PUBLIC TRANSPORT AND TRAFFIC ENGINEERING

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ABSTRACT: *The Victorian Government's Transport Policy places a heavy emphasis on the upgrading of public transport to provide a level of service responsive to demand and at a cost which the community can afford. The challenge issued to the Managers of the public transport sector to bring existing services and practices into line with current community, technological and cost recovery standards is daunting. It has, however, been taken up and part of the programme to improve tram and bus services involves innovative traffic engineering solutions to overcome the present on-road operational problems which are delaying and disrupting services. This paper examines a number of these treatments, their cost, effectiveness, and other operational characteristics. A number of further opportunities to extend current practice through low-cost traffic management techniques, such as traffic signal priority measures are also discussed.*

It is apparent that traffic management has not in general been responsive to the needs of public transport in a time when services were being adversely effected by the impacts of other road users and whilst rider patronage was deteriorating. Redress of this situation should be an important feature of current transport planning and examples are discussed in which public transport operational improvements can be achieved without significant impact on other road users.

INTRODUCTION

The Road Traffic Authority is currently implementing a program of route based traffic management improvements with the objective of reducing delays and improving the on-time running of road based public transport. The initial phase of the program known as the "Fairway" Project aims to redress the decline in operational performance, of the unique tram service, which has occurred over the last decade. In general the increase in delays and the variability of delays has been observed to be related to the network wide increase in congestion, particularly during peak hours.

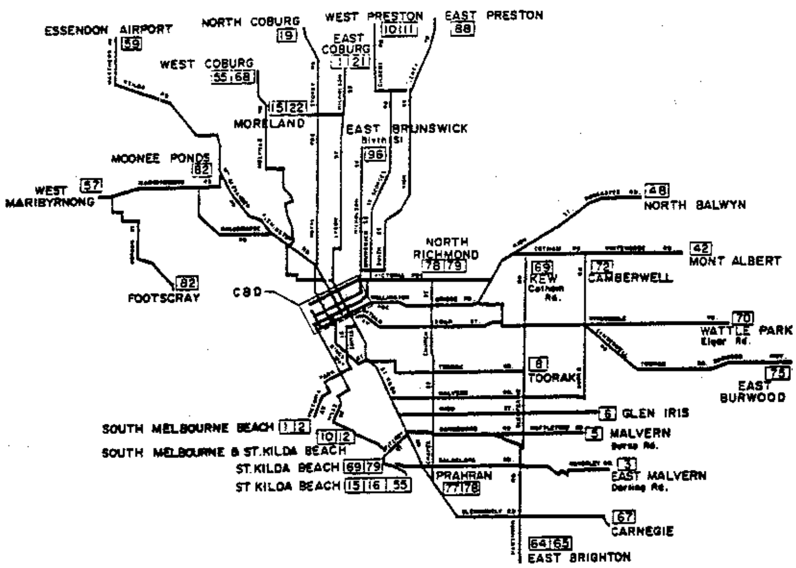
The tram network in Melbourne is one of the largest in the world with over 250 route kilometres (see figure 1) and a number of minor extensions now being built or at the advanced planning stage. At present approximately ten percent of the tram network operates in a reserved right-of-way with minimal friction with other road users. The significant majority of the network is located along standard four lane (including the kerbside parking lane) roads where trams compete with the full range of road-users for the available road space.

Trams, because of their physical and operational characteristics, have been effected considerably by previous traffic engineering practices that tended to consider the movement of vehicles without sufficient attention being given to the "people and goods" factors.

The RTA Fairway Project is therefore a conscious departure from the more traditional traffic management techniques and seeks to develop and implement low cost, innovative measures that assist tram operations at high delay sites. The requirement that Fairway treatments are low cost is based on the fact that as the major proportion of the tram network is located in the older, established inner and middle suburbs of Melbourne, opportunities for larger scale improvements are generally not economically justified nor socially and environmentally acceptable.

