○ GIS-BASED EVALUATION OF PERSONAL RAPID TRANSIT (PRT) FOR REDUCING CAR DEPENDENCE WITHIN MELBOURNE, AUSTRALIA

Ray Wyatt, *University of Melbourne, Australia*

Correspondence to Ray Wyatt: ray.wyatt@unimelb.edu.au

Metropolitan Melbourne's car dependence continues to grow. This is despite major expenditure on trams, trains and buses as well as attempts to alter land use patterns to make suburbs easier to service by public transport. Melbournians are simply reluctant to give up the flexibility, convenience, speed and privacy advantages that cars still hold over conventional public transport modes. Accordingly, we have here resurrect a less conventional public transport mode, first mooted during the 1960s and known as Personal Rapid Transit (PRT). This alternative incorporates many of the advantages of the private motor car; yet it is cheaper, faster, less polluting, quieter, safer, more convenient and less space consuming. We will use GIS to quantitatively evaluate PRT's feasibility in Melbourne, and eventually conclude that it might be viable provided that it is implemented incrementally, and in a way that exploits current transport infrastructure. That is, we will exploit modern GIS' ability to measure the lengths of linear features, to buffer, to intersect, to plot standard-deviation ellipses and to statistically analyse attribute tables in order to quantify PRT's costs, as well as some of its benefits, at different localities, thereby suggesting places where PRT might best be trialled.

1. INTRODUCTION

For the last fifty years the dominance of road-based traffic has been a nagging problem in Melbourne. Cars are "eating" the city; perhaps not as much as in some other places, but substantially none the less. The results have been noise, congestion, wasted resources, inefficiency, atmospheric pollution, community damage and perhaps even changes to the lives and character of Melbournians themselves.

Two major solutions have been mooted. On the one hand, most of the city's land use planners have advocated "urban consolidation", whereby people live in sufficiently high-density neighbourhoods for a Hong Kong- or Zurich- like public transport system to become viable. This will discourage people from owning and using private cars (Department of Sustainability and Environment, 2005b; Newman and Kenworthy, 1989). By contrast, a minority of planners have argued that Melbournians will never tolerate living at such high densities, and even if they did it would be foolhardy to transform the current, low density of the "world's most liveable city" into the higher densities endured by cities which are not the world's most liveable. The solution to the transport problem, they argue, is to locate jobs closer to homes and so reduce the need for long commutes (Troy, 1996).

Each side seems to be right; yet each side seems to be wrong. On the one hand it is true that both urban consolidation and placing jobs closer to residences will reduce car travel. On the other hand, it is also true that within any liberal democracy, governments can neither force people to live closer together nor change the dominant pattern of workplaces location inside a generation

or two. That is, both sides appear to be advocating extremely impractical policies, which is probably why the problem continues to remain unsolved.

Put differently, the more extreme public transport advocates sometimes try to shame Melbourneans into jettisoning their cars in favour of trams, trains and buses, even though Melbourne's sprawl makes it quite difficult for any public transport system to achieve reasonable standards of convenience, safety, service, flexibility and speed at a tolerable price. By contrast, the oil, freeway and car lobbies continue to fuel, literally, traffic gridlock by myopically pursuing the cycle of "more roads for more cars which in turn require more roads".

Suggested underlying causes of this apparently unsolvable problem are presented below in Section 1. It eventually concludes that much automotive pollution is caused by workers who live in the middle and outer suburbs but travel into the central areas each day by car. If such car-dependent commuters could somehow be enticed onto Melbourne's extensive, centrally-focusing railway network, then considerable reductions in commuter-based, automotive emissions would ensue. This is why Section 2 describes a less conventional form of public transport – Personal Rapid Transit (PRT) which may be able to get some suburban commuters out of their cars and onto the trains.

Section 3 develops this further by using GIS methods to design a cautious, incremental, prototype PRT system for Melbourne. Such a "toe in the water" approach is an attempt to nullify PRT's high costs and detrimental aesthetic impacts, for which it has been widely criticised in the past. In other words, our prototype PRT tries to locate close enough to Melbourne's existing transport facilities to make it into a viable and "neutral" alternative – one that stands aloof from the unproductive chasm across which public versus private transport advocates have been throwing vitriol at each other for several decades.

Finally, Section 4 quantifies our prototype PRT system's costs and benefits. We conclude that PRT's payoffs are high enough to warrant a further, more detailed study of its potential sooner rather than later. We also identify locations in Melbourne where we might start experimenting with PRT if commitment to the whole prototype system is not an initial option. Given the dearth of inroads that have been made into the problem of Melbourne's car dependence over the last fifty years, it seems wise to at least consider this fresh, new idea.

2. THE CAR-DEPENDENCE PROBLEM

Melbourne has not always had a car-dependence problem, because for much of its history it has been well served by a strong public transport system. Unlike other Australian cities, which de-commissioned their trams in favour of buses during the 1950's and 1960's, Melbourne retained its tramways system. Today it is the largest such system in the world and extends in all directions outwards from the CBD for about 10-12 kilometres, and even further in some cases. Also, Melbourne has several railway lines extending outwards from the CBD. These serviced suburban commuters, as they located ever outwards and further away from the tram system, during the first half of the twentieth century.

Melbourne's tram and train networks are shown in Figure 1, which is a map of "sealed road segments". The latter are small linear features which amalgamate into roads and streets. Since there are more roads and streets in built up areas than in rural areas, when one plots the map at

Figure 1's small scale the road segments run into each other to generate a reasonably accurate expression of how far the metropolitan built up area extends.

Figure 1 Melbourne's trams and trains in 2001. At this small scale the roads and streets, shown in brown, indicate the extent of the built up area.
Source: *VicMap*, 2001

One can see from Figure 1 that by the 21st century Melbourne extended well beyond its 19th-century tramways system and its early 20th-century extensions along the green railway lines. Such growth, away from trams and trains, was only made possible by the popularization of the motor car during the second half of the 20th century – Melbourne being traditionally weak in terms of buses (Mees, 2000).

The result was that a huge portion of Melbourne's workers used their cars to get to work, thereby boosting traffic congestion and increasing air pollution. The extent of this can be gauged from the bottom map in Figure 2, which shows, in white, those areas that are serviced by a tram or a train – because they are within 500 meters walking distance from one.

Such a map was produced by getting a GIS to plot a 500-meter buffer around the tramway and railway themes in the top map, intersecting this buffer with the sealed road segments theme so as to select those road segments that are within it, and then reversing this selection to show only the non-selected road segments – in the bottom map. The latter's brown areas are where

workers who are not serviced by a tram or train live – people who are likely to be dependent on car-based transport and, therefore, generate brownish, photo-chemical smog.

