23rd Australasian Transport Research Forum
Perth, Western Australia. 29 September – 1 October 1999

'Relative Speed' Not 'Time Savings': A New Indicator for Sustainable Transport

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Abstract

"Time savings" is found to be an unreliable indicator for urban transport as it is illusory and leads to costly transport systems due to car-dependence. Data from an extensive international comparison of cities show that the more cities invest in roads and the more they improve the average travel speed on their road system, the higher car use they generate without any savings in travel time compared to transit-oriented cities. An alternative - 'relative speed of transit to traffic' - is shown to be more related to sustainability goals and to be more reflective of community values as it assists cities to control growth in car use. The data show that urban rail systems that are able to compete in speed terms with existing road traffic conditions are the key element in improving the ratio of transit to traffic speed and are also critical in developing a more cost-effective transport system overall.

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Introduction

The approaches taken to decide priorities in Australia's transport system in the past few decades have been based on international transport economics techniques. Commentators like Scrafton (1998) suggest that Australian transport reform processes based on Commonwealth inquiries have been largely supportive of the progress made using these techniques. However, the data we have been collecting for the World Bank on urban transport reveal that there must be something wrong with the approaches. This paper tries to set out the nature of the problem, what is the fundamental cause of the problem (based on an over-dependence on 'time savings') and how a new indicator (based on the 'relative speed of transit to traffic') can help to create more sustainable transport systems in Australian cities.

The Problem

The data which we collected (summarised in Newman and Kenworthy, 1999 and more extensively laid out in Kenworthy and Laube et al, 1999) show that on all economic parameters Australian cities and US cities have the highest transport costs. The cities in our study are listed in Table 1.

US cities	Australian cities	Canadian cities	European cities	High-income Asian cities	Lower-income Asian cities
Houston	Perth	Toronto	Hamburg	Tokyo	Seoul*
Phoenix	Brisbane	Vancouver*	Frankfurt	Hong Kong	Kuala Lumpur*
Detroit	Melbourne	Calgary*	Zurich	Singapore	Bangkok*
Denver	Adelaide	Edmonton*	Stockholm		Jakarta*
Los Angeles	Sydney	Montreal*	Brussels		Manila*
San Francisco	Canberra*	Winnipeg*	Paris		Surabaya*
Boston		Ottawa*	London		
Washington			Munich		
Chicago			Copenhagen		
New York			Vienna		
Portland*			Amsterdam		
Sacramento*					
San Diego*					

Table 1. Cities in the international comparison of urban transport and land use.

Notes :

(1) The 16 new cities in the sample are marked with an asterisk (the other 30 were in Newman and Kenworthy, 1989).

(2) Some recent data have also been collected on Auckland, Wellington and Christchurch in New Zealand (Bachels, Newman and Kenworthy, 1998)

The data reveal substantial differences when US and Australian car-based cities are compared to European, Canadian and Wealthy Asian cities (Singapore, Tokyo and Hong Kong), which have considerably better public transport. For the year 1990 the US and Australian cities have:

- 76% more expenditure per capita on roads ($US223 cf $US127 per capita),
- almost half the cost recovery from their public transport systems (37% cf 72%),
- 56% more traffic accidents per head of population (13.7 cf 8.8 per 100,000), and
- 31% more total operating costs for running their private and public transport systems ($US3,033 cf $US2,307 per person).

The most revealing parameter is shown in Figure 1 which indicates how the most auto-based cities compare in the amount they spend on passenger transport (direct private and public transport costs) as a proportion of city wealth (Gross Regional Product or GRP, i.e. the goods and services produced in the city-region). This demonstrates that US and Australian cities use, on average, 12.7% of their city wealth on the operation of passenger transport; however European, Canadian and Asian cities use only 6.6% of their wealth on getting around. This does not include external costs which would only make the comparison even more striking.

These data show that in our car-based cities we are working up to an extra day a week just to be able to pay for our transport operating costs. The newly developing Asian cities are investing heavily in new roads and are even worse off in terms of the extra work they must do to pay for their passenger transport.

The past few decades of transport decision-making have been based on approaches that suggest the provision of faster flowing road traffic will be an overall benefit to the urban economy, whilst the provision of infrastructure for mass transit (especially rail systems) will inherently be a drain on the economy. However, our data show the reverse to be true. Cities with the most roads have the highest proportion of their city wealth needed for transport, whilst those with the most rail have the least proportion of their wealth absorbed by transport (see Figures 2 and 3).

