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Abstract

There is much debate in the UK, North America and Australia within both crime prevention and planning concerning New Urbanism and the design of suburban housing layouts. New Urbanism promotes high-density, mixed-use residential developments in 'walkable' neighbourhoods close to public transport, employment and amenities. One significant factor is New Urbanism's support for permeability and the preference of the grid street layout over the cul-de-sac (Morrow-Jones *et al.*, 2004). The authors present the evidence as it relates to the grid and the cul-de-sac across a range of inter-disciplinary issues such as crime, walkability, social interaction, travel behaviour, traffic safety, cost and sustainability and housing preferences.

This paper provides a brief history of the grid and cul-de-sac, discusses their respective strengths and weaknesses and concludes that any 'one-size-fits-all' approach is myopic and simplistic. It calls for a more holistic approach to understanding the localised and contextual dimension to suburban street layouts and how they may affect human behaviour. The paper highlights key areas for future research and calls for more inter-disciplinary debate and cooperation, particularly between environmental criminologists, planners and town centre managers.

Introduction

There is an emerging debate in the UK, North America and Australia within both crime prevention and planning concerning the effectiveness and sustainability of suburban housing, which has important potential implications for existing and future developments. Much of the discussion is centred upon developing more sustainable housing, which is at higher densities, is more 'walkable' and interconnected and is close to public transport and amenities, commonly known as New Urbanism. It is largely a reaction against the perceived failures of many existing suburban designs and ever-increasing urban sprawl, although many of the claims of New Urbanism remain largely untested.

New Urbanism promotes high density, mixed-use residential developments in 'walkable' neighbourhoods close to public transport, employment and amenities and generally advocates the use of the grid street layout in preference to the cul-de-sac (Morrow-Jones *et al.*, 2004) with car parking commonly hidden from view, often in rear lanes (Martin, 1996). New Urbanists argue that cul-de-sac layouts are car-oriented, pedestrian-unfriendly and can encourage crime by virtue of reduced levels of social cohesion and connectivity, while grid layouts are less car-dependent, can enhance walkability and reduce crime by virtue of their permeable configuration. This paper explores some of these claims.

Friedman (1987) has defined planning as the link between knowledge and action (Alexander, 2005), and arguably knowledge of the history and effectiveness (or otherwise) of both the grid and cul-de-sac layouts is essential for planners to action 'best practice' in the design of suburban street layouts. Many discipline-specific studies have compared the cul-de-sac with the grid in relation to a number of themed issues, but few have attempted a truly multi-disciplinary evaluation.

Davison (2006) discusses the history, changing function and meaning of the suburb and concludes; "interest in urban sustainability promises not techniques by which to prove the best way to live, but skills of informed debate and wise judgement" (Davison, 2006, p213).

This paper seeks to contribute to this ongoing debate by reviewing the respective strengths and weaknesses of grid and cul-de-sac layouts. The terms 'accessibility' and 'permeability' afford specific meanings for planners (including New Urbanists), which are in conflict with those commonly held by police and crime prevention analysts. The criminological evidence associated with grid and cul-de-sac layouts is presented as background for a methodological call to arms for inter-disciplinary debate and cooperation between disciplines, particularly environmental criminologists, planners and town centre managers.

Planning, CPTED and Designing Out Crime

In North and South America, Australia, South Africa, the UK and many European countries, crime prevention through environmental design (CPTED) or 'designing out crime' is increasingly being used as a planning tool to reduce opportunities for crime, to reduce fear of crime and to assist in the rejuvenation of blighted areas (Taylor and Harrell, 1996; ODPM, 2004; Office of Crime Prevention, 2004; Cozens, 2005). CPTED is underpinned by a substantial body of research published in the second half of the twentieth century (Jacobs, 1961; Angel, 1968; Jeffery, 1969; 1971;

Newman, 1973; Clark and Mayhew, 1980; Brantingham and Brantingham, 1981) and recent reviews have consistently supported its effectiveness as a crime prevention strategy (eg. Poyner, 1993; Taylor and Harrell, 1996; Feins *et al.*, 1997; Eck, 2002; Sorenson, 2003; Cozens *et al.*, 2005).

CPTED is defined by Crowe (2000, p1) as “the proper design and effective use of the built environment [which] can lead to a reduction in the fear of crime and the incidence of crime, and to an improvement in the quality of life”. It involves the design and management of the physical environment to reduce the opportunities for crime and is based upon the assumption that the offender enters into a rational decision-making process before undertaking a criminal act. Following the work of several researchers (e.g. Lynch, 1960; Jacobs, 1961; Angel, 1968; Jeffery, 1969, 1971; Newman, 1973; Clarke and Mayhew, 1980) specific elements of urban design became widely associated with manipulating opportunities for crime. ‘Defensible Space’, for Newman “. . . is a surrogate term for the range of mechanisms - real and symbolic barriers, strongly-defined areas of influence, and improved opportunities for surveillance - that combine to bring an environment under the control of its residents” (Newman, 1973, p3).

Since the 1970’s, CPTED has evolved into a robust sub-division within criminology and now considers the ‘Broken Windows’ thesis (Wilson and Kelling, 1982) which stresses the importance of maintaining the built environment as a physical indicator thereby influencing levels of social cohesion, informal social control and reducing fear of crime. Subsequent work in this area has repeatedly supported these findings (Skogan and Maxfield, 1980; Lewis and Salem, 1986; Vrij and Winkel, 1991; Nair *et al.*, 1993; Kelling and Coles, 1996; Cozens *et al.*, 2001, 2002). A recent review of the CPTED literature (Cozens *et al.*, 2005) finds that there is growing evidence and acceptance of the effectiveness of CPTED as a crime prevention strategy.

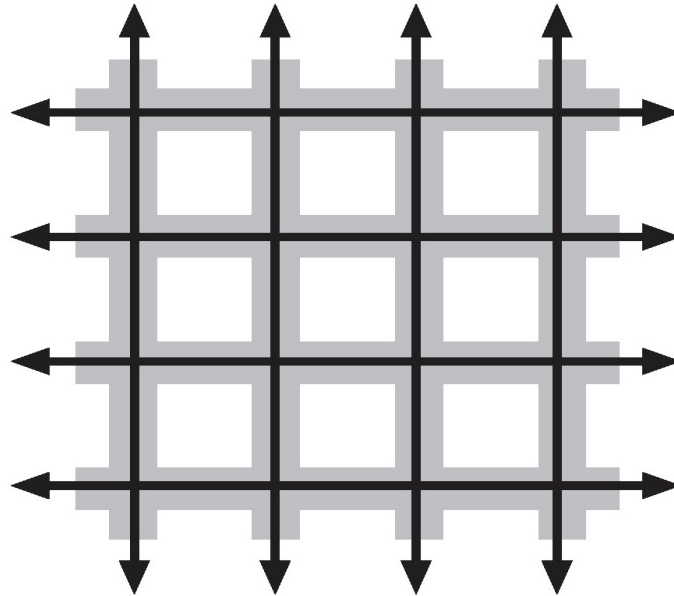
CPTED has emerged in recent years as a socio-physical perspective within both criminology and urban planning and is subject to continuing refinement and evaluation. CPTED builds upon four key strategies of territoriality, natural surveillance, activity support and access control with maintenance and management representing a crucial fifth dimension. It encourages the active use of urban space and discouraging the under-use of such space (e.g. dereliction and vacancy).

However, a significant area of disagreement and debate concerns the issue of how permeable suburban residential areas should be. Some researchers (Hillier, 1988; Hillier and Shu, 2000a, 2000b) argue for permeability and the opportunity this provides for greater pedestrian flows and hence safety through casual surveillance (more ‘eyes on the street’). Others (Town *et al.*, 2003; Poyner and Webb, 1991) argue for less permeability and more enclave-type layouts where it is less easy to walk through, particularly so for non-residents. This polarised debate has now gathered momentum given the rising popularity of New Urbanism and urban policies to increase pedestrian activity and promote the use of public transport. In this paper New Urbanism and the grid and the cul-de-sac layouts are discussed and compared in terms of an array of key issues including crime, physical activity, transportation, safety (traffic accidents), housing preferences, sustainability and cost.

The Grid and the Cul-de-sac – History, Definitions and Meaning

The grid (see Figure 1) is an ancient urban form, which refers “to a plan of generally straight streets meeting at roughly perpendicular intersections in a consistent and comprehensive pattern” (Grant, 2001, p219). It has been observed in many cultures and locations and colonising Europeans exported the grid as a simple and replicable design to Canada, America and Australia (Mumford (1961), where it is relatively common today.

Figure 1. The Grid Street Pattern



Note: the black arrows and grey shaded areas represent shared vehicular and pedestrian routes.

Source: Adeane (2007)

As the problems of urbanisation, industrialisation and ‘laissez-faire’ development became evident in the latter part of the nineteenth century, the proponents of town planning “associated the grid with the worst problems of industrial society” (Grant, 2001, p234). Some urban analysts and planners turned to the Garden City model and winding streets, crescents and irregular shapes came to dominate urban thinking and design throughout much of the twentieth century.

The meaning of ‘cul-de-sac’ derives from a French term meaning ‘bottom of the sack’ and commonly refers to a dead-end street. The *Oxford English Dictionary* defines it as “a street, lane, or passage closed at one end, a blind alley; a place having no outlet except by the entrance”. Cul-de-sac style courts, closes and quadrangles are found in many English, French and German towns of the Middle Ages (Southworth and Ben-Joseph, 2004) and is therefore not a modern idea.

