It Looks Good, But What is it Like to Live There? Exploring the Impact of Innovative Housing Design on Crime

Rachel Armitage, Leanne Monchuk and Michelle Rogerson*

Correspondence should be addressed to: Dr. Rachel Armitage, Reader, Applied Criminology Centre, University of Huddersfield, HHR02/01, Queensgate, Huddersfield, HD1 3DH. Telephone: +44 (0)1484 473854. Fax: +44 (0)1484 473603. E-mail: r.a.armitage@hud.ac.uk.

ABSTRACT

This paper reports on the findings of a collaborative project (funded by the Home Office and managed by the Commission for Architecture and the Built Environment - CABE) which was conducted in late 2009 and early 2010. The project set out to strengthen and update the evidence base on the impact of design on a range of crime types – with a specific focus upon housing developments acclaimed for their innovative design and award winning architecture. This paper presents the findings of an in-depth assessment of the impact of housing design features on crime. Utilising a comprehensive data collection exercise, the specific design features of thousands of homes were collated and assessed against police recorded crime data. The design features were based upon the key elements of Crime Prevention Through Environmental Design (CPTED) including road layout, house design, surveillance, territoriality, car parking, communal space, management and maintenance and physical security. The unique and painstaking methodology not only provided an excellent dataset for analysis, but also highlighted the need both for greater conceptual clarity within CPTED and for crime-risk assessments to be based on the careful operationalisation and measurement of CPTED factors. As well as assessing the impact of specific (and combined) design features upon crime, the research also resulted in the production of a new data collection tool designed to address the weaknesses of existing checklists in assessing innovative contemporary developments, which are often unconventional in nature. The paper explores the degree of conflict and/or synergy between the traditional principles of CPTED and contemporary directions in architecture and design. Finally the paper considers the extent to which traditional CPTED principles remain relevant within contemporary residential developments and explores whether areas of revision are required.

Key Words: Building for Life, car parking, connectivity, CPTED, designing out crime.

* Dr. Rachel Armitage is a Reader in Criminology at the University of Huddersfield. Leanne Monchuk is a Research Assistant within the Applied Criminology Centre at the University of Huddersfield. Michelle Rogerson is a Senior Research Fellow within the Applied Criminology Centre at the University of Huddersfield.

INTRODUCTION

This paper presents the findings of a study, commissioned by the UK Home Office and managed by CABE (the UK's Commission for Architecture and the Built Environment), which was conducted between 2009 and 2010. The project aimed to strengthen the evidence base regarding the impact of residential design on crime. The research presented an opportunity to clarify some of the confusion regarding particular design features and their impact upon crime (Armitage, 2007) and to investigate the extent to which developments regarded as good practice examples of design quality and place making offer crime reduction benefits – they look good, but what is it like to live there?

The research explored many elements of housing design including surveillance, territoriality, communal space, management and maintenance and physical security. However, this paper focuses upon the two themes which revealed significant and interesting findings – car parking and through-movement/connectivity.

As well as presenting key findings regarding the impact of innovative and award winning design on crime, this paper also discusses the suitability and relevance of existing methods and tools for collecting data on environmental factors and their association with crime. Key issues explored include problems with police recording practices for crimes taking place at high-rise developments[i], the complexities of road layouts which do not follow the traditional categorisation of through road/culs-de-sac, and the categorisation of footpaths (front, rear-access, short, sinuous, linear). One of the key methodological issues to emerge from this study was the importance of physically assessing the site a) to ensure that the environmental features were accurately recorded, b) to account for the adaptations made by residents regarding through-movement, the use of space and car parking, and c) to ensure that the crime and disorder issues, perhaps not traditionally associated with Crime Prevention Through Environmental Design (CPTED) were accounted for within the qualitative analysis. These crime and disorder issues are discussed in detail throughout the paper, but include neighbour disputes regarding car parking allocation, fraud relating to theft from external mailboxes and landlords letting city properties for short city breaks.

Designing out Crime within the Built Environment

It Looks Good

Although there has been an increasing recognition that designing out crime is an essential consideration in the development and design of secure and sustainable communities (Poyner, 1996; Cozens, 2002, 2007; Dewberry, 2003; Office of the Deputy Prime Minister and Home Office, 2004; Department for Transport, 2007; Armitage and Monchuk, 2009; Department for Communities and Local Government, 2008b; ACPO Secured by Design, 2010), the reduction of crime is only one of a growing array of factors which developers, architects and planning authorities must consider in the design and build of residential communities. Additional considerations include financial constraints, energy-efficiency, flood risk and ecological concerns, as well as local factors stipulated (in England and Wales) within the Local Development Framework.

CABE's 'Building for Life' offers a national standard for well designed homes and neighbourhoods. The standard includes twenty criteria set out under the four headings of (1) Environment and Community, (2) Character, (3) Streets, Parking and Pedestrianisation and

(4) Design and Construction. The Building for Life *Award* is given to exceptional entries and is selected by a panel of judges. An additional measure of housing quality is CABE's Housing Audits which, using the four Building for Life categories, allocate a percentage score to housing developments allowing for their categorisation as very good (80% or more), good (70% or more), average (50% or more) and poor (less than 50%). Although the Building for Life standard has been used to reflect good practice in housing design (CABE, 2008, 2009; Department for Communities and Local Government, 2008a), prior to the commencement of this research, little focus had been given to establishing whether award winning developments actually represent safe and sustainable communities.

One of the key considerations within this research was to establish the extent to which design features that enhanced a development's design quality could actually heighten that development's risk of crime and anti-social behaviour. For car parking – the trade-off between parking within the curtilage of the property to minimise risk of crime, versus parking away from the property to minimise the risk of the car dominating the street scene or obstructing the house frontage. For through-movement and connectivity – the trade-off between creating a development which connects well with others and offers ease of access to local amenities and transport, versus the risk of aiding entry and escape for potential offenders.