The tendency is for projects to be directed at minimum roadwork solutions with complementary traffic signalling facilities that improve tram operations with little or no disbenefit to other road users. The techniques used to address the complex issue of improving the level of service provided by trams was practical and expedient and offers a good model that has wider traffic management applications.

In adopting a route based approach to the project Traffic Managers were able to use "critical intersection" matching techniques whereby improvements within a sub-system were balanced to provide consistency of operation along a route. This practice assisted in avoiding over designs and maintained attention on the key delay sites.



MELBOURNE TRAM NETWORK FIG 1

MAKING A START

Information relating to the nature and site specific extent of delays to trams was at the start of the Fairway Project almost non-existent. An assessment undertaken by the Metropolitan Transit Authority, which reported route travel times, indicated that 1982 running times were longer than in the pre-war period, despite modern rolling stock, upgraded track and signalling/communication systems and other improvements designed to increase the level of service and amenity, provided to the public.

As a consequence, the Government established a Working Party with representation including officers from RTA, MTA and the Tram Drivers Union. Two separate areas of investigation were developed by the Working Party; one to prepare guidelines to be used by traffic design engineers involved in determining short term treatments of tram routes and the other a subjective listing of high delay sites where larger scale treatments were considered to have a priority status.

The methodology used in relation to the latter investigation area was in recent traffic engineering terms in Melbourne unique, but very successful. Through the Tram Drivers' Union representative on the Working Party, it was arranged for tram drivers at each of the regional depots to identify and prioritise those sites on tram routes (serviced from a particular depot) which represented the biggest delay problem. All drivers were encouraged to consider and nominate intersections and through the co-ordinating work of MTA officers and the Working Party Union Representative a single listing of high delay sites was produced for the entire tram network.

The listing which became known as the High Profile Sites formed the basis of further subjective assessment methodologies to determine broad priorities for works programming. The next phase in the process involved an experienced RTA Traffic Engineer, an MTA Operations Officer and the Working Party Union Representative visiting each site to make preliminary estimates based on available data of the appropriate treatments that could be implemented and the benefits that would be achieved.

This process which was by design very broad in its approach resulted in the High Profile Sites being assessed in terms of cost, benefits and difficulty of implementation. The sites that were identified as having high relative benefits, low costs and no implementation difficulties became the initial group of sites for more formal investigation and evaluation. It is noteworthy, however, that the methodology employed produced a practical result in terms of agreed sites for investigation and remarkably few locations were subsequently rejected due to significantly incorrect subjective assessments of either cost or benefit.

TREATMENT IMPLEMENTATION

The Working Party produced recommendations covering three separate areas, each aimed at improving tram services. These were:

(i) Proposed new road traffic regulations which established 'tram only' lanes during certain times of the day and restricted turning movements across tram tracks;

(ii) Guidelines for the application of priority measures using facilities at traffic signals and the provisions of the new regulations; and

(iii) The prioritised listing of High Profile Sites referenced above.

Details of the new road traffic regulations and a description of the typical treatments contained in the Fairway Project Guidelines are given in Daff and Saggers (1984) and Piper and Cornwell (1984). It should be noted that through experience gained with practical application of these provisions, there have been some changes to both the regulations relating to tram only lanes and their use. The principles and operational detail are, however, unchanged.

In October 1983, the first Fairway treatments along the North Balwyn Route were implemented covering 10.3 kilometres of tram route. The details of this route based approach to road space management are documented in Howie and Daley (1984). In summary, the North Balwyn route Fairway comprises of:

(i) 4.5 km of peak time tram only lanes generally on the approaches to congested signalised intersections;

(ii) Some 1.3 km of full time tram only lanes; and

(iii) Selective vehicle detection for trams at 13 signalised intersections to enable trams to call and utilise special signal priority features.

During 1984 a further two routes were treated and extensive traffic surveys completed to measure the effectiveness of the implemented improvements. The results of these surveys are summarised in Tables 1 and 2.