In the UK, the cul-de-sac can be found in Unwin and Parker’s designs for Hampstead Garden Suburb in London over a century ago. An Act of Parliament was required to enable the use of the cul-de-sac in new developments since, according to

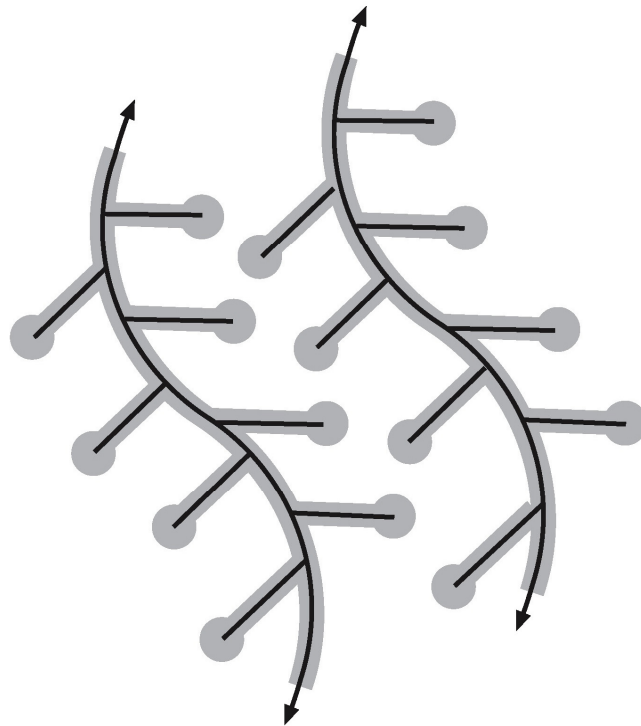
Southworth and Ben-Joseph (2004), this design was previously associated with unplanned medieval cities, unhealthy living conditions and social fragmentation.

A quiet, pedestrian-focused environment was created where courts and close arrangements of terraced houses bordered a central green space accessed by a single narrow service road connected to the public street system.

Early cul-de-sacs were short and narrow, with no circular turning point provided and were often equipped with mid-block pedestrian walkways, which connected to another street or cul-de-sac. Sidewalks were always present with trees and shrubs and architectural features such as walls, fences and gates created a unique pedestrian thoroughfare. They were designed to provide a public realm for residents while allowing safe, slow vehicular traffic movements.

However, although Figure 2 illustrates the commonly recognised 'curvilinear' design, the cul-de-sac can be both as linear and regimented as the grid and has become both elongated and widened – with more dwellings incorporated (see Figure 2).

Figure 2. The Cul-de-Sac Street Pattern



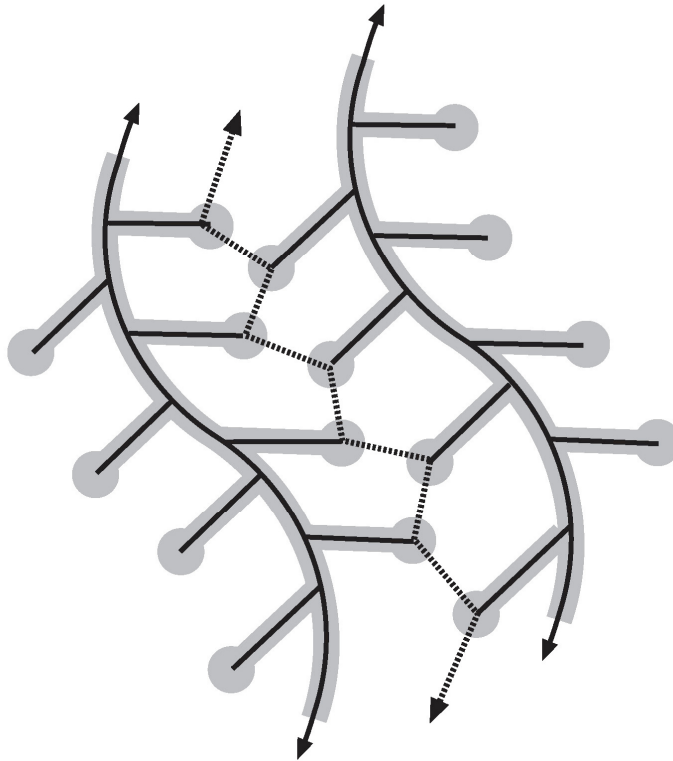
Note: the black lines and grey shaded areas represent shared vehicular pedestrian routes.

Source: Adeane (2007)

The terms 'pure' and 'non-leaking' cul-de-sacs have recently evolved and refer to those designs, which provide access only to the residents who live there and which do not link to other cul-de-sacs or developments via a network of public access ways or pathways (e.g. Figure 2).

Conversely, there are significantly more permeable cul-de-sacs, which are often referred to as 'impure' or 'leaking', which connect to other cul-de-sacs via pedestrian pathways (see Figure 3).

Figure 3. Impure or Leaking Cul-de-sac.



Note: the black lines and grey shaded areas represent shared vehicular and pedestrian routes while the dotted lines represent connecting pathways for pedestrians only.

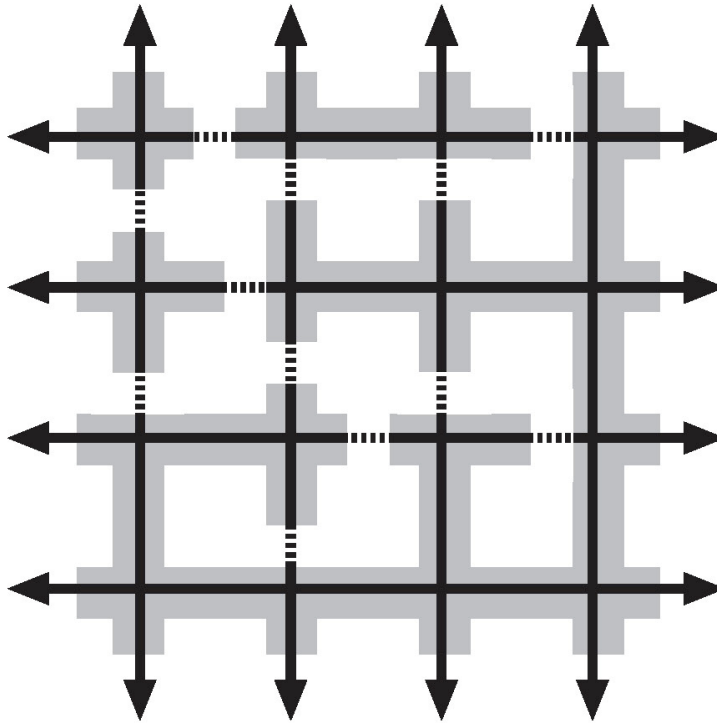
Source: Adeane (2007)

The meaning of 'suburbia' is both highly subjective and contentious and the issue of the grid and the cul-de-sac as street layouts is arguably a dimension within "the semantic confusion that surrounds this subject" (Davison, 2006, p206). This confusion has profound implications for urban analysts, planners, police and residents.

Indeed, although early designs for cul-de-sacs favoured short and narrow streets Southworth and Ben-Joseph (2004, p32) argue "sadly, the urban design qualities of the original have been lost in its offspring", thereby potentially challenging their effectiveness in reducing crime. 'Leaking' and 'non-leaking' cul-de-sacs have been identified and cul-de-sac developments can vary dramatically in terms of their connectivity to other cul-de-sacs and to other facilities (see Figure 3)

Furthermore, there is also a range of more complex grid designs, including staggered and curvilinear grids. An amended grid involves the closure of streets at one end, effectively creating a version of the cul-de-sac (see Figure 4).

Figure 4. Modified Grid



Note: the black lines and grey shaded areas represent shared vehicular and pedestrian routes while the dotted lines signify pedestrian only routes.

Source: Adeane (2007)

Contrary to common belief some New Urbanist themed developments have actually employed a combination of grid and cul-de-sac layouts (Lee and Stabin-Nesmith, 2001). However, in New Urbanist designs the grid is normally the design layout that is promoted as the preferred solution (Morrow-Jones *et al.*, 2004); a decision challenged by this paper.

Grant (2001) argues that planners should recognise the varied history of the grid since it has been applied in urban societies to promote power and control rather than for 'egalitarian' purposes, as some of the New Urbanist thinkers would wish to argue. She argues "while the grid stands as an important civic symbol, the historical record shows that it can represent a wide array of meanings in societies with divergent objectives and organising strategies" (Grant, 2001, p221).

A review of the historical and contemporary use of cul-de-sacs and grids suggests that both continue to be utilised as generic models, which have become fashionable at different points in planning history. Such planning policy shifts are arguably the result of a knee-jerk reaction to a perceived crisis in the city. Both 'courts' and early medieval 'cul-de-sac'-style designs were common and became associated with a range of problems. The grid patterns dominated the period of industrialization where rapid uncontrolled growth created numerous problems for the city. The Garden City movement emerged as a reaction to this – along with the re-emergence of cul-de-sacs. Increased car-ownership and usage during the last fifty years and more recent

issues such as sustainability, walkability and obesity represent some of the current 'problems' facing those planning the city and its suburbs with a return to the grid design and New Urbanist thinking representing the 'new' solution.

Urban sprawl and the rapid increase in the number of cars and car journeys have undoubtedly contributed towards reducing the relative benefits of living in the suburbs with the cul-de-sac now symbolizing all the problems of suburbia (Southworth and Ben-Joseph, 2004). Indeed, Lee and Stabin-Nesmith (2001) have recently re-examined the 1930s Radburn cul-de-sac development in New Jersey and observe many similarities with New Urbanism such as "pedestrian-friendly environments, high-density and mixed land-use development, dependence on public transit and an extensive green park system" (Lee and Stabin-Nesmith, 2001, p179). They argue that not only is the Radburn (permeable cul-de-sac) model still viable, but it can be improved and could underpin a reformed Garden City movement.

This paper will review the research conducted across several disciplines in order to evaluate the strengths and weaknesses of the cul-de-sac and grid design. Specifically, research is presented relating to issues such as crime, walkability, social interaction, travel behaviour, traffic safety, cost and sustainability and housing preferences.

