MAKING A CONNECTION BETWEEN PLANNING AND ROAD SAFETY

A basic premise of planning?

The essential principle of planning for road safety is that *a created physical environment should not contain or encourage situations carrying unacceptable traffic risk*. This is entirely consistent with the assumption implicit in the very origins of "modern town planning" in the latter part of the 1800s: that physical planning could create humane, happy and healthy environments, and solve many of the ills in urban society. The pre-car Garden City concept, for example, sprang from a belief that living in a "town in the country" would induce better health and greater well-being in residents. The importance of urban services such as clean water and sewerage inevitably became a central component, along with housing standards, of town planning regulations and professional responsibilities. Thus, from the early days, local government engineers and others responsible for public works claimed a major role in the evolution of town planning, as the papers presented at the first Australian town planning conferences in 1917 and 1918 show (Brindle 1988). The control of urban environments to protect health and safety of citizens thus has a long heritage, and dealing with the car and its impacts was soon put on the same agenda.

"Planning for road safety" (or "safety conscious planning", to use a more recent phrase) was a very active subject in the 1970s and early 1980s. During this period, experience matured with both the segregated land use of the UK "New Town" models, and the post-war "Anglo-American" collector-based suburb. Some of the safety disadvantages of these models and their conventional grid suburb predecessors became apparent.

Nearly 30 years ago, as part of a national review of road safety, a large number of consultant reviews of factors affecting road safety were commissioned by what was then the Office of Road Safety in the Commonwealth Department of Transport. (One was on Town Planning and Road Safety (Loder and Bayly 1973), on which this writer cut his teeth. It was a learning experience.) The immediate outcomes of the review were not clear, but some years later the Office of Road Safety decided to revisit and expand on the subject, with a view to establishing a research program and producing guidelines for practitioners. The task was given to what was then the Australian Road Research Board (ARRB) through the period 1978-84, and the result was a somewhat ambivalent assessment of the subject that identified some clearly warranted principles and many uncertainties (Brindle 1984).

Despite a flurry of official interest in the subject in the 1970s and 80s, there was not much impact on Australian town planning practice. Engineers involved in land development and local street networks did pick up the matter of safety in local streets, and, with the encouragement of the Office of Road Safety, the pioneering moves towards Australian traffic calming were taken during this period. The Office of Road Safety produced two (it must be said, unremarkable) versions of a general guide for town planning and road safety (ORS 1978, 1984). But there the matter rested, as far as overt promotion of road safety in planning was concerned.

There has a been a revival of interest in the technical consequences of safety conscious planning in recent times, including a major commitment by the Insurance

Council of British Columbia and current work by VicRoads to develop processes to assist those engaged in planning. However, more typical in current town planning circles is the view that road safety considerations – along with other "engineering" criteria – have unduly influenced planning ideas and controls. "Of course we're in favour of road safety, but not at any price", one former state government planner was heard to say. A clear conflict of purpose and beliefs has arisen.

Considerable documentation of the information and research basis of the role of planning in road safety took place at ARRB in the period 1978-1988. This paper recalls some outputs from that work as a basis for observations about the current conventional wisdom, and searches for some common ground. Inevitably, however, some of the assumptions behind current planning attitudes have to be challenged if urban communities in the future are to benefit from the experience and knowledge accumulated in the past 50 years.

Environment and behaviour

There are two broad concepts behind the linking of the physical environment, which results from urban planning and development control (or the absence of it), with health, welfare and safety outcomes: *physical determinism*, and *creation of "fail safe" environments.* Both have long been underlying motives of town planning through the 20th Century:

1. The way people behave in the physical environment (according to the first view, known as *physical determinism*) is affected by the nature and character of that environment. Extreme forms of this concept would hold that the environment actually *determines* behaviour. This implies an approach based on *inducement* through creation of particular types of environment. For example, moving people from the slums to Glasgow to Cumbernauld New Town would, it was argued (with some justification, in the event), reduce the prevalence of vandalism and local crime. At its most naïve, physical determinism can lead to a belief that simply providing for something (e.g. cycling or walking, or an opportunity to work locally) will make that behaviour happen.
2. *Physical intervention* which aims for "fail safe" environments can reduce opportunities for harm or conflict and minimise the severity of outcomes when potential for harm does occur, without people necessarily playing a conscious role. Obvious examples are public health utilities such as water supply and sewerage. Less appreciated are the different road safety outcomes from different forms of neighbourhood layout.

Both mechanisms can be seen at work to some extent in urban communities, and both (according to various forms of planning theory) can be exploited to achieve desired outcomes. This certainly was the assumption implicit in a classic monograph by Sir Harry Alker-Tripp, a deputy chief commissioner in the Metropolitan Police and significant amateur writer in the field:

> "Any town so planned that its citizens are killed and injured in vast numbers is obviously an ill-planned town." (Alker Tripp 1942)

No more blunt assertion of the direct link between quality planning and level of road safety could be imagined.

WHAT WE ALREADY KNOW (OR OUGHT TO)

Table 1 recalls the key research and policy sources that were known to Australian practitioners of safety-conscious planning, at least up to 1990.

The origins of these planning guidelines and practices are venerable. ARRB's Town Planning and Road Safety Review (Brindle 1984) traced most of the key principles of safety-conscious planning back to the early days of modern town planning (*Figure 1*). It is clear that these origins are firmly in the planning mainstream, not an invention of highway engineers.