TABLE 1 : TRAVEL TIMES OF TRAMS IN PEAK DIRECTION/PEAK HOURS

	ROUTE (11 KM)		Mean Travel Time (min)		
			Before	After	% Differ.
TRAM	E. Preston	a.m.	37.1	35.0	-6*
		p.m.	28.8	27.0	-6*
	W. Preston	a.m.	34.7	31.2	-10*
		p.m.	34.2	31.0	-9*
CAR	E. Preston	a.m.	29.0	27.0	-7
		p.m.	33.1	32.7	-1
	W. Preston	a.m.	26.6	24.8	-7
		p.m.	25.7	25.4	-1

TABLE 2 : CAR TRAVEL TIMES ACROSS FAIRWAY ROUTES

(peak direction/peak hour)

Route		Mean Travel TIME (Min)		
		Before	After	% Differ.
Johnston	a.m.	3.36	2.00	-41*
	p.m.	2.68	2.56	-4
Separation	a.m.	5.61	4.90	-13*
	p.m.	5.14	5.26	2
Bell	a.m.	4.01	4.52	13*
	p.m.	4.46	4.16	-7

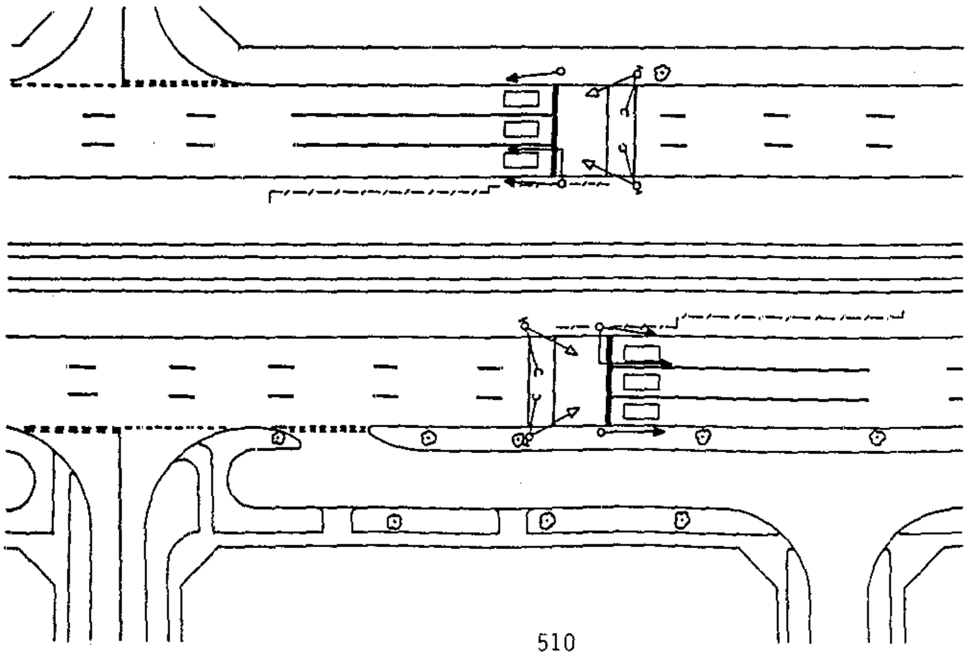
* Significant at the 95% level

In general it can be seen from the above tables that the package of Fairway treatments implemented along the East and West Preston tram routes were successful in reducing tram travel times. The impact of the treatments on other road users varied considerably; however, at three critical sites along the routes it can be seen that benefits were also provided to private car users. This is in the main thought to be due to the improvement in tram running times and responsive traffic signal operations which also assist other road users otherwise delayed by the stop-start movement of trams.

More importantly than the above overall improvements in tram travel times was the reduction in variations in running times. The North Balwyn route showed a 20 percent reduction whilst the figures for the Preston routes were slightly higher.

The implementation of improvements requiring roadworks at significant traffic signal remodelling naturally lagged the Fairway treatment schedule. The need for more extensive design and evaluation phases meant that at some sites temporary treatments, or possibly the status quo, had to be maintained until the proposed improvement could be installed.