Crime

Jane Jacobs' observations in *The Death and Life of Great American Cities* (1961) underpin much of New Urbanist thinking and her contribution to late twentieth century planning is profound. However, notwithstanding a lack of scientific rigour (common to this era in the evolution of planning and the social sciences), Jacobs' (1961) observations were singularly focused on inner city areas of large American cities in the 1950s. Crucially, the seminal concepts of mixed and diverse land-uses and 'eyes on the street' were not observed in suburban localities. Indeed, Bohl (2000, p766) comments that in spite of the growing number of New Urbanist infill projects "... until recently the volumes of material written on New Urbanism and the modicum of research on it have focused almost exclusively on suburban applications, not the city". Significantly, Jacobs (1961, p26) stated: "I hope no reader will try to transfer my observations into guides as to what goes on in towns, or little cities, or in suburbs which are still suburban".

Furthermore, 'eyes on the street' was a different phenomenon in the 1950's, whereby the usage of interior (domestic) and exterior (public) space was markedly different. Adults used public transport more extensively, went to the cinema, occupied their garden space, shopped on foot locally, walked children to school, walked routinely and frequently to visit relatives (these then lived nearby) and simply socialised at street level. Today, interior spaces are utilised much more and homes are commonly filled with technologies and electronic means of entertainment (also providing more opportunities for crime) and is now defined as the 'leisure action space' for both adults and children. This has led to exterior/public spaces being less used and this withdrawal has led to them being re-labelled and re-defined...often as 'dangerous'. Indeed, Conley and Ryvicker (2001) review three modern ethnographies (one being the locale of Jacobs' original observations), and not surprisingly, finding a very different place, different users and markedly different sets of 'eyes on the street' (the ethnic mix has changed and homelessness is now a significant issue).

Furthermore, some researchers have raised the issue that although design may provide more opportunities for surveillance and more 'eyes on the street', it does not necessarily mean that this routinely takes place (Mawby, 1979).

Superficially, the grid layout would appear to promote Jacobs' (1961) concept of 'eyes on the street'. However, the success or failure of highly permeable and walkable street networks relies on the density of residents and the level of pedestrian use. Under-used connected streets can be isolated and vulnerable to crime and well-used streets have also been associated with higher victimisation rates (Rubenstein *et al.*, 1980). This study also asserted that the shape of traffic intersections influenced levels of crime, with isolated cul-de-sacs being least accessible to crime and cross sections the most accessible. Finally, homes located on streets with heavy traffic flows also exhibited increased vulnerability to crime, as do houses that have easy access and egress routes. Taylor and Gottfredson (1986) echoed these findings reporting that a neighbourhood is more permeable to crime if it directly adjoins a four-lane road or it is close to an exit from a major highway. Both studies found that crime rates are higher for cross-intersections and through streets (grid layouts) than for less permeable cul-de-sacs. Such features impact on the ease with which offenders can learn the street design (including escape routes) – and it is more difficult to familiarise themselves with areas with dead-end roads whilst searching for vulnerable targets. Offenders may also believe that they have less justification for actually being there – since only residents would normally use such space. Research also indicates that the majority of property crimes take place within the routine activity and awareness space of offenders (Beavon *et al.*, 1994). Offenders typically travel short distances to offend in high crime areas (on average 1 mile) and six of the first seven most important reasons for selecting a property to burgle were related to access (Town *et al.*, 2006).

In an American study of crime and proximity to interstate highways, Clontz *et al.*, (2003) found that counties which contained or were close to major highways, had the highest crime rates and higher levels of burglary in houses located on busy residential streets as opposed to cul-de-sacs have been reported (Rengert and Hakin, 1998).

The UK's Secured By Design scheme, which largely promotes the use of non-permeable cul-de-sac layouts, has been evaluated and results indicate that such developments reduce both crime and fear of crime (see Cozens *et al.*, 2004 for a review). Properties on isolated cul-de-sacs generally have lower rates of burglary than more permeable grid layouts and road closures have also been used as a successful crime prevention strategy by limiting access (Newman, 1995, Lasley, 1998).

In a study of a suburb of Dayton, Ohio, Newman (1995) redesigned a traditional grid layout into cul-de-sacs which was suffering from high rates of drug-related violence and property crime. Within two years, violent crime in that neighbourhood fell by 50 percent and overall recorded crime by 25 percent, even as recorded crime in Dayton itself actually increased by 1 percent.

Conversely, research by Hillier and Shu (2000a, 2000b) found that incidents of burglary were higher for more isolated properties located on cul-de-sacs. However, this study analysed a total of only 213 recorded burglaries in three separate towns

over a period of one year – using no control areas and giving no consideration to exogenous or socio-economic factors. The findings revealed that properties in cul-de-sacs were more vulnerable to burglary than properties on grid layouts. Similar findings were reported in an Australian study of the City of Gosnell's Safer City Urban Design Strategy (City of Gosnells, 2001). The approach innovatively investigates burglary 'points of entry' (eg. from a rear lane, direct access from the front or from the side) and uses 'space syntax' software to map the level of intervisibility between buildings and estimates of pedestrian flows. Although houses located on busy streets were less vulnerable than those on isolated streets, the estimates for pedestrian flows may not necessarily reflect the actual levels of use. Crucially, the researchers call for more empirical studies to be conducted and acknowledge that their findings are provisional and should be treated with caution (Hillier and Shu, 2000, 247).

The block unit of the grid provides protection from access to rear gardens and potential access by burglars and is sometimes referred to as the 'island layout'. Here, the entire site is surrounded by roads, and back gardens lie within the interior of the development, accessible only to residents. However, rear lanes and alleyways can significantly increase the vulnerability of this relatively 'secure' layout. Multiple routes make policing more complex and expensive since they provide more opportunities for escape.

Rear laneways are commonly promoted in New Urbanist thinking (Martin, 1996; 2001) and are often used to remove cars from view. However, they also provide offenders with easy, concealed and unchallenged access to the rear of properties and to vehicles that may not be routinely or casually overlooked by residents. Research indicates that such laneways (at least in the UK) are synonymous with crime, fear of crime, litter and anti-social behaviour (Johnson and Loxley, 2001; Tilley *et al.*, 1999). Crucially, much car crime is linked to the location and proximity of parking areas in relation to the domestic property and visibility is an important factor. Garages / driveways located within the curtilage of the building which are visible to residents from the property have obvious advantages compared with car parking areas hidden from view in rear alleyways for example. According to Town *et al.*, (2003), the safest parking location is in a garage within the property and the risk of theft increases significantly for cars parked in the driveway (16 times more vulnerable), in the street outside the home (52 times more vulnerable) and in public car parks (200 times more vulnerable).

Guttery (2002) highlights some of the potential crime problems associated with alleyways (providing access to the rear of properties) and in the light of this urges New Urbanists to consider traditional on-street parking as an option. Furthermore, a United States Department of Justice (USDOJ) Report (Clarke, 2002) cites numerous examples of studies (Bevis and Nutter, 1977; Beavon *et al.*, 1994; Wagner, 1997; White, 1990), which indicate that reducing connectivity reduces crime. Such findings are also consistent with those emerging from the British Crime Survey (Mirrlees-Black *et al.*, 1998) and warrants serious consideration by New Urbanist thinkers and practitioners. Indeed, the USDOJ report states (Clarke, 2002, p6) "most research supports the idea that burglars avoid houses in cul-de-sacs, unless these abut wooded areas or wasteland affording access from the rear".

More recently, Schneider and Kitchen (2007) have reviewed the issue of

permeability, citing further studies, which indicate that reducing connectivity can reduce crime (Rengert and Hakim, 1998; Hakim *et al.*, 2001; Yang, 2006). The authors also cite a study by Yang (2006), which analysed over three thousand incidents of recorded residential burglary and investigated the influence of a variety of environmental factors, including street layout. Yang's study (2006) revealed that cul-de-sacs exhibited significantly lower levels of victimization from burglary than did houses on grid street layouts.

To complicate matters further, it may be the case that each type of street layout will respond differently in relation to different types of crimes. Indeed, crimes against the person require the presence of a person or people at different densities in different circumstances for different crimes and the layout of streets may facilitate or discourage different crimes in different ways. Indeed, an investigation of crimes committed at bus stops found that most serious offences occurred late at night when people (and therefore surveillance) were scarce (Loukaitou-Sideris, 1999). On the other hand, most public nuisance crimes (e.g. pick pocketing, street drinking, buying and selling of drugs and stolen merchandise) occurred when there was a large volume of pedestrian traffic, which served to effectively screen low level offences (Mayhew *et al.*, 1979, Loukaitou-Sideris, 1999). A study by Armitage (2007) also demonstrates that permeable street layouts are subject to higher levels of crime than less permeable layouts, such as non-leaking cul-de-sacs.

Crucially, Brantingham and Brantingham (1998, p53) have called for a broader consideration of environmental criminology within planning arguing "most planning proceeds with little knowledge of crime patterns, crime attractors, crime generators, the importance of edges, paths and nodes or the site specific solutions that facilitate or even encourage crime".

Walkability

Supporters of New Urbanism claim it can reduce both travel distance and travel time, extend public transport use and lessen car-dependency and has been demonstrated using simulated environments (Kulash *et al.*, 1990; Gordon and Peers, 1991; McNally and Ryan, 1992), however, few newly-built New Urbanist developments have been critically or systematically evaluated.

In terms of the grid, it permits better connectivity, more choices and shorter distances between destinations and housing can be built at higher densities than in cul-de-sacs. The cul-de-sac lacks well-connected pedestrian / cycle networks – unless it is a 'leaking' cul-de-sac, where it may well be better connected than a grid pattern.

Frank *et al.*, (2004) reviewed recent research reporting that it indicates that more compact urban environments with mixed uses and interconnected streets are associated with higher levels of physical activity (Saelens *et al.*, 2003) and lower levels of obesity (Saelens *et al.*, 2003; Frank *et al.*, 2003; Ewing *et al.*, 2003; Frank *et al.*, 2005). However, studies have also found that urban design factors such as street connectivity and density were not significantly associated with obesity (Frank *et al.*, 2005).