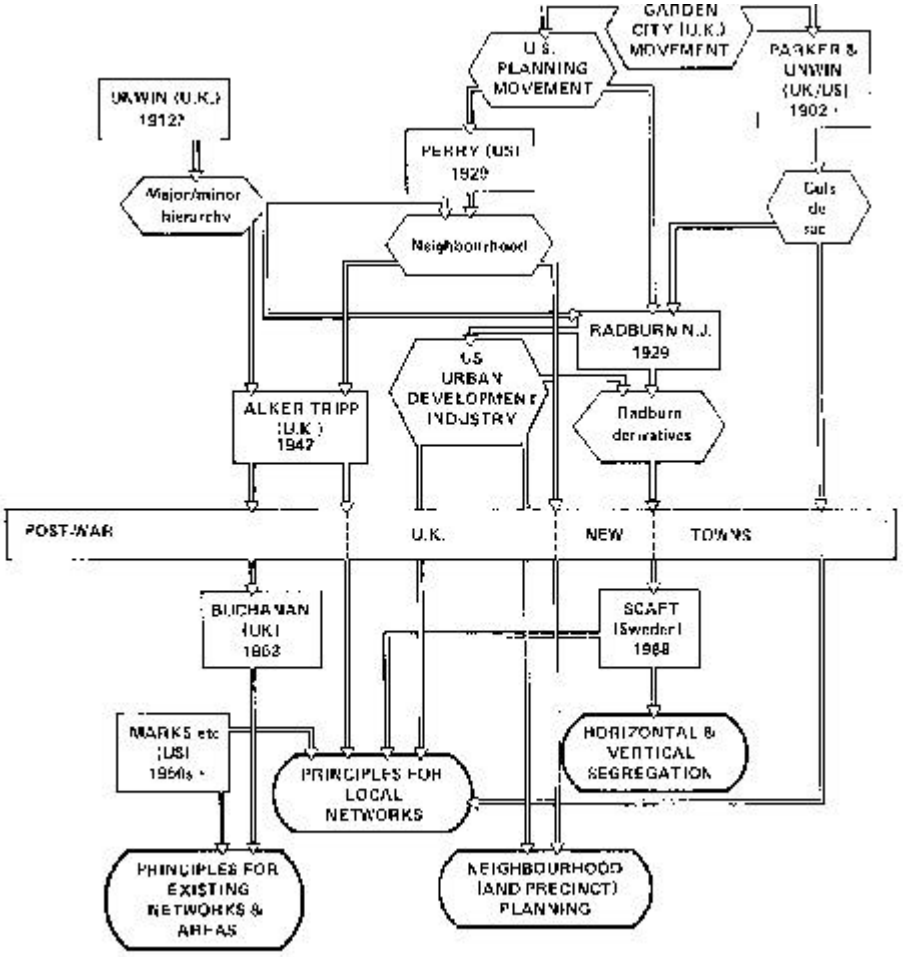

Fig. 1. The origins of "conventional" planning elements for road safety.
(Source: Brindle 1984)

Table 1. Key research and policy sources for safety-conscious planning

Town planning and road traffic (1942) by H. Alker Tripp, (Edward Arnold: London)	Seminal work, the first English-language publication (and possibly the first anywhere in the world) to focus on the road safety aspects of town layouts and particularly road function. Provided a first interpretation of modern thinking about traffic precincts, access management, and separation of local functions from through traffic functions of roads.
Principles for Urban Planning with respect to Road Safety (The "SCAFT Guidelines") (1968) by the Swedish National Board of Urban Planning	Established the need for clear separation of traffic functions and access functions, and foreshadowed road layouts that go sharply from largely-segregated arterial roads to access clusters. The keystone of the Swedish guidelines was maximum possible segregation of vehicular and non-vehicular traffic. The SCAFT Guidelines were implicit in much of modern road and neighbourhood planning thinking. Elements of the SCAFT Guidelines were becoming known in Australia in the early 1970s, and encouraged the view that good planning did create safer cities.
Design of the local street system (1970) by B.C.S. Harper. In*:* N.F. Clark (ed) Analysis of Urban Development (Proc. "Tewksbury Symposium"), University of Melbourne.	Harper reported the first published analysis of accident rates in Australian local streets, conducted by the Victorian Traffic Commission in the middle 1960s.
Town Planning and Road Design (1972). Chapter 3 in "The Road Accident Situation in Australia - A National review". Expert Group on Road Safety, Dept of Shipping and Transport, Canberra.	The Report recommended that planning authorities should establish and implement guidelines based on what it described as "well-known" principles for a safe road system in new and old areas, and "initiate the redevelopment of road layouts in existing areas to improve their safety". It also recommended that studies be undertaken to establish the cost-effectiveness of specific town planning measures to reduce road accidents, and to determine possible safety benefits of improvements to public transport services.
Road Safety Guidelines for the Planning of Urban Roads. (1977) by JWM Cameron. Tech. Note TF/1/77, National Institute of Transport and Road Research, South Africa.	The South African review was restricted to the influence of the layout of the road network on road safety. Within that scope, its principles are similar to those promoted in the Australian work. Some useful contributions on the relative performance of T and cross intersections came from parallel South African studies.
Road Safety Guidelines for Town Planning (1978), by the Office of Road Safety, Department of Transport. (AGPS, Canberra)	Based on a not entirely faithful interpretation of work in the 1970s, these advisory guidelines relied on three basic objectives: ❑ The reduction of the need for motor car traffic and the encouragement of the use of public transport. ❑ The planning of a hierarchical street pattern in which different classes of street serve different purposes in order to minimise conflicts between traffic streams and between traffic and people. ❑ The design or redesign of intersections to minimise conflicts and facilitate traffic movement. There were 24 guidelines for new development and 7 for the modification of existing street systems.