Safety zones which provide a physically protected waiting area for passengers were installed at a number of sites along the boulevard style roads many in conjunction with "Split Pedestrian Operated Signal" treatments (see Figure 2). The features of safety zones are that traffic, except trams and in some instances buses, must pass to the left of the protected centre of the road tram stopping zone. Typically, safety zones are implemented on the approach side to a signalised intersection or pedestrian signal where there are two clear moving traffic lanes between the kerb and the zone. They reduce delays to trams because other vehicles tend to queue off the tram tracks and give trams an unimpeded path to the stop.



SPLIT PEDESTRIAN OPERATED SIGNAL TREATMENT FIG 2

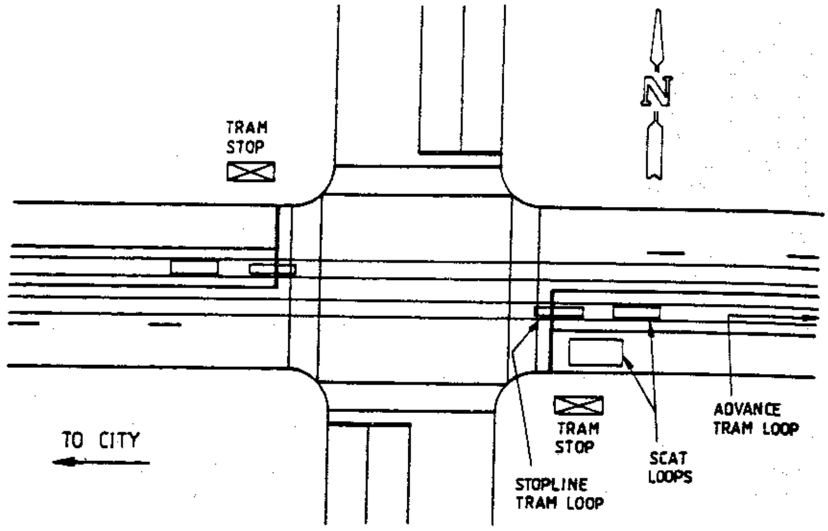
The Split Pedestrian Operated device controls non-tram traffic through normal signal practice, but allows trams free movement by not providing control of the middle carriageway where trams operate. Pedestrian movements in this area contend with only the relatively few conflicts presented by the arrival of a tram. A further benefit of the Split Pedestrian Operated Signals device is that signal co-ordination is enhanced by the separation of pedestrian movements across the roadway.

Traffic signal remodelling along Fairway routes involves the provision of active tram priority using the features of the dynamic signal system SCATS. In most instances the remodel requires a new intersection controller, additional signal hardware (lanterns etc.) and supplementary detector loops, some activated only by trams.

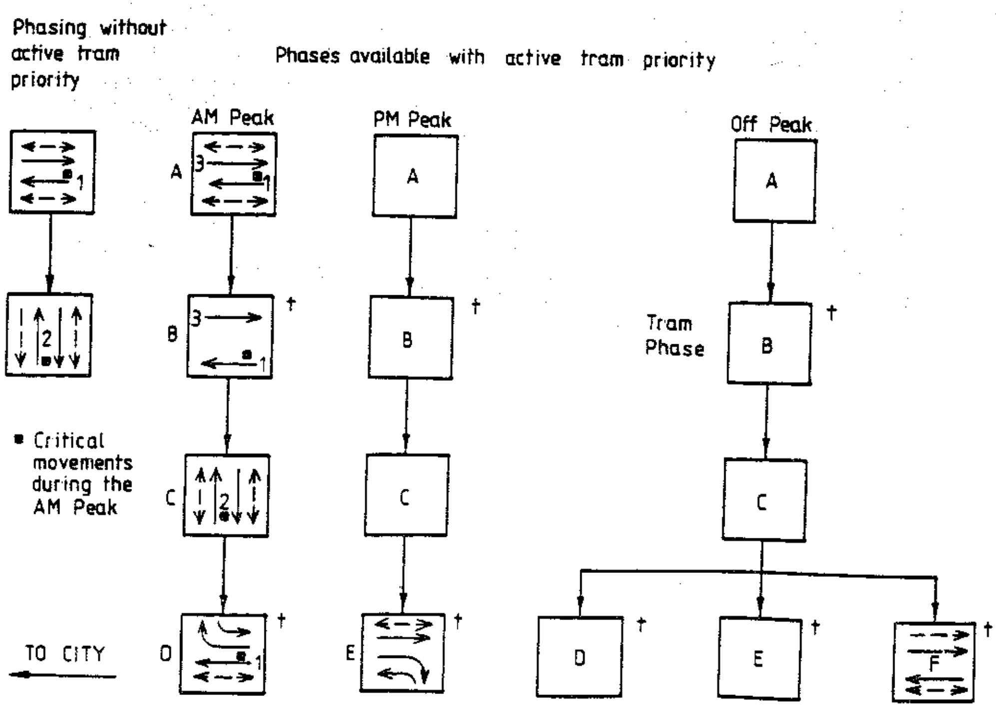
Figure 3 details the most common intersection layout currently existing along the tram network, featuring shared use of the centre lanes, nearside tram stops and in the majority of cases kerbside parking is available. Traffic signal phasing to provide tram priority requires optional phase selection and special movement phases for trams, some dependent on time of day. (See Figure 4.)