Randall and Baetz (2001) measured 'pedestrian connectivity' in grid versus cul-de-sac layouts finding that connectivity was higher for grid layouts and estimate that

walking distances can be 40% longer for isolated cul-de-sac layouts. However, actual levels of pedestrian activity were not studied and this raises the issue as to whether such increased connectivity necessarily consistently results in increased levels of pedestrian use.

Neighbourhoods with adequate pedestrian activities and amenities (Kitamura *et al.*, 1997; Moudon *et al.*, 1996), higher population densities (Frank and Pivo, 1995; Kitamura *et al.*, 1997) and those with more direct routes (Shriver, 1996) exhibit higher levels of pedestrian activity. A significant issue is therefore whether or not pedestrian activity in the suburbs can attain those levels observed in more vibrant inner city neighbourhoods.

Social Interaction

Human-scale, people-friendly street designs have been linked with increased interaction between residents and increases in children's play activity (Appleyard and Lintell, 1972; Bosselmann *et al.*, 1999). Some research has shown that social interaction and a sense of community may be higher in grid layouts (Hillier, 2000) while other studies report that cul-de-sac layouts can promote neighbourliness, familiarity and interaction (Sanoff and Dickerson, 1971; Smith, 1973; Appleyard, 1981; Je, 1986).

Significantly, European and Australian studies indicate that residents of suburbs value safety and social interaction above easy access and reduced congestion (Ben-Joseph, 1997). Ben-Joseph (1995) compared grids, loops and cul-de-sacs and the findings indicated that cul-de-sacs were preferred even by residents living on grid and loop layouts. The residents felt that they were safer, the environment quieter and that they would be more likely to socialise with their neighbours. Indeed, although the grid system can potentially ease congestion on main thoroughfares it will inevitably generate additional through traffic on residential streets (Kulash, 1990, 1996; McNally and Ryan, 1993; Crane, 1996) travelling at excessive speeds, which challenges both pedestrianisation and social integration.

Transport Behaviour

New Urbanists claim permeable street networks result in less people using cars and more people using public transport, however, some transport planners have challenged this association (Crane, 1996; Crane and Crepeau, 1998). Indeed, Crane and Crepeau (1998) reviewed this literature and concluded that the neighbourhood street pattern does not have any significant impact on levels of car or pedestrian travel when controlling for land uses and densities around the trip of origin, trip costs and traveller characteristics. They highlight a range of methodological shortcomings in the research, which prompt questions concerning the conclusions reached in previous studies.

It has been asserted that the cul-de-sac restricts transport choices in that they can be isolated from transport nodes. However, this may be more related to the location of the suburb rather than its layout and a grid suburb that is isolated from public transport would similarly restrict transport choices. Indeed, a study by Cervero and Gorham (1995, p217) found just that, concluding "islands of neo-traditional development in a sea of freeway oriented-suburbs will do little to change fundamental community habits".

Urban sprawl and suburbanisation have created residential environments that were designed for the car, rather than for people (Christoforidis, 1994). However, it is naive to assert or accept that these suburbs are simply cul-de-sacs and confuses the importance of their isolated location with a specific design form. There is also the problem of assuming that interconnected grid layouts will somehow change people's lifestyle habits and reduce car dependency. Audirac and Shermyn (1994) argue that car-focused isolation is attributable to changes in lifestyle and changing patterns of personal preferences rather than the structure and design of our cities. Furthermore, Southworth and Ben-Joseph (2004) report that in many American cities that possess the connectedness, walkability and accessible land-use patterns advocated by New Urbanism, the problems of traffic congestion, noise pollution and road hazards have resulted in the conversion of the grid layout into cul-de-sac patterns using bollards and concrete planters.

Traffic Safety.

Although the grid system can potentially ease congestion on main streets it will generate additional through traffic on residential streets (Kulash, 1990, 1996; McNally and Ryan, 1993; Crane, 1996) travelling at excessive speeds, which challenges pedestrianisation and social integration and has implications for traffic safety.

In terms of safety from road traffic accidents research suggests residents living in cul-de-sacs experience lower levels of risk than residents of grid layouts (Southworth and Ben-Joseph, 2003; 2004). In general, areas with busier streets (greater posted vehicle speeds and/or greater traffic volumes) were associated with an increased risk of pedestrian injuries (Mueller *et al.*, 1990).

However, children living in cul-de-sacs may not develop effective road crossing and traffic awareness skills in relation to other designs and may be more vulnerable if and when they move in and around properties that are not in cul-de-sacs. A comparative study of street patterns by Southworth and Ben-Joseph (2004, p31) suggests that cul-de-sac streets "perform better than grid or loop patterns in terms of traffic safety, privacy and safety for play".

Cost and Sustainability

Disconnected cul-de-sac layouts adapt better to topography and can work around areas of premium ecological or historical value (Ben-Joseph, 1997; Southworth and Ben-Joseph, 2003; 2004) thereby contributing to sustainability. Moreover, in certain contexts the cul-de-sac can be *the* most appropriate and effective layout, particularly in residential developments which are adjacent to major transport routes such as motorways and railway lines or major geographical features in the landscape, such as rivers. Connectivity across such routes is clearly problematic and inappropriate and cul-de-sacs are often well-suited to these situations.

Research has indicated that the proportion of development land taken up by roads in cul-de-sacs is lower than that of grids (Girling and Helphand, 1994) and that utility costs are also lower. Other analysts suggest that the grid design consumes more open space, is less supportive of an independent pedestrian network, and is less environmentally sensitive. (Kaplan, 1990; Handy 1991; Crane 1996). The sustainability of the grid has also been challenged in a study by Ben-Joseph (1997)

which revealed that neo-traditional grid developments had more than half as many street miles as the typical cul-de-sac design and nearly a third more street intersections, as well as 73 percent more acres of rights-of-way. This additional acreage and greater street mileage resulted in higher infrastructure costs that were ultimately borne by the homebuyers (Wells, 1993) and a study by Hughes (1992) suggests house prices are negatively affected by traffic intensity.

A controversial report, *The Cost of Policing New Urbanism* (Knowles, 2003) claims that policing costs for a 4,500 housing development would be three times higher for permeable New Urbanist designs as compared with the non-permeable cul-de-sac layouts advocated by the UK's Association of Chief Police Officers (ACPO) in the Secured By Design scheme. This report also asserts that reported crime (burglary, motor vehicle theft, theft from a motor vehicle and criminal damage) is five times higher in the New Urbanist layouts investigated (Town and O'Toole, 2005). However, some have argued that many of these layouts were not necessarily New Urbanist in character (Steuteville, 2003) and have challenged these findings

Housing Preferences

Research findings consistently report homebuyer preference for cul-de-sacs compared with alternative layouts (Morrow-Jones *et al.*, 2004) and for detached and semi-detached properties in suburbia with private gardens (Senior *et al.*, 2006). Furthermore, homebuyers often pay premium prices for properties in the most isolated cul-de-sacs (Smith, 1973; Bookout, 1992; Southworth and Ben-Joseph, 2004; Morrow-Jones *et al.*, 2004). A study of housing values by Guttery (2002) asserts that properties backing on to alleyways should be costed at 5% less than those not on alleyways and suggests New Urbanists should "reconsider alleyways in favour of traditional suburban parking" (Guttery, 2002, p271).

Research consistently demonstrates that, not only do homebuyers desire properties on cul-de-sacs but they also believe them to be safer, quieter and more secure from crime (Southworth and Ben-Joseph, 2003; 2004; Morrow-Jones *et al.*, 2004).

Table 1 summarises the evidence on crime, walkability, social interaction, transport behaviour, traffic safety, cost and sustainability and housing preferences. Clearly, much of the evidence is inconclusive and some challenges the claims of New Urbanism as they relate to the cul-de-sac street layout. In their re-examination of the cul-de-sac Southworth and Ben-Joseph conclude; "rather than tossing out the cul-de-sac as an urban pattern, it is worth reconsidering its values and possibilities in creative ways" (2004, p33).

Table 1. A Summary of the Evidence

Issue	Summary of Evidence
Crime	<p>Permeable street layouts exhibit higher levels of crime than less permeable street layouts. Rear laneways can be problematic and provide both access and escape routes for offenders.</p> <p>Research strongly suggests permeable street layouts are more vulnerable to crime.</p>
Walkability	<p>Some studies show permeable street layouts encourage walking and physical activity while other studies reveal contradictory findings.</p> <p>Research is largely inconclusive and methodological issues make conclusions difficult.</p>
Social interaction	<p>Some studies show social interaction is higher in communities with permeable street layouts, other studies dispute this finding.</p> <p>Research is largely inconclusive</p>
Travel behaviour	<p>Some studies show permeable street layouts reduce car use while other studies reveal contradictory findings.</p> <p>Research is largely inconclusive and methodological issues make conclusions difficult.</p>
Traffic safety	<p>Studies report reduced levels of traffic accidents in less permeable street layouts.</p> <p>Research largely supports less permeable street layouts.</p>
Cost	<p>Less permeable street layouts use less land and utility costs are lower. Policing and infrastructure costs are higher for permeable networks.</p> <p>Research largely supports less permeable street layouts.</p>
Sustainability	<p>Permeable street layouts consume more land and are less environmentally sensitive. Cul-de-sac layouts adapt better to topography and can work around areas of premium ecological or historical value. Other research supports permeable networks which can be built at higher densities.</p> <p>Research is largely inconclusive and methodological issues make conclusions difficult.</p>
Housing preferences	<p>Semi-detached and detached properties on a large block of land in a cul-de-sac remain the preferred residential choice for many modern home buyers in the UK, North America and Australia.</p> <p>Research reports the preference for less permeable street layouts which are seen as being safer, quieter and more secure from crime.</p>

Empirical Research


On a broader level, research in the disciplines of planning and crime prevention are both plagued by methodological problems associated with evaluating precisely how the urban environment may affect human behaviour, be that transport choices, walking and lifestyle habits, social interaction or criminal activity. Similar problems are also associated with clearly defining precisely which type of urban form or street configurations are being investigated.