Table 1 cont…

Safer Roads in New Urban Areas (1980) by Loder and Bayly, for RoSTA Bayside Corridor Traffic Study. ISBN 0 86853 0247	This study explored the various features and causes of accidents at the neighbourhood level, and proposed planning and design measures to reduce accident propensity. It noted: ❑ The relatively high rate of pedestrian accidents at the local level. ❑ Accidents in local areas are not generally 'black spot' problems. ❑ Opportunities to 'build in' safety in new areas. ❑ That this should be done at the network planning stage rather than in design. (Traffic flows, street length, pedestrian activity and intersection form and numbers are all determined at the planning stage; only sight lines are susceptible to detailed design treatment.) The report states: "We believe that it is in the layout design of the local street traffic access system that the greatest gains could be made in reducing accident rates"
Planning for Road Safety (1984) by the Office of Road Safety, Department of Transport, Canberra.	The revision of the 1978 guidelines added more material on street modification and public transport planning, and was more copiously illustrated. However, the bibliography was still substantially the same and the guidelines themselves were only slightly different in substance.
Town Planning and Road Safety (1984) by R.E. Brindle, Special Report 28, Australian Road Research Board/ Office of Road Safety Report CR 33. ***Table 1 cont…***	This review of literature and Australian practice aimed to find out what was being promoted as good town planning practice, what was actually being done, what was the scope for improvement, and what research was required. The following general conclusions were reached: ❑ While over 90 percent of responding local authorities reported experience with some planning-for-safety measures, effective practice was not universal. ❑ Some of the commonly-accepted guidelines (such as a conventional application of 'road hierarchy' to accept conflicting access and traffic-carrying functions) appeared to be counter to effective road safety practice. ❑ Conversely, some potentially effective practices (such as frontage management techniques) appeared not to be covered by guidelines at that time. ❑ Local area planning appeared to present the greatest opportunities for effectively applying planning-for-safety measures. A large number of casualty accidents occur in the local street system and there had up until then been little or no deliberate road safety action in the local network.
	❑ Most of the potentially effective actions were the responsibility of, or are under the influence of, local government. ❑ The subject lacked adequate research and monitoring, meaning (among other things) that there was not adequate information to evaluate alternative plans. "The safety benefits of most specific planning measures cannot currently be quantified", the report said. Most of these observations could still apply today. The study listed several principles that could be supported by available evidence.

Table 1 cont…

Planning for Safer Subdivisions (1990): Working Paper No. 1 *Safety on Residential Streets*; Working Paper No. 2 *Addressing Institutional Constraints to Achieving Safer Roads*; Working Paper No. 3 *Design Ideas for Safer and More Liveable Streets.* *by* Loder and Bayly, for VicRoads and Dept. of Planning and Urban Growth, Melbourne.	This unique study provides the most comprehensive examination of the empirical basis for the movement planning aspects of existing and possible new planning-for-safety practice. Despite its undoubted usefulness and the fact that it coincided with an upsurge of interest in revisions to local planning codes, it seems to have been totally ignored by the professional planning and development communities, and by the State planning body. Working Paper No. 1 demonstrated a method by which alternative road networks in a subdivision can be compared for safety performance. The investigators focussed on the 'key question' of the frequency of local street/arterial road connections, and concluded that there might be grounds to relax the spacing requirements for uncontrolled left in-left out junctions. Working Paper No. 2 calculates that the additional extra cost per lot of no-access local traffic routes (collectors) rather than mixed-function roads is 'quite marginal', and would be balanced by higher lot sale price. Working Paper No. 3 tries to balance safety requirements with the demands of amenity and the "new urban design" calls for 'legibility' and 'permeability'

The sources listed in *Table 1* (typified by ORS (1984)) reflect three central principles for safety-conscious planning:

- The need for motorised travel should be minimised.
- Where vehicles and other road users mix, speeds should be moderated to an appropriate level so that the various users of the road space can be *integrated*.
- If this cannot be achieved, or is undesirable for other reasons, vehicles and vulnerable road users should be *segregated*.

Specifically, these conventional guidelines and practices typically proposed road safety considerations in the following planning elements:

- *Reduction in vehicle use*
  - Macro-urban form:
    - Employment location and concentration
    - Location and size of suburban centres
    - City size
  - Local urban form:
    - Mixed land uses to provide local trip destinations
    - Higher residential densities to increase catchment sizes
  - Increase public transport use through planning and design
  - Parking limitations through the planning process
- *Access management on arterials (the relationship between land and road, including parking generation)*
  - Management of frontages/vehicular access
  - Control of intersection spacings and types
  - Medians and control of median break spacing.
- *Centres*

- "Traffic-free" centres
- "Under one roof" centres
- Control of mixed strip centre traffic environments
- Avoiding split activity centres (including development at intersections)

❑ *Local planning and management*

- Neighbourhood planning – provision and location of schools, local centres, employment, open space and play areas, pathways, churches, community facilities etc; creation of neighbourhoods or precincts not penetrated by external traffic; location of land uses to minimise traffic and its impacts.
- Emphasise the streets/roads distinction; "Rooms and corridors".
- Local distributor roads (collectors) to be treated as traffic routes (frontage management etc) or avoided altogether.
- Network planning and street function – internal road hierarchy; connectivity; network clarity.
- Low-speed planning and design; traffic calming
- Type/treatment of local intersections (T junctions favoured)
- Sight lines and other aspects of design protected in planning decisions
- Parking on local street carriageways.
- Development control (e.g. to permit home occupations)
- Protection of residential amenity
- Pedestrian and cycle provisions – paths linking local activities: connection with town-wide path system.
- Management of existing local areas – control over changes in land uses; correction of network deficiencies; elimination of cross intersections; area-wide traffic management.

