary Melbourne is featured by extensive road network consisting of expressways, highways, four-carriage roads, local roads and laneways. Many inner-ring suburbs, but even more so, outer ring suburbs, have been established in parallel with major road developments. Excessive car-dependence has led to car-oriented urban morphology, so these suburbs are predominantly residential and dependent on driving. This post-colonial urban concept is also based on the existence of activity...
centres that usually consist of shopping malls, community centres and offices surrounded by low-density car-dependent extensive housing areas.

Melbourne public transport network consists of rail, tram and bus networks. Railways are a reliable transit option; however, they follow a radial network pattern intersecting at the ‘City Loop’. This short circular railway line is the only ring connection in rail network and provides effective access across the city centre from multiple suburban lines. In this sense, the current state of Melbourne’s public transport infrastructure functions as a means of getting people in and out of the central business district. The key limitation of Melbourne public transport is the lack of outer lateral network connections. The current conception imposes difficulties for any travel in-between suburbs. With the City Loop as the key transfer line to any alternative destination, mass transport has become inconvenient and time-consuming. Trams can at times effectively facilitate trips by public transport, but they follow the same radial pattern with a few exceptions in the south-eastern suburbs. They have many short segments, sometimes share roads with other vehicles and although very useful when used locally, they cannot be seriously considered as means of traveling efficiently to the other side of the city. Melbourne public transport has multiple bus lines, however they are low-volume, infrequent and at times unreliable because of the same traffic congestion that slows down cars.

This paper explores the capacity for decentralizing Melbourne through efficient public transport. We will analyse the possibility of a new orbital line across the city that would relieve central Melbourne of unnecessary traffic and crowds. The idea is to create secondary centres of interest around the stations that form the circular route around Melbourne. We chose to base this analysis on a case study in Footscray as this suburb has been studied in detail in our broader research and is also declared one of the central activity districts intended for further intensification (State Government of Victoria 2015). This paper sets out to make a small contribution to understanding urban intensification by fostering a better understanding of the potentials for improved accessibility of a Melbourne case study. While our broader research is multi-scalar including different aspects of urban morphology such as densities, functional mix, permeability, networks, public/private interfaces and streetlife, the scope here is to tackle the problem of accessibility on a large metropolitan scale.

2 Complexity, adaptation and assemblage
The primary theme explored in this paper is accessibility and is underpinned by the theoretical frameworks of complex-adaptive systems and assemblage thinking. The role of these theories is to provide a framework that is sensitive to flows, interdependencies and dynamic tendencies of urban environments. This is important because accessibility is a complex process linked to different aspects of urban morphology and patterns of how the city is used (Hillier 1996; Vaughan 2007)

Theory of complex systems is the first of two frameworks for understanding the complexity, multiplicities and interdependent oppositions in urban environments. Complex-adaptive systems theory is explored by multiple authors (Holling 1996; Johnson 2002; Gunderson & Holling 2002; Walker & Salt 2006; Gunderson et al. 2010). This theory provides a framework for understanding the way in which a complex system undergoes dynamic processes and phases, wherein the unpredictable network of local interactions can generate novel forms or affect larger-scale qualities of the system (Johnson 2002). Complex systems consist of parts that are interconnected and interdependent in multiple ways and across temporal and spatial scales (Holling 1996; 2001). Local interactions, external factors, as well as the slow large-scale processes cause the system to adapt and self-organize (Gunderson & Holling 2002). The key concept here is the one of ‘panarchy’. For Gunderson & Holling (2002), it is a self-organizing form of governance and the antithesis of hierarchical organization; panarchy underpins the transformability and adaptive changes of complex-adaptive systems. Panarchy is the way of framing the complex and unpredictable behaviour, as well as the emergence of novel forms spatially, temporally and structurally (Gunderson & Holling 2002, pp. 19-22).