But what is it Like to Live There? What Works in Reducing Crime through Design

Research findings relating to the impact of design features on crime have often been overstated to create attention grabbing headlines such as "*End of the Road for the Cul-de-Sac*" (Fairs, 1998: 1), and "*Culs-de-Sac Hit the Skids*" (Stungo 1998: 2). However, such over-simplification does little to help those practitioners faced with the task of reducing crime. A review of 74 papers and 13 policy and guidance documents aimed to clarify the evidence base relating to the impact of specific design features of residential housing on crime. The review examined the impact of key design features on levels of crime and disorder. These included house design, management and maintenance, security measures, communal space, surveillance and visibility, territoriality, car parking and connectivity/through-movement. In this paper we focus on the last two, which, as said, revealed significant and interesting findings.

Car Parking

The review of literature found very few studies which specifically identified particular designs for accommodating parking within residential areas as being more vulnerable than others. Brown and Altman (1983) studied the environmental features of 306 burgled houses on burgled blocks, non-burgled houses on burgled blocks and non-burgled houses on non-burgled blocks in an attempt to establish which factors were associated with burglary-prone homes. Several features were found to be associated with burglary-prone homes, one of which was the absence of a garage. Brown and Altman (1983) concluded that properties with a garage were less vulnerable to burglary than those with garages. Cromwell *et al* (1991) used staged-activity analysis with a sample of 30 active burglars as a means of identifying which environmental cues influenced their target selection. One of the features identified by burglars was the presence or absence of a garage. Burglars found properties without a garage, or with an open carport, to be more vulnerable to burglary.

The review of research relating to the impact of car parking on crime revealed no contradictory findings. In contrast, a review of policy and guidance documents revealed some conflicting guidance and recommendations. *Manual for Streets* (Department for Transport, 2007) suggests that parking within the front curtilage of a property should be avoided as this breaks up the frontages and restricts informal surveillance. *Secured by Design New Homes* (ACPO Secured by Design, 2010), on the other hand, suggests that where garages cannot be provided, cars should be parked on hard standing within the dwelling boundary, preferably behind a gate.

Connectivity and Through-movement

Debates surrounding connectivity and through-movement (often referred to as permeability) dominate the academic and policy literature on designing out crime within residential housing. The cul-de-sac layout is favoured by the majority of criminological literature. However, urban designers highlight the negative features of this low permeability layout. Culs-de-sac increase travel distance and therefore reliance upon the motor vehicle, they are an inefficient use of land and increase the difficulty of ensuring public transport runs close to residential properties. Explanations for higher crime along major vehicular or pedestrian pathways point to the operation of three underlying mechanisms. Firstly, developments with high levels of through-movement provide ease of entry and escape for potential offenders (Rubenstein *et al,* 1980; Taylor and Gottfredson, 1987; Poyner and Webb, 1991). The operation of this mechanism has been demonstrated through the crime reductions observed following physical changes to the layout of existing residential areas, such as the closure of streets (Matthews, 1992; Atlas and LeBlanc, 1994; Newman, 1995, 1996; Lasley, 1998; Zavoski *et al*, 1999, Eck, 2002). Secondly, developments with high levels of through-movement are more likely to fall within the activity space, and therefore awareness space, of potential offenders (Brantingham and Brantingham, 1984) with offenders selecting targets properties as they take part in day to day activities (Letkemann, 1973; Feeney, 1986; Gabor *et al,* 1987; Poyner and Webb, 1991; Rengert and Wasilchick, 2000; Wiles and Costello 2000). The third mechanism explains that developments with high levels of through-movement offer increased levels of anonymity for potential offenders (Angel, 1968; Suttles, 1968; Brantingham and Brantingham, 1975; Taylor and Gottfredson, 1987; Poyner and Webb, 1991).

A range of studies conducted across Europe and North America have demonstrated the link between high connectivity/through movement and crime by employing a range of methodologies and varied indicators of connectivity. Beavon *et al* (1994, in Canada) and Johnson and Bowers (2010, in the UK) demonstrated that increases in the number of roads connected to a street segment led to statistically significant increases in the number of burglaries to that segment. These increases were greatest when street segment connections lead to a major traffic thoroughfare (White 1990, in the USA and Johnson and Bowers 2010). Further, the majority of research projects directly comparing burglary levels on highly connected through roads to culs-de-sac and streets with the lowest connectivity have demonstrated that culs-de-sac experience the lowest rates of burglary (Bevis and Nutter, 1977; Mirlees-Black *et al,* 1998; Rengert and Hakim, 1998; Armitage, 2000; Hakim *et al,* 2001; Yang, 2006; Johnson and Bowers, 2010). Johnson and Bowers' (2010) study further concluded that culs-de-sac are safer than through roads and that sinuous[ii] culs-de-sac are safer still. However the study did not distinguish between 'true' culs-de-sac and 'leaky' culs-de-sac (those that are breached by footpaths). Research has demonstrated that leaky culs-de-sac experience more crime than true culs-de-sac and through roads (Armitage, 2006; Hillier,

2004). Therefore any research that conflates leaky and true culs-de-sac is liable to dilute positive conclusions relating to culs-de-sac.

Taylor (2002) concluded that: "*Neighbourhood permeability is … one of the community level design features most reliably linked to crime rates, and the connections operate consistently in the same direction across studies: more permeability, more crime*" (Taylor, 2002: 419). However, a prominent exception to this assertion relates to studies conducted using Space Syntax techniques which have concluded that increased levels of through-movement have a beneficial impact upon crime (Rudlin and Falk, 1995; Jones and Fanek, 1997; Hillier and Shu, 1998, 2000; Shu, 2000; Shu and Huang, 2003; Hillier, 2004; Hillier and Sahbaz, 2009). Only one study utilising Space Syntax measures (Nubani and Wineman, 2005) has found high local integration [iii] and high connectivity to be positively associated [iv] with crime, including breaking and entering, larceny, vehicle theft and robbery. Using Space Syntax, Hillier and Sahbaz (2009) argue that high levels of street connectivity in a grid-like system result in lower levels of crime, with lower levels of connectedness resulting in higher vulnerability to crime. Hillier and Sahbaz (2009) argue that culs-de-sac are the least safe option but can be safer where they are embedded into the street network and made large and linear enough to provide that safety in numbers. The divergence between findings stemming from the use of Space Syntax and those from other approaches appears to be the product of key differences in methodology. Although Space Syntax allows for greater sample sizes (Hillier and Sahbaz looked at 101,849 properties) the methodology relies on the remote and automated assessment of street layouts and movement patterns which may not reflect the true nature of street layouts and how they are used. Studies that have manually assessed the area (or asked offenders to comment on vulnerability whilst at the development) have all concluded that increased connectivity and through movement leads to increases in crime. The table below summarises the literature reviewed on the impact of through-movement on levels of crime within residential developments, highlighting the dominance of studies concluding that higher levels of through movement increase the risk of crime.