Most of the principles and specifics promoted by these guides are familiar and are (or at least, were) widely applied. As observed in the report of second Office of Road Safety review of 1978-1984, many of the elements promoted in the planning-for-safety literature, at least at the local level, were familiar as longstanding "good planning practice":

> "Most of today's 'safe' residential area planning practices arose from observations on the performance of various types of layout and planning concepts, rather than from deliberate development of safe practices from first principles. Much of what is generally accepted as desirable from a safety point of view is seen largely (and originally evolved) as good planning and design practice in the broad sense. The definition of areal units (e.g. neighbourhoods in new area planning, and precincts in the management of existing areas), the recognition of a functional distinction between arterial roads and roads within localities, the provision of full or partial separation of motorised from non-motorised traffic, and even the extensive use of culs-de-sac illustrate basic elements of the safety principles which are far from recent concepts." (Brindle 1984)

Yet 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 importance of the subject in empirical terms, as other values such as sustainability and

environmental protection, resource management, affordability and more latterly a range of urban design concepts have displaced road safety and traffic amenity from the local planning agenda.

A document was drafted for the New Zealand Land Transport Safety Authority in the mid-1990s that compiled detailed planning and design techniques, many derived from Australian sources, to support the familiar principles of functional separation, speed management, road user protection and orderly planning (LTSA 1995). The fate of the document is unclear, but it is not believed to have been completed or put into practice.

The only other known antipodean source of any substance in the 1990s is a review of road safety in transport and land use planning, policies and guidelines in NSW by Graham Pindar (1994). We shall return to that source later.

The road safety interests have otherwise been largely silent, until quite recently, over the past decade or so of development of new planning thought and design guides. As far as can be ascertained, for example, the existing national guidelines for town planning and road safety were neither offered nor acknowledged in the development of *AMCORD* (the Australian Model Code for Residential Development) and *AMCORD Urban*. It was only through the professional skill and knowledge of two experienced consultants involved in AMCORD that road safety factors received implicit attention at all.

Part of this trend has seen a virtual erasure of the contributions of previous generations of planners, surveyors and engineers from the collective memory. We are now at the point, as in many fields, of having to re-learn old truths, modify them for today's conditions and develop new understandings, but also revive and affirm the fundamentals, and identify what we do not yet know with sufficient certainty. Then we can be clearer about what we are doing right, what we can productively do differently, and what we need to investigate in order to be sure of which is which. A program under way in Victoria by VicRoads offers hope that at last these matters will receive some attention. A preliminary study by ARRB Transport Research for VicRoads stressed that the challenge was to get planning once again onto the road safety agenda – and safety onto the planning agenda (Brindle 1999, 2000).

GETTING SAFETY BACK ON THE PLANNING AGENDA

Taking road safety seriously as a planning objective is not simply a matter of reviving the former thinking and information. Two trends in modern urban planning (which seem, superficially at least, to provide support to safety-conscious planning) may in fact be actively throwing up barriers to continued best practice:

- Integrated planning, and
- "New urbanism".

It is stressed that it is not being argued here that these facets of planning inherently *must* inevitably involve or require rejection of safety-conscious planning. Rather, it is observed that the actual practice of integrated planning and "new urbanism" is, either by ignorance or misguidedly, often excluding safety considerations.

Safety-conscious planning as part of integrated planning

Integrated planning ought to mean planning in which all sectors work towards common desired outcomes, employing targets and strategies that are not conflicting. There has been an upsurge in political interest in integrated planning in Australia in recent years, and many words written on it (to which this author has contributed perhaps excessively – see Brindle and Lansdell (1999)). But this has not always meant a truly integrated policy approach.

Pindar (1994) observed from a survey of practitioners in NSW agencies that, while there appeared to be no significant impediment to achieving integration of land use and transport strategies, road safety was not perceived as a "driving force" in strategic land use planning. This is taken to mean that road safety sits as an assessment criterion (i.e. a *consequence* of planning) rather than an *objective* with its own specific strategies. This may not seem such a bad thing. But by relegating road safety to a yardstick rather than a target, we will find it hard to achieve anything like a "vision zero" for road safety – unless the performance criterion rejects, in effect, any situation likely to involve any sort of collision risk. The result of such an absolute criterion is likely to be the complete stifling of the planning process.

Pindar was led to ask whether or not it was appropriate for road safety to claim a more strategic role. He added that, if it was, then it was incumbent upon the state road and traffic agency to "provide a theoretical basis for road safety". (One could comment here that the lack of a theoretical basis has not held back other dominant planning criteria.)