These data would suggest that if greater economic cost-effectiveness in transport has been the goal, then Australia has been making the wrong transport investments in the last few decades. For example, the Federal government from 1975 to 1998 has invested $43 billion in roads, $1.2 billion in rail and $1.3 billion in Urban Public Transport. These investments are of course for the whole transport system, in cities and between them, but the biggest part of the transport system, in vehicle kilometres travelled (VKT) or in fuel use, is in our cities. State Government expenditure during this period is not as easily obtained but indicates the same orientation to road funding (Industry Commission, 1994). The past quarter century has been dominated in Australia by investment in roads to the detriment of all other modes. Yet the data above would suggest it has not achieved its economic goals as Australian cities are amongst the most costly in transport terms in the world. Road investment, it seems, is largely self-defeating.

Supportive data are now emerging from the US where a new study (STPP, 1998) examined 15 years of transport infrastructure investment and found that metro areas which invested heavily in road capacity expansion fared no better in easing congestion than metro areas that did not. Cities with a penchant for road building spent in total $US22 billion more on road construction than those that did not have this priority, and ended up with similar or slightly worse congestion.

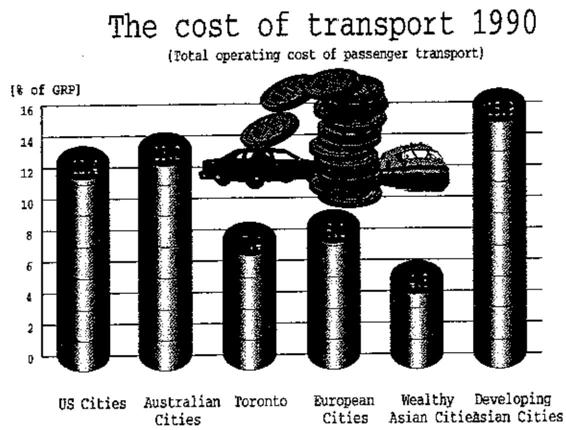

Figure 1.

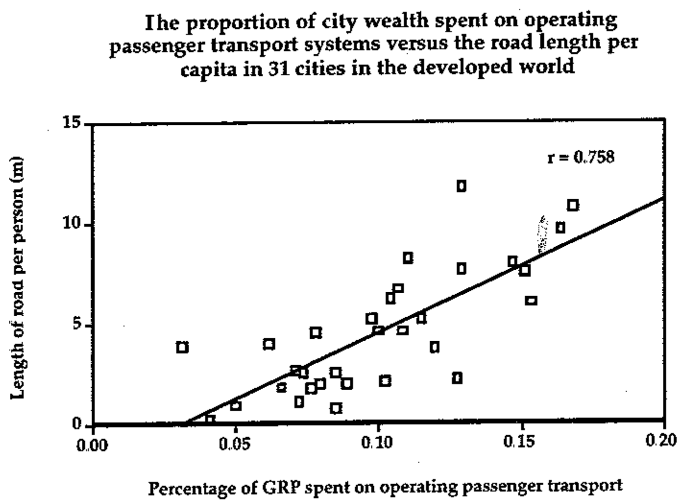

Figure 2.

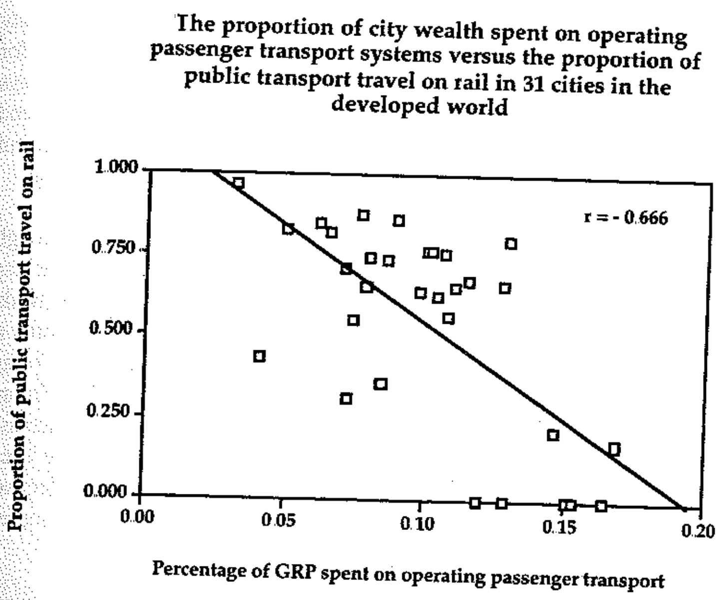

Figure 3.