Transportation and urban planning literature have documented that the number and proportion of those walking and cycling increases with residential density, mixed use, and street connectivity. This is especially so when adjusting for socio-demographic co-variables including age, income, and educational attainment (Ewing and Cervero, 2001; Frank, 2000). Consequently, a significant new relationship between urban form, travel behaviour and public health is currently being interrogated within the academic community (Sallis *et al.*, 2004; Dannenburg *et al.*, 2003; Srinivasan *et al.*, 2003; Lavizzo-Mourey and McGinnis, 2003).

However, Frank *et al.*, (2004) point out that most of the research is of a cross-sectional design where levels of travel and physical activity are observed for different respondents in different urban environments. They highlight the problems of measuring the influence of other (exogenous) factors, such as attitudes to walking and the initial self-selection of a walkable environment in which to reside (Krzizek, 2003).

Similar operational problems persist within the field of CPTED, with numerous studies 'indicating' that design can influence criminality without necessarily 'proving' the precision of this relationship empirically. Crucially, the US Congress report *Preventing Crime: What Works, What Doesn't, What's Promising* (Sherman *et al.*, 2002) revealed that 90% of place-based crime prevention evaluations showed some evidence of crime reduction effects – often relatively large reductions. The review used a framework for categorising the methodologies used in the studies evaluated to assess how empirically robust they were. The Maryland Scientific Methods Scale (Sherman *et al.*, 2002) evaluates the strength of evidence concerning a programme's effects on crime. It focuses on the question of whether there is reasonable evidence that a programme has any beneficial effect whatsoever in reducing crime (see Figure 5).

Figure 5. Maryland Scientific Methods Scale

Level of empiricism and reliability	Scale	Description
<p style="text-align: center;">LOW</p>  <p style="text-align: center;">HIGH</p>	1	Correlation between a crime prevention programme and a measure of crime or crime risk factors at a single point in time. Studies without pre-intervention measures.
	2	Temporal sequence between the programme and the crime or risk outcome clearly observed, or the presence of a comparison group without demonstrated comparability to the treatment group. Pre-post design without control areas.
	3	A comparison between two or more comparable units of analysis, one with and one without the programme.
	4	Comparison between multiple units with and without the programme, controlling for other factors, or using comparison units that evidence only minor differences.
	5	Randomised assignment and analysis of comparable units to the programme and comparison groups.

Source: Sherman *et al.*, 2002.

In Sherman *et al.*, (2002) the effectiveness of the majority of the place-based initiatives was categorised as ‘unknown’ and most failed to meet the highest methodological and evaluative standards. Indeed, only two place-based studies (Crow and Bull, 1975; Eck and Wartell, 1996) met Level 5 on this scale (Sherman *et al.*, 2002). However, this does not necessarily mean that studies below Level 5 did not demonstrate the effectiveness of a place-based strategy, merely that it cannot be empirically ‘proven’ that they did so.

Crucially, conclusions drawn from criminological and planning research may be less reliable or even flawed if they derive from poorly designed studies. Indeed, Farrington (2003, p218) comments “it is recommended that policy makers, practitioners, funders, the mass media, and the general public need better education in research quality so that they can tell the difference between good and poor evaluation studies”. Developing a model for measuring and categorizing the quality of planning research along the lines of Sherman’s Maryland Scientific Methods Scale (2002) will go some way to achieving this.

Government policy is increasingly evidence-based, but certainly appears to lack such evidence with regard to some of the claims of New Urbanism, particularly in its preference of the grid over the cul-de-sac layout.

Intriguingly, planning policy in the UK, America and Australia increasingly promotes the use of CPTED and designing out crime while also supporting connectivity and permeability. This may be effective for vibrant, inner city areas, but is potentially

problematic for more quiet, residential suburbs, where levels of pedestrian activity and 'eyes on the street' are likely to be lower. Planning practice is also beginning to adopt CPTED, but its application is often 'one-size-fits-all' and fails to consider local context, conditions and dynamics, particularly in relation to permeability. If CPTED is to represent a useful tool for planners, it must expand beyond the current 'cookie-cutting' approach that policy and practice appears to be promoting. CPTED is best applied as a process to assist planning decision-making, rather than promoting one design typology over another. It can be used for both measuring and understanding local crime and fear of crime problems and for the subsequent evaluation and installation / modification of appropriate environmental design solutions.

This paper has highlighted the dilemma that currently confronts planners, urban analysts and policy makers in that there is simply a shortage of critically evaluative, empirically grounded and scientifically rigorous research concerning the design of residential areas in our towns and cities. The way forward requires not only a thorough review of existing designs and their performance but also the systematic monitoring of a range of residential designs in different urban locations as a matter of priority. Without such an approach to evaluating the design of urban residential spaces the future of our towns and cities will continue to be determined by those ideas that acquire fashionable status, the whims of politicians and other powerful commentators or uncritical allegiance to a particular design solution. Some tentative suggestions as to how both future research and policy initiatives may be influenced by adopting such a stance are briefly presented below in the sections entitled Recommendations for Research and Policy Recommendations.

Conclusion

The rise in popularity of New Urbanism has certainly influenced a planning policy shift towards permeable, high-density, grid layouts close to transport facilities and other amenities. However, this is much to the chagrin of the police, particularly in the UK, where less-permeable cul-de-sac layouts are the preferred option, underpinned by research evidence. In the UK, America and Australia, government policy now largely supports the use of grid layouts while the cul-de-sac has been largely rejected and in parts of America it has been banned altogether (Southworth and Ben-Joseph, 2004). This review of the literature across a range of disciplines indicates that the evidence to support New Urbanism's advocacy for permeable street networks is unfounded or largely inconclusive at best. For several of the issues, such as traffic accidents, housing preferences and crime, the evidence suggests less permeable street layouts perform more effectively (see Table 1). The evidence relating specifically to crime strongly indicates that increased levels of permeability are associated with increased levels of crime.

In view of the evidence, it is argued that the principles of good design are being undermined by the myopic use of simplistic planning 'templates' and 'one-size-fits-all' approaches, such as New Urbanism's promotion of the permeable street networks and in the application of CPTED. Indeed, Alexander (2005, p102) comments "there is no one kind of planning" [and] ... "different kinds of planning need different kinds of knowledge". Planning for suburban housing should therefore utilise good design principles, rather than generic off-the-shelf solutions since research indicates that both the grid and the cul-de-sac street configurations can and do work effectively, and equally there are examples where they are both ineffective. However, it is the

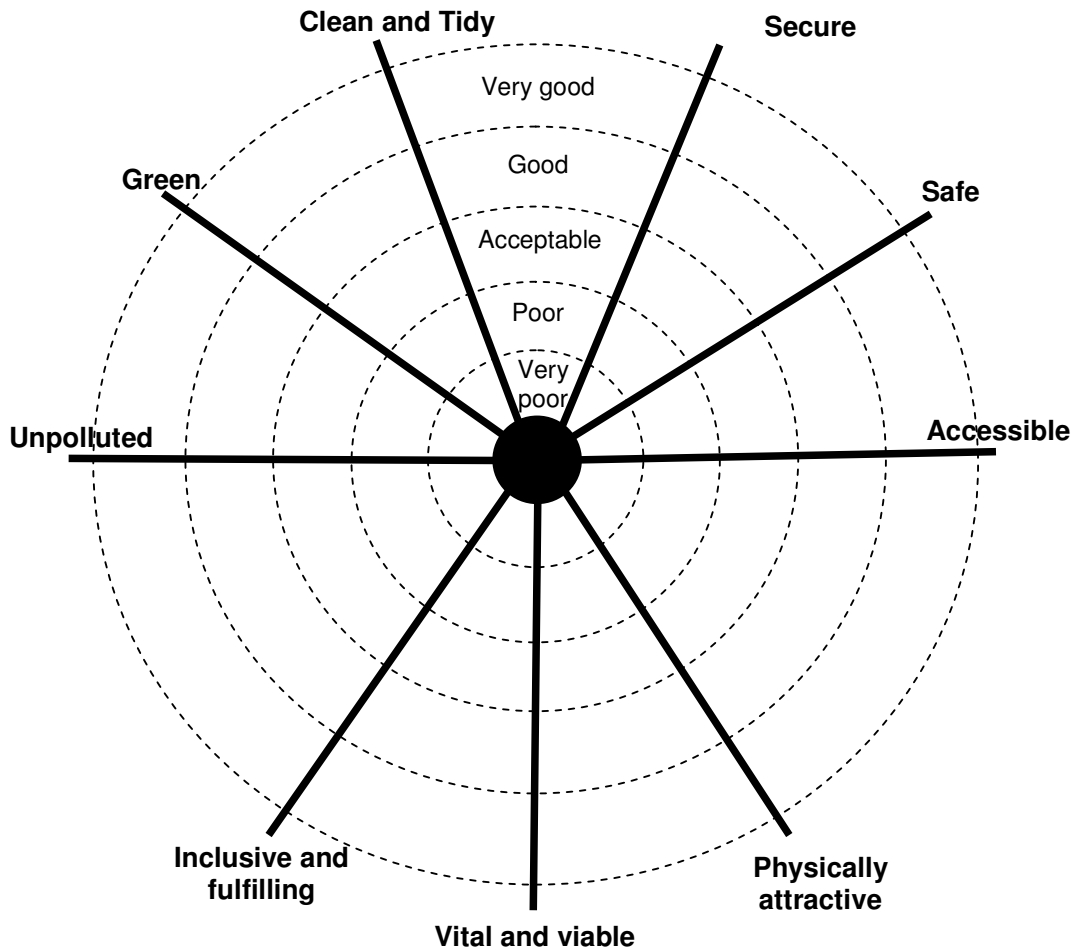
context of each specific situation and the prudent application of design principles that dictates success or failure, not the dichotomous choice of one 'template' in preference to another. Indeed, Pascoe (2006, p2) asserts; "believing that a particular approach to planning has some sense of universality ignores the practical reality of context".