It would be difficult enough to deal with this situation if the integrated planning process gave credit to the contributions of alert and informed road safety professionals. However, there may sometimes be subtle forces working in the opposite direction. "Integrated planning" has, for some, been taken to mean implicitly "retrieving transport planning from the engineers" (although so far the result of integrated planning has, if anything, been to the contrary). A discussion of that point, tempting as it might be, is not our purpose here, but one of its spin-offs is: There is a corollary of "integrated planning" that implies that what are perceived as engineering-based requirements in planning and development (e.g. public works, transport operations, and road safety) are in some way counter to good outcomes, *ergo* engineering-based constraints on plans can be discounted (see, for example, Department of Planning and Urban Development (1990)). Put another way, it is implied that there is always an engineering solution to any problem, so safety considerations can be regarded as a management issue once the physical environment has been arranged. You will not find this stated anywhere, but it underlies much current planning thought. If this is true, it is a severe impediment to integrating safety-conscious planning into modern urban planning – and the more so for being covert and unspoken.

Safety-conscious planning and "new urbanism"

The terms "new urbanism" and "traditional neighbourhood design" cover a wide variety of development fashions, many of them merely commercial architectural and development concepts in different clothing (just as the terms "town planning" and

"Garden Suburb" were usurped by speculators in the 1910s). Essential features of "new urbanism" listed by its exponents include:

1. All planning should be in the form of complete and integrated communities containing housing, shops, workplaces, schools, parks, and civic facilities essential to the daily life of the residents.
2. Community size should be designed so that housing, jobs, daily needs, and other activities are within walking distance of one another.
3. As many activities as possible should be located within easy walking distance of transit stops.
4. The location and character of the community should be consistent with a larger transit network. The community should have a centre focus that combines commercial, civic, cultural and recreational uses.
5. Streets, pedestrian paths, and bike paths should contribute to a system of fully connected and interesting routes to all destinations. Their design should encourage pedestrian and bicycle use by being small and spatially defined by buildings, trees, and lighting and by discouraging high-speed traffic.
6. The regional land use planning structure should be integrated with a larger transportation network built around transit rather than freeways.

Readers will note that this list – which is based on current planning literature and material readily available on Internet – is a mixture of objectives and measures, or means and ends. In the absence of objectives (or a rationale) for a specified requirement, it is harder to specify safety-conscious alternative ways to produce the same outcome. One of the key principles of integration through strategic planning (Austroads 1998) is that there is usually more than one way to achieve a desired outcome. The popular interpretation of "new urbanism", on the other hand, has carried with it certain dogmatic ("essential") elements and detailed requirements, some of which may have an impact on road safety outcomes. Planning philosophies that are based on prescriptive solutions or measures allow for no flexibility. One must conclude therefore that dogmatic statements such as "we control everything down to the picket fences" and "if you allow one cul de sac, you've lost the whole game" (both of which were said by a "new urban" enthusiast at a Royal Australian Planning Institute Congress some years ago) *are contrary to integrated planning processes.* The same could be said, of course, about inflexible traffic engineering requirements. As a basis for road safety policy, it is thus necessary to look for other ways to meet the required objectives, if they exist. Why, for example, is it essential that traffic routes be "fully connected" in order to meet the objectives of access and ease of pedestrian movement, especially since one consequence might be the creation of street systems where pedestrians can nowhere be dominant? The repeated use of the word "should" in the language of "new urbanism" – evocative of old-style planning rules – may thus sit a little uneasily with those used to performance-based planning.

Apart from the language, however, there may appear to be some similarities with standard town planning imagery, of the sort that underpinned the planning-for-safety concepts of the 1960s to the 1980s. This reminds us that, if one can accept the

marketing gloss of the name, "new urbanism" is a valid restatement of some important wishes about the design of urban environments. It offers a way to re-invigorate enthusiasm for planning. But there are two significant sticking points for those concerned about safety-conscious planning:

1. The pre-packaged, off-the-shelf "requirements" that common practice of new urbanism promotes (e.g. through the many Murrain-Morris workshops held in Australia about 10 years ago (Department of Planning and Urban Development 1990) in which participants were discouraged from exploring forms that did not meet the formula).
2. New urbanism emphasises mixed rather than segregated road functions at all levels of the network.

In principle, "new urbanism" thus *seems* conducive to road safety in neighbourhoods, but in practice it leaves little room for safety-conscious variations and in fact puts barriers in the way. Moving to a common set of outcomes and strategic objectives, a focus on ends rather than means, and an acceptance that traffic-related safety is an important planning criterion are essential first steps before safety conscious planning and the "popular" interpretation of new urbanism can find common ground. The segregation-integration divergence would still need to be resolved.

Comparison of contemporary planning thinking and safety-conscious planning

The road safety practitioner involved in planning and development will at one time or another have come across one or more of the conflicts between contemporary planning thinking and the expectations of safety-conscious planning listed in *Table 2.* The foregoing discussion has suggested that the underlying sources of these tensions are found in the common interpretations of integrated planning and new urbanism. Whether or not that is so, the many countervailing positions in *Table 2* need to be resolved. This ultimately depends on sufficient interest from the responsible agencies to initiate the required investigations and interpretations. Readers are left to make their own assessments in the meantime, or at least to become aware that the conflicting positions summarised in *Table 2* exist.

A full discussion of possible convergences and divergences in these comparisons is not possible within the constraints of a conference paper, even if all the material were available. The brief observations in the last column of *Table 2* are offered as discussion starters, and as prompts for further investigation. The main purpose here is to remind readers that much of this ground has already been covered in past years, and only needs re-interpretation in today's context.

Local street networks

Given the focus that is often placed on the local street network, some specific comments about that aspect are warranted.

The "new urban" emphasis on "permeability" and "legibility" means that collector-based tributary road systems and the much maligned (but very safe) cul-de-sac are particular targets of current planning philosophy (e.g. Morris 1989; Murrain 1990a,b).