The Culprit – Time Savings

Why are we finding that these approaches to funding transport are not working as they were expected to do? The models which we base our decisions on must be flawed. In particular the simple cost-benefit models which are applied (in isolation) to individual road projects without feedback effects within the urban system, seem to be totally inadequate. The biggest factor in the benefit column is time savings, followed by fuel and accident reductions. All of these require a bigger perspective on the way the city adjusts in its land use and transport priorities if they are to be assessed properly. But they are not. A road that permits a higher speed is seen to reduce congestion, hence it is seen to reduce time-loss, fuel and accidents (through eliminating or minimising intersections), but in the total view of a city, building bigger roads mostly leads to people travelling further as well as faster. It also shifts priorities away from other modes. The result is cities which have sprawled more and have induced more car use (and truck use). Data supporting these links are now widespread, some of these are provided below but are developed in more detail in Newman and Kenworthy (1999).

Yet the models do not help us to see these results of our spending. There is not even any follow up to assess whether the claimed benefits are ever actually found as a reality. The main supporting evidence that time savings are illusory is found in the many studies which have given rise to the theory of Constant Travel Time Budgets (eg Manning, 1978, Zahavi and Ryan, 1980, Neff, 1996). The constant travel time budget of an average half hour journey to work applies in every city no matter how it invests in infrastructure, and it was found in the

UK to apply to cities there over the past 600 years (SACTRA, 1994). The one great certainty in our data comparing cities around the world is that people do take around half-an-hour for the journey-to-work on average. Other studies have shown that essentially cities are always about "1 hour wide" regardless of how people travel, whether on foot or on high speed freeways (Marchetti, 1994). Thus the time savings claimed by the models are never real but are transferred into land use change which means people just travel further in the same time.

A confirmation of the fact that higher speed roads in particular induce more car travel through urban sprawl can be found in our data in the close correlation between density and car use (Figure 4). Thus all the cities on this graph take about the same time for people to get to work, but the amount of car use varies with how widespread the city has become. In other words if all cities have the same travel time then higher speeds must mean more distance is being travelled; the data in Figure 4 support that with higher car use linked to lower density. Figure 5 further supports this by showing how car use per capita increases strongly with an increase in the average speed of private transport. Such links between sprawl and car use have been shown before; but never has it been shown how this sprawl is not economically cost-effective. This can be seen in the correlation between density and the proportion of city wealth absorbed by transport (Figure 6); sprawling cities are car-dependent and expensive to operate.

Travel Time Comparisons

The importance of the constant travel time budget to understanding this issue cannot be understated. Despite the enormous commitment in US and Australian cities to 'saving time', the past quarter century of investment appears to have made no obvious gains in this area.

Table 2 demonstrates this quite clearly. Using detailed data for each city in the global survey it is possible to calculate the per capita hours of travel experienced in private transport, public transport and for total motorised travel (Kenworthy and Laube et al, 1999). This is done by dividing per capita passenger kilometres in cars by the average road traffic speed and per capita public transport passenger kilometres by the corrected average speed of the public transport system (all kerb-to-kerb speeds). Table 2 contains the results for the regional groupings of cities, along with the respective average speeds of the road systems and public transport systems.

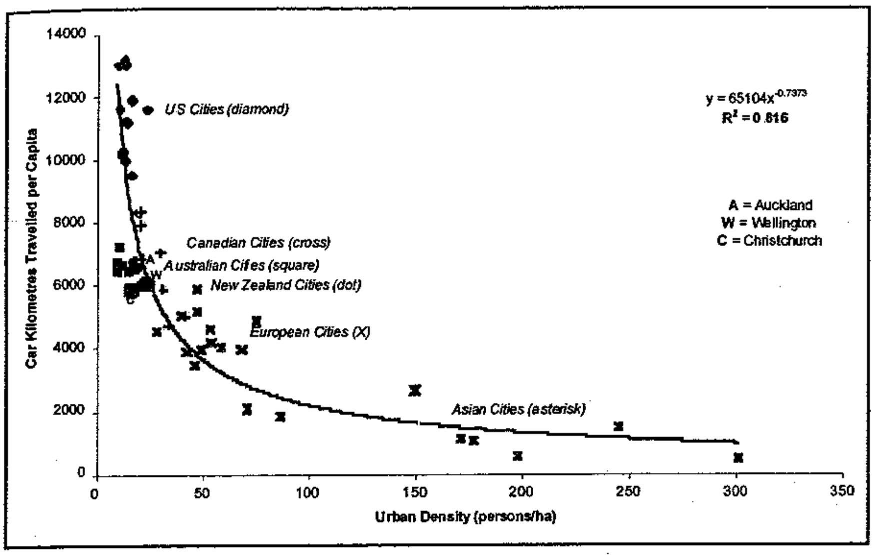

Figure 4. Car kilometres per capita versus urban density (1990)