Table 1: Summary of Literature on the Impact of Permeability on Crime

Study Revealed that:	Study Reference
Being located on a development with high levels of permeability/connectivity/through movement increases the risk of crime	Bevis and Nutter (1977) Rubenstein *et al* (1980) Taylor and Gottfredson (1987) Van der Voordt and Van Wegen (1990) White (1990) Poyner and Webb (1991) Beavon *et al* (1994) Mirlees-Black *et al* (1998) Rengert and Hakim (1998) Hakim *et al* (2001) Taylor (2002) Nubani and Wineman (2005) Yang (2006) Armitage (2006)
Being located on a travel path increases the risk of crime	Letkemann (1973) Brantingham and Brantingham (1984) Feeney (1986) Gabor *et al* (1987) Poyner and Webb (1991) Wiles and Costello (2000) Rengert and Wasilchick (2000)
Being located on a culs-de-sac, or a development with low connectivity, reduces the risk of crime	Bevis and Nutter (1977) Johnson and Bowers (2010)
Closing off streets reduces crime	Matthews (1992) Atlas and LeBlanc (1994) Newman (1995,1996) Lasley (1998) Zavoski *et al* (1999) Eck (2002)
Being located on a leaky culs-de-ac increases the risk of crime	Hillier (2004) Armitage (2006)
Being located on a development with high levels of permeability/connectivity/through movement reduces the risk of crime	Hillier and Shu (1998) Shu (2000) Hillier (2004) Hillier and Sahbaz (2009)

The review of policy and guidance documents revealed several areas of contention regarding through-movement and connectivity. *Manual for Streets* (Department for Transport, 2007) highlights that street networks should be connected to encourage walking and cycling and that connectivity within and between developments is important. *Secured by Design New Homes* (ACPO Secured by Design, 2010), on the other hand, reiterates the research evidence that high levels of connectivity create opportunities for criminals. While only two guidance

documents actually discouraged the use of culs-de-sac (CABE, 2009 and Queensland Government, 2007) several raised concerns regarding the limits this design places upon walkability. A final divergence between guidance and research related to culs-de-sac size and layout. *Secured by Design New Homes* (ACPO Secured by Design, 2010)*, Manual for Streets* (Department for Transport, 2007) and *Safer Places* (Office of the Deputy Prime Minister and the Home Office, 2004) each highlighted how culs-de-sac are an acceptable design, but must be short, linear and not linked by footpaths. However, Johnson and Bowers (2010) highlight how sinuous (curvy) as opposed to linear culs-de-sac experience less crime (although both experience less crime than through roads).

Research aims

The aim of this research was to update and strengthen the evidence base on the impact of the design of residential housing on a range of crime types and to investigate the impact of, what are considered by CABE to be, good designs of the built environment on crime. To achieve this aim a unique methodology was adopted encompassing three strands of analysis. Table 2 summarises the key research questions and the research methods adopted to investigate them. The first strand of the research entailed a comprehensive review of literature, guidance and policy documents. The second strand involved a detailed assessment of the link between residential design and crime within twelve case study sites. To ensure that the research focused upon design features that reflect the most innovative practice in high quality housing design, this strand focused on developments that had received commendations for their exceptional design quality and architecture through the receipt of a Building for Life A*ward,* or through achieving the Building for Life *Standard* which represents a score of 70% or over on the CABE Housing Audits. The third strand, reported elsewhere (Armitage *et al,* 2010), conducted a secondary data analysis of CABE's Housing Audit data on 34 developments spread throughout England, exploring the links between housing design quality and crime.

Table 2: Research Strands and Research Methods Adopted

Research Strand	Research Question	Methods Employed
First strand: Literature and policy review	What guidance currently exists to inform housing design in respect of presumed links to crime?	Comprehensive review of literature, guidance and policy documents.
Second strand: Detailed assessment of the link between residential design and crime	Which elements of housing design, in what contexts, act as a protective factor against crime?	Design Features Checklist Site visits and walkarounds Interviews with practitioners Analysis of Police recorded crime data
Third strand: Secondary data analysis of CABE's Housing Audit	Do developments of high design quality experience less crime and disorder than developments with lower design quality?	Modeling of CABE Housing Audit Data and Police Recorded Crime Data

METHODOLOGY

Sample selection

The core sample was comprised of four Building for Life *Award* winning housing developments and two Building for Life *Standard* developments. To obtain a geographical spread of developments, two were selected from the north of England, two from the midlands and two from the south, giving a total of six Building for Life developments. The developments were selected to provide a contrasting range of design features and contexts, for example, urban/suburban, high and low density and a mix of high, medium and low rise developments. To maximise this variation each case study site was matched against a non Building for Life (or equivalent) development. Criteria for comparison site selection included: close proximity to the case study development; equivalent size area and number of dwellings; comparable socio-demographic composition and an equivalent range of housing types and density (e.g. detached, semi-detached dwellings, apartments).

Table 3: Geographical distribution of sampled developments

North	North: Building for Life 1 (179 dwellings)	North: Non-Building for Life 1 (96 dwellings)
	North: Building for Life 2 (51 dwellings)	North: Non-Building for Life 2 (181 dwellings)
Midlands	Midlands: Building for Life 1 (514 dwellings)	Midlands: Non-Building for Life 1 (158 dwellings)
	Midlands: Building for Life 2 (237 dwellings)	Midlands: Non-Building for Life 2 (73 dwellings)
South	South: Building for Life 1 (361 dwellings)	South: Non-Building for Life 1 (176 dwellings)
	South: Building for Life 2 (88 dwellings)	South: Non-Building for Life 2 (79 dwellings)

Data Collection

Crime data for a three year period (January 2007 to December 2009) was requested for the entire police force area for each of the three forces selected. Crime categories included burglary dwelling and non dwelling, theft of and theft from motor vehicle, criminal damage, theft from person, and assault. For each crime the individual crime reference number, location (easting and northing), full address (flat/apartment/house number, street/road, town/city, postcode), date and time and *modus operandi* details[v]. In order to control for variations in area crime levels, two contextual crime variables measured crime in a 500m buffer surrounding each development, the first measuring domestic burglary levels, the second measuring total crime. Similarly, to control for the influence of socio-demographic factors, the areas were classified according to the Output Area Classification Supergroups (OACs)[vi] .