The tram only, or tram motivated, phases are called by means of an active transponder mounted on the chassis of the tram which activates a receiver/decoder installed inside the traffic signal controller. The front end of the receiver is a loop antenna and is installed in the same fashion as normal vehicle detector loops. Sin (1984) provides a full description of the investigation and adoption of a selective tram detection system currently used in Melbourne. It is not possible to separate from the results of the surveys undertaken along Fairway routes, the measure of benefits which are provided by the various elements of the treatment package. Most observers agree, however, that a significant proportion of the total benefit is derived from the improved traffic signal priority features including the introduction of SCATS.

The sites requiring physical changes to the carriageway, ie road widening or improved intersection treatment are each assessed on merit and evaluated in terms of the impacts on safety, than operations and other road users. Two typical examples of recently implemented treatments are detailed in the case studies below:



TYPICAL INTERSECTION LAYOUT FIG 3



† Phases: B (Tram extension), D & E (Tram leading turns), & F (Tram Early Start) are called by tram only

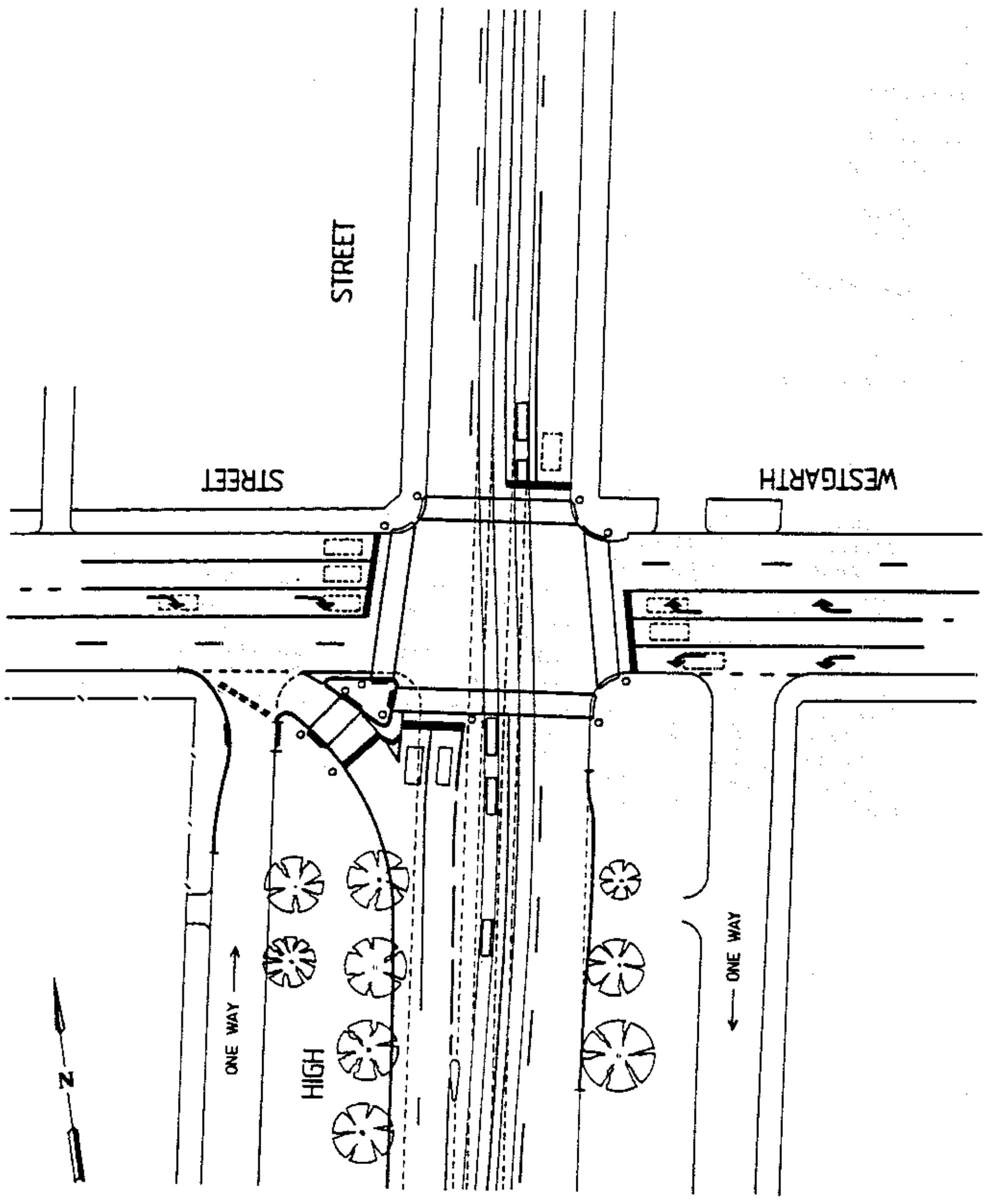
TYPICAL ACTIVE TRAM PRIORITY MEASURES FIG 4

Case 1:	High Street/Westgarth Street, Northcote (See Figure 5)	
Treatment:	Intersection improvement to provide a safety zone on south approach with left-turn slip to cater for high volume strategic movement (South to West) during pm peak period. Tram track relocation was required.	
Cost:	$191,000	
Performance Measures:	BEFORE	AFTER
Degree of Saturation		
A.M. Peak	1.00	0.85
P.M. Peak	1.12	1.05
Average Vehicle Delay		
A.M. Peak (Righ Lane -(sec))	104	17

Discussion

The implemented treatment has had a significant impact on the operational performance of the intersection and provided relief from the previous congestion for trams (and other road users). During the morning peak the average vehicle delay for peak direction movement in the lane containing the tram tracks dropped from 104 seconds to 17 seconds and queue lengths in the kerbside lane were at the same time reduced by approximately 30% (172 metres to 116 metres). In the evening peak period, the improvement provided for trams was quite dramatic. The installation of the safety zone, together with a tram (and bus) only approach lane allows these vehicles unimpeded movement on this section of road and hence the previous delay to operations caused by congestion is eliminated. A marginal improvement in the theoretical degree of saturation of the intersection was also achieved to benefit other road users.

FIG 5



INTERSECTION TREATMENT WESTGARTH ST / HIGH ST

Case 2:	Montague Street/Park Street, South Melbourne (See Figure 6)
Treatment:	Intersection improvement to replace Stop Sign control with roundabout treatment incorporating kerb extensions, tram safety zones and tram movement through the central island.
Cost:	$85,000

Performance Measures:	BEFORE	AFTER
Delays to Trams		
Park Street	21	NIL
Montague Street	10	NIL
Accidents		
1983	8	
1984	4	

* No accidents reported in four months following treatment implementation

<u>Discussion</u>

The intersection of Park Street and Montague Street experienced significant problems in terms of traffic management under the former stop sign control. Montague Street with a kerb to kerb width of 13.2 metres and having a long uninterrupted length with all intersections controlled to give it priority by Stop or Give Way signs was a source of concern, particularly on safety grounds. The intersection with Park Street had an adverse accident record and trams experienced extensive delays in making their turning movements into and out of Montague Street. Tram drivers complained regularly about the hazards associated with moving a large and slow moving vehicle (the tram) into and out of Montague Street. It was also felt that passengers boarding and alighting in Montague Street were exposed to risk as a result of the fast moving traffic.

The installation of the roundabout incorporating safety zones on the approach splitter islands has also provided a landscaping opportunity which incorporates angle parking to service commercial premises.

Following the introduction of the new regulations that provided trams with priority over all other vehicles in a roundabout, a number of innovative designs incorporating tram movements through the central island were installed with considerable success. In the case of Montague Street/Park Street, the roundabout solution has proven most appropriate, acting as a speed control measure along Montague Street, addressing the previous accident problem and providing much improved operational conditions for trams.

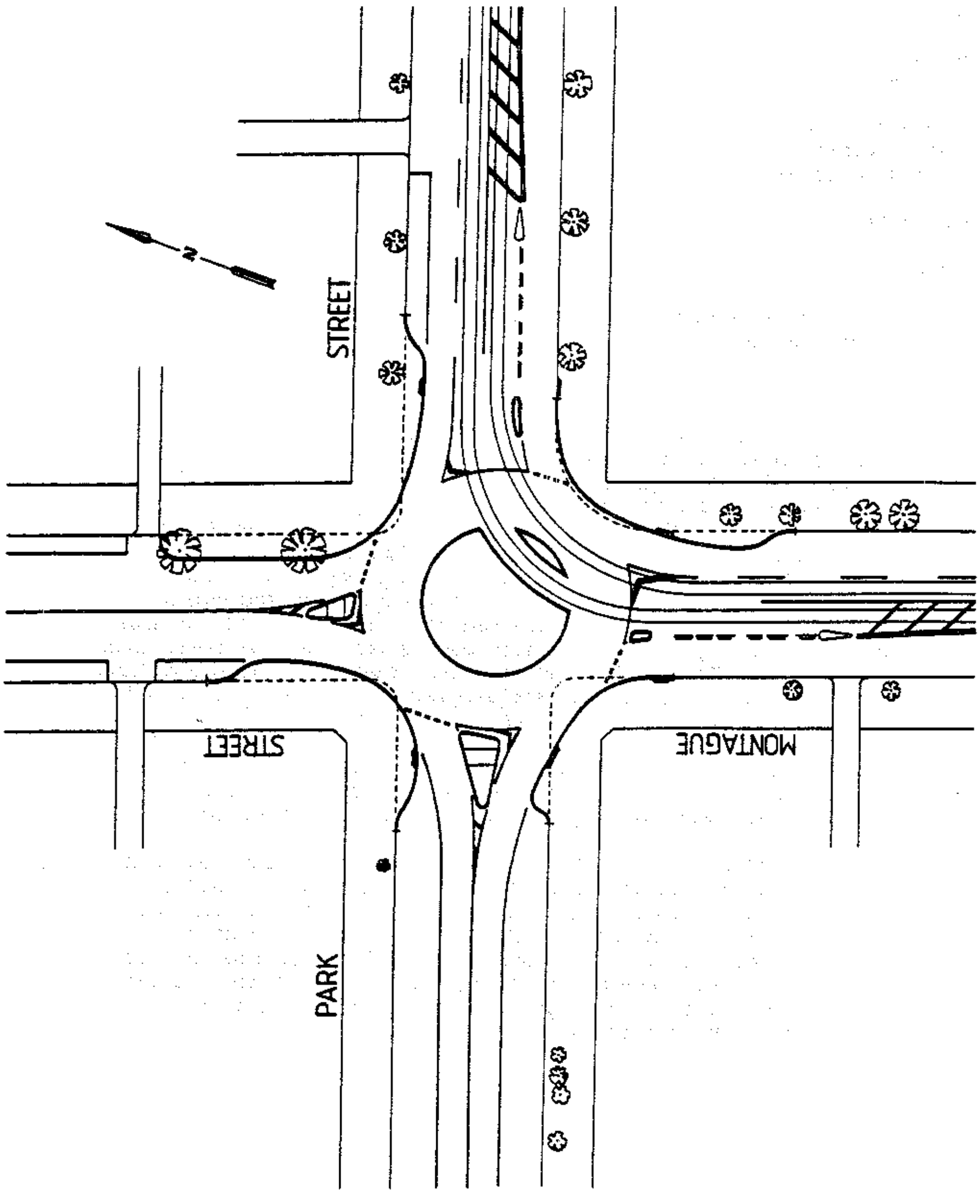


FIG 6

INTERSECTION TREATMENT MONTAGUE ST/PARK ST

CURRENT DEVELOPMENTS

The opportunities presented through modern technology to provide further improvements for public transport are extensive and should be pursued. Two relatively cheap but effective enhancements now in development are outlined below:

(a) Bus Lane Enforcement

Exclusive bus lanes provide buses with a high level of priority and have gained wide acceptance throughout the world. As a public transport priority measure bus lanes have proven effective, cheap to implement and maintain.

In congested traffic conditions, where exclusive lanes are most useful, the temptation for private vehicle road users to take the opportunity to (illegally) use the bus lane is high. Enforcement of exclusive use lanes is generally not high, policing agencies do not as a rule regard enforcement as a priority task, and the perceived benefit to the motorist is significant. Accordingly, violations of bus lanes provisions are common and unless the risk of being penalised for use of the lanes is high, or the actual penalty severe, delays caused by other vehicles will continue to impede bus movements.

The problem in Melbourne, along Johnston Street where peak period bus lanes have been installed has been addressed using simple, commercially available technology. A red light traffic violation camera has been modified to be used as a bus lane enforcement device. The camera has been mounted adjacent to the kerb in the footpath and operates using inputs from special purpose, time of day activated detector loops. A detector logic strategy has been programmed into the controller unit such that buses with their physical characteristics do not activate the camera, but cars will be photographed to provide registration numbers, etc. A trial application of the technique proved operationally sound and a full scale implementation project involving four cameras is now being conducted. Back-up legislation to enable prosecutions of offenders has been introduced and it is expected that the system will prove highly effective in reducing the number of lane violations.