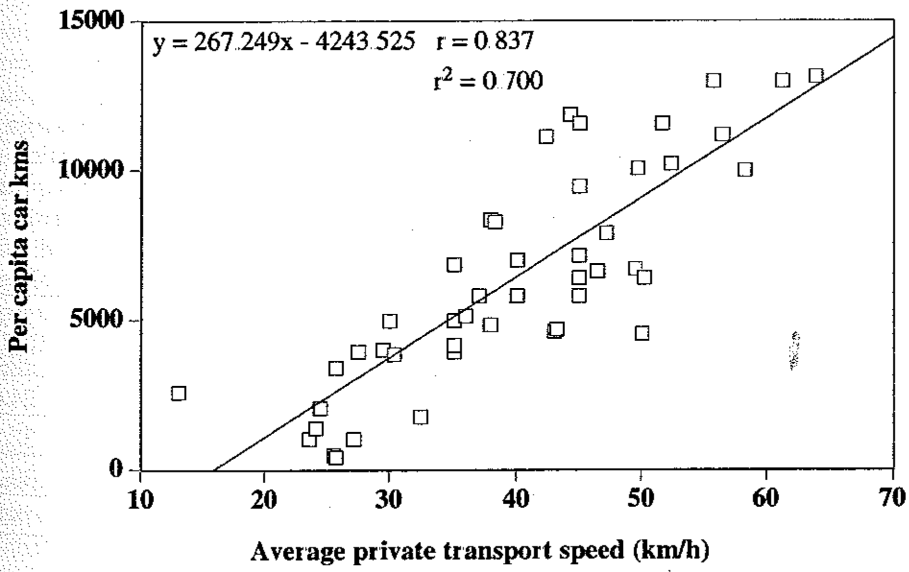

Figure 5. Car kilometres per capita versus private transport speed (1990)

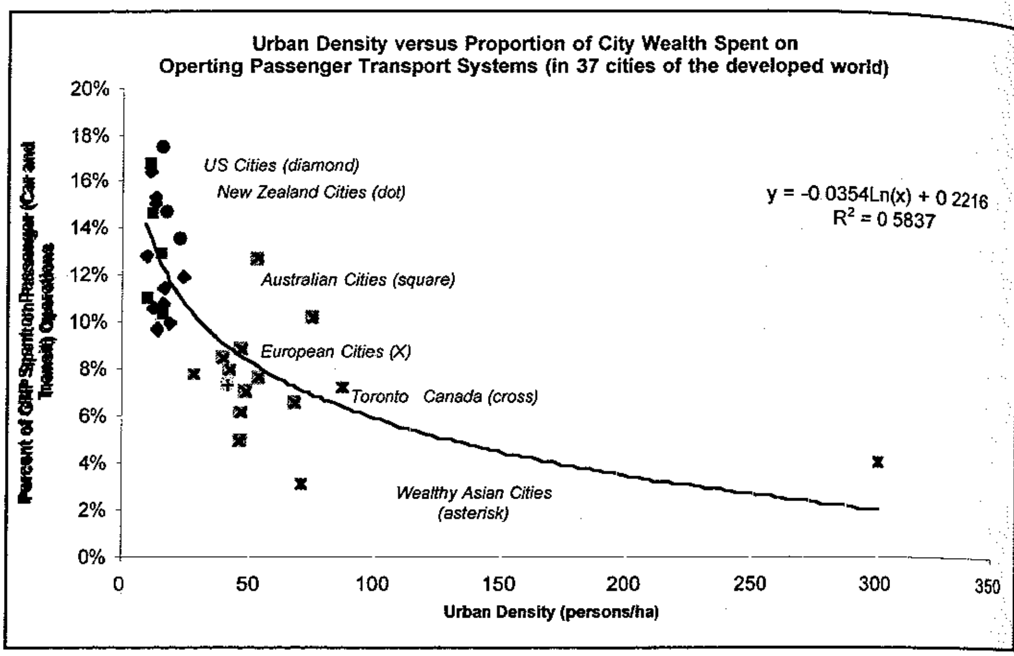

Figure 6.