Assessing the design of developments

In addition to the collection of crime and socio-economic data, specific features of the design of each property and development were collated using the Design Features Checklist (hereafter the Checklist). The Checklist built upon existing risk assessment mechanisms (such

as Armitage, 2000), in particular through the distinction between sinuous and linear culs-de-sac, as well as examining the property and development both in daylight and after dark. Nineteen questions related to the development as a whole and these covered layout, navigation, parking, surveillance and visibility communal space, management and maintenance and signs of disorder. Thirty-one questions focused upon each individual property, and these examined street layout, house design, parking, surveillance and visibility, territoriality and physical security. The final section of the Checklist (comprised of twenty questions) focused upon specific elements of design quality. Checklists were completed for each property located within a case study or comparison development, a total of 2192 Checklists.

Interviews with key personnel

In addition to collecting Checklist data, key personnel were invited to take part in a 'walk around' during which they were asked about the design of the development, crime and disorder issues, problems highlighted at the planning stage (and whether these issues were rectified), and details of retrofit security measures installed at properties on the development. Key personnel included the police Architectural Liaison Officer/Crime Prevention Design Advisor, the Local Authority Planning Officer, the local Neighbourhood Policing Team and, in some cases, a representative from the local Residents' Association. Walk-arounds took place at each of the Building for Life developments, with a total of twenty-six participants.

The importance of assessing developments on the ground

This unique and painstaking methodology involved the fieldworkers spending at least one day (and evening) at each of the twelve case study sites. Detailed assessments of each property and the development upon which it was located ensured that accurate information on factors such as the presence or absence of footpaths (and where those footpaths led to) and the classification of road layout (true versus leaky culs-de-sac, sinuous versus linear culs-de-sac) was collected. Several examples of potential errors in classification emerged throughout the research phases, these included presence of unofficial short-cuts created by residents that would not appear on official maps but represented important sources of movement throughout sites, as well as the difficulty in categorising a cul-de-sac as true or leaky, sinuous or linear simply through the use of remote maps and plan layouts. Detailed site visits also allowed an assessment of the parking provision allocated to each dwelling to be made. Factors which would have been overlooked through a remote assessment of the sites included the allocation and positioning of parking spaces – an issue which proved to be a concern raised by the interviews with key personnel, and within the analysis of crime statistics. Physically visiting the sites also allowed the fieldworkers to collate information on the presence of retrospective security measures (such as the application of anti-climb paint to fences/walls) or crime prevention initiatives (such as Neighbourhood Watch schemes) as well as the actual application of these measures (were the security gates actually locked? Could the fieldworkers access an area supposedly limited to residents only?).

The methodology adopted in this study contrasts sharply with studies that classify road layouts remotely via computer algorithms - notably Space Syntax. Although Space Syntax allows a greater number of dwellings to be included within a sample, road layout is not manually assessed and therefore classifications do not always reflect the true layout of a road (or use of a road by residents).

Analysis of crime data

Police recorded crime data were cleaned, validated and mapped (using a Geographical Information System), producing hotspot maps which highlighted the location of key offences committed within the three year period January 2007 to December 2009. The analysis of crime data was separated into two strands: detailed mapping and inspection of crime locations, and the statistical modelling of crime data against design attributes.

Analysis of crime patterns

Maps of each site were annotated with location specific data obtained from interviews and fieldworker observations. Particular attention was afforded to features identified in the research literature as criminogenic such as footpaths, open land, public buildings and play areas. These annotations were completed blind to the location of crimes on the development. The next step was to overlay crime locations onto the detailed maps to explore the extent to which offences could be linked to the identified design features and whether crimes took place at locations where research evidence suggests that they would.

Statistical modeling

A single level negative binomial regression model (Tseloni and Pease, 2004) was fitted to analyse the relationship between design features and crime. A negative binomial model was used as crime represented a relatively rare event at the property level. An empty level model demonstrated that 94% of the variation in crime was explained at the property level. The absence of street and development level variation precluded the execution of a multi-level model. The analysis was conducted via the software package MLwiN (Goldstein *et al*, 1988).

Limitations of crime recording

Analysis of police recorded crime was limited by the quality of the data. Of critical importance was the frequent absence of detailed location data, particularly for crimes within apartment blocks. In one high rise site studies, of the 31 crimes recorded, only seven specified the actual block (of five blocks) at which the crime took place, and of those seven offences, only four provided an apartment number. At another high rise site, only 15 of the 34 recorded offences specified an apartment number. The exact locations of car crimes were also difficult to ascertain with very few specifying the exact location of the offence – be that car park, on-plot, on street or within underground parking facilities.

The case study sites

A brief description of the six Building for Life standard case study sites and their non-Building for Life matched comparisons is presented below.

North: Building for Life 1

North: Building for Life 1 was a located close to a city-centre. It comprised of an eight storey apartment block with 179 dwellings and shops and offices to lower floors. The site did not include any social housing. North: Building for Life 1 was recognised with a Building for Life Award owing to its striking modern design and the provision of an exceptional living environment within a high-density and cost-competitive development. The block fronted onto a leaky linear cul-de-sac, with pedestrian paths leading from the site to join key pedestrian routes that ran along the perimeter of the site and into the city centre. Access to the site was

via two controlled communal entrances. Allocated car parking and bicycle storage was located underground.

North: Non-Building for Life 1

The non-Building for Life site matched to North: Building for Life 1 was a large apartment block of contemporary design containing 96 apartments. As with North: Building for Life 1, this was a mixed use development with allocated underground car parking. This site was located on a sinuous leaky cul-de-sac and connected to North: Building for Life 1 by a footbridge. Elsewhere in the development, it was noted that a gap in a fence had been created providing pedestrians with a cut through to join key pedestrian routes to and from the city centre.