Local networks can be for vehicular movement, walking, cycling, communications, services etc. Movement networks (vehicles, foot, cycle) may be separated or

coincident. These networks may be described by the extent to which they are *internally connected* (that is, what proportion of streets have connections at both ends, and how many alternative paths are there for movement within the area). Paths within networks may also be described by their *connectivity.* This is a technical measure of the relative time or distance between two points via a designated path, compared with time or distance via the shortest preferred path.

Permeability is an attribute of an area, not the networks or links themselves. It describes the ease of passing through the area by the nominated mode. High permeability of an area is assisted by, but not totally prescribed by, high internal connectedness of the network(s) and individual local street connectivity. Areas with hierarchical movement networks can be just as permeable as areas with non-hierarchical networks. In urban centres in particular, permeability is influenced by the degree of penetrability through buildings and individual sites. Note that multi-occupancy buildings of two or more storeys are not "permeable", but rather function as (often "gated") vertical culs-de-sac. To promote denser, vertical development while flatly banning short culs-de-sac on the grounds of "permeability" seems perverse.

Association of connective networks with "traditional" design is easily understandable, given the preponderance of grid and other highly-connected street systems in older development. But the reasons for such networks in modern suburban development are more opaque. Justification is expressed in broad terms such as "the legibility and shape of the local street pattern play a key role" (as interpreted by Crane and Crepeau 1998), or by reference to the highly-concentrated centres of old cities (Murrain 1990b). The given or implied specific reason is that connected networks allow for efficient vehicle use and encourage walking.

On the other hand, high connectivity of traffic paths has been identified as being a root cause of through-traffic penetration in localities, especially in the residential suburbs that are alien territory for many urban design opinion leaders. The seminal work by Bennett (Bennett 1969, 1974, 1979; Bennett and Marland 1978) established that "traditional" estates (as he called them in the 1970s), with their grid and connective networks, clearly had worse safety records, all other things being equal, than "modern" layouts relying on many low-connectivity streets (*Table 3*). This reinforced work conducted in the 1960s in Sweden, culminating in the SCAFT Guidelines (1968), which was based on the same philosophy.

In addition, the form of local distribution of traffic is important. A key document in the 1970s suggested that traffic should be distributed on the periphery of a residential area – that the "approach should be from the outside" (OECD 1977a). Gunnarson (1974) observed that districts with spinal (i.e. internal) distributors had double the accident rate of districts with external distributors.

As an aside, there is widespread confusion between network *form* and road *layout*. Predominantly straight road sections (required, for example, for solar efficiency) need not form highly connective networks, and curvilinear street systems can be (and often are) effectively grid in character – i.e. have high internal connectivity.

Table 2. Comparison of contemporary planning thinking and safety-conscious planning

	Contemporary planning thinking	Emphasis in safety-conscious planning	What we know
1 Primary values	Principles of new urbanism; energy conservation; personal security; "architecture of community"; importance of form; cost savings; "sustainable transport".	Road safety should not be compromised. There are ways to satisfy all important objectives.	Integrated planning requires that all valid objectives be acknowledged and pursued in the planning process.
2 The importance of road safety.	Road safety is not a dominant (often not even an explicit) objective, and certainly not at the cost of other planning values.	Developments with identified levels of inherent risk are unacceptable.	Road safety is high on the community agenda.
3 Validity of past guidelines and experience.	Engineering requirements have created unliveable neighbourhoods. Past evidence not valid (e.g. Higgs 1999).	Accumulated research and experience cannot be ignored. Trade-offs between objectives are neither desirable nor necessary.	The validity and legitimacy of the role of technically-based road safety expertise in local planning matters needs to be re-established. Until it is, debate and investigation on the other matters would seem to be futile. As *Figure 1* shows, the network and road elements of "conventional" planning for road safety had their origins in classical planning of the early and mid-1900s, not from traffic engineering.
4 Integration or segregation of road functions?	Encouragement of mixed street environments and functions. 'Active' and 'supervised' spaces are needed for pedestrians.	Segregate vulnerable road users and local circulating traffic from arterial traffic movements.	The two requirements are not incompatible. However, the separation of vulnerable road users from higher volumes and speed of traffic is a classic requirement (Biehl 1969; Scaft 1968, DoE 1973; OECD 1975, 1977a, 1977b; ORS 1978, 1984; Brindle 1978). "Segregated" new towns were observed to have the lowest pedestrian accident rates (Riddell 1977; Muhlrad 1976; Bennett 1974; Gunnarson 1974).

Table 2 cont…

5 Corollary: Ubiquity or protection of functions?	All roads are residential and/or for community use.	Transport arteries must be kept away from residential and community activity.	Demands for greater, rather than less, conflict between frontage development and arterial traffic is a major area needing resolution. Increased frontage activity is known to lead to kerbside parking (hence greater pedestrian hazard), lower amenity and safety for occupants and road users alike, and greater generation of random pedestrian crossing movements. "Frontages without vehicular access" may overcome some of the difficulties, but dispute still remains over the safety effects of deliberate side friction and interruptions to traffic flow. Access management (below) arises from this concept of functional differentiation.
	Contemporary planning thinking	**Emphasis in safety-conscious planning**	**What we know**
6 Access management	Encouragement of frontage land uses along arterials.	Separate access functions from movement functions as much as possible.	Objectives are not incompatible. The relationship between level of access and accidents is well-established (Brindle 1998). Access management is currently the most significant area of road safety activity in land use-transport planning and management
7 Disperse or concentrate traffic?	Spread the traffic to disperse the traffic problems: Uniform distribution of traffic through the local street system, as a design objective. Greater capacity and environmental savings will result.	Minimise exposure to traffic risk and dis-amenity by concentrating it where it belongs. Capacity of the local network is not a significant issue. Environmental costs of dispersing traffic are greater.	Areas containing multi-path street systems expose more residents to traffic intrusion and disturbance. Experience with LATM (traffic calming) suggests that there is resentment of "other people's traffic"; the "problem" is not disposed of by being dispersed.
8 The nature of local street networks.	Create "permeable" (sic) (that is, connective and internally connected) street networks inside neighbourhoods.	Design the local street system to deter through traffic movements, to minimise trip segments on the local street system, and to maximise use of the arterial system by purposeful traffic.	"Within the scope allowed by current conventional standards, the safety effects of design details are observed to be quite small compared with the effects of traffic flow (Bennett and Marland 1978). This leads the same authors to the observation that 'the safety of an estate is likely to depend principally upon the basic strategy of its layout, rather than on