Cities	Per capita hours in cars	Per capita hours in public transport	Total per capita hours of travel in motorised modes	Average road traffic speed (km/h)	Average public transport system speed (km/h)
American	314	17	331	51.1	27.8
Australian	237	29	266	45.5	30.5
Canadian	234	42	275	39.8	24.0
European	198	51	249	33.4	37.2
Wealthy Asian	87	131	218	27.5	30.7
Developing Asian	127	111	238	23.8	16.8

Table 2. Per capita hours of travel in motorised modes and average speeds in global cities, 1990

The results show that despite having the fastest road traffic systems, US city residents spend 331 hours per capita per year travelling (all purposes) and this is 20% higher than their closest rivals, the Canadian cities, followed closely by Australian cities. The data also show that, generally speaking, as the cities become more transit-oriented, the per capita hours spent in cars declines. By contrast, although per capita hours spent in public transport rise as the cities become focussed around transit, these extra hours do not equate to the lower hours spent in cars in transit-oriented cities. In other words, as cities become less auto-dependent, the total time invested in travelling in motorised modes declines. The average wealthy Asian city's resident spends only 218 hours per year in motorised travel which is 52% below the US city resident.

Ideally the data in Table 2 should incorporate the time spent travelling on foot and by bicycle. In practice, these data are almost impossible to get with any degree of reliability across so many cities. This is mainly because of the problem outlined earlier that the methods of transport planning focus almost entirely on motorised travel and in particular, the travel time "savings" possible for cars by building faster road links within the urban system. Walking and cycling in these terms almost do not exist within the computer-based models used in conventional transport planning.

Notwithstanding this problem, it can probably be argued that walking and cycling become more and more important for all trips as the cities become less orientated to cars. This is certainly shown in the modal split data for the journey-to-work for these cities which show the European and Asian cities average between 18% and 20% of workers using and foot and bike, compared to only 5% to 6% in US, Australian and Canadian cities (Newman and Kenworthy, 1999). As such it can be expected that all cities would increase in the hours spent travelling each year, but that the European and Asian cities would increase much more. **One would thus expect a levelling out of per capita hours of travel for all modes at around the 300-350 hours per capita in all cities. This figure, averaged across all days of the year, equates to about 58 minutes per person per day.** Other studies on constant travel time budgets have suggested between 60 and 66 minutes, so these global city data would appear to be in the right range (Schafer and Victor, 1997; Zahavi, 1989; Manning, 1978; Neff, 1996).

Quite clearly, it does not seem possible to actually save travel time in any city by building transport infrastructure that offers a higher travel speed *per se*. Rather, investment in travel time seems to be a physically determined constant and that populations divide their travel budget between the modes that are best provided for in the city or that offer the best service for each trip type. In this sense, if the aim is to produce a more sustainable city that uses public transport, walking and cycling for more trips, then the *relative speed between modes* rather than absolute speed of any mode is likely to be a key determining factor in mode choice. Nevertheless, building freeways and large highways that provide cities with higher absolute traffic speed, means that this relative speed term is pushed in favour of private transport and away from more sustainable modes.

A New Indicator for Sustainable Transport

The mood in transport policy has shifted inexorably to providing more sustainable transport through better vehicle technology and through approaches that reduce car use growth. This is seen to simultaneously improve the environment, the economy and the quality of community life in cities (Trans Scan, 1999). The question is how best to respond to this agenda. In particular, how can we provide transport infrastructure which shifts travel patterns away from car use growth? It is no longer possible to use time savings per se as the indicator or focus of all the cost-benefit analyses. We would suggest that a preferable indicator is the relative speed of public transport (transit) to traffic.

The basis for suggesting this indicator can be seen in Figure 7 which shows how the cities with the highest transit to traffic speed ratios have the least proportion of their city wealth accounted for by passenger transport

The relative speed of transit to traffic is obtained by calculating the average kerb-to-kerb speed of all public transport operations in cities (properly weighted) and comparing it to the 24hr/7day average road traffic speed across all road categories. Its value is that it can show how a decision on transport improves or detracts from this ratio. As suggested above, this indicator implies that cities need not become faster in absolute terms in their travel, but rather that transit needs to be faster than the prevailing road traffic speed. In this way cities can gain in terms of their economies (less costs of travel overall), have much reduced environmental impacts (confirmed in data on all parameters such as CO_2, smog emissions, land loss) and reduced community impacts (less road accidents, reduced severance and so on); this is developed further in Newman and Kenworthy (1999).