North: Building for Life 2

North: Building for Life 2 comprised of 51 dwellings in the form of apartments and houses. None of the units were 'affordable housing'. The site consisted of architectural variety tied together with a common palette of materials throughout. This case study site received a Building for Life Award for the 'creation of a desirable location' providing places that 'fit current ways of living'. This site was entirely gated and pedestrian and vehicular access into the site was access controlled. However, site assessments identified that in places the perimeter fencing was compromised by the positioning of street furniture outside the development which afforded 'climbing aids'. Once within the site, footpaths and alleyways provided a high level of within-development through-movement. Car parking was provided with a mixture of on-street and two large communal parking lots.

North: Non-Building for Life 2

The non-Building for Life site selected as a comparator to North: Building for Life 2 formed a later phase of the same development. In contrast to North: Building for Life 1, this site was not a gated development. This site contained 181 dwellings including both houses and flats, many of which were buy-to-let. Housing was located on two main roads, a loop road and a cul-de-sac. There were two vehicle access points onto the site. Car parking provision was mainly in the form of rear communal car parking courtyards. These car parks had gates but they were left unlocked. Rear access footpaths were common throughout the development and tended to be poorly overlooked.

Midlands: Building for Life 1

Midlands: Building for Life 1 was selected as a 'high quality' exemplar on the basis of receiving a score above 70% in CABEs Housing Audit. This development of 514 homes included 444 new dwellings (a mixture of town houses and apartments) and housing situated within converted Grade 2 listed buildings. Thirty per cent of dwellings were allocated as social housing. Two vehicle access points were connected via a permeable grid of loop roads and leaky culs-de-sac with housing organised around internal courts containing private gardens and parking areas. There were many footpaths and alleyways running through the site increasing the potential for pedestrian through movement. These footpaths were poorly overlooked. Access paths also ran to communal car parking and refuse storage at the rear of dwellings. Parking provision included a mix of on-plot spaces, small groups of spaces and rear communal car parking courtyards. The limited number of connections with the surrounding area resulted in a sense of isolation within the development.

Midlands: Non-Building for Life 1

Midlands: Non-Building for Life 1 was located directly opposite Midlands: Building for Life 1. A low density site, it contained 158 houses and flats, many of which were social housing or sheltered accommodation for the elderly. With one vehicle access point the layout mainly comprised small sinuous leaky culs-de-sac leading out from a central tree-lined linear cul-de-sac, producing a very permeable development.

Midlands: Building for Life 2

This site formed a small part of a far larger regeneration project. The 237 dwellings were predominantly social housing and consisted of bungalows, two and three storey flats and houses. The development was awarded a score of 77% in the CABE housing audit. The scheme was commended for its use of innovative design, bold colours and the creation of a pedestrian friendly environment. The permeable grid layout of the site facilitated high levels of both vehicle and pedestrian through movement. The site offered good connections to local facilities, pedestrian permeability was 'designed in' and roads were constructed in materials designed to provide a pedestrian feel. The development incorporated a boulevard which was well-used by pedestrians and cyclists at different periods throughout the day and evening. Parking was provided through a mixture of on-plot parking and small groups of on-street spaces. This was the only site in the sample to have received Secured by Design accreditation which demonstrates compliance with CPTED principles. For this reason, although the site consisted of a number of footpaths, none of the footpaths ran to the rear of any properties, the site did not contain any windowless gable ends of houses, and corner windows were installed to promote natural surveillance.

Midlands: Non-Building for Life 2

This site was located adjacent to Midlands: Building for Life 2 and comprised of 73 dwellings. Compared to Midlands: Building for Life 2, this development had very low permeability, was low density and was formed of more traditional house types. Car parking was provided through a mixture of garages and on-plot parking. The road layout comprised a series of leaky culs-de-sac, offering low vehicle permeability. The dominance of culs-de-sac resulted in routes to surrounding areas being quite tortuous, in response pedestrians had created their own 'short-cuts' including trespassing through residents' properties.

South: Building for Life 1

South: Building for Life 1 comprised of 360 dwellings and formed part of a larger redevelopment of a waterfront site. This case study site consisted of houses and apartments and was an example of a high density development. The development received a Building for Life Award for its use of subtle architecture and strong place-making. This large development was divided into several discrete housing areas each with their own character. Branching out from one vehicle access point was a highly permeable layout of through roads and culs-de-sac. The development was connected via footpaths and cycleways to neighbouring areas; this included a busy footpath along the waterfront at the edge of the development. Footpaths were well overlooked. Parking at this development was provided mainly through garages and communal parking areas.

South: Non-Building for Life 1

Located adjacent to South: Building for Life 1, three neighbouring areas formed this comparison site. Comprising of 176 dwellings, South: Non-Building for Life included houses and apartments some of which were located on (mainly leaky) culs-de-sac and others on a through road. The site included a small area of gated properties. The variation in road layout complemented the road layouts in the case study site. Footpaths running through the site were reasonably overlooked. Provision for car parking was predominantly garages with some on-street parking and communal parking.

South: Building for Life 2

This site comprised 88 dwellings in a mixture of houses and flats. This development was awarded a Building for Life Award owing to the design of modern dwellings that utilised sustainable materials while respecting the vernacular architecture of the local area. The result was a small, intimate but yet high density development. Car parking was integrated within the housing in a combination of garage and small communal areas. This case study site was very permeable, predominantly composed of leaky culs-de-sac leading off one through road; roads were designed to avoid the dominance of the car and encourage pedestrian priority. Footpaths that connected the site with other areas were generally well lit and well overlooked.

South: Non-Building for Life 2

This comparison site was located adjacent to South: Building for Life 2 and consisted of predominantly large detached dwellings. This site contained 79 dwellings and was less dense than South: Building for Life 2. The road layout consisted of a permeable grid of culs-de-sac and through roads. Similar to South: Building for Life 2, roads had been softened to reduce the dominance of the car and footpaths connected pedestrians to other areas. The majority of car parking was on-plot, with some car parking provided through communal courtyards to the front and rear of the dwellings. A number of these parking courts had gates but on inspection these were found to be open and unlocked.