			its detailed design', confirming conclusions from observed differences between accident rates in different modern residential estates (Gunnarson 1974)". (Brindle 1978)
9 Culs-de-sac.	Total avoidance of loops and culs-de-sac.	Maximise the number of dwellings on low-connectivity streets.	Neighbourhoods based on low-connectivity streets (including culs-de-sac) have lower accident rates than areas containing connective streets and many cross-intersections (see *Table 3*). (Bennett 1974; Bennett and Marland 1978; supported by subsequent empirical experience in Australia.)
10 Local road hierarchy	Avoidance of collector-type streets (i.e. ostensibly non-hierarchical).	Minimise length of collector (distributor) street within a development. Hierarchical distinction between roads is important	A clear distinction between local streets and traffic routes is well-founded, but the problems of local distributors (collector roads) are well-known (Brindle 1989).
11 Local intersections and junctions.	(By implication) Many minor-minor intersections are acceptable.	Network types that increase the number of intersections are less desirable.	Safety and economic efficiency of a development are inversely related to the number of local intersections. 10-15% of urban crashes occur at minor local intersections.

(Table 2 ctd.)

	Contemporary planning thinking	Emphasis in safety-conscious planning	What we know
12 Local cross intersections	Cross intersections commonly encouraged and are an inevitable consequence of connective grid networks. Opposition to cross intersections is dismissed as "paranoia" (Higgs 1999).	Uncontrolled cross intersections to be avoided.	Uncontrolled local cross intersection commonly feature highest in local crash sites. Roundabouts may be an answer, but frequent roundabouts at intersections of narrow streets present severe difficulties for service and emergency vehicles.
13 Street lengths	Longer continuous street lengths, as a consequence of connectivity and connectedness.	Keep uninterrupted street lengths below 150-200 m.	Street section lengths are the major influence on speed.
14 Connections with boundary arterials.	Frequent minor-major junctions.	Moderate minor junction frequency along higher-order and higher-speed roads, to minimise conflicts and exposure.	Around a third of urban crashes appear to occur at minor-major intersections (mostly T-junctions) (Cairney 1986; Daff and Hua 1981). See *Table 4*.
15 Land use mix.	Create mixed land uses.	Minimise exposure of residential and other sensitive environments to inappropriate traffic.	Not commonly raised as a road safety issue, except in terms of traffic mix.
16 Kerbside parking.	Acceptance (even encouragement) of kerbside parking on all classes of road, as an element of urban activity and a speed control measure (e.g. Higgs 1999).	Parking should be regulated and probably avoided on all through lanes carrying traffic above 60 km/h. Parking should be indented or prohibited where there is likely to be risk of sight distance limitations.	High involvement of parked vehicles in local street non-intersection accidents. Hazards to small children caused by parked vehicles was a primary impetus for the original *woonerf* concept in Delft.
17 Dealing with traffic and safety problems.	Traffic calming and management can resolve problems that arise.	Not all problems can be adequately fixed later; known problems should be avoided in the planning and design stages.	Safety auditing encourages early detection of likely safety problems and their avoidance at the planning stage if possible.

Table 3. Pedestrian accident rates in culs-de-sac compared with rates for all streets (UK)

	Pedestrian accidents per 10 000 inhabitants of relevant age group	
Age group	Culs-de-sac	All residential streets
All children	4.0	23.6
Children 0-4	7.9	23.8
Children 5-9	4.15	36.3
Children 10-14	1.0	12.1
Adults	0.18	2.6
All persons	1.3	8.5
Non-pedestrian accidents per 10 000 inhabitants per year	0.4	8.5

Source: Bennett and Marland (1978)

What does the evidence say about network form and walking or vehicle efficiency?

The first point to make is that propensity to walk is influenced by the attractiveness of the alternatives. Grid street systems that make car trips more direct are hardly likely to encourage walking. As Martin (1989) pointed out, permeability for pedestrians does not mean that street systems have to be connective or internally connected.

There has been some misinterpretation of the Victorian Greenhouse Neighbourhoods Study (Loder and Bayly 1993), even by the client for that study, to claim that it "proves" that local grid street systems are more "Greenhouse friendly" (Department of Planning and Development 1993, p.17). However, close examination of the source documents reveals that the consultants very carefully stated that, of the factors they were asked to vary, the nature of the street system could not be shown to affect travel behaviour. The consultants for that study were required to test the effects of varying three components: density, mix of land uses, and grid vs collector-based networks. They concluded that network type was not a major influence on fuel use and emissions, and pointed out that in any case they had not been asked to consider other externalities *(such as safety consequences)* which would have to be taken into account in practice. It is perhaps significant that the same consultants had earlier produced material that tried to balance the demands of road safety and those of "New Urbanism" (Loder and Bayly 1990, Working Paper 3). Their contribution has rarely, if ever, been acknowledged.