The variations in this parameter can be analysed further by considering its regional patterns (Figure 8). In the US/Australian cities the speeds are 48 km/h for traffic compared to 29 km/h for transit. In the European/wealthyAsian cities the speeds are 30 km/h for traffic and 34 km/h for transit. The difference seems to be that the latter groups of cities have good rail systems. Rail gives a competitive advantage to transit which buses caught in traffic do not. Giving public transport a competitive edge requires that it compete in speed, that is where time 'savings' can mean something on a city-wide modal split basis. The difference is dramatically illustrated in the poorest Asian cities where there are very low traffic speeds (24 km/h) but even slower transit (17 km/h).

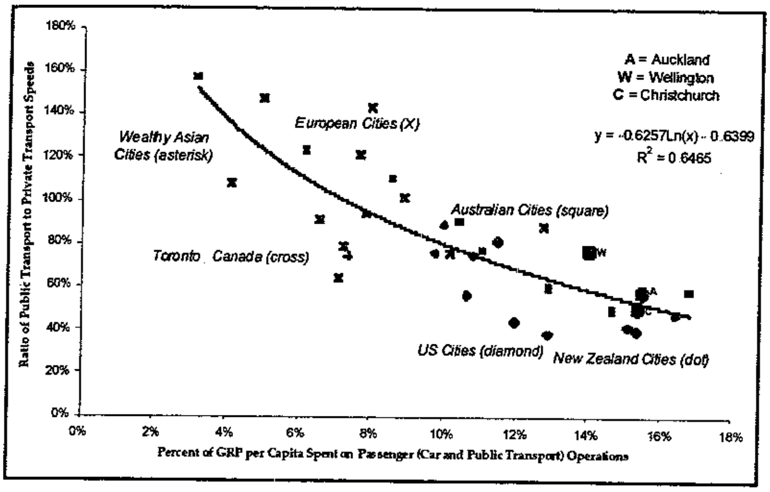

Figure 7. Public/private transport speeds and % GRP spent on total passenger transport operations, 1990 (excluding developing Asian cities).

Table 3 shows the regional averages and some selected cities in terms of speed for each motorised mode and our new indicator of the relative speed of transit to traffic. It shows very clearly that where the indicator is low, the cities have no rail (or very little rail), but where the indicator is high, the cities have good rail systems.

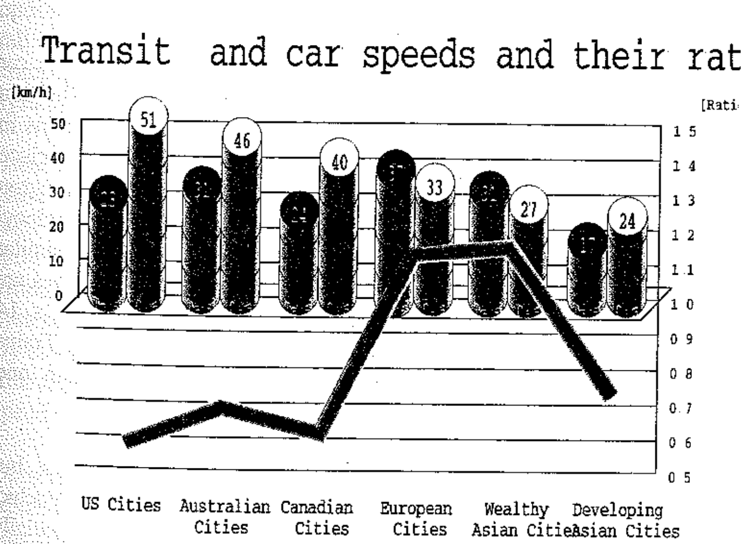

Figure 8. Public and private transport speeds and their ratio by city groupings, 1990

Cities	Average speed (km/h)			Relative speed of transit to traffic
	Car	Train	Bus	
US cities (av.)	**51**	**37**	**22**	**0.55**
Houston	61	..	24	0.39
New York	38	39	19	0.89
Australian cities (av.)	**45**	**35**	**25**	**0.67**
Perth	45	34*	25	0.58
Sydney	37	42	19	0.91
Canadian cities (av.)	**40**	**33**	**21**	**0.60**
Ottawa	40	-	24	0.60
Vancouver	38	42	20	0.67
European cities (av.)	**33**	**41**	**21**	**1.11**
Copenhagen	50	59	24	0.94
Zurich	36	45	21	1.24
Wealthy Asian cities	**28**	**40**	**17**	**1.12**
Tokyo	24	40	12	1.58
Poorer Asian cities (av.)	**24**	**37****	**15**	**0.71**
Bangkok	13	34**	9	0.70
Seoul	24	40	19	1.07

Table 3. Average speed by mode and relative speed of transit to traffic in global cities (regional averages and selected cities, 1990).