A critical issue of context relates to socio-economic conditions and the notion of class. The authors recognise that less permeable streets such as cul-de-sacs may attract more affluent residents, who may be more able to afford security measures and who will potentially be more likely, both to report criminal activity and to receive a positive response from the police. However, within the literature and more generally, there is limited disaggregated data at the micro scale indicating the social class of residents of properties located in either cul-de-sacs or grid layouts. This review has compared two specific design alternatives and calls for a context-specific approach and does not seek to explicitly include variables of social class. However, research should certainly attempt to consider such variables as ethnicity, demography, income levels and social class in any analysis of the socio-spatial complexities of the human-environment relationship.

Also crucial to context are the dimensions of place, time and change. Most studies are cross-sectional and focus on a particular place at a particular point in time. Crucially, context and locationally-specific findings and recommendations are frequently and simplistically transferred to other locations. Consequently, many of these applications may not be effective and little is known about how specific suburbs in different places evolve or how the perceptions of their residents may differ and change over time. The ongoing local monitoring of the key issues and the perceptions of the community is one area where a contextual dimension can be adopted to more effectively apply generic research findings to achieve more effective local outcomes. In a recent paper on monitoring outcomes in planning, Carmona (2007, p10) presents a useful model (Figure 6) "to provide a means to regularly monitor urban change and map outcome quality" in planning.

In terms of the issues discussed in this paper, such as crime, walkability, social interaction, travel behaviour, traffic safety, cost and sustainability and housing preferences, all have application within this model. It is argued that understanding how suburban layouts perform and how local residents and users perceive them, can contribute much to assessing the outcomes of planning and in improving the contextual application of generic planning theories, such as New Urbanism. Furthermore, engaging with the multidisciplinary evidence and fostering more empirical studies will contribute further to developing a more informed knowledge base from which to make more effective planning decisions and develop more appropriate planning policies. Indeed, in addition to the collection of existing data Carmona (2007, p12) calls for "an explicitly local (as well as national) approach to [the] measurement of a holistic view of outcome quality".

Figure 6. Proposed Community Quality Profile



Source: Carmona (2007, p10).

This paper has reviewed the strengths and weaknesses of the grid and the cul-de-sac street layouts across a range of inter-disciplinary areas, challenging New Urbanism’s advocacy for the grid. It seeks to progress the debate by highlighting the current status of inter-disciplinary knowledge on the performance of the grid and the cul-de-sac street layouts. The review has identified the problem of measuring the quality and value of existing research, emphasized the importance of local context and recommended a move away from the ‘one-size-fits-all’ approaches which usually employ single-issue perspectives, such as those advocated by New Urbanism and current planning policy in the UK, America and Australia.

In the final analysis, it must be concluded that until empirical research demonstrates the superiority of one design over the other, the grid and the cul-de-sac should both remain available within the toolbox of all planners, including New Urbanists. However, adopting a multi-issue perspective that is informed by evidence from a variety of disciplines will assist in improving the decision-making process. The development and collection of local indicators and the perceptions of local residents

of these key issues, in addition to monitoring community quality (Camona, 2007) will be a complex task, but potentially promises crucial local and contextual insights for understanding how suburban street design layouts perform for different communities, in different places and at different times. This review suggests a range of recommendations for planning research, practice and policy, which can contribute to the development of more sustainable and liveable residential suburbs. The recommendations seek to sponsor more evidence-based, informed decision-making to more effectively design and manage 'the shape of things to come'.

Recommendations for Research

- To engage with the evidence from across disciplinary boundaries, particularly criminology;
- To systematically review the quality of evidence as it applies to walkability, travel behaviour, traffic safety, housing preferences, cost, sustainability and crime, and commission high level scientific research;
- To develop a model for measuring and categorizing the quality of planning research to enhance understanding of good / poor evaluation studies;
- To conduct high quality, randomised controlled experiments at Scientific Scale Level 5 research (Sherman *et al.*, 2002) into permeability and crime;
- To promote inter-agency and inter-disciplinary collaboration concerning research which considers placed-based factors *and* attitudinal dimensions to understanding the dynamics of the people-place relationship; and,
- To undertake an empirical and contemporary review of Jane Jacobs' ideas, including 'eyes on the street' (1961) as this may relate to modern suburban residential settings in the twenty-first century.

Policy Recommendations

- To monitor residents' perceptions and use local data for the development of community quality profiles;
- To develop the measurement and availability of more locationally-specific recorded crime data and the commission of research to investigate the relationship of urban form to specific types of crime;
- To execute local fear of crime mapping for analysis in conjunction with the mapping of recorded crime statistics; and,
- To sponsor critical evaluation of 'good' design principles, rather than the application of generic models which may appear to have worked somewhere else.

References

- Adeane, M. (2007) **Personal communication via email 17th February**. Drawings produced by Design Design, Perth Western Australia.
Michael@designdesign.com.au
- Alexander, E. (2005) What do planners need to know? Identifying needed competencies, methods, and skills. **Journal of Architectural Planning and Research**, 22(92), pp.91-106.
- Angel, S. (1968) **Discouraging Crime Through City Planning** (California: University of California Press).
- Appleyard, D. (1981) **Livable Streets** (University of California: Berkeley).
- Appleyard, D. and Lintell, M. (1972) The environmental quality of city streets: the residents' viewpoint **Journal of the American Institute of Planners**, 38 (2). pp84-101.
- Armitage, R. (2000) An evaluation of secured by design within West Yorkshire, **Home Office Briefing Note 7/00** (London: Crown Copyright).
- Armitage, R. (2007) Sustainability versus safety: confusion, conflict and contradiction in designing out crime, pp81-110. In Farrell, G., Bowers, K., Johnson, S. and Townsley, M. (Eds.) **Imagination for Crime Prevention. Crime Prevention Studies Volume 21** (Monsey, New York, Criminal Justice Press).
- Audirac, I. and Shermyn, A. (1994) An evaluation of neo-traditional design's social prescription: postmodern placebo or remedy for suburban malaise? **Journal of Planning Education and Research**, 13, pp.161-173.
- Beavon, D., Brantingham, P. and Brantingham, P. (1994) The influence of street networks on the patterning of property offenses. In R. Clarke (ed.), **Crime Prevention Studies**, Volume. 2 (Monsey, New York: Criminal Justice Press).
- Ben-Joseph, E. (1995) *Livability and safety of suburban street patterns: a comparative Study*. **Berkeley Institute of Urban and Regional Development and University of California Institute of Transportation Studies Working Paper 64**.
- Ben-Joseph, E. (1997) Traffic calming and the neotraditional street. **Resource Papers for the 1997 Institute of Transportation Engineers. International Conference**, pp47-52. Online: <http://www.ite.org/traffic/documents/CCA97A47.pdf>.
- Bentley, I., Alcock, A., Murrain, P., McGlynn, S. and Smith, G. (1985) **Responsive Environments** (London: Architectural Press).
- Bevis, C. and Nutter, J. (1977) **Changing Street Layouts To Reduce Residential Burglary**, (American Society of Criminology: Atlanta, GA).
- Bohl, C. (2000) New urbanism and the city: potential applications and implications for distressed inner-city neighbourhoods. **Housing Policy Debate**, 11(4), pp.761-797.
- Bookout, L. (1992) Neotraditional town planning: the test of the marketplace. **Urban Land**. Washington D.C. June. 12-7.
- Bossleman, P., Macdonald, E. and Kronermeyer, T. (1999) Liveable streets revisited. **Journal of the American Planning Association**, 65(2), pp.168-180.
- Cozens, P.M. and Hillier, D. 2008. The Shape of Things to Come': New Urbanism, the Grid and the Cul-De-Sac. *International Planning Studies* Volume 13(1), pp. 51-73. 22.

Bowers, K., Johnson, S. and Hirschfield, A. (2005) Closing off opportunities for crime: an evaluation of alley-gating. **Journal European Journal on Criminal Policy and Research**, 10(4), December, pp.285-308

Brantingham, P. and Brantingham, P. (1981) **Environmental Criminology** (Beverly Hills: Sage Publications).

Brantingham, P. and Brantingham, P. (1998) Environmental criminology: from theory to urban planning practice. **Studies on Crime and Crime Prevention** 7(1), pp.31–60.

Carmona, M. (2007) Monitoring Outcome Quality in Planning – Challenges and Possibilities. **Town and Country Planning Journal: Tomorrow Series Paper 8**, 76(6/7), pp1-12.

Cervero, R. and Gorham, R. (1995) Commuting in transit versus automobile neighborhoods. **Journal of the American Planning Association**, 61.

Christoforidis, A. (1994) New alternatives to the suburbs: neo-traditional developments. **Journal of Planning Literature**, 8(4), pp.429-440.

City of Gosnells. (2001) **SafeCity Urban Design Strategy**. Perth, Western Australia: City of Gosnells and Australian Urban Solutions,

Clarke, R. (2002) Closing streets and alleys to reduce crime: should you go down this road? **Problem-Oriented Guides for Police Response Guides Series No. 2**. U.S. Department of Justice Office of Community Oriented Policing Services. Online: www.cops.usdoj.gov.

Clarke, R. and Mayhew, P. (1980) **Designing Out Crime**, (London: HMSO).

Clontz, K., Mericle, J. and Maskarinec, M. (2003) **On the Road Again: Crime and Major Transportation Routes**. On-line <http://gis.esri.com/library/userconf/proc03/p0122.pdf>.

Conley, D. and Ryvicker, M. (2001) Race, class, and eyes upon the street: public space, social control, and the economies of three urban communities. **Sociological Forum**, 16(4), pp.759-772.