FINDINGS

Although the research focused upon many dimensions of housing design the discussion will focus on the two themes which form the focus of this paper: through-movement/connectivity and car parking. The following section presents the findings from the detailed case studies including fieldwork observations, interviews with key personnel, and the analysis of crime locations. The subsequent section reports the findings of a statistical model which examined the relationship between design features and crime.

Detailed case studies: Connectivity and Through Movement

The research highlighted several key issues relating to through/movement and connectivity, notably the role of street layout, footpaths and gated developments as discussed below.

Street layout

The sample sites presented a variety of street layouts (see Table 4) ranging from North: Non-Building for Life 2 where all properties were situated on a through road, to South: Building for Life 1 which contained the greatest mix of different street types. Across the whole

sample, 54.5% of properties were situated on a cul-de-sac, compared to 45.5% on through roads. Sinuous culs-de-sac were more common than linear. Importantly the Checklist data revealed that leaky culs-de-sac were considerably more prevalent that true culs-de-sac (78% and 33% of culs-de-sac respectively). Several of the sites proved difficult to navigate, particularly: Midlands: Building for Life 1; Midlands: Building for Life 2; South: Building for Life 1 and South: Building for Life 2. It is notable that the more innovative designs of the Building for Life schemes were generally less navigable that their matched comparisons.

Table 4: Distribution of Street Types across the sample

		Percentage of Properties Situated on :				
Site	N	Linear True Cul-de-sac	Linear Leaky Cul-de-sac	Sinuous True Cul-de-sac	Sinuous Leaky Cul-de-sac	Through Road
North: Building for Life 1	179		100			
North: Non-Building for Life 1	96				100	
North: Building for Life 2	51		39.2			60.8
North: Non-Building for Life 2	181					100
Midlands: Building for Life 1	514			16.7	26.5	56.8
Midlands: Non-Building for Life 1	158			8.9	91.1	
Midlands: Building for Life 2	237	1.7				98.3
Midlands: Non-Building for Life 2	73			30.1	69.9	
South: Building for Life 1	361	3.9	20.2	4.2	28.3	43.5
South: Non-Building for Life 1	176	7.4		52.3	26.1	14.2
South: Building for Life 2	88				60.2	39.8
South: Non-Building for Life 2	79		20.3		21.5	58.2
Total	**2193**	**1.2**	**13.3**	**10.5**	**29.4**	**45.5**

Interviews revealed the contrasting views of police and design practitioners in relation to connectivity and through movement. Police interviewees voiced concerns regarding the high permeability of development layouts, notably at Midlands: Building for Life 1, Midlands: Building for Life 2 and South: Building for Life 2. In contrast, planners spoke of the benefits provided by permeable designs, providing an open feel and encouraging people to walk or cycle.

Footpaths

All of the schemes contained footpaths (see Table 5) and the majority of properties were visible from a footpath. With the exception of Midlands: Building for Life 1, all schemes had footpaths leading to other residential areas. In half of the developments footpaths were linked into a 'maze' of other footpaths (North: Building for Life 1; North: Non-Building for Life 1; North: Non-Building for Life 2; Midlands: Building for Life 2; South: Building for Life 1 and South: Building for Life 2). Footpaths to the rear of properties were absent at South: Non-Building for Life 2 and virtually absent at Midlands: Building for Life 2 (0.8% of properties) and North: Building for Life 2 (2%). The tower blocks at sites North: Building for Life 1 and North: Building for Life 2 were backed by a footpath. At sites North: Non-Building for Life 2 and Midlands: Non-Building for Life 1 footpaths to the rear of properties were noticeably more prevalent (44% and 53% respectively). In two schemes – North: Building for Life 1 and Midlands: Building for Life 1, fieldworkers noted that footpaths were not adequately lit. At

Midlands: Building for Life 2, South: Building for Life 2 and North: Non-Building for Life 1 footpaths had adequate lighting, the remaining seven schemes having only some footpaths with adequate lighting.

Table 5: Footpaths with developments

Site	N	Percentage of properties: Visible from a footpath	Percentage of properties: With footpath to the rear
North: Building for Life 1	179	99.4	100
North: Non-Building for Life 1	96	100	100
North: Building for Life 2	51	74.5	2.0
North: Non-Building for Life 2	181	89.0	43.6
Midlands: Building for Life 1	514	68.2	29.2
Midlands: Non-Building for Life 1	158	80.6	52.8
Midlands: Building for Life 2	237	57.0	0.8
Midlands: Non-Building for Life 2	73	49.0	25.5
South: Building for Life 1	361	73.7	35.3
South: Non-Building for Life 1	176	84.8	32.6
South: Building for Life 2	88	72.7	29.5
South: Non-Building for Life 2	79	54.0	0.0
Total	**2193**	**63.1**	**32.6**

At North: Building for Life 1 and North: Non-Building for Life 1 access to a canal tow path had been a condition of planning permission. This path was a busy thoroughfare and high footfalls were observed although the level of lighting was inconsistent. Pedestrian connectivity appeared to have increased the vulnerability to opportunistic offenders; an apartment adjacent to the footpath had installed retrospective security measures including razor wire, CCTV and anti-climb paint. Only one recorded crime was linked to this location (miscellaneous thefts), although the recording of crime locations at this site was particularly poor with apartment numbers frequently not provided. In a number of sites, most notably North: Non-Building for Life 2 and Midlands: Building for Life 1, paths leading to refuse areas and communal parking courts were unsecured or inadequately secured and commonly led to the rear of properties. Lighting and natural surveillance to these paths was generally poor.

Cross referencing of crime locations and environmental features consistently revealed that crimes were clustered around alleyways and footpaths. This was noted at sites North: Building for Life 2; North: Non-Building for Life 2; Midlands: Building for Life 1; Midlands: Non-Building for Life 1; South: Building for Life 1 and South: Non-Building for Life 1. Although Midlands: Building for Life 1 only experienced nine burglary dwelling offences (of the 132 crimes), these were clustered around footpaths and alleyways. Properties were particularly vulnerable when footpaths allowed access to the rear or side of the dwelling; corner plots located next to footpaths were also highlighted as vulnerable. Practitioners reported that footpaths at Midlands: Building for Life 1 and Midlands: Non-Building for Life 2 provided escape routes for offenders. The analysis of the *modus operandi* for offences at Midlands: Non-Building for Life 1 did suggest that the footpath connecting the development to a main road was frequently used by offenders escaping from the scene. Indeed, two offences - a robbery and an actual bodily harm, occurred upon this particular footpath.