* Before the full electrified rail system. Rail system speed is now 51km/h with the northern suburbs line considerably above this

** Have very small and mostly older, slower rail systems

In particular, the bus-only cities of the US, Australia and Canada provide little incentive for car users to switch to transit. On average, transit speeds in these cities are 20 to 25 km/h. The data show that only the rail option can compete with cars as the average speed of urban trains in selected cities where rail systems are significant are close to that of cars (eg San Francisco trains 43 km/h and cars 44 km/h; Chicago trains 46 km/h and cars 45 km/h; Washington trains 39 km/h and cars 42 km/h; New York trains 39 km/h and cars 38 km/h). In Sydney, train speeds exceed average car speeds by 5 km/h and in Europe the contrast is similar (average train speeds of 41 km/h and car speeds of 33 km/h). Train speeds in Asian cities are extremely competitive with cars (eg Singapore's trains are 8 km/h faster, Hong Kong's 14 km/h faster, Tokyo's and Seoul's trains are 16 km/h faster than average road traffic). Trains are also a lot faster in developing Asian cities where the services exist (Newman and Kenworthy, 1999; Kenworthy and Laube et al, 1999).

Tram speeds are generally much lower than trains and sometimes are lower than buses, but they act usually as distributors in central areas, linking in to the major train stations (Vuchic, 1981), and they typically operate in inner areas with very high passenger loadings especially compared with buses. New light rail systems have much higher speeds (eg San Diego 35 km/h, Portland 32 km/h and Sacramento 31 km/h), but they are still slower than the older heavy rail systems in US cities (Newman and Kenworthy, 1999; Kenworthy and Laube et al, 1999).

It is also interesting that the average speed of buses in US, Canadian and European cities is a fairly stable 21-22 km/h; Australian cities are a little higher at 25 km/h but this is only due to Canberra's low traffic density busways which give it an average speed of 34km/h. In Canadian cities, Ottawa has busways but this raises its transit average speed to only 24 km/h. These are remarkably constant figures, considering the enormous diversity in urban conditions in these cities. In the very much denser and congested Asian cities bus speeds drop to 15 km/h, with Bangkok as low as 9 km/h. It would thus appear that, in general, bus-based public transport systems seem to have an in-built limit on operating speed of no more than about 25 km/h, unless in rather exceptional circumstances, and thus they cannot be considered genuine competitors in speed to the car in any city. Even in Canberra, average car speed is 15 km/h higher than its bus system and in Ottawa it is 16 km/h higher.

It could be concluded that any city seriously wishing to try to change the private car/public transport equilibrium in favour of public transport, must move in the direction of electric rail-based transit systems. Only in this way can a city begin to compete with the car in the most basic travel choice factor of all: speed. This is the kind of change occurring in many cities (examined in Newman and Kenworthy, 1999) which have considered that a move towards a rail spine for their transit system provides the most promising means of boosting transit use and reducing car mobility. Busways are often seen as a major boost for transit, but in our data they are not as successful as rail options and in our experience are often used to stop rail options being built. There is little evidence supporting the contention that buses can do what rail can do and a lot of evidence supporting our contention that a city can only have a competitive transit system when it has a fast rail spine along corridors and a good feeder bus system.

Some evidence in our own city demonstrates this. The revamped and considerably faster Perth electric rail system has had spectacular growth in patronage over the past 7 years, especially with the opening of the Northern Suburbs railway. The data in Figure 9 show how this growth has occurred in comparison to the slower Adelaide diesel rail system which has stayed virtually static during this time. The difference would appear to be that Adelaide's old diesel system is just not competitive in time as well as not going where it can compete with the car. By contrast, in Perth for the first time it is now possible to move along the rail corridors in a time that is competitive with traffic speeds. The Northern Suburbs line has an overall average speed of around 60 km/h and even higher for peak period express services.