Cozens, P. M., Hillier, D. and Prescott, G. (2001) Defensible space: burglars and police evaluate urban residential design. **Security Journal**, 14 (3), pp.43-62.

Cozens, P. M., Hillier, D. and Prescott, G. (2002) Defensible space, community safety, the British city and the 'active citizen'. Penetrating the criminal mind. **Crime Prevention and Community Safety: An International Journal**. 4(4), pp.7-21.

Cozens, P.M, Pascoe, T. and Hillier, D. (2004). Critically reviewing the theory and practice of Secured-by-Design for residential new-build housing in Britain. **Crime Prevention and Community Safety: An International Journal**, 6(1), pp.13-29.

Cozens, P.M. (2005). Designing out crime - from evidence to action. **Delivering Crime Prevention: Making the Evidence Work**. Australian Institute of Criminology and the Attorney-General's NSW Department. Carlton Crest Hotel Sydney, 21-22 November 2005. <http://www.aic.gov.au/conferences/2005-cp/cozens.html>

Cozens, P.M. and Hillier, D. 2008. The Shape of Things to Come': New Urbanism, the Grid and the Cul-De-Sac. *International Planning Studies* Volume 13(1), pp. 51-73. 23.

- Cozens, P.M., Saville, G. and Hillier, D. (2005). Crime prevention through environmental design (CPTED): A review and modern bibliography. **Journal of Property Management**, 23(5), pp.328-356.
- Crane, R. (1996) On form versus function: will the new urbanism reduce traffic or increase it? **Journal of Planning Education and Research**, 15, pp.117-126.
- Crane, R. and Crepeau, R. (1998) Does neighbourhood design influence travel?: Behavioural analysis of travel diary and GIS data. **Working Paper UCTC No. 374**. University of California Transportation Centre, Berkley. Online: <http://www.uctc.net/papers/374.pdf>.
- Crow, W. and Bull, J. (1975) **Robbery Deterrence: An Applied Behavioral Science Demonstration - Final Report** (California: Western Behavior Sciences Institute).
- Crowe, T.D. (2000). **Crime Prevention Through Environmental Design: Applications of Architectural Design and Space Management Concepts**. (2nd Edition). (Oxford: Butterworth-Heinemann).
- Dannenburg, A., Jackson R., Frumkin H., Schieber R., Pratt M., Kochtitzky, C. and Tilson, H. (2003) The impact of community design and land-use choices on public health: A scientific research agenda. **American Journal of Public Health**, 93, pp.1500-8.
- Davison, A. (2006) Stuck in a cul-de-sac?: suburban history and urban sustainability in Australia. **Urban Policy and Research**, 24(2), pp.201-216. Online: <http://search.informit.com.au/fullText;dn=200609301;res=APAFT> > ISSN: 0811-1146. [cited 23 Feb 07].
- DOE. (1994) **Planning Out Crime Circular 5/94**, (London, Home Office).
- Eck, J. (2002) Preventing Crime at Places. In Sherman, L., Farrington, D.P., Welsh, B and Mackenzie, D. (Eds.). **Evidence-Based Crime Prevention**, pp9241-294. Routledge, London and New York.
- Eck, J. and Wartell, J. (1996). **Reducing Crime and Drug Dealing by Improving Place Management: A Randomized Experiment**. Report to the San Diego Police Department, (Washington DC: Crime Control Institute)
- Ellis, C. (2002) The new urbanism: critiques and rebuttals. **Journal of Urban Design**, 7(3), pp.261-291.
- Ewing, R. and Cervero, R. (2001) Travel and the built environment: a synthesis. **Transportation Research Record**, 1780, pp.87-122.
- Ewing, R., Schmid, T., Killingsworth, R., Zlot, A. and Raudenbush, S. (2001) Relationship between urban sprawl and physical activity, obesity and morbidity. **American Journal of Health Promotion**, 18, pp.47-57.
- Farrington, D. (2003) A Short History of Randomized Experiments in Criminology: A Meager Feast. **Evaluation Review**, 27(3), pp. 218-227.
- Feins J, Epstein J. and Widom R (1997) **Solving Crime Problems in Residential Neighborhoods: Comprehensive Changes in Design, Management and Use**. US Department of Justice, National Institute of Justice. Washington, D.C
- Cozens, P.M. and Hillier, D. 2008. The Shape of Things to Come': New Urbanism, the Grid and the Cul-De-Sac. *International Planning Studies* Volume 13(1), pp. 51-73. 24.

- Frank, L. (2000) Land use and transportation interaction: implications on public health and quality of life. **Journal of Planning, Education, and Research**, 20 (1), pp.6-22.
- Frank, L. and Pivo, G. (1995) impacts of mixed use and density on utilisation of three modes of travel: single-occupancy vehicle, transit and walking. **Transportation Research Record**, 1466, pp.44-52.
- Frank, L., Engelke, P. and Schmid, T. (2003) **Health and Community Design: The Impact of the Built Environment on Physical Activity**, (Washington DC: Island Press).
- Frank, L., Engelke, P. and Schmid, T. (2004) Public health and the built environment: emerging evidence and complexity. **Canadian Journal of Dietetic Practice and Research**, 65 (2), Summer. Online http://www.kelloggnutrition.com/includes/pdf/2004%20Summer%20DCIns_Built%20Environment.pdf.
- Frank, L., Schmid, T., Sallis, J., Chapman, J. and Saelens, B. (2005) Linking objectively measured physical activity with objectively measured urban form: findings from SMARTRAQ. **American Journal of Preventive Medicine**, 28(2), pp.117-12.
- Friedman, J. (1987) **Planning in the Public Domain: From Knowledge to Action**. (Princeton, New Jersey: Princeton University Press).
- Girling, C. and Helphand, K. (1994) **Yard, Street, Park: The Design of Suburban Open Space** (New York: Wiley).
- Gordon, S. and Peers, J. (1991) **Designing a Community for TDM: The Laguna West Pedestrian Pocket**. 71st Annual Meeting of the Transportation Research Board. Washington, DC.
- Grant, J. (2001) The dark side of the grid: power and urban design. **Planning Perspectives**, 16, pp.219-241.
- Guttery, R. (2002) The effects of subdivision design on housing values: the case of alleyways. **Journal of Real estate Research**, 23(3), pp.265-273.
- Handy, S. (1991) Neo-traditional development: the debate. **Berkeley Planning Journal**, 6, pp.135-44.
- Hilborn, J. (2007). **Planning and Crime**. Resource for Urban Design Information Discussion Forum. Online: <http://www.rudi.net/forums/10880>.
- Hillier, B. and Shu, S. (2000a) Crime and urban layout: the need for evidence. In Ballintyne, S., Pease, K. and McLaren, V. (Eds), **Secure Foundations: Key Issues in Crime Prevention, Crime Reduction and Community Safety** (London, Institute of Public Policy Research), pp.224-48.
- Hillier, B. and Shu, S. (2000b) **Do Burglars Understand Defensible Space?** Space Syntax web site available at: www.bartlett.ucl.ac.uk/spacesyntax/housing/BillCrimePaper/BillCrimePaper.html
- Hughes, W. (1992) Traffic externalities and single-family house prices. **Journal of Regional Science**, 32(4), pp.487-501.

Jacobs, J. (1961) **The Death and Life of Great American Cities** (London: Jonathon Cope).

Je, Hae-Seong. (1986) **Urban Residential Streets: A Study of Street Types and Their Territorial Performances**. Unpublished Dissertation (Pennsylvania: University of Pennsylvania).

Jeffery, C. (1969) Crime prevention and control through environmental engineering. **Criminologica**, 7, pp.35-58.

Jeffery, C. (1971) **Crime Prevention Through Environmental Design** (Beverly Hills: Sage Publications).

Johnson, L. (2003) **SOS – Sustaining Our Suburbs. In Urban Frontiers** (ed), State of Australian Cities National Conference. Carlton hotel, Parramatta, 3-5 December. Deakin University.

Johnson, S. and Loxley, C. (2001) Installing Alley-Gates: Practical Lessons From Burglary Prevention Projects. **Home Office Briefing Note 2/01** (Home Office, London).

Kakim, S., Rengert, G. and Shachamurove, Y. (2001). Target search of burglars: a revised economic model. **Papers in Regional Science**, 6(4), pp.445-464.

Kaplan, S. (1990) The Holy Grid: A Skeptic's View. **Planning**. 59. (November).

Kelling G. and Coles, C. (1996) **Fixing Broken Windows. Restoring Order and Reducing Crime in Our Communities** (Touchstone, Simon and Schuster. New York).

Kitamura, R., Mokhtarian, P. and Laidet, L. (1997) A Micro-Analysis of Land Use and Travel in Five Neighbourhoods in the San Francisco Bay Area. **Transportation**, 24, pp125-158.

Knowles, P. (2001) **Defensible Space and the Distribution of Crime and Disorder in Residential Areas**. Unpublished paper for Bedfordshire Police.

Knowles, P. (2003) The Cost of New Urbanism. **Community Safety Journal**. 2(4), pp33-38. Online: Accessed 10th July 2006
<http://www.americandreamcoalition.org/safety/policingnu/policingnu.html>

Krizek, K. (2003) Residential Location and Changes in Urban Travel: Does Neighborhood Scale Urban Form Matter? **Journal of the American Planning Association**. Spring, 69(3) pp.265-281.

Kulash, W. (1990) **Traditional Neighborhood Development: Will the Traffic Work?** Eleventh International Pedestrian Conference. Bellevue, WA.

Lasley, J. (1998) **Designing Out Gang Homicides and Street Assaults**. (Washington, D.C: U.S. National Institute of Justice).

Lavizzo-Mourey, R. and McGinnis, J. (2003) Making the Case for Active Living Communities. **American Journal of Public Health**, 93, pp.1386-8.