Footpaths at Midlands: Building for Life 2 had been explicitly designed, named and publicised to encourage pedestrian and cyclist through movement. Police expressed concern regarding the number of footpaths within the estate but acknowledged that their careful design, connecting people directly to destinations, ensured they were frequently used. The avoidance of footpaths to the rear of properties appears to have limited their criminogenic potential. It is notable that in contrast to other sites, recorded crimes were not associated with the presence of footpaths at Midlands: Building for Life 2 and no burglary dwellings were recorded at this site over the three year period. One footpath at this site which was situated extremely close to the front of residences did cause issues with anti-social behaviour from young people as they passed on their way to school (pressing door buzzers as they passed). South: Building for Life 2 was also permeated by several footpaths although, in contrast to Midlands: Building for Life 2, this included paths situated to the rear of properties. Practitioners reported that this had not led to any specific problems, with the exception of occasional damage to street lighting caused by young people 'passing through' the area. It was felt that a strong sense of community negated potential problems and that this highly permeable design would not prove as trouble free in a less affluent area. Only one offence against a dwelling was reported against a dwelling at this site (criminal damage), the property targeted was a corner plot and was located adjacent to a footpath.

Where developers had either deliberately or unintentionally restricted pedestrian movement residents frequently created convenient 'short-cuts'. This was observed at Midlands: Non-Building for Life 2 where the street layout had ignored existing 'desire routes'. In response, some pedestrians climbed over high fences in an attempt to access the development (confirming this, one person was observed climbing the fence during the site visit). Similarly at North: Building for Life 1 pedestrians had created a short-cut through a gap in railings, giving access to other footpaths leading to the city centre and other residential and commercial areas. Unofficial short-cuts will be not be subject any maintenance and are unlikely to be adequately lit or overlooked. Designs which restrict pedestrian movement therefore risk prompting the development of desire routes that are far more criminogenic than deliberately designed-in alternatives.

Gated developments

North: Building for Life 2 was a gated development, however the local planner stated that the solution of gating is unlikely to be used in future developments. Nevertheless, the gates had proved ineffective in keeping crime out of the development; 26 offences were committed at this site. In places gates were low enough to be climbed over and elsewhere street furniture was located so as to provide climbing aids. Once within the development an offender would be free to select an appropriate target. Similarly at South: Non-Building for Life 1 a gated portion of the site proved unsuccessful at preventing crimes. Four burglaries of dwellings were recorded at this location. Again it was noted that fences and walls around this area were of insufficient height to prevent unauthorised access.

Detailed Case Studies: Car Parking

The research revealed car parking, currently overlooked in criminological research, to be a critical issue for residents and place managers. Key issues relating to parking included inadequate rear communal parking courts, poor allocation of spaces and inappropriate car parking innovations.

Table 6: Parking arrangements across the sample

Site	N	Percentage of properties:	
		Visible from a footpath	With footpath to the rear
North: Building for Life 1	179	99.4	100
North: Non-Building for Life 1	96	100	100
North: Building for Life 2	51	74.5	2.0
North: Non-Building for Life 2	181	89.0	43.6
Midlands: Building for Life 1	514	68.2	29.2
Midlands: Non-Building for Life 1	158	80.6	52.8
Midlands: Building for Life 2	237	57.0	0.8
Midlands: Non-Building for Life 2	73	49.0	25.5
South: Building for Life 1	361	73.7	35.3
South: Non-Building for Life 1	176	84.8	32.6
South: Building for Life 2	88	72.7	29.5
South: Non-Building for Life 2	79	54.0	0.0
Total	**2193**	**63.1**	**32.6**

Rear parking courts

Table 6 shows that rear parking courts were present at seven of the twelve developments and were particularly prevalent at Midlands: Building for Life 1, North: Building for Life 2 and North: Non-Building for Life 2. One local authority planning representative (Midlands: Building for Life 1) explained that the popularity of rear parking courts resulted from government pressure to reduce the dominance of the car on the street scene. Problems relating to rear parking courts were reported by practitioners across the breadth of the sample. The majority of rear parking courts were open access (Figure 1), and where gates were provided they were frequently left unlocked, as was observed at North: Non-Building for Life 2 and South: Non Building for Life 2. Open entrances to rear parking courts provided access not only to vehicles but to the rear of properties. Natural surveillance to rear courts was frequently limited with poor or no lines of sight from surrounding properties and poor lighting. At Midlands: Building for Life 1 the courts were overlooked by upper floor windows, however, the majority of these were bathroom windows so in reality surveillance was minimal. At this site practitioners reported that rear courts had become a site for the abandonment of stolen vehicles and groups of anti-social young people. This site also had mailboxes located within the rear parking courts which had been subject to vandalism and theft with the potential to contribute to identity frauds. Fieldworkers observed that rear parking courtyards were infrequently used by residents who preferred to park, often illegally, on the pavement near to their property 'for convenience' (as confirmed by one resident we spoke to). This observation demonstrates that not only were parking courts creating problems of crime and disorder, they were also not operating as an adequate parking solution for residents and that the objective to remove the car from the street scene had failed.

An alternative approach to rear parking courts was taken at South: Building for Life 1, where small amounts of housing had been included within the courts to facilitate natural surveillance. Communal parking areas at Midlands: Building for Life 2 were also kept small and were situated to the front of dwellings.

Figure 1: Open archway provides access to a rear parking court

As noted above, seven developments included rear parking courts. At six of these developments offences were reported either within or on the boundary of the parking courts. *Modus operandi* data provided indications that the parking courts experienced a large number of crimes including theft of, theft from and damage to vehicles and assault offences. Further, rear parking courts appear to have provided access to properties for the commission of burglary offences. Communal parking courts may also provide access to properties they do not directly serve. At South: Building for Life 1 two properties were victimised which had garages for their own parking but backed on to the parking courts of neighbouring properties. Each of these properties suffered two offences, a 'burglary dwelling' and 'burglary other'. Confirming the findings from the fieldwork, at Midlands: Building for Life 1 ten offences of criminal damage to mailboxes located within rear parking courts were recorded.