Assemblage thinking has many overlaps with the theories of complex adaptive systems. It focuses on connections, flows, and processes between entities (Deleuze & Guattari 1987; also DeLanda 2006; 2011; Dovey 2010). These ideas are applied here to understand how transit-oriented development works and how urban morphology, people, activities, and processes are linked with access. Assemblages are argued to be self-organized, ‘bottom-up’ wholes whose entities can be removed or added, causing the assemblage to transform and adapt (Deleuze & Guattari 1987). This is particularly true for cities wherein buildings are erected or demolished, people come and go, streets are closed, and new ones opened, while the city adapts and re-organizes to sustain itself (Dovey 2010). Assemblages are always in the productive process of change between polar states of anarchy and order; stability and instability; spatiality and sociality (Deleuze & Guattari 1987).
These frameworks are important because the question of accessibility is complex, both spatially, and socially, and is essentially multi-scalar. In that sense, a phenomenon of travelling to work by public transport functions both at large and small scale. At the large scale, it is underpinned by public transport morphology and operating patterns, but also the functional mix at both ends of the journey. Where we need to arrive matters as much as the time we need to arrive there. This is where the small scale becomes relevant since one will usually walk on both ends of the ride. It is more likely that this mode choice becomes permanent if the walking section includes pedestrian amenities like shade, trees and rest areas. What is also important is a rich land-use mix that would enable this trip to cover multiple purpose trips that include errands, shopping or dropping kids to school. The theoretical lenses of complex-adaptive systems and assemblages are essential conceptual tools for framing and understanding the interdependencies of spatial, social, temporal and multi-scalar aspects underpinning accessibility and transit-oriented development.

3 GIS analysis

In our analysis, we focus on two different times of the day. Morning peak analysis is very important, because of the vast amount of people trying to enter the city centre. It usually lasts from 7 to 9 am, but it is noticeable that the roads are most congested as it gets closer to 9 am. This is why we analysed the period from 8 to 9 am, where public transport is most competitive in comparison cars that use 20-40% of their carrying capacity, yet contributing 100% to road congestion. In the evening, we look at the timeframe from 9 to 11 pm where the option to use public transport exists, but with limited accessibility and it can hardly compete with clear roads and personal transportation.

By generating a visual representation of accessibility on a map, it becomes much clearer what are the limits of access for different modes of travel at chosen intervals. These representations are by no means perfect, as they depend on a limited amount of data used in the simulation, wherein reality there are many arbitrary factors that were not taken into consideration. On the other hand, the data used in these simulations is by no means small and gives some insight on how these networks function, based on the facts and physical limits of the transport infrastructure.

Public transport isochrones are generated by simulating movement through the network that is defined by public transport authority timetables (Public Transport Victoria). The software simulates all the possible movement scenarios through the network from a specified location (in our case Footscray Railway Station) for a duration of 30 minutes. At a specific departure time, there are many possible paths that one might take. Some paths will take us to our destination faster than others and only those are considered as they cover the largest area accessible within a certain time interval. This includes travelling by public transport and walking in any direction. Cycling as a part of intermodal travel is beyond the scope of this paper. Between 8 and 9 am, an isochrone is calculated every 30 seconds resulting in 120 isochrones. The average of all these isochrones gives us the final isochrone for this timeframe.

Car isochrones are generated by analysing many single destination routes within the range of 25-minute travel from Footscray station. To simulate time spent on parking the car, we deducted 5 minutes from the total which effectively adds up to 30 minutes. Graphical representation is generated with a similar type of software used for public transport but adapted to use a third party navigational system to gain realistic calculations of car movement through the network. The isochrones include traffic information for the selected time of day.

The design scenario for Footscray is a proposal for an extension of public transport infrastructure. Currently, all the existing lines move in and out of the city, so there is certainly a major stress on the city circle. This stress can be reduced by a proposed circular line (Figure 1) as it would be much more efficient for passengers that have no need to go through the city centre. Both underground and elevated infrastructure has been considered, but we chose to focus on elevated rail, perhaps monorail which comes at substantially lower cost, includes straightforward engineering, while its narrow guideway and placement imposes minimal overshadowing and disruption of normal urban rhythms (The Monorail Society 2015). The scenario also includes a new elevated connection to the airport from Essendon Station and to Port Melbourne from Flinders Street station; a direct link from the orbital line to these key destinations would facilitate more effective urban access. The trip on the elevated rail could also be a unique experience and would give passengers a pleasant view of the scenery. It is outside the scope of this paper to go into specific details regarding engineering or transport planning; the idea of monorail is only conceptual and subject to further research on capacity, speed and implementation. We rather seek to explore a concept for improved coverage and accessibility of potential new centres on high-volume public transport.
To test the idea we chose ten stations where each is on one of the existing radial rail lines. These include: Footscray, Essendon, Moreland, Thornbury, Alphington, Camberwell, Glen Iris, Malvern, Balaclava and Port Melbourne, the last being the only ‘new’ station. The selection includes nodes that are established suburban centres or minor centres that seem to have the capacity for intensification and thus could become a desirable visiting, residential and working locations. Both types were important for us as this scenario aims to explore new approaches to accommodating a growing urban population in a way that promotes mass and active transportation, diversity, equity and vibrant new centres. While we have carefully selected these focal points on the above-mentioned criteria, they may be subject to change if further research indicates so.

We examined a circular line in Tokyo named Yamanote (JR East 2014) and applied these specifications to our proposed circular line. Yamanote has the length of 34.5 km and 29 stations which gives 1.2 km average traveling distance between stations. Trains used on this line are E231 series, and they can achieve an acceleration between 2.5 to 3.3 km/h/s and deceleration of 4 km/h/s. They can achieve a maximum speed of 120 km/h, but they are operated at 90 km/h. With these numbers in mind, it takes around 400 meters and 30 seconds to accelerate to operating speed and around 300 meters and 23 seconds to come to a full stop. The remaining 500 meters of 1.2 km average distance, take another 20 seconds while driving at the operating speed. This adds up to 35
minutes spent driving the train and by taking into consideration another 1 minute per station for the passengers to disembark and board the train it results in 64 minutes travelling time for the full circle.

When applied to the proposed circular line for Melbourne, which is 43 km long and has ten stations, this results in a 3.3 minute average ride between stations. This adds up to around 43 minutes total travelling time for the entire circle (including boarding/disembarking time), which means that one might be able to reach all the stations in under 22 minutes. It would take another 9 minutes to reach Tullamarine Airport from Essendon Station. Although we look at the average values to figure out how the circle would work, actual distances and time intervals have been used for timetable construction. With trains arriving every 9 minutes and going in both directions, a total of 10 trains would simultaneously ride the circle, 5 in each direction.

The stations that belong to the conceptual orbital line are selected as locations that are five to eight kilometres away from city centre. They also have the capacity for further development as transit-oriented activity centres in a sense that there is vacant underutilized land or extensive mono-functional area where mix and intensity may be introduced.
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To be able to test accessibility we chose a case study focused on a railway station within the new circular line. While we could have chosen any of the stations within our proposed orbital line as a test site, we used the same test site of Footscray that was used in our broader research.

4 Existing access
Footscray is a suburb that is reachable from central Melbourne in ten minutes by car or twelve minutes by train. It is positioned on a rail node that houses four major train lines. The proximity to the central city and transit-based position makes Footscray a potential redevelopment place. Currently, Footscray is a low-density, low-rise suburb, where functionally segregated precincts and car-based morphology are very common. Footscray is also a post-industrial suburb with relatively weak heritage controls. This means that the development proposals for Footscray are likely to avoid community resistance, which is a serious obstacle to contemporary development in Melbourne.

Since the 1950s, Footscray emerged as an industrial suburb, but the manufacturing industry started to decline in the 1960s and 1970s. Today, this inner-ring suburban rail-based case study features

Figure 3 – EVENING. 50km x 50km
Thirty-minute public transport and car isochrones from Footscray.
housing, industry and mixed-use north-west from the station. The station is five kilometres away from the city centre and houses passenger, regional and freight lines. There is a single connecting tramline and multiple bus lines from Footscray station. In 2008, Footscray was declared one of the Central Activities Districts (State Government of Victoria 2015), designated as a vibrant and diverse activity centre. The Footscray City Edge Masterplan (Maribyrnong City Council 2012) presents Footscray as an extension of inner Melbourne and a new centre that will accommodate growing urban population.

Figures 2 and 3 show morning and evening isochrones for thirty minutes by car and public transport. The images show that car and public transport have divergent accessibility patterns in particular timeframes. In the morning peak hour, driving gets slowed down by traffic congestion, particularly towards the city centre. This is particularly easy to see when compared to evening car isochrones which extend far beyond the area accessible in the morning. From a location that is 5 km away from the city centre, a thirty-minute car trip can take us only a little beyond the centre if our destination is along major roads. On the other hand, traffic in the evening timeframe is negligible, which renders the car isochrone much larger than in the morning. Now, the fact that the extensive areas are accessible in this time does not overlap with the demand for travelling. The problem with car dependency is reflected in the discrepancy between the time of effective access through the network and the time when effective access is in high demand.

If we look at public transport, the temporal pattern is almost the opposite. In the morning peak when car traffic slows down due to the high density of flows, public transport operates at its best offering the highest frequency of service. In the evening, service frequency drops dramatically and waiting time becomes longer than the actual trip.

Of course, these juxtaposed car and public transport isochrone maps are not representative of actual, but rather potential accessibility. Although we argue that the areas accessed by cars in morning peak are four times that of public transport, accessibility is much more complex than that. These maps cannot be read linearly; that is we cannot just compare the catchment areas. In the context of transit-orientation, accessibility also involves the question of land use and density – what are the destinations and how many people wish to take the journey to each destination. We do not provide answers to all these questions, but we understand the importance of raising them.

In this sense, car isochrone from Footscray station encompasses Melbourne outskirts that include low-density suburban areas with destinations of little interest to general public. Although this area is accessible within thirty minutes, very few people need to go there. This is not to say these maps are meaningless, but to illustrate that they cannot be read literally. Instead, these maps show an alarming fact that cars can get us far and fast where we do not need to go, and very slowly, where we want to go, generating road rage and frustration. Public transport, on the other hand, can get us (and many others) effectively where we want to go if our start and end of the journey is within walking distance from public transport. Even if both ends of our journey are close to public transport, the effectiveness of travel drops as the destination gets further from the city because the network morphology often dictates we should get to the city first to be able to transfer to a different line for our suburban destination. Such a network is by no means an effective transportation option.
5 Accessibility scenario discussion
The proposed public transport scenario includes a new elevated circular infrastructure that could improve overall accessibility, making up for the time lost in connections through the city centre. By providing much-needed lateral links between suburbs, it could activate the newly connected stations as new centres (Figures 4 and 5). Quick access to the city and other inner suburbs would increase the desirability of rail nodes for investments, businesses and housing. Connection to the airport and a link to Port Melbourne strengthens the overall network by adding an alternative high-volume fast connection to the areas of high-interest from the city or any ring station. This concept is also linked with the idea of ‘regional cooperation and coordination’ - a sophisticated network system which maintains multiple connections across the CBD, inner and outer suburbs allowing for diverse access, economic and social opportunities while limiting isolation and congestion (Calthorpe & Fulton 2001, p. 5).

The aim of this scenario is to go anticipate projected population growth (Plan Melbourne 2014) and accommodate the increased needs for effective transportation throughout the growing city. The new orbital line would have the capacity of carrying large numbers of people in both directions. It would create new arteries for the city while complementing the old radial network. In this way, the scenario relieves the pressure off the CBD as a primary transfer point because the orbital line now takes that role. Any inter-suburban trips could then be realized via the ring, while trips to the city would have the city itself as a destination.

This scenario for a new circular line handles the accessibility issue by quality, not by quantity. It improves public transport by making better connections to already existing land uses. At the moment, excluding stations on the City Loop, all the existing stations are at a desirability level that is influenced mostly by closeness to the city centre. This linearity creates more and more problems and less room to handle them. Stations that would be connected laterally with a circular line would rise a couple of ranks above other stations because the movement options would grow exponentially. It would effectively add a second dimension for the existing single dimension network. The connectivity of the areas near these stations would rise, and since areas with better connections are attractive for businesses and housing development, these areas would indirectly grow into secondary centres and locations of great value for the city.

Figures 4 and 5 show a juxtaposition of cars, and existing plus proposed public transport isochrones. If we compare areas of existing and proposed catchments, it shows a significant increase in the area accessible by public transport, particularly in the evening. What matters more than the area ratio of ‘before’ and ‘after’ is the nature of the connection that enables the isochrone. The same or an even larger accessible area could have been accomplished by a different network conception; however, we are not after quantity with little functional value but a scenario which would enable the city to ‘run’ and adapt to emerging urban conditions.

The fact that car isochrone remains far beyond the reach on public transport is not an indicator of how the potential new network might be used. This is because the isochrone mapping does not show actual trips and mode share but only a potential of the network in a given time. In addition, such a morphological change (new orbital line) would have a dynamic and unpredictable effect across different socio-spatial aspects and scales of Melbourne as an urban assemblage. In this sense, the quality of this scenario is difficult to show only through isochrone mapping; to explore its potential more comprehensively, further multi-scalar analysis of diverse aspects of urban morphology and socio-economics needs to be conducted. Ultimately, we do not produce any scientific truth, but rather a humble input towards exploring the possibilities for improved access and transit-orientation in Melbourne.

This scenario also has parallels with the theory of complex adaptive systems through the ideas of panarchy and redundancy. Panarchical, i.e. nonlinear interdependency between different scales within a complex system underpins the idea of improved city scale accessibility that has the capacity to affect the desirability for new development. Intensification of options, possibilities and connectivity on a large scale can consequently trigger the emergence of novel forms, functions, investments, services in new activity centres along the orbital line. In other words, new transit-based centres could become more desirable for living, working and leisure.

Redundancy is also a feature of complex adaptive systems and an important aspect of every network, as it enables quick reroutes in case of unpredictable events that would bring an entire branch of the network to a halt. As it currently is, the only redundancy available is within the city loop or to a degree
on railways that have more than a single line which is redundant only linearly. The introduction of the circular line would create redundancy in a broader sense, and it would extend to the entire city. If we apply assemblage thinking, the change from less to more effective access of this urban assemblage would be dynamic and productive in different aspects of urban morphology, as the city would adjust to this change. The new line appears to be only formal, but it is essentially linked with urban sociality as new nodes would not only work as physical transfers but also as portals for people that come and go from there. Node/place model of transit-oriented developments (Bertolini 1999; Bertolini et al. 2012) also explores this idea of spatio/social character of transit stops and their context. While Bertolini’s concept is a normative one and theorizes the degrees of ‘nodal’ and ‘place’ properties of transit-based environments, we are here interested in understanding the idea of access and spaces of access which transcend the quantitative to encompass broader urban assemblage.

A debate between private automobiles and mass transport remains a matter of personal preference and convenience. Perhaps we could never eliminate cars before we face the new era of autonomously operated vehicles that could eventually become public transport itself. But if we are to limit car-dependency, public transport should become a convenient way of transportation. However,
what we can do now for our cities is to find ways to make public transport more effective. We can get people to use mass transport only if we provide reliable and time-effective service. This paper has explored one scenario of how this might be done; while it is by no means the only way, it certainly is a step towards a more transit-oriented future.

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