Figure 2 The parts of Melbourne's built-up area, coloured brown, which are NOT within reasonable walking distance of fixed-rail, public transport.
Source: VicMap, 2001

Note that the bottom map of Figure 2 is not *visually* realistic. This is because public transport catchments tend to be circular, around stops/stations, rather than take the form of linear strips along rail lines. Nevertheless, 500-meter buffers are likely to encapsulate the approximate *number* of potential tram and train commuters because, provided that a rail service is fast, safe, efficient and frequent, people will be willing to walk to their nearest stop or station from as far away as 700 meters.

To clarify this, assume that stops/stations are one kilometre apart. This makes the most distant person in a 500-meter buffer exactly 500 meters from a stop/station down the line, and 500 meters from the line itself – a diagonal distance, by Pythagoras, of the square root of $2 \times 500^2 = 707$ meters.

Note that in practice tram stops tend to be much closer to one another than a kilometre, but train stations can be up to 1500 meters apart. Yet even at this latter spacing everyone in the buffer will still be within $(500^2 + 750^2)^{0.5} = 901$ meters of the nearest railway station. Hence 500 meters for the buffer constitutes a middle value. In fact, it is likely to underestimate passenger catchments, because when stops/stations are 1500 meters apart the area of 700 meter circles

around them is $700\text{m}^2 \times 3.14 = 1.54 \text{ km}^2$, whereas the area of the two 500-metre buffers on either side of a station is only $1500\text{m}^2 = 1.5 \text{ km}^2$.

In Figure 3 the bottom part of Figure 2 has been overlaid by a map of Local Government Areas (LGAs), or municipalities, which makes it possible to deduce which LGAs are largely serviced by fixed-rail public transport – the “Serviced Zone”, and those municipalities which are not serviced by public transport, the “Unserviced Zone”. There are 5 serviced LGAs and 25 Unserviced LGAs.

Figure 3 Groups of Local Government Areas (LGAs) that are serviced (yellow) and unserved (pink) by fixed rail public transport.

Finally, Figures 4 and 5 use yellow dots to designate workers respectively living and working in the serviced zone, and they use red dots to represent workers respectively living and working in the unserved zone. Figure 4 shows that those who *work* in the serviced zone tend to come from all over Melbourne, whereas those who *work* in the unserved zone live mainly within the unserved zone itself. Figure 5 shows this from the opposite perspective – those *living* in the serviced zone tend to work locally, with relatively few travelling outwards to work in the suburbs, whereas those *living* in the unserved zone tend to work in both zones.

Figure 4 Where workers work.

Figure 5 Where workers live.

Accordingly, if one views Figure 5 as the workforce distribution overnight, and Figure 4 as the workforce distribution after the next day's morning peak hour, one can begin to appreciate the scale and pattern of Melbourne's commuting. Note that the high density of workers moving around in the inner area each day is not a result of there being more jobs located there. On the contrary, in 2001 there were 478,005 jobs in the serviced zone, compared to a massive 929,757 jobs elsewhere in Melbourne. Inner congestion comes about simply because the density of jobs there is higher.

It follows that those workers who drive into the central area each day, from the unserved, brown areas of Figure 3, cause a large part of Melbourne's peak hour, air pollution. Just how much can be gauged from the web site of the Victorian Environmental Protection Authority (EPA) (2006). This explains that oxides of nitrogen, which affect the throat and the lungs to cause emphysema, cellular damage and reduced breathing efficiency, are 60% caused by vehicles, and are monitored hourly at several observation stations, including one in the CBD. Accordingly, hourly levels of this pollutant were plotted for the working week before the time of writing, as shown in Figure 6. It can be seen that the morning and evening peaks increase the levels of this pollutant in the CBD by about 100%, with some lagging effect.

Figure 6 Oxides of nitrogen levels in Melbourne's CBD air during a typical winter working week. The doubling of pollution during the morning and evening peaks, with some lag, can be seen clearly.

Note also that the peak hour boosts to levels of carbon monoxide, a pollutant that is taken up by blood much more readily than oxygen to subsequently disrupt essential bodily processes through tissue damage, is 80% caused by vehicles. Consequently, peak-hour traffic congestion is likely to boost levels of this gas even more than indicated in Figure 6. However, the EPA only monitors this gas at eight-hourly intervals. All in all therefore, car traffic is probably responsible for at least 60% of air pollution in central Melbourne during peak hours.

Peak-hour traffic brings other maladies as well, such as noise, accidents, frustration, and congestion costs. The latter is almost exclusively caused by peak-hour commuting and is estimated to cost Melbourne somewhere around \$5 billion annually (Australian Bureau of Transport and

Regional Economics, 2005). Such costs would be hugely reduced if car-driving commuters from the unserved zone did not clog inner-city roads, forcing trams to run very slowly and so prompt many served zone residents to also take their cars to work – clogging up the roads even more.

Therefore, the next section will outline a technology that might convince unserved commuters to take the train to work instead of their cars. Such a technology is attractive because it can ferry commuters to their nearest railway station quickly, cleanly, cheaply, quietly, safely, conveniently and aesthetically.

3. A POSSIBLE SOLUTION – PERSONAL RAPID TRANSIT (PRT)

Personal Rapid Transit (Cole and Merritt, 1968; Irving et al, 1978; Buchanan et al, 2005) was first proposed in 1953 by an American transport planner, Don Fichter. It has been hotly debated at various times since, and much of this debate has been of the “half empty or half full glass” variety. That is, one well known transport expert has declared that PRT combines all of the *disadvantages* of both private and public transport and so should be paid no heed. However, one might just as validly argue that PRT combines all the *attractions* of both public and private transport – the glass is not half empty, it is half full. The author personally veers towards the more optimistic, glass is half full philosophy, but he urges readers to make up their own minds based on the analyses below.

The argument in favour of PRT often begins by pointing out how it overcomes one of the major deficiencies of car travel – a voracious appetite for urban space. This is shown by the sequence of images in Plate 1, where a large freeway’s cars (A) are stripped of everything but their occupants (B). They are then transported within a four meter wide corridor down the middle of the freeway (C), and then placed in Personal Rapid Transit (PRT) cars (D).

This means that the former freeway can now be scaled down to a minor road sufficient for accommodating only freight, business travel and recreational traffic. Indeed, with car-dependent cities currently dedicating a huge chunk of their total area to infrastructure for peak-hour car travel, PRT could massively redeem open space, which would be guaranteed to make any current urban environment much cleaner and greener.