Despite the clear success of the Northern Suburbs rail system which now carries the equivalent of 6-lanes of traffic at peak times, the decision to build this was mercilessly attacked by the Industry Commission report on Urban Transport (Industry Commission, 1994). The decision was portrayed as being purely political, yet no mention was ever made of the fact that the present approaches to transport infrastructure funding have ensured that most public transport investment has little other way of being addressed. The funding system in this case ensured that the freeway which contains the Northern Suburbs railway was a Federal grant, whereas the railway had to be a State loan. A funding system which incorporated an indicator of relative speed of transit to traffic would have been more able to recognise the ultimate value of the rail system to Perth's northern corridor.

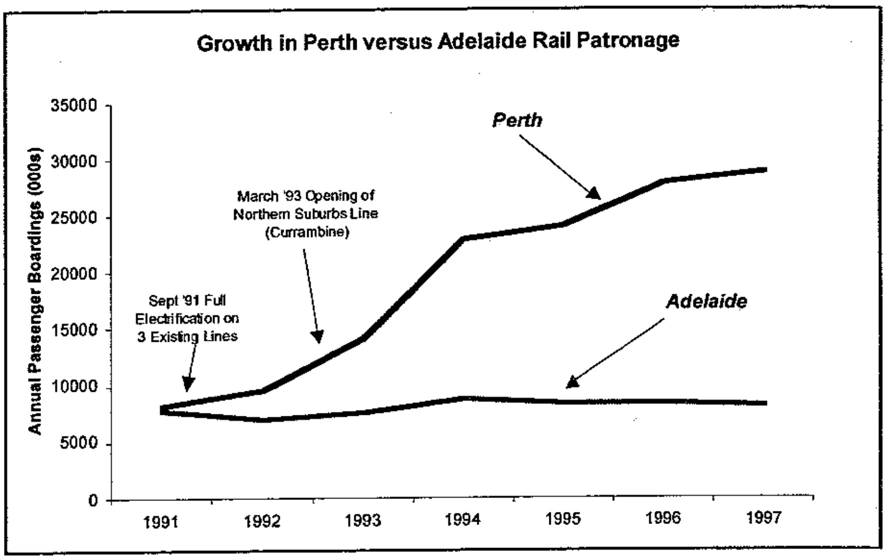

Figure 9. Perth and Adelaide rail patronage, 1991-1997

Involving the Community

It is little wonder that in the US a new approach to assessing transport investment is emerging. New models are being built and at the TRB conference this year a whole session on 'time savings' recognised that this goal of the modellers which has been the basis for much of the world's road investment, may indeed be illusory. But of greatest significance is the new approach in the US to transport decision-making which is to require by law the involvement of the community in transport planning (Transportation Equity Act -TEA 21, the successor to the original ISTEA legislation or Intermodal Surface Transportation and Efficiency Act). There are no longer road funds but transport funds and they can only be spent to fulfill the goals of the local community expressed in their regional plans. This is in stark contrast to half a century of Highway Trust Fund money applied almost exclusively to freeways in the USA. There has been an inexorable shift in funding towards the more sustainable modes. Community values seem to be shifting transport towards a higher relative speed for transit over traffic, eg in California only 14% of people still believe freeways solve congestion and 35% support rail options (Franz, 1989).

In Australia, we are still dominated by an archaic system of transport decision-making that does little to recognise either the poverty in the 'time savings' approach or the importance of reflecting community values and their desire for a higher relative speed of transit to traffic. The evidence from surveys shows that the public would indeed shift transport spending away from freeways and towards quality public transport options. The political processes in the Northern Suburbs rail decision were merely a reflection of a community that were determined not to have foisted on them a second rate bus option, but who clearly wanted a fast rail option. Their choice has been exonerated. Perhaps they know something the experts are missing. A more democratic approach to transport decision making is not often available in Australia but it would seem important to reflect community values at a time when the models for transport investment are clearly not working.

Conclusion

'Time savings' has been shown to be totally elusive in urban transport and should be abandoned as the basis of cost-benefit analyses. Not only are time savings illusory, but when used to build major highways, have become the basis of car dependent land uses that are very costly in transport terms.

An alternative approach has been suggested that incorporates a new indicator of the relative speed of transit to traffic. This indicator appears to be more reflective of the mood to shift towards more sustainable cities (i.e. cities that are simultaneously reducing their energy use, sprawl and emissions whilst improving their economies) and to be more oriented towards community values. A transport system that makes decisions in a more democratic way will need an indicator like this to help it in future infrastructure priorities.

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