Lee, C. and Stabin-Nesbith, B. (2001) The Continuing Value of a Planned Community: Radburn in the Evolution of Suburban Development. **Journal of Urban Design**, 6(2), pp.151-184.

- Lewis, D. and Salem, G. (1986) **Fear of Crime; Incivility and the Production of a Social Problem** (Transactions: New Brunswick).
- Loukaitou-Sideris, A. (1999) Hot Spots of Bus Stop Crime. **American Planning Association Journal**, 65, pp.395-411.
- Lund, H. (2003) Testing the Claims of New Urbanism: Local Access, Pedestrian Travel and Neighbourhood Behaviours. **Journal of the American Planning Association**, (4), pp.414-429.
- Lynch, K. (1960) **The Image of the City** (MIT Press: Cambridge, Massachusetts).
- Martin, M. (1996) Back-Alley As Community Landscape. **Landscape Journal**, 15(2), pp.138-153.
- Martin, M. (2001) The Question of Alleys, Revisited. **Urban Design International**, 6,2(1), pp.76-92.
- Mayhew, P. (1979) Defensible Space: The Current Status of Crime Prevention Theory. **The Howard Journal**, XVIII, pp.150-159.
- Mayhew, P., Clarke, R., Burrows, J., Hough, J. and Winchester, S. (1979) **Crime in Public View: Home Office Research Study No. 49** (Her Majesty's Stationary Office, London).
- Mayo, J. (1979) Suburban Neighboring and the Cul-de-sac Street. **Journal of Architectural Research**. 7(1).
- McNally, M. and Ryan, S. (1992) **A Comparative Assessment of Travail Characteristics for NeoTraditional**. Resource Papers for the 1997 International Conference 51 Development (University of California, Irvine: Institute of Transportation Studies).
- Mirrlees-Black, C., Budd, T., Partridge, S. and Mayhew, P. (1998) **The 1998 British Crime Survey** (HMSO: London).
- Morrow-Jones, H., Irwin, E. and Roe, B. (2004) Consumer Preference for Neotraditional Neighbourhood Characteristics. **Housing Policy Debate**, 15(1), pp.171-202.
- Moudon, A., Hess, P., Snyder, M. and Stanilov, K. (1996) Effects of Site Design on Pedestrian Travel and Mixed-Use, Medium-Density Environments. **Transportation Research**, 1578, pp.48-55.
- Mueller, B., Rivara, F. Shyh-Mine, L. and Weiss, N. (1990) Environmental Factors and the Risk for Childhood Pedestrian-Motor Vehicle Collision Occurrence. **American Journal of Epidemiology**, 132(3), pp.550-560.
- Mumford L. (1961) **The City in History: Its Origins, Its Transformation and Its Prospects** (Harcoufi Brace Jovanovich: New York).
- Nair, G., Ditton, J. and Phillips, S. (1993) Environmental Improvements and the Fear of Crime. **British Journal of Criminology**, 33(4), Autumn, pp.555-561.
- Newman, O. (1973) **Defensible Space People and Design in the Violent City** (Architectural Press: London).

Newman, O. (1995) Defensible Space: A New Physical Planning Tool for Urban Revitalization, **Journal of the American Planning Association**, 61, pp.2149-155.

Office of the Deputy Prime Minister. (2004) **Places: The Planning System and Crime Prevention** (Office of the Deputy Prime Minister, Home Office: London).

Pascoe, T. (1999) **Evaluation of Secured by Design in Public Sector Housing**. Final Report, BRE, Watford.

Pascoe, T. (2006) **Building Confidence**. Paper in the Designing Out Crime Association's Members' CD-Rom, Unpublished.

Poyner B. (1993) What Works in Crime Prevention: An Overview of Evaluations. In Clarke, R.V. (Ed.), **Crime Prevention Studies**. Volume 1. Criminal Justice Press, Monsey, New York.

- Poyner, B. and Webb, B. (1991) **Crime Free Housing** (Butterworths-Architecture: London).
- Randall, T. and Baetz, B. (2001) Evaluating Pedestrian Connectivity for Suburban Sustainability. **Journal of Urban Planning and Development**, 127(1), March, pp.1-15.
- Rengert, G. and Hakim, S. (1998) Burglary in affluent communities: a planning perspective, in Felson, M. and Pieser (eds) **Reducing Crime Through Real Estate Development and Management** (Urban Land Institute: Washington, DC).
- Rubenstein, H., Murray, C., Motoyama, T. and Rouse, W. 1980. **The Link Between Crime and the Built Environment. The Current State of Knowledge** (National Institute of Justice: Washington, DC).
- Saelens B., Sallis J., Black J. and Chen D. (2003) Neighborhood-Based Differences in Physical Activity: An Environment Scale Evaluation. **American Journal of Public Health**, 93, pp.1552-8.
- Sallis, J., Frank, L., Saelens, B. and Kraft, M. (2004) Active Transportation and Physical Activity: Opportunities for Collaboration on Transportation and Public Health Research. **Transportation Research Part A: Policy and Practice**, 38, pp.249-268.
- Sanoff, H. and Dickerson, J. (1971) Mapping Children's Behavior in a Residential Setting. **Journal of Architectural Education**, 25(4).
- Schneider, R. and Kitchen, T. (2007) **Crime Prevention and the Built Environment** (Routledge: London).
- Senior, M., Webster, N. and Blank, N. (2006) Residential Relocation and sustainable Urban Form: Statistical Analyses of Owner-occupiers' Preferences. **International Planning Studies**, 11(1), pp.41-57.
- Sherman, L., Farrington, D., Welsh, B. and Mackenzie, D. (2002) *Evidence-Based Crime Prevention* (Routledge: London).
- Shriver, K. (1996) Influence of Environmental Design in Pedestrian Travel behaviour in Four Austin Neighbourhoods. **Transportation Research Record**, 1578, pp.64-75.
- Skogan, M. and Maxfield, M. (1980) **Reactions to Crime Project Evanston, II** (Center for Urban Affairs: Northwest University, USA).
- Smith, B. (1973) Cul-de-sac Means Safety Privacy for Home Buyer, **The Atlanta Journal and Constitution**, January 14, Section H.
- Sorensen D. (2003) **The Nature and Prevention of Residential Burglary: A Review of the International Literature with an Eye Towards Prevention in Denmark.**
<http://www.jur.ku.dk/medarbejdere/davesorensen/Publikationer/Nature.pdf>. Site visited 19/07/04.

Southworth, M. and Ben-Joseph, E. (2003) **Streets and the Shaping of Towns and Cities** (Island Press: Washington DC).

Southworth, M. and Ben-Joseph, E. (2004) Reconsidering the Cul-de-sac. **Access**, 24, Spring, pp.28-33.

Srinivasan, S., O'Fallon, L. and Deary, A. (2003) Creating Healthy Communities, Healthy Homes, Healthy People: Initiating a Research Agenda on the Built Environment and Public Health. **American Journal of Public Health**, 93, pp.1446-1450.

Steuteville, R. (2003) **New Urbanism Does Not Promote Crime**. Online: <http://www.planetizen.com/node/107>. Visited 24.01.07.

Taylor R. and Harrell A. (1996) Physical **Environment and Crime**. **National Institute of Justice**. US Department of Justice.

Taylor, R.B. and Gottfredson, S. (1986) Environmental Design, Crime, and Prevention: An Examination of Community Dynamics, Communities and Crime. **Crime and Justice**, 8, pp.387-416

Taylor, R.B. and Harrell, A.V. (1996) **Physical Environment and Crime** (National Institute of Justice, US Department of Justice: Washington, DC).

Tilley, N., Pease, K., Hough, M. and Brown, R. (1999) Burglary Prevention: Early Lessons from the Crime Reduction Programme. **PRCU Research Paper 1** (Home Office Research, Development and Statistics Directorate: London) Online <http://www.homeoffice.gov.uk/rds/index.htm>.

Town, S. and O'Toole, R. (2005) **Crime-Friendly Neighborhoods: How "New Urbanist" Planners Sacrifice Safety in the Name of "Openness" and "Accessibility"**. Online: <http://www.reason.com/news/show/36489.html>. Visited 24.01.07

Town, S., Davey, C. and Wooton, A. (2003) **Design Against Crime: Secure Urban Environments By Design** (The University of Salford: Salford, UK).

U.S. Department of Justice. (2002) **Closing Streets and Alleys to Reduce Crime. Problem-Oriented Guides for Police Response Guides Series No. 2** (Office of Community Oriented Policing Services, U.S. Department of Justice: Washington DC), Online: <http://www.cops.usdoj.gov/mime/open.pdf?Item=1346>

Vrij, A. and Winkel, W. (1991) Characteristics of the Built Environment and Fear of Crime; A Research Note on Interventions in Unsafe Locations. **Deviant Behavior**, 12, pp.203-215.

Wagner, A. (1997) A Study of Traffic Pattern Modifications in an Urban Crime Prevention Program. **Journal of Criminal Justice**, 25(1), pp.19-30.

Wells, M. (1993) **Neo-Traditional Neighborhood Development: You Can Go Home Again** (Virginia Wells & Assoc., Inc: Arlington).

White, G. (1990). Neighborhood Permeability and Burglary Rates. **Justice Quarterly**, 7(1), pp.57-67.

Wilson, J. and Kelling, G. (1982) The Police and Neighbourhood Safety. 'Broken Windows'. **The Atlantic Monthly**, 3, pp.29-38.

Cozens, P.M. and Hillier, D. 2008. The Shape of Things to Come': New Urbanism, the Grid and the Cul-De-Sac. *International Planning Studies* Volume 13(1), pp. 51-73. 30.

Yang, X. (2006) **Exploring the influence of environmental features on Residential burglary using spatial-temporal pattern analysis**. Unpublished PhD dissertation University of Florida. Online:
[www://etd.fcla.edu/UF/UFE0013390/yang_x.pdf](http://etd.fcla.edu/UF/UFE0013390/yang_x.pdf).