It would seem reasonable to expect solid evidence to support deviations from established empirically-based practices. However, as is often the case when there is a strong body of conventional wisdom, research in this field has been slow to evolve – on the contrary, there is "little empirical and theoretical support for these claims" (Crane and Crepeau 1998). Objective analysis of actual travel behaviour is not supporting the case for "connectivity at all costs". Crane and Crepeau, for example, analysed travel diary and GIS data in San Diego. In summary, they found little role for land use in explaining travel behaviour, and no evidence at all "that the street network pattern affects either short or long non-work travel decisions". Unless one

believes that the exceptions prove the rule, there are increasing grounds to doubt the absolutist position that connective street systems are essential to increasing walking and reducing car use for local journeys.

Meanwhile, there remains the potential traffic safety downside inherent in a preference for connective over tributary or disconnective local street systems. It would be enlightening to know of parents' attitudes to their children walking to school in such networks; a grid network with perceived traffic exposure and safety problems, especially at intersections, may well *deter* walking, at least by children.

The sad irony is that there is no need for the conflict that the "passion for permeability" has created. An adequate level of permeability for vehicle travel to meet fuel consumption and other environmental objectives can be provided through a connective traffic network at around 800 m grid spacing. Permeability for pedestrian movement requires a much finer grain of connective paths at the local level. To match that level of connectivity for motor vehicle movement is likely to encourage more rather than less car use. It almost certainly would be disadvantageous to pedestrian safety and amenity, and to the quality of the locality as a whole.

Table 4. Accident percentages by location type, Melbourne 1981.
(See Item 14, Table 2)

Location category	Percentage of reported casualty accidents
Major/major intersections	18
Major links	28
Major/local intersections	30
Local intersections	12
Local links	10

Source: Cairney (1986)

Summary and conclusions

The key points that this paper moves toward can be simply stated:

1. There is a reasonable body of literature and extensive experience to back safety-conscious planning and the guidelines to which it gives rise.
2. Contemporary town planning rarely acknowledges this established body of knowledge, and in fact is more likely to actively discount it.
3. The standard guidelines for road safety previously available to planners emphasised three main things: reducing vehicle travel; creating conditions conducive to integration of road users where appropriate; and segregating vulnerable road users from vehicles in other cases.
4. The frequency of local street crashes justifies continued concern about the safety aspects of local planning in particular.

5. Awareness of the contribution of planning to road safety has fallen away in the past 15 years, and there has been a corresponding paucity of new contributions to research and knowledge. There have been recent signs of a desire to get planning on to the road safety agenda, and vice versa.
6. Two current trends in planning have had the effect of inhibiting the cause of road safety in planning practice: the introduction of integrated planning, and the explosion of enthusiasm for urban forms and design philosophies under the banner of "new urbanism". Many issues can be identified from conflicts between contemporary planning thinking and safety-conscious planning.
7. Integrated planning seems to have had the unexpected effect of marginalising road safety considerations and those who promote them in planning – notably, professional engineers.
8. Current planning practice is driven by enthusiasm for the "new urban" demands for "permeability" and "legibility" in local network design, as principle tools to encourage walking and cycling, and to create local community. In practice, this has meant an insistence on highly-connected local street systems and rejection of culs-de-sac, even though this is likely to create less safe walking environments that may deter rather than encourage walking and mixed street use.
9. Given that planning-for-safety literature commonly supports low-connectivity local street systems, and maximising the number of dwellings on culs-de-sac and loop roads, there is a clear conflict in design intent.
10. Most of the objectives of new urbanism can be satisfied without sacrificing local road safety. There appears to be room for exploring creative compromises by giving due attention to the scale of the area under consideration, the relevance of grain in the networks, traffic generation under various scenarios, and factors influencing driver decisions on trip-making, route choice and so on.
11. Moving to a common set of outcomes and strategic objectives, a focus on ends rather than means, and an acceptance that traffic-related safety is an important planning criterion are essential first steps before safety conscious planning and the "popular" interpretation of new urbanism can find common ground.
12. While it is clear that these uncertainties deserve some attention, it is also clear that many well-founded planning-for-safety measures are being ignored or deliberately contradicted in current practice. The empirical or experiential basis for the "new urbanism" and other innovations is not strong. While some of the claims for "fail safe" street environments may be over-optimistic, the alternatives are to some extent based on unproven faith in physical determinism, and are driven more by architectural values than by behaviourally-based planning.

The fundamental issue is the relevance or otherwise of road safety as a planning outcome. Getting safety onto the planning agenda means first of all getting road safety acknowledged as a key performance outcome, not merely a disposable option.

With regard to practice, there appear to be many issues that require exploration of planning outcomes that satisfy both safety and the new planning intentions. For that to be possible, however, contemporary planning needs to be more specific about desired outcomes (ends) rather than focussing on prescriptive means.

There may be sufficient concern for local authorities and traffic safety agencies to require safety audits of development proposals by suitably accredited persons. To do that consistently and reliably, some form of codification of basic requirements would seem to be warranted. At the same time, the road safety community needs to look hard at the quality of the information it uses to justify its own demands in the planning arena. Both intentions seem to require some up-to-date research and data interpretation.

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