Of course, a still more effective way to rid Plate 1 of its traffic would be to transport everyone on buses or trains. But this would mean that people would be crowded together, and the great advantage of car travel – possession of one’s own “capsule” of privacy and convenience, would be forgone. This is why PRT is different to other forms of public transport. It seeks to emulate the advantages of the private motor car by rejecting buses, trams and trains in favour of small, five feet wide cars that accommodate up to three people, or one person plus a bicycle. This is shown in Plate 2.

Plate 1 Personal Rapid Transit (PRT) has the potential to reclaim much road space for parkland
Source: Taxi 2000 Corporation

Plate 2 A PRT carriage
Source: Taxi 2000 Corporation

Now, the occupant of the PRT carriage does not have to drive because the whole system, shown in Plate 3, is computer driven. Moreover, unlike trains, buses and trams, and like cars, the PRT carriages do not have to stop for other passengers, since the computer will work out each carriage's shortest route to their nominated destination and take them straight there, with no transfers, at an estimated 60 kilometres per hour. Such a speed is certainly faster than those obtainable by cars during urban peak hours, which is the point being made in Plate 3B.

Plate 3 Elevated PRT tracks enable uninterrupted travel at speeds that are impossible to achieve by cars travelling on congested city roads
Source: Taxi 2000 Corporation

The elevated tracks for an urban PRT are quite cheap to build compared to the vast expense of resurfacing and preparing road surfaces. This is because the light weight guideways are made in 30 meter sections and simply placed on posts that have been drilled into the ground, as shown in Plate 4. Moreover, there is no need for levelling or tunnelling as there is with roads and railway lines. Also, operating costs are far lower than for any other system of urban transport.

Plate 4 PRT construction is cheap
Source: Taxi 2000 Corporation

Plate 4 (cont'd) PRT construction is cheap
Source: Taxi 2000 Corporation

The aesthetics of PRT systems are sometimes debated because people are said to be less comfortable with electric cars moving along, 4 meters above ground level, than they are with the ugliness of road and rail traffic to which they have become accustomed. Nevertheless, it is possible to have PRT systems blend into the urban landscape far better than roads and rails – by painting them the same colour as the buildings, attaching guideways to walls, placing stations in hotel or shopping centre foyers, and so forth. Plate 5 shows some of the possibilities.

Plate 5 PRT can be blended into the cityscape
Source: Taxi 2000 Corporation

PRT has several other benefits as well. Firstly, with controlling software having first been written and tested in the 1970s, it is most unlikely that there will be any accidents – unlike in car-based transport systems. Secondly, there will be zero emissions of air pollutants in the city,

since the complete system is powered by electricity. Thirdly, there are no motors in the carriages, power being taken up from an electric rail within the guideway, and so the whole system will be extremely quiet.

As well as all these advantages, it should be noted that waiting times for passengers will be close to zero, twenty four hours per day – PRT carriages queue and wait for passengers rather than vice versa. This is achieved by having many carriages moving continuously around the system at any one time and placing stations on a siding (Plate 6).

Plate 6 Stations are located away from the main lines and carriages join the flow under control of the allocating computer program.
Source: Taxi 2000 Corporation

Finally, even though any PRT system will work best when passengers can proceed from the station in any direction, this does not necessarily mean that the tracks have to be bi-directional everywhere. This is illustrated in Figure 7, where a passenger can reach anywhere even though the system is completely one-way. The only consequence is that some anti-directional travel will be required if one wants to go to a location “behind” the spot where one boarded, but at 60 kilometres and hour and no effort required by the rider, this is not likely to be a huge inconvenience.

Figure 7 All-directional travel is possible even when much of the PRT system is one-way only
Source: Taxi 2000 Corporation

In summary, PRT enables commuters to travel more comfortably, quickly, conveniently, quietly, safely, cleanly and aesthetically than any other form of transport. Moreover, it enables cities to get much of their lost greenery back, by decommissioning a major proportion of their roads network. This will surely increase the incidence of bicycling and walking – partly because of the more pleasant environment and partly because of the absence of cars. It has even been suggested that PRT will be able to bring in the city’s mail, and take out the rubbish, during off-peak hours.

Some might argue that VII - Vehicle Infrastructure Integration (US Department of Transportation, 2006), is more feasible. This approach involves cars signalling data to each other, thereby having the fleet avoid poor road conditions, accident sites and each other, which should allow travel much closer together in safety. As such, VII can begin to attain many of the pollution-reduction, congestion-decrease and speed-increase goals towards which PRT aspires. Yet VII uses existing infrastructure, polluting engines and individual drivers whereas PRT, by contrast, has a far lighter “footprint” and so stands to make far greater environmental gains, especially in terms of redeeming road space for the people instead using it for vehicles.

In search of such gains, a small PRT line was once built in Germany (Cabintaxi, 2006), as shown in Plate 7. It featured one set of carriages travelling on top in one direction and another set on the bottom going the other way. It worked perfectly and was accident free over hundreds of hours of testing. The German city of Hamburg was then supposed to implement a version of the system, but at the last moment the national, non-defence budget was reduced and so the system was never built.

Plate 7 The prototype PRT system that was tested, over several years, in Germany
Source: Taxi 2000 Corporation

It therefore has to be said that for such an apparently superior technology PRT has a paltry performance record. Although it has been available since the 1970s, no fully fledged system has ever been built. Are there serious problems encountered when trying to implement a genuine PRT system in the real-world? The answer to this question is affirmative, and so in the next and penultimate section we will try to overcome some of PRT’s drawbacks by designing a different sort of prototype.

4. A PROTOTYPE PRT SYSTEM

Since it is impossible to detail all of PRT's problems within a paper of this length, they will be dealt with in summary form only. Our strategy will be to introduce each type of problem and then suggest ways to overcome it.

4.1 REDUCING COSTS

It seems likely that the reason for virtually every city rejecting PRT is its expense. This is despite PRT being far cheaper than any other form of transport in terms of both construction and operating costs. It requires only the sinking of poles rather than grading, tunnelling and surface preparation, and rights of way seldom need to be acquired. Moreover, it requires no drivers, or at least very few. As well, costs for security, maintenance and cleaning should be no greater than those for any other form of transport.

The core problem seems to be the density of the guideways required. To function properly, all users will need to live within walking distance, again for measurement purposes, about 500 meters, from the nearest PRT track, and so for comprehensive coverage the total distance of guideways needs to be huge.