Poor allocation of car parking spaces

Insufficient availability of car parking spaces or inappropriate allocation of spaces frequently became the source of neighbour disputes. This problem was most apparent at Midlands: Building for Life 1 where allocated car parking spaces were not always directly adjacent to each resident's property. This meant that, in some cases, a resident's parking space could be located directly in front of another resident's front window (Figure 2). This issue had led directly to serious incidents between neighbours, including a public order incident and an assault - reports that were confirmed following inspection of the crime data. Neighbour disputes over communal car parking had also occurred at Midlands: Building for Life 2. However, at this development problems were viewed as isolated examples of new tenants 'settling in.' The fact that communal parking at this site was restricted to small courts of a maximum of six cars likely assisted residents in 'self-managing' parking issues.

Figure 2: Poor allocation of car parking spaces

Inappropriate car parking solutions

Several sites included innovative approaches to parking designed to remove the car from the street scene, however, these were not always successful and commonly created new problems. At South: Building for Life 1 driveways had been designed deliberately short of the average car length with the intention of encouraging residents to use their garages for their cars while discouraging parking on the driveway. However, residents tended to use their garage for storage and continued to park their cars where it was most convenient - on the shortened driveway at the front of the property. The result was cars parked on driveways, but jutting out onto the pavement or roadway. The experiment therefore appears to have been counter- productive as a result of misunderstanding the needs of residents. Unfortunately, the consequences of the experiment will be felt for the lifetime of the houses requiring the employment of a management company to enforce parking regulations.

Garages used for storage rather than car parking were also observed at South: Building for Life 2. Fieldworkers also observed high levels of illegal parking on pavements at this development which again led to neighbour disputes and road blockages (Figure 3). The planning representative stressed the pressure which they had faced to encourage parking away from the property frontages and into garages, and acknowledged that the desire to park close to their property had led to residents continuing to park on pavements.

Figure 3: Illegal on-pavement car parking

On-plot car parking and garages

While on-plot parking is recommended by policy guidelines (Office of the Deputy Prime Minister and the Home Office, 2004; Department for Transport, 2007; ACPO, Secured by Design, 2010), in many cases this arrangement took up all of the private space in front of the dwelling, leaving no remaining space for the resident to personalise the environment. This arrangement could lead to blocking natural surveillance of the wider street environment, this problem being exacerbated where parking to the front of a dwelling is not allocated to that dwelling as highlighted above. The dominance of cars on the street scene was particularly noticeable at Midlands: Building for Life 1 and Midlands: Non-Building for Life 1.

Police recorded crime data revealed an unexpectedly high level of 'burglary other' offences from garages at South: Building for Life 1. These garages were either under-dwelling or detached and at the end of the rear garden). These garage designs may not be affording sufficient lines of sight from the street and neighbouring dwellings.

Underground car parking

At North: Building for Life 1 and North: Non-Building for Life 1 parking was provided in underground parking that was assessed as well integrated into the design of the development and secure. However, as demonstrated through the analysis of crime data these car parks were not without their problems, with several offences committed within them. While a relatively low number of offences were recorded at these two sites, a large proportion took place within the secure underground car parks. These offences were mainly theft from vehicles and theft of pedal cycles. This raises the possibility of offences being committed by residents themselves and highlights the need to ensure that security measures are applied also to communal spaces within apartment blocks.

Design Features and Crime: A statistical model

A total of 425 crimes[vii] were recorded across the twelve sites during the three year analysis period. The vast majority (86%) of properties experienced no crime while eleven percent experienced one crime. The sample developments were selected without prior knowledge of crime levels and subsequent inspection of crime data revealed that none of the developments were the highest crime neighbourhoods in their vicinity. Low crime levels precluded the analysis of individual crime types, the model described below was fitted for the total crimes committed. It should be noted that the relatively low number of crimes recorded across the sample reduces the likelihood of identifying statistically significant relationships.

The majority of offences (39%) were criminal damage, 22% were crimes against the person (assault, theft from the person and robbery), 20% were domestic burglary (including 'burglary other' and attempted burglaries) the remaining 19% were vehicle crimes (theft of vehicles including 'taking without consent', and theft from vehicles).

Design attributes and crime

A single level multivariate regression model was fitted to explore the relationships between design attributes and crime. The variables modelled were derived from the Checklist and included indicators of surveillance, permeability, connectivity, density and parking arrangements. Contextual variables included the area's socio-demographic classification and crime levels in a 500m buffer surrounding the selected sites[viii]. The results are displayed in Table 7 which contains only those variables that exhibited a statistically significant association with crime levels. The final model contains only three significant variables.

Table 7: Model to predict the distribution of crime counts (key crime types) across the sample

Explanatory Variable		Estimated change in crime %
Street Type	True Cul-de-sac (base)	-
	Leaky Cul-de-sac	110 **
	Through road	93 **
Property is on a corner plot	No (base)	-
	Yes	18 m
Number of properties overlooking the property	Not overlooked (base)	-
	One to Two	ns
	Three to Five	-38 **
	Six or More	-34 *

Table Notes
Number of Cases 2268
m=marginal significance p<0.1
* significant p<0.05
** highly significant p<0.01

For each of the explanatory variables entered into the model one category was selected as the base. The final column of Table 7 presents the estimated percentage change in crime levels expected for each category when compared to the base. For example, a property located on a leaky cul-de sac is estimated to have 110% more crime than a property located on the base category (true cul-de-sac.)

The table highlights the clear importance of development layout in explaining crime levels. Street type - an indicator of connectivity and through movement, was by far the most influential variable tested. Properties on true culs-de-sac experienced the lowest levels of crime. Properties located on a through road experienced 93% more crimes compared to those on a true cul-de-sac. Properties situated on leaky culs-de-sac experienced an average of 110% more crimes than properties on true culs-de-sac. Location on a corner plot increased a property's risk of crime by 18% (compared to non corner properties) although the significance of this relationship was only marginal.

The final variable which proved significant in the model was the number of other properties overlooking the rear of a dwelling. Properties overlooked from the rear by three to four properties experienced 38% fewer crimes, while properties overlooked from the rear by five properties or more experienced 34% fewer crimes (compared to those homes that were not overlooked). There was no significