Introduction

Western Australia is pursuing a strategy that aims for a balanced approach to transport provision and use; a switch from car dependence towards demand management which provides for transport choice. A 'balanced transport system' is defined as one that moves away from a transport system dominated by low occupancy car travel towards a system in which public transport and non-motorised options are feasible for many trips.

Land use and development planning have a key role to play in the package of measures put forward in the strategy. It is important to ensure land use and development are accessible by all modes of transport and one means of achieving balanced transport provision is through better integration of land use planning and transport. This is in part expressed through the actions of planners and urban designers in creating "liveable neighbourhoods", a planning concept more commonly termed "new urbanism". Such places are designed at a scale and form that favours pedestrians and cyclists, and provides interconnected streets for better public transport accessibility.

New urbanism as an approach to land use development has been evident in the town planning arena for just over a decade (see for example AMCORD – the Australian Model Code for Residential Development, 1989; VicCode- Victoria; Liveable Neighbourhoods - Community Design Code for Western Australia, 1997; Shaping Up – Shaping Urban Communities to reduce car dependency in Queensland, 1998). Brindle (1999) notes that this new approach questions the dominance of road safety as a major influence in development plans. It is true that the new urbanism approach challenges the conventional road safety wisdom, but planners and urban designers argue that the new urbanism concepts do continue to provide for road safety whilst balancing this with the main aim of providing for a liveable and sustainable community.

New urbanist planners argue that in order to meet conventional vehicular road safety objectives it seems that urban design and liveability are being sacrificed. In the context of this conference theme then, the fear is that zero tolerance for the road toll may well mandate poor urban design in some circumstances, and thus create un-liveable neighbourhoods. This is because the key design features of conventional road safety guidelines promote a preference for tributary street layouts replete with culs-de-sac, a predominance of 3-way intersections, and limitations on direct property access. Such an approach can impede pedestrian, cycle and bus access in our residential subdivisions, and denude our local and district distributors of active frontages which can provide a safe and attractive walking environment. Road Safety Audits are now being proposed for subdivision design approvals yet the engineers who would undertake them are the ones promoting the automobile dominated standards that have taken over our street layout, design and intersection control methods.

The purpose of this paper is to promote a wider debate about the way forward. Is it possible to achieve the objectives of both groups, that is the goal of a liveable neighbourhood and of zero tolerance for the road toll. To enable this, the paper starts by highlighting the main objectives and approach put forward by those planning for road safety. Then the paper examines the main approach and objectives for new urbanism or liveable neighbourhoods as put forward by the Western Australian government. Using examples the paper examines the approach now being proposed for traffic management under new urbanism principles and highlights the key issues of concern in conventional road safety. It is argued that it is possible to achieve the objectives of both groups, there may however be a need for further empirical research to support the new urbanist traffic management approach. The prime means of achieving this is through greater multi-disciplinary working rather than a polarised debate. Furthermore, it may be that the main physical design concept that both groups should focus on is speed reduction as this can effectively result in the achievement of both groups' objectives. It is concluded that there are limits to the extent to which physical design can achieve zero road toll, changing attitudes and behaviour may ultimately be the most valuable approach.

Planning for Road Safety – the Conventional Approach

Brindle's paper (1999) provides a useful summary of the conventional approach to planning for road safety. He points to guidelines spanning a half century (1940's to 1980's) on the road safety aspects of town layouts and design, he notes that they are 'familiar as long standing 'good planning practice'". These guidelines cover network planning and street function, access management, road design (street cross sections), intersection control, provision for pedestrians and cyclists, area wide traffic management and land use location. They have promoted a range of practices that have become the mainstay of conventional traffic management, the key features include:

- Clear separation of traffic functions and access functions – the planning of a hierarchical street pattern;
- Segregation of vehicular and non-vehicular traffic;
- Intersection design to minimise traffic conflict and facilitate vehicular traffic movement.

The three key practices identified above would certainly feature under a new urbanism approach. Not surprising given the generality of the classification. The main area of difference between conventional road safety practice and new urbanism at this general level of classification is in the approach to the segregation of traffic, from segregation of modes under the conventional approach to shared road space under new urbanism.

Brindle examines the guidelines supported by conventional road safety practice in a little more detail. From the twelve key sources he examines he identifies 41 generalised guidelines. Assessed against the need to achieve balanced transport objectives - very few of these generalised guidelines can be seen to be promoting such an approach. Only nine items can be seen to support balanced transport –and even then three of these nine items are only cited by one of the 12 key sources, and mainly by the more recent sources. These items include:

- planning to limit total travel;

- locating land uses to maximise public transport efficiency (but even here it would depend upon the definition of efficiency!);
- adapt mixed-function roads for other road users;
- access streets designed for low speeds (but speed is not specified);
- plan to minimise the need to drive locally;
- pedestrian/ cyclist/ public transport priority in local planning.

Liveable Neighbourhoods and the approach to traffic management

The Western Australian Planning Commission (WAPC) introduced the 'Liveable Neighbourhoods: Community Design Code' in 1997 for a trial period of testing and review. Modifications were made to the Code and a second version was released in June 2000. At this stage the trial is planned to run until February 2001. The Code promotes "a more traditional spatial structure for new developments and provides an alternative approach to the design of neighbourhoods and towns to achieve compact, well-defined and more sustainable communities" (WAPC, 2000). The Code is an assessment tool for structure plans and subdivision in new urban development and is intended to deliver sustainable development as indicated by the State Planning Strategy.

The key design approach is to plan for communities based on a system of 'walkable neighbourhoods'. These neighbourhoods then are limited to a circular area of 400 metre radius (deemed to be a five minute walk) amounting to around 50 hectares. The aim is to cluster these neighbourhoods around a town centre. Unlike conventional town planning the neighbourhood centre is not located in the centre of the 'cell'. Instead arterial streets and local streets (neighbourhood connectors) form the spine of the neighbourhood, and town and neighbourhood centres are located at the junction of these streets. Conventional planning located such streets at the edge of the neighbourhood. This design feature provides for centres to serve local neighbourhood pedestrian and cyclist traffic as well as passing vehicles. In this way facilities can be economically supported at the neighbourhood level, and so be located to provide for travel choice.

> "All streets, including Arterial streets and Neighbourhood Connectors, have an important role in the urban structure. They contribute to community liveability by integrating all modes of travel including motoring, walking, cycling and using public transport; and by supporting active land uses on both sides. The emphasis is upon connectivity, amenity and integration to achieve safe, efficient and attractive street networks." (WAPC,2000)

A key design component is a highly connected network of streets. This is a key difference to the conventional tributary street layouts replete with culs-de-sac. The network serves two objectives. It allows compatible land uses that are required for daily needs to be located with walkable access and proximity, in doing so it provides a viable alternative to car based travel, this in turn reduces traffic congestion on arterial streets. Culs-de-sac are rarely used since they reduce connectivity, and where they are used they are designed to provide for pedestrian and cycle access.

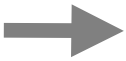
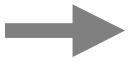
Another key design feature is the 'perimeter block' development where land uses are designed to provide an active street frontage in order to provide for passive surveillance and so improve personal safety of pedestrians. Segregated pathways are not favoured.

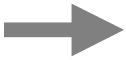
Finally on-street parking provision is a key component of the approach. This provides for shared public parking and better utilisation of parking spaces between developments. In so doing it also enables more intensive use of lots and improved pedestrian amenity.

Liveable Neighbourhoods - Traffic Management Guidelines

A major component of the Code is its approach to the 'movement network', and within this street design and intersection control. A set of traffic management guidelines is promoted. The guidelines, designed to achieve the above objectives of the Community Design Code, cover three design categories: street layout, street cross section design and intersection control. Each category is interrelated. Each of these categories has its own set of concerns within the overall context of achieving good urban design. These concerns are expressed in the following table. It can be seen that the traffic management guidelines strive to meet road safety principles whilst addressing new urbanist principles.

Table One: The relationship between the aims of New Urbanism and of Traffic Management

New Urbanism		**Traffic Management**
Street Layout: High levels of accessibility to centres of activity. Locate Neighbourhood Centres and Town Centres on important streets. Walkable communities. Energy efficient, solar access, site responsive design. 	THE DESIGN	*Street Layout:* Provide accessibility without through traffic problems. Network design using a hierarchy of streets based on movement and access functions. Limit attractiveness of access streets to through traffic by controlling connectivity. Network design to match desired street environment and intersection control methods. 
Street Cross section design: Equity for all – Priority to needs of the disabled, pedestrians, cyclists and public transport as well as cars. 	INTERFACE	*Street Cross section design:* Control traffic speed through appropriate street design and manage conflicts at driveways using access management techniques. Specify appropriate paved width, verge, walkways, street trees, medians, parking embayments, etc. 

Intersection Control: Consider vehicle, cyclist and pedestrian safety and access needs as they relate to the adjacent land uses. Recognise the impact of intersection control type on space requirements and built form. 		*Intersection Control:* Manage conflicting movements safely with an acceptable level of delay. Match intersection control method (ie. priority, roundabout, or signal control) to the type of intersection and user mix (arterial/arterial, arterial/local street, etc.) 

Source: adapted from WAPC 2000.

The "Liveable Neighbourhoods Traffic Management Guidelines' are unique amongst traffic management guidelines in the extent and detail to which they deal with interconnected streets. A review of other guidelines found some which move towards this approach including those produced by the Institute of Urban and Regional Development, Berkley, USA and the Western Cape Road Access Guidelines, South Africa.

The perceived problems with the conventional approach to road safety

In promoting the development of 'Liveable Neighbourhoods' planners and urban designers point to a number of problems that can occur as a result of the conventional planning-for-safety approach. These problems are considered next using examples to illustrate. The issues are discussed under the three main pillars of the guidelines: street network, street cross section design and intersection control.

Street Network

Under conventional planning the hierarchical street network generally results in a significant separation of different land use functions. Neighbourhoods are sited between arterial roads in large single land use components. This means that land uses that individuals need to access (in order to undertake their daily activities) are spread over a larger area, usually beyond walking and cycling distance. The result is increased car use and associated road safety problems. A vicious circle as increased car use also leads to less people walking and cycling. The 'liveable neighbourhoods' solution strives to create compact neighbourhoods where land uses needed to serve the daily needs of inhabitants are located in close proximity to housing and served by a network of interconnected streets.

The difference between these two approaches to street layout is illustrated in Figures One and Two. Figure One shows the network in a conventional design with a hierarchical tributary style network – there are long distances to be travelled, usually by car. Traffic congestion occurs at intersections between the local distributor and arterial. Figure Two demonstrates the extent of connectivity throughout the cell.

Figure One: The conventional approach to street layout. (Source: Reynolds and Solomon, 1998)

Figure Two: A new approach to street layout

In the new approach, centres are located at the intersection of major streets while still accessible to the neighbourhood. The interconnected street provides a choice of possible routes for vehicles so spreading the traffic and avoiding congestion. A hierarchy is still imposed in order to avoid through traffic and 'rat running' in residential cells. The interconnected street system also provides a choice of routes for non-auto modes making the neighbourhood more permeable for pedestrians and cyclists. The layout also provides for improved accessibility for public transport; buses are able to penetrate the neighbourhood. The network is designed in an integrated fashion whereby land uses and activities are matched with appropriate street types to cater for all modes of transport.

An interconnected street system does pose road safety issues. There is the potential for through traffic on local streets. With a careful and iterative design process involving close liaison between urban designers and traffic engineers these problems can be resolved. This can be achieved with a range of devices including configuration of street blocks, street cross section design, and restricting some movements at intersections. It is possible to achieve both the objective of safety and of balanced transport.

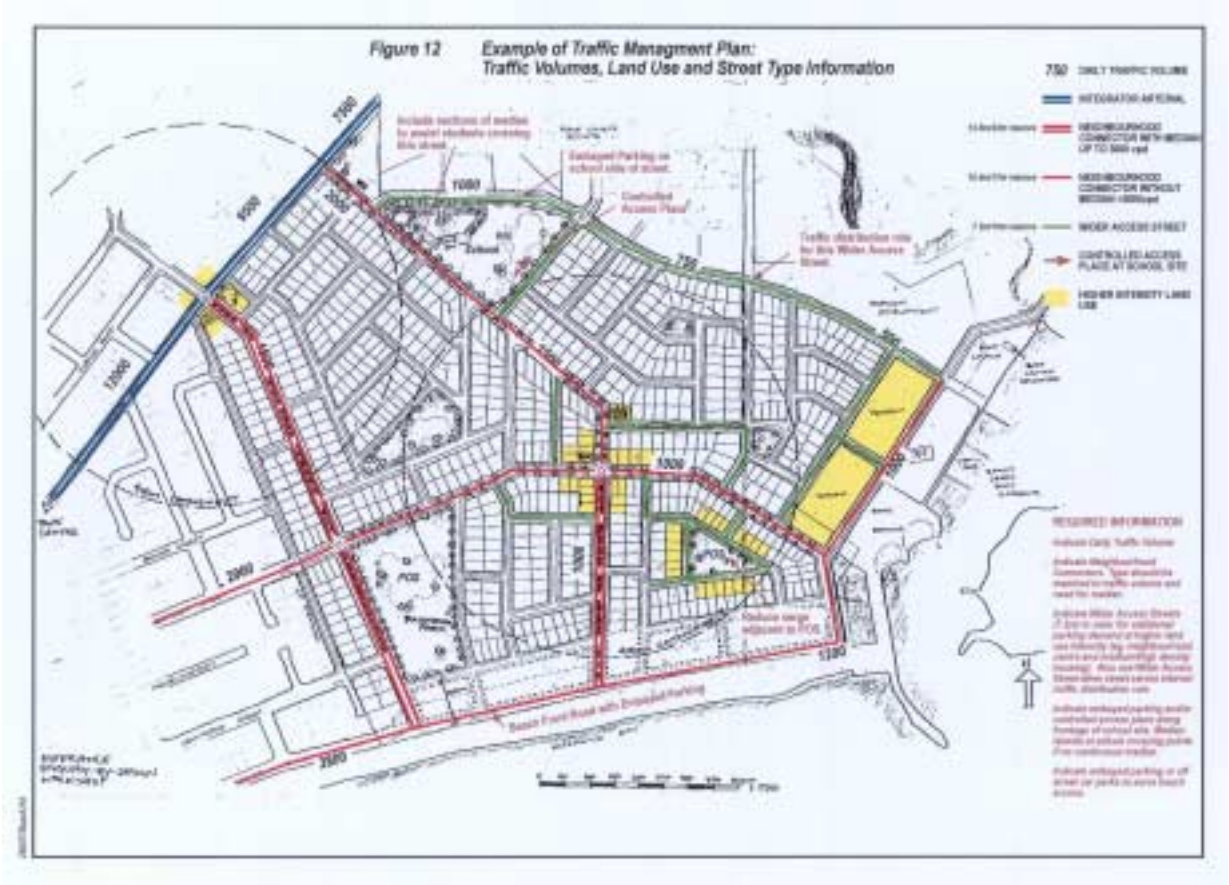
The interconnected movement system is shown in a theoretical model in Figure Three. It is evident that there is a hierarchy of streets in place, but that there is direct connection between some lower order and higher order streets in the network.

Figure Three: The Interconnected Street System – Theoretical Model

Source: WAPC, 2000.

Figure Four illustrates the selection of street types within the network in relation to land use as well as traffic volumes. Neighbourhood connectors link neighbourhoods to each other, to the town centre and to the regional road system. Wider and narrower access streets complete the network a serve a low traffic function and a high access function in a low speed environment.

Figure Four: Street layout and land use relationship.



Source: WAPC,2000.

Street Cross section design and access management

In designing street cross sections the conventional practice aims for an unimpeded flow for auto-modes. To achieve this the priority is in segregating different types of road user; this also addresses safety issues. Therefore pedestrians and cyclists are not provided for on the road, instead the intention is to give them given separate pathways. Attention is given to providing wide streets, this is thought to reduce crashes and increase the carrying capacity of the road network. This in turn is believed to reduce congestion.

The problems that arise from this approach in the context of a liveable neighbourhood, is that wide streets can create unsatisfactory integration with land use. Buildings are too distant across the street; this reduces pedestrian and cycling activity, and life on the street. Again a vicious circle results in increased car use. Interestingly it has recently been suggested that widening streets and reducing congestion actually reduce safety. Noland (2000) notes that road infrastructure safety improvements actually lead to increases in fatalities and injuries whereas congested roads lead to fewer casualties.

In the interests of safety the conventional approach then seeks to segregate the road from the activity arising from adjoining development. Direct property access on district

and local distributors is limited or prohibited. Properties thus back onto the road and two metre high fences and walls flank arterial roads. As a result neither residential or business use has a street address. This practice results in outcomes where natural surveillance is reduced, as is land use activity and interest for pedestrians. On-street parking is eliminated in the interests of safety. Instead large mono-use car parks are built, often fronting development creating even wider spaces for pedestrians to negotiate. New urbanists argue that cars parked on-street (a devise only applicable for 60km/hr or below operating environments) are an important safety device in that they calm traffic. In catering for pedestrian and cycle travel it is important to plan active streets, which have variety and points of interest.

Street Design in Residential Environments

In the conventional approach pedestrians are segregated from vehicles, usually along pathways which are distant from activity and not overlooked. This replaces road safety dangers with creates personal safety dangers. It can then reduce the numbers who choose this mode – even for very short journeys. The issues are illustrated in Figures Five through Twelve.

Figure Five: Four lane Divided Distributor without driveway access

Figure Six: Four lane Divided Distributor with driveway access.

Figures Five and Six show different treatments for a four lane divided district distributor in a residential environment. In Figure Five, the conventional approach is to prohibit direct driveway access onto the distributor. Note however the set back of houses from the street, the walls and vegetation – a hostile environment for the pedestrian with no interface between buildings and road. Figure Six shows an improvement in terms of the walking experience. Houses front the street and driveway access is allowed, opening up the street and its activity and providing interest along the walk. Clearly there are safety issues, traffic turning left in or left out of driveways pose a conflict to through traffic. However these properties are low traffic generators and the median eliminates the more problematic right turning movements. Overall, this "compromise" to access management has proven quite successful in Perth yet has been abandoned in pursuit of complete road safety and traffic efficiency. While left in left out access means the traffic has to slow, to completely disallow such access is an excessive reaction given the sacrifice to the land use interface and pedestrian safety.

Figure Seven: Controlled Access Place (right) adjacent to a local distributor (left).

Figure Eight: Closer view of driveways and Pedestrians along Controlled Access Place.

Figures seven and eight show one type of treatment which avoids the "walled estate' approach of earlier. This is an approach on a neighbourhood connector (local distributor) recommended by traffic engineers and promoted by the local council who were concerned with access control and frontage management. It involves the creation

of a controlled access place on each side with access to the distributor at 150 metre intervals through staggered 'T' intersections. This approach enables good auto-traffic operation but manages to provide an aesthetically pleasing street. Low traffic volumes and slow travel speed mean pedestrians can share the street with parked cars and slow moving traffic. This reserve would require approximately 30 metres to cater for the controlled access places on either side of the single carriageway local distributor.

The 'Liveable Neighbourhoods traditional boulevard is shown in Figure Nine. In this example of a Neighbourhood Connector properties front the street providing interest to the pedestrian and natural surveillance. On-street parking provides some protection for pedestrians from moving vehicles; it also enables more intensive use of the site. The median separates opposing traffic streams, provides for control of right turn movements, and provides for 2-stage pedestrian crossing. Driveways have left in/left out access and this requires a 'U-turn operation via median breaks at intersecting minor streets and via roundabouts. This cross section would require a reserve of 22-25 metres depending on traffic volumes (the shared parking/cycle lane widens from 2.3m to 3.8m when 3000vpd is exceeded.

Figure Nine.

Street Design in Business Environments

Figures Ten through Twelve compare the treatments for district distributors in a business environment. This road in Figure Ten functions as an urban expressway. The conventional approach is to provide a divided distributor with frontage and roads or service lanes adjacent to commercial properties. The huge road reserve and high vehicle speeds do not create a friendly place for non-auto modes, the human scale and liveability of the urban place is lost.

Figure Ten

Figure Eleven

Figure eleven shows an historic design and demonstrates clearly the need for road safety considerations. While the reserve is smaller, and buildings front the street, the lack of right turn control creates significant problems:

- rear end crashes,
- right angle and indirect right angle crashes associated with movements across the median, and
- weaving to avoid vehicles turning right and consequent side swipe crashes.

Figure Twelve

In Figure Twelve a 4 lane divided distributor is provided with building frontage but no access or service lanes and no on-street parking. The median prohibits right turns to large commercial car parks found at the rear of the perimeter block development (except where openings and right turn storage lanes are provided). On-road cycle lanes are provided. The experience for pedestrians and cyclists is significantly better than the two previous examples but on-street parking could be considered in speed environments of 60kph or less.

Intersection design

Conventionally designed intersections are primarily designed to facilitate vehicular traffic, maintain its efficient flow, and reduce conflicting vehicle movements. The problem with many conventional designs is that the slowest travellers (pedestrians, and cyclists) do not have priority, their efficient movement is not provided for. Often intersection design solutions place them in greater danger, for example junctions with wide radii designed to provide for an unimpeded vehicle flow mean that pedestrians have to cope with crossing where vehicle speeds are higher than is necessary if balanced transport considerations were considered. The liveable neighbourhoods approach promotes:

- reduced kerb radii to shorten pedestrian crossing distances and limit vehicle turning speeds,
- signal control instead of dual lane roundabouts in areas of high pedestrian/cycle demand (eg. in/near town centres),
- small single lane roundabouts in residential environments designed for 20-30kph vehicle speeds,
- stop/give-way control at 4-way intersections of access streets to minimise proliferation of roundabouts in interconnected street systems.

Conclusions

The neighbourhood and town design that has resulted when conventional practices are followed has been shown to be environmentally and socially unsustainable. With functional land use separation we have seen the increase in the number of journeys made by car at the expense of other modes of transport. We have also seen trip distances by car increase per capita. Both of these outcomes also exacerbate road safety problems for the vulnerable modes of walking and cycling, and even access to bus routes. The conventional approach to road safety has promoted segregation rather than integration. If zero tolerance in relation to the road toll means that less people walk, cycle and use public transport – instead resorting to the car for almost all trips, then this is clearly unsustainable.

In Australia there is policy commitment to sustainability at both Federal and State levels. We have an international commitment "reducing" greenhouse gas emissions (of which transport contributes something in the order of 20%); clearly car travel reduction must be an imperative. We are also striving to improve our neighbourhoods, to re-create that sense of "community" by designing neighbourhoods where crime and the fear of crime is reduced. Key design approaches to achieve this objective include encouraging more people to walk and cycle coupled with active land use frontage, both of which provide for human surveillance of the community.

As Brindle's review shows the road safety guidelines and practices for the most part have continued a philosophy developed in the 1940's, this is well before the objective of sustainability was born. Indeed Brindle's review notes that:

> "There has been very little added to the planning-for-safety literature in the past 15 years – indeed, if anything, there has been an implicit downplaying of the subject in empirical terms, as other values such as sustainability…have displaced road safety and traffic amenity from the local planing agenda" (Brindle R, 1999, pp2).

If road safety practice has had limited update in the past 15 years then it is questionable if the agenda reflects sustainability as coined at the first summit on Climatic Change at Rio in 1992. What is needed is for engineers, the professionals charged with designing for road safety and for conducting road safety audits, to revisit the road safety guidelines and marry their conventional objectives with those for sustainability, which includes transport sustainability.

Brindle (1999) notes that the design features of new urbanism "clearly have potential conflict with the various planning-for-safety guidelines". As can be seen in this paper the conventional tributary street layout is replaced with an interconnected or permeable street network; intersections between minor and major streets are accepted, assuming appropriate spacing and design and internal layout so that 'rat running' does not occur; in place of the clear separation of traffic and access functions there is provision for active land uses along arterials; and on-street parking is accepted in 60kph and less environments. An important component of the physical design solutions in both the planning-for-safety arena and in the new urbanist field would appear to be speed reduction. This appears to be the key, designing streets for reduced speed provides a safer environment for non-auto modes, while still supporting the car. Land use activity may then adjust to a new pattern of development based on walkable catchments rather than unsustainable car-based catchments. Such car-based catchments are driven by economies of scale rather than environmental or social sustainability.

What is needed is for greater multidisciplinary team working in order that the different professions can test and challenge each other's objectives and work towards a shared goal. This needs to be supported by new empirical research.

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