One solution would be, of course, to not propose comprehensive coverage of the city at all. It would seem wiser to propose a smaller, incrementally built PRT system that compliments and enhances the city's existing transport infrastructure. Specifically, it should *not* be built, at least for several decades, within the serviced zone shown above in Figure 3. Since peak hour pollution in this zone is largely caused by car-driving commuters coming from outside, any PRT system should locate, at least initially, only in the suburban commuter belt.

More specifically, PRT in Melbourne needs to begin life as a feeder system that carries unserved workers to their nearest railway station. Such a tactical approach would enable authorities to "try out" PRT and to monitor its beneficial effects very cheaply. If successful, other small networks, at other locations within suburbia might then be built. Moreover, some or all of the latter could eventually be linked together, thereby boosting the total prototype system's power and flexibility.

4.2 REMOVING STREET CLUTTER

If carriages are to queue for passengers rather than vice versa, ordinary urban neighbourhoods might become cluttered with large numbers of PRT vehicles stored in sidings above normal urban footpaths. This would tend to destroy local amenity. Hence a solution might be to use some of Melbourne's existing transport infrastructure for storing PRT carriages.

For instance, the railway lines that intersect with Melbourne's commuter suburbs would be ideal for running PRT systems along, and PRT carriages could even be stored in railway car parks. Indeed, railway station car parks are precisely where we want our PRT system to deposit its peak hour clients.

Also, suburban Melbourne has several suburban freeways with grass verges and breakdown lanes, above which several kilometres of unused PRT carriages could be stored off peak. Driving along a freeway is hardly an aesthetic experience, and so few people are likely to object if PRT facilities are located along them.

The result would be that early-rising residents, for the privilege of not having large numbers of PRT carriages stored along their street, would sometimes have to wait one or two minutes for a carriage to come from the nearest railway or freeway. This would be a relatively small and mostly un-noticed sacrifice for protecting residential amenity.

4.3 SEGREGATING PRT FROM SUBURBAN NEIGHBOURHOODS

PRT carriages gliding along four meters above the pavement might spoil residents' lines of sight and the privacy of their upstairs bedrooms. For this reason our proposed prototype PRT system does not run through residential areas at all. Again, it uses some of Melbourne's existing infrastructure – main roads. The latter frequently have four or more lanes, median strips, noise and considerable pollution. As such, their existing low level of amenity is unlikely to be much further eroded by adding the relatively light footprint of a PRT system.

In other words, since many Melbourne workers live within walking distance of a main road, it should be possible to have a functioning PRT system, one that services large numbers of commuters who are presently unserved, whilst not decreasing the aesthetic quality of Melbourne's environment very much, if at all. Most of our PRT system can be kept away from Melbourne's green and leafy streets, without even mentioning the distinct possibility of routing PRT guideways along fire access lanes, strips of council land, industrial properties, the abandoned inner circular railway, bike trails and other suitable areas.

4.4 LAYING OUT A SYSTEM

All in all, the best locations for PRT seem to be neighbourhoods where unserved residents live within walking distance of a main road and relatively close to a freeway or a railway. Any GIS can be used to identify such areas, as will now be demonstrated.

Figure 8 reproduces Figure 3 along with a map of Melbourne's designated main roads, freeways and railways. Note that the latter do *not* include what are known as "arterial" roads, which traditionally serve as routes coming into and going out of Melbourne. These trunk routes already carry too much infrastructure, and they frequently host strip shopping centres as well, so we do not consider them suitable locations for erecting elevated, PRT guideways.

More promising are main roads that are about 1 kilometre from a railway line or freeway, so that nearby residents are not likely to be currently walking to the railway line. Yet such residents would be within walking distance of a PRT system if one were built along the main road segments. Moreover, since the latter are as close as possible to the railway without poaching its customers, PRT costs would be minimized.

Such road segments, within the "sealed road segments theme" can be found by using the "Select by theme" function in the *ArcView* GIS, or the "Select by location" function in the *ArcMap* GIS. These commands can identify those segments which are between say, 900 and 1100 meters from a railway line. The result of doing this, within the suburban, Whitehorse municipality of Melbourne, is shown in the magnified map of Figure 9. The small brown streets are part of the unserved road segments from Figures 3 and 8, and the red road segments are those that the GIS found to be 900-11000 meters from the (green) railway line.

Figure 8 The main roads (blue), freeways (black) and railways (green), along which PRT guideways might be built

Figure 9 The GIS' specification of candidate main road segments along which a PRT guideway might be built (red). These segments are between 900 and 1100 meters from the railway line (green).

Now, if one connects these red main road segments by clicking on their blue line extensions to make such extensions red also, making sure not to stray too far away from the railway line, it follows that one will generate a fragment of a PRT system that has minimal length yet services portions of the (brown) unserved areas. In Figure 9 for example, this procedure is likely to generate a network that comprises about six north-south main roads, a main road that runs about one kilometre away and roughly parallel to the railway line, and perhaps some more main roads that extend a little further to the north in order to take advantage of the freeway there.

In fact, by first selecting all the (green) railway lines within the unserved zone, the GIS will identify (red) road segments of the type shown in Figure 9 at all locations across the unserved zone. Moreover, when such segments are joined up in those localities where there are many currently unserved road segments (brown), the result is the red lines shown in Figure 10. By definition, such lines constitute a prototype PRT system that maximizes usage of current suburban transport infrastructure (green railways, blue main roads and purple freeways), minimizes total cost by running as close as possible to the railway lines while servicing previously unserved localities. and minimizes visual impact by being exclusively on a main road, a railway or a freeway.

Figure 10 A prototype Personal Rapid Transit (PRT) system which services many previously unserved commuters, has minimal costs and is entirely located on main roads, railways and freeways

Figure 11 highlights the potential impact of this prototype PRT system. It shows how our prototype PRT system has potential for ferrying many car-driving commuters to the nearest railway station because it straddles many of the currently unserved (brown) neighbourhoods.

Counting how many such neighbourhoods there are, and the consequent reduction that is likely in peak-hour pollution, is the subject of the next and final section. Again, we will need to exploit several of modern GIS's capabilities to perform such analysis rigorously.

Figure 11 How the prototype PRT system (red) covers many of the unserved areas of Melbourne (brown)

5. COSTS AND BENEFITS

This section will first describe the method we used for analysing the costs and benefits of our PRT prototype system. This will be followed by a mapping and tabulation of its results.

5.1 METHOD USED

The procedure we used is set out in Figure 12's flowchart. Step 1 was to estimate the approximate size of the PRT system's catchment by buffering outwards, again for 500 meters, on either side of all the guideways. Step 2 was to intersect this buffer with the brown, unserved road segments theme in order to select out the set of formally unserved but now potentially serviced neighbourhoods, and colour them green. Then, in each municipality (i), we divided the number of green road segments by the former number of brown segments in order to estimate the proportion ($PROP_i$) of previously unserved commuters who might now be converted into train users because there is a PRT guideway within 500 meters of their home (Step 3).

Figure 12 Procedure for calculating each municipality's PRT-induced reduction in Melbourne's total peak-hour pollution.

This proportion, $PROP_i$, was then used (step 4) to calculate each municipality's approximate number of PRT-using, former car-driving commuters. This was possible because "journey to work" statistics reveal each municipality's number of workers who work in the serviced zone, WS_i , and its number of workers who work in the unserved zone, WU_i , which must then, of course, be reduced to account for those workers who are already travelling to their workplace by train.

Newton et al (2001) point out that about 9% of commuting is by train in the middle suburbs, and about 6% of commuting is by train in the outer suburbs, presumably in terms of residents rather than in terms of jobs located there, although this is not made perfectly clear. Taking the numbers of workers who work in the serviced zone but live in middle and outer suburbs respectively, the weighted average comes to 8%. This means that 92% of commuters who travel from outside in order to work in the serviced zone do *not* go by train, and since distant commuting by bus into the serviced zone is relatively minor, this figure is close to the number of car users.

This estimate also conforms to the assertion by Fujii et al (2005) that in 2001 the proportions of car-using commuters to two of the serviced zone's non-Melbourne LGAs – Port Phillip and Yarra, were 68% and 65% respectively – presumably in terms of the holders of jobs there rather than in terms of residents living there, although again, this is not made perfectly clear. Many of

the 32% – 35% of job holders who did *not* come by car were surely locals, who travelled by tram, train, bus, bicycle or by walking, making the 92% car-user figure for the more distant commuters seem plausible.

However, it is true that some non train users actually take a bus, especially in the LGA of Manningham, and it is also not clear how many car users actually “park and ride” at a local railway station before taking the train. Hence we needed to reduce our 92% estimate to something smaller, although without detailed statistics it is impossible to say how much smaller. Accordingly, we somewhat arbitrarily settled on a figure of 82%. For cross-suburb commuters, the reduction of the 92% should almost certainly be less marked, and so for these workers we settled on a percentage of 87%.

In other words, step 4 calculated each municipality’s (number of) *Converts to PRT who used to commute by car to the Serviced zone from LGA_i*, CS_i, using equation 1:

$$CS_i = WS_i * 0.82 * PROP_i \dots\dots\dots 1.$$

where CS_i = Converts to PRT who used to commute by car to the Serviced zone from LGA_i,
 WS_i = Workers in Serviced zone who live in LGA_i,
 0.82 = estimated fraction of WS_i who currently commute by car, and
 PROP_i = Proportion of unserviced neighbourhoods that are within 500 meters of PRT in LGA_i,

and *Converts to PRT who used to commute by car to the Unserved zone from LGA_i*, CU_i, using equation 2:

$$CU_i = WU_i * 0.87 * PROP_i \dots\dots\dots 2.$$

where CU_i = Converts to PRT who used to commute by car to the Unserved zone from LGA_i,
 WU_i = Workers in Unserved zone who live in LGA_i,
 0.87 = estimated fraction of WU_i who currently commute by car, and
 PROP_i = Proportion of unserviced neighbourhoods that are within 500 meters of PRT in LGA_i,

We then divided these numbers by the total number of car-using commuters to the serviced zone (step 5) to calculate the % *Reduction in peak-hour Pollution in Serviced zone due to PRT in LGA_i*, RPS_i, using equation 3. The divisor was based on Fujii et al’s (2005) assertion that in 2001, 30% of commuters to the CBD came by car, as did 57% of commuters to the rest of the Melbourne LGA and 65% – 68% of commuters to the other four municipalities within the serviced zone. Multiplying such proportions by the respective LGAs’ numbers of jobs, and summing, generated a total of 255,164 car-using commuters coming to the serviced zone each day. Note that the % reduction needed also to be multiplied by 0.6 because Figure 6, above, showed that only about 60% of peak-hour, inner-area air pollution is caused by vehicles:

$$RPS_i = (CS_i * 100 / 255,164) * 0.6 \dots\dots\dots 3.$$

where RPS_i = % Reduction in peak-hour Pollution in Serviced zone due to PRT in LGA_i,
 CS_i = Converts to PRT who used to commute by car to the Serviced zone from LGA_i,

255,164 = number of car-based commuters working in the serviced zone, and
 0.6 = adjustment because not all serviced-area pollution is caused by cars.

We then used similar reasoning to calculate % *Reduction in Fuel used by commuters to the Serviced zone due to PRT in LGA_i*, RFS_i , using equation 4 (step 7), But before doing so we had to adjust for the fact that fringe-area commuters travel further and so use more petrol than commuters who live closer in. That is, all distances from LGAs' PRT systems to the CBD were measured using a GIS (step 6), and these were standardized by dividing each distance against the average of such distances. For example, if an LGA's PRT system was 1.55 times the average distance away from the CBD, then its adjustment for "remoteness", AR_i , would be 1.55; if its distance was 0.8 times the average then its AR_i would be 0.8, and so on:

$$RFS_i = CS_i * AR_i * 100 / 255,164 \dots\dots\dots 4.$$

where RFS_i = % Reduction in Fuel used by commuters to the Serviced zone due to PRT in LGA_i,
 CS_i = Converts to PRT who used to commute by car to the Serviced zone from LGA_i,
 AR_i = Adjustment for the Remoteness or otherwise of LGA_i, and
 255,164 = number of car-based commuters working in the serviced zone.

A similar equation, equation 5, was then used (step 9) to calculate % *Reduction in Fuel used by commuters to the Unserviced zone due to PRT in LGA_i*, RFU_i . Note however that CU_i , equation 2's estimate of the number of PRT converts who commute within the unserved zone, is an exaggeration. This is because our prototype PRT system will not take every cross-suburb commuter to wherever they want to go. Equation 5, therefore, refers more to a future time in which small local PRT systems have been connected to each other, thereby beginning to effectively service cross-suburban commuting.

Note also that we again had to make adjustments in order to reflect the propensity of commuters from one LGA to travel longer or shorter distances than workers from another LGA, and this time such adjustments were not simply proportional to distance from the CBD. They were a function of the extensiveness, or otherwise, of the LGA's amount of jobs "spread" in *all* directions. We therefore had a GIS calculate the areas of the standard deviation ellipses that encapsulated each LGA's residents' jobs distribution (step 8) and we used such areas, standardized, as the adjustment factors, AS_i , in equation 5.

Note that the divisor in equation 5 corresponds to 87% of the number of jobs located in the unserved zone – 1,054,198:

$$RFU_i = CU_i * AS_i * 100 / 1,054,198 \dots\dots\dots 5.$$

where RFU_i = % Reduction in Fuel used by commuters to the Unserviced zone due to PRT in LGA_i,
 CU_i = Converts to PRT who used to commute by car to the Unserviced zone from LGA_i,
 AS_i = Adjustment for the Spread or otherwise of the jobs held by workers living in LGA_i, and
 1,054,198 = number of car-based commuters working in the unserved zone.

We then proceeded to step 10, which involved using a GIS to identify, as a separate theme, all those segments of main road, railway and freeway that have been nominated to be part of

our prototype PRT system, and to then measure their total length. In the *Arcmap 9.0* GIS the latter is done by creating a new field/column in the selection's Table of Attributes, and then calculating values for this field using a *VisualBasic* script that can be found by typing "length" into the Help routine.

This PRT theme was then intersected by each (selected) LGA in turn, and the "statistics" function within each LGA's Table of Attributes was used to find the sum of all the lengths of the PRT segments within it. Such a sum, of course, indicated how many kilometres of PRT guideway would have to be built, within each LGA, if the system proposed above were to function.

Note that the actual kilometre totals were approximate only, because when manually clicking segments of roads, railways and freeways it was often difficult to capture every single one. Nevertheless, the final measurements of the PRT system's municipal lengths give a broad indication of how much the PRT system will cost to build in each locality.

Moreover, we assumed PRT building costs are \$10 million per kilometre, even though some researchers maintain that the actual cost is much lower – more in the order of \$5.5 million per kilometre (Innovative Transportation Technologies, 2006; ATS Ltd, 2006). However, others claim that costs are as high as \$15 million per kilometre (Advanced Transit Association, 2003), and so the figure of \$10 million is basically a compromise value.

PRT's costs and benefits were then reviewed in step 11 – a table was constructed that showed each LGA's PRT cost against its predicted benefits. This enabled us to identify whether or not an LGA's PRT seems to have a reasonable payoff for its cost.

Finally, step 12 compared each municipality's PRT costs with its three types of percentage reductions, as calculated in equations 3, 4 and 5. This enabled us to suggest what appear to be the most productive municipalities for building PRT within.

5.2 RESULTS

Figure 13 shows the 500 meter buffer around Figure 10's prototype PRT system. It therefore represents PRT's "greening" of Melbourne; the green parts of the currently unserved areas of Melbourne will become safer, quieter and cleaner when some of their streets are replaced by trees and grass.

Figure 14 superimposes the LGA boundaries onto Figure 13, and by using the statistical options within each municipality's "Table of Attributes" in the GIS, we can count how many of its formerly brown road segments have become green. This number then allows us to calculate the proportion of the municipality's car-driving central city workers who might now be tempted to catch the PRT system to the nearest railway station - $PROP_i$ in equation 1.

Note that this process has to be modified slightly in some fringe LGAs by estimating the number of brown road segments there that are actually "urban". Moreover, $PROP_i$ will be a slight over-estimate because not all car-driving commuters will use PRT to go to work simply because they live near a guideway. However, in view of the tendency towards underestimation elsewhere, this is not likely to be a serious inaccuracy.

Figure 13 PRT: a step towards the “greening” of Melbourne

Figure 14 Newly serviced (green) and still unserved (brown) areas within each LGA after building the prototype PRT system

Two standard deviation ellipses that enclose a municipal workforce's spread of job locations are shown in Figure 15. The blue dots represent where the residents of the Bayside LGA work, and the red dots indicate where residents of the Manningham municipality work. Each municipality's standard deviation ellipse, as calculated by the *ArcMap 9.0* GIS, is optimally oriented and sized so as it most economically encompasses a certain percentage of the dots. It is therefore obvious that Manningham residents (red) go to work across a wider area than do the residents of Bayside (blue), because the red standard deviational ellipse is larger than the blue one.

Figure 15 Where residents of Bayside (blue dots) work and where residents of Manningham (red dots) work, along with their respective standard deviation ellipses

If we do this for every LGA, as shown in Figure 16, we see that due to Melbourne's sprawl towards the south and east, average commuting distances there are greater than in the north and west. Note also that semi-rural LGAs, house workers who travel both inwards to the CBD and outwards to rural centres, and this artificially elongates such LGAs' "urban" standard deviation ellipses. Hence for the LGAs of Hume, Whittlesea, Nillumbik, Yarra Ranges and Casey, their standard deviation ellipse's areas were simply estimated on the basis of the scores attained in the neighbouring, urban LGA(s).

Each LGA's standard deviation ellipse's area, standardized, is shown in Figure 17. The LGAs with the largest multiples, because their commuting distances are larger, are in the east and south and shown in red. By contrast, workers in the north and west live closer to the central city and commute over shorter distances, so they are responsible for less pollution per car, as shown by their LGAs tending to be coloured green. Orange and yellow LGAs are in-between. Such multiples were used as the AS_i adjustment factors in equation 5.

Figure 16 The spatial extent of each LGA's commuting activity, as given by the area of its journey to work, standard deviation ellipse

Figure 17 Each LGA's relative polluting potential per car-based commuter

This brings us to a point where we are finally in a position to estimate the costs and some of the benefits of our prototype PRT system using the equations above. The balance sheet is shown in Table 1. Looking at the left-hand green column we can see that building those parts of the PRT system that are in the Casey LGA will decrease peak-hour pollution in Melbourne's serviced zone by 0.5%. Alternatively, if the sections that are in the Manningham LGA are constructed then inner Melbourne's peak-hour pollution will be reduced by 1.1%, and so on.

Local Government Area (LGA _i)	Cost @ \$10m. per km (\$ mil.)	Workers in Serv. zone (WS _i)	Workers in Unserv. zone (WU _i)	Now serv.: originally unserv. areas (PROP _i)	Adjust. for Remote (AR _i)	Adjust. for jobs' Spread (AS _i)	% Reduc. of peak-hr. Pollution in Serv. zone (RPS _i)	% Reduc. of Fuel for commute. to Serv. zone (RFS _i)	% Reduc. of Fuel for commute. to Unserv. zone (RFU _i)
Casey (C)	905	8171	64031	0.32	1.92	1.40	0.5	1.6	2.4
Monash (C)	773	20646	44768	0.32	0.95	0.92	1.3	2.0	1.1
Brimbank (C)	630	16243	41593	0.23	0.65	0.91	0.7	0.8	0.7
Greater Dandenong (C)	620	6259	35959	0.36	1.27	1.03	0.4	0.9	1.1
Whittlesea (C)	588	9683	34156	0.39	0.91	1.10	0.7	1.1	1.2
Kingston (C)	423	15444	42089	0.34	1.17	0.90	1.0	2.0	1.1
Manningham (C)	369	16236	30543	0.36	0.80	1.21	1.1	1.5	1.1
Whitehorse (C)	334	20720	37844	0.29	0.88	1.04	1.2	1.7	1.0
Banyule (C)	333	20646	33555	0.30	0.72	1.12	1.2	1.4	0.9
Maroondah (C)	329	8789	33988	0.23	1.35	1.55	0.4	0.9	1.0
Hume (C)	292	30485	52877	0.18	0.75	1.00	1.1	1.3	0.8
Frankston (C)	258	4800	39198	0.16	1.93	1.46	0.2	0.5	0.8
Bayside (C)	248	14423	22470	0.38	0.73	0.67	1.1	1.3	0.5
Glen Eira (C)	183	23412	28258	0.37	0.62	0.67	1.7	1.7	0.6
Wyndham (C)	169	9298	25137	0.35	1.36	1.11	0.6	1.4	0.8
Knox (C)	111	11103	52333	0.12	1.41	1.41	0.3	0.6	0.7
Nillumbik (S)	92	6759	21093	0.41	1.06	1.25	0.5	0.9	0.9
Darebin (C)	72	19493	26491	0.18	0.52	0.92	0.7	0.6	0.4
Maribyrnong (C)	65	9031	11878	0.17	0.35	0.74	0.3	0.2	0.1
Yarra Ranges (S)	49	7060	51505	0.03	1.57	1.20	0.0	0.1	0.2
Moonee Valley (C)	29	17578	27434	0.17	0.46	0.73	0.6	0.4	0.3
Moreland (C)	9	21187	27740	0.05	0.62	0.81	0.2	0.2	0.1
Totals ->	6881	317466	784940	Ave. = 26	Ave = 1	Ave = 1	15.7	23.2	17.5
(AS _i for Hume, Whittlesea, Nillimbik, Yarra Ranges & Casey = estimates only)									

Table 1 The costs, and some of the quantifiable benefits, of our suggested prototype PRT system for Melbourne

The totals along the bottom show that if the complete prototype system is built, then peak-hour pollution in the serviced zone will decrease by a massive 15.7% – all for the cost of about \$6.8 billion. Moreover, such expenditure will decrease the amount of petrol used by current car-

based commuters to the serviced zone by 23.2% and, in the future, it will reduce the fuel used by car-based commuters to the suburban belt in the order of 17.5%.

It should always be remembered, however, that the benefits of PRT are far more than it has been possible to measure here. By unclogging their roads and so encouraging serviced-zone residents to use their trams, trains and buses again, our prototype PRT system should reduce most of the peak-hour traffic congestion within inner Melbourne, as well as bring substantial gains in terms of safety, quietness, speed, convenience and replacement of roads by trees, parks, gardens and bike paths.

It should also be remembered that due to the above-explained uncertainties around the amount of bus commuting and “park and ride” participation, the actual numbers in Table 1 are of doubtful validity. Yet they are still a guide to *comparative* costs and benefits in different localities, and so they are useful for indicating where one might begin, should it ever be decided to start implementing PRT. Accordingly, implementation will be covered in the next and final sub-section. It begins by reviewing costs, and then it suggests where the best places are for trying out PRT in Melbourne.

5.3 IMPLEMENTATION

The municipality where our prototype PRT system would cost the most is Casey, with a total construction bill of about \$905 million. However, this is actually cheaper than the billion dollar *EastLink* freeway that is currently being built, from Casey to the Eastern freeway, in order to service car-based commuters. Hence whereas the *EastLink* freeway is guaranteed to increase inner-area, peak-hour pollution, Table 1 indicates that PRT in Casey will actually decrease pollution by a conservatively estimated 0.5%, as well as reduce the petrol used by city-bound, car-based commuters by 1.6% and decrease fuel used by suburban-bound commuters by around 2.4%.

Also, Table 1 tells us that the cost of the next most expensive PRT sub-system, in the Monash LGA, is around \$773 million, which happens to be about the same as that of the recently completed roof for Southern Cross Railway Station in the Melbourne CBD. Ironically, this roof at the time of writing is being accused of trapping diesel fumes, belched by railway engines, to the extent of making staff and commuters feel unwell. By contrast, the Monash PRT system is guaranteed to reduce central Melbourne’s peak-hour pollution by at least 1.3%. It will also decrease city-bound, car based commuters’ fuel usage by 2% and that of suburban-bound commuters by 1.1%.

Therefore, given all of its other benefits besides pollution reduction, surely PRT has a very strong case for being considered when it comes to deciding between large transport infrastructure projects in the future,. Indeed, some LGAs’ prototype PRT systems could be paid for by taking just half of the exorbitant remuneration packages with which top executives in several Australian companies annually reward themselves. It is hard to believe that such executives are able to even spend the top half of their salaries – the latter seem to be a result of corporate greed. Yet unless we, the people, take a stand by demanding that some of this money is put towards enhancing environmental amenity, our cities are likely to become monuments to privatization in which it is difficult and unpleasant for ordinary people to move around.

Yet no matter how comparatively cheap PRT is compared to both roads and conventional public transport, governments will invariably say it is too costly. This is because existing infrastructure already exists, having been paid for by the people over the last 150 years, and it takes

less money to maintain such infrastructure than to build new PRT guideways. It is therefore wise, when deciding where to trial PRT, to keep an eye on local returns per dollar expended.

For this reason we have taken the three green columns of Table 1 and divided them by municipal costs to generate each municipality's "benefits per \$". The resulting three arrays, sorted in decreasing order of return, are shown in Table 2. Note that some LGAs do not have enough settlement, or railways, freeways or main roads to have many kilometres of potential PRT guideway. This means that PRT within such LGAs will be non viable unless a neighbouring LGA builds a larger PRT system into which it can connect. Such LGAs were, therefore, excluded from the analysis, and they are shaded in grey in Table 2.

% Reduc./ Pollution in Serv. Zone		% Reduc. / Fuel to Serv. zone		% Reduc. / Fuel to Unserv. zone	
Local Government Area (LGAi)	per \$ * 100	Local Government Area (LGAi)	per \$ * 100	Local Government Area (LGAi)	per \$ * 100
Moreland (C)	0.024775223	Moreland (C)	0.025671607	Moreland (C)	0.011176397
Moonee Valley (C)	0.019296595	Moonee Valley (C)	0.014844594	Nillumbik (S)	0.009672897
Darebin (C)	0.009559703	Nillumbik (S)	0.01018706	Moonee Valley (C)	0.009461234
Glen Eira (C)	0.009083603	Glen Eira (C)	0.009412254	Knox (C)	0.006429895
Nillumbik (S)	0.005793477	Wyndham (C)	0.008406551	Darebin (C)	0.005087876
Maribyrnong (C)	0.004467611	Darebin (C)	0.00825465	Wyndham (C)	0.004755161
Bayside (C)	0.0042533	Knox (C)	0.005327078	Yarra Ranges (S)	0.003549045
Wyndham (C)	0.003705599	Bayside (C)	0.005175106	Glen Eira (C)	0.003120571
Hume (C)	0.003623432	Whitehorse (C)	0.005167444	Maroondah (C)	0.003000176
Banyule (C)	0.003611411	Kingston (C)	0.004690247	Frankston (C)	0.002990224
Whitehorse (C)	0.003520243	Hume (C)	0.004522503	Manningham (C)	0.002949471
Manningham (C)	0.003017459	Banyule (C)	0.004337404	Whitehorse (C)	0.002853711
Kingston (C)	0.002399577	Manningham (C)	0.004003038	Banyule (C)	0.002801073
Knox (C)	0.002262071	Maribyrnong (C)	0.002630257	Hume (C)	0.002689999
Monash (C)	0.001643299	Maroondah (C)	0.0026187	Casey (C)	0.002599434
Whittlesea (C)	0.001226736	Monash (C)	0.00260573	Kingston (C)	0.002521853
Maroondah (C)	0.001166429	Yarra Ranges (S)	0.002483375	Whittlesea (C)	0.002037286
Brimbank (C)	0.001143303	Frankston (C)	0.001883896	Bayside (C)	0.001903038
Yarra Ranges (S)	0.000947184	Whittlesea (C)	0.001858531	Maribyrnong (C)	0.001866114
Greater Dandenong (C)	0.000702743	Casey (C)	0.001768643	Greater Dandenong (C)	0.001772956
Frankston (C)	0.000586776	Greater Dandenong (C)	0.00148392	Monash (C)	0.001407671
Casey (C)	0.000553585	Brimbank (C)	0.001247492	Brimbank (C)	0.001137765

Table 2 Different sorts of PRT benefits, per \$, in different LGAs

From the left hand columns in Table 2 it follows that in order to gain the best return in terms of reducing peak-hour pollution in the serviced zone, one should build PRT in the LGAs of Glen Eira and Bayside. Both have relatively large numbers of residents who commute to the serviced zone (Table 1), along with a network of main roads, railways and freeways that is well enough placed to service the presently unserved commuters using a relatively small length of PRT guideway.

Similarly, the middle columns of Table 2 show that to reduce fuel usage by in-bound, car-driving commuters at the cheapest cost, one should construct PRT in the LGAs of Glen Eira and Wyndham. Not only do their main roads and railways efficiently straddle their presently unserved neighbourhoods, but they are also reasonably far from the CBD which makes fuel savings greater per PRT convert.

Finally, the right hand columns of Table 2 indicate that if one wants to most efficiently begin to reduce the fuel usage of cross-suburban commuters, it is best to build PRT guideways in the LGAs of Knox and Wyndham. These municipalities, again, have main roads and railways efficiently straddling their presently unserved neighbourhoods, along with relatively large numbers of workers whose jobs are spread relatively widely across the unserved zone (Table 1)

Such recommendations have been mapped in Figure 18, which shows the location of the prototype PRT system, the unserved areas and the two top-scoring LGAs under each criterion – the LGAs with non-viable PRT systems have not been considered.

Figure 18 Candidate localities for building the first PRT guideways in Melbourne

It can be seen that the Glen Eira municipality, because it is the top-scoring LGA in terms of efficiently in reducing both inner-area air pollution and in-bound fuel use, has been highlighted

twice. As such, perhaps the first experimentation with PRT in Melbourne should take place in this locality. The Wyndham LGA has also been mapped twice, because of its efficiency in reducing both in-bound and cross-suburban fuel bills for commuters. Hence the second location for PRT might be the Wyndham LGA. Thirdly, building PRT guideways in Bayside and Knox would bring further, efficient reductions in inner-area pollution and cross-suburban fuel usage respectively.

Moreover, if PRT guideways were ever built in these four municipalities and if they proved to be a success, it may not take long before less suitable suburban areas were similarly serviced by PRT, with the different local components eventually being connected to make the whole system much more effective. Indeed, if all of our prototype PRT system were ever built, the construction of PRT lines across the serviced zone itself could begin. This would *completely* connect all of Melbourne at the currently impossible speed of 60 kilometres per hour.

6. CONCLUSIONS

We are now at the end of our long, but still very tentative and preliminary study of PRT's feasibility in Melbourne. We have argued that PRT, as a technological solution, might now be worth considering. However, we believe that various interest groups, such as the retailing, property and road-building lobbies, will automatically resist PRT very strongly. This is because PRT is not in their interests – the current situation is. However, a possible exception could be the property developers who can surely see PRT's huge potential for improving amenity and so boosting property values.

Yet a more insidious source of opposition to PRT is likely to be people who simply like trams, or trains, or buses, or cars for their own sake. This is because if PRT were ever fully embraced, Melbourne would need very few conventional vehicles. A small number of buses, trams and trains would probably still be required to shift large crowds, quickly, away from major events, albeit probably only to the many scattered parts of the PRT system, and some roads and vehicles would still be needed for deliveries, emergencies, some business travel and supermarket shopping. But Melbourne would mostly become a greener, safer and quieter place; something that would be most unattractive both to the car-based, hobbyist sub-culture and to the tram, train and bus nostalgics.

Yet if one momentarily puts aside such sentimentality, then surely there is a good chance that by the late 21st century authorities will finish the job that was begun by the first English town planners during the late nineteenth century. These pioneers sought to obviate the squalor of Dickensian, industrialized cities by incorporating into them the benefits of the countryside through the building of “garden cities”. Yet the latter only worked for so long as everyone lived close to a railway, a situation that was torpedoed by the emergence of car-based sprawl during the late 20th century.

Hence it is reasonable to assume that by the late 21st century, planners will use PRT to finally bring back into the city unprecedented amounts of countryside flora, fauna, fresh air and open space. Melbourne can either be in the vanguard of such change, or it can continue to suggest dated and impractical solutions to its car-dependence problem.

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