(b) User Information Services

Waiting time at a stop for vehicles is recognised a key factor in public transport operations and service attractiveness. At the present time little information is provided (in Australian networks) to waiting passengers on the approach of a vehicle either in the form of its destination or expected time of arrival. In regard to the road network where advanced technology traffic signal systems are utilised an opportunity has been identified to improve this current situation.

In Melbourne, where trams are already equipped with selective detection units, a relatively simple enhancement to the existing SCATS features could be introduced to enable information to be provided to passengers waiting at stops further along tram routes. Initially, it is expected that time of arrival advice will be provided at key interchange stops where the route approach site distance is limited. However, this can, it is believed, in the short term be extended to detail route information and thereby provide a service enhancement.

CONCLUSION

Public transport provides an essential community service which requires in almost every city large operating subsidies to cover costs. The Melbourne experience shows that over the past decade the decline in passenger usage of public transport is in part linked with dissatisfaction over the level and reliability of services provided.

The Fairway Project and the other initiatives presented in this paper are part of a Government Strategy to improve the attractiveness of public transport and raise its effectiveness in the total city transport plan. It has been demonstrated that low cost-high benefit improvements can be implemented to reduce the average delay and variability of running times for public transport vehicles. Importantly, it is apparent that through the use of the new technology traffic signal facilities such as in SCATS, improvements to public transport vehicle operations can be achieved without general reductions in the level of service provided for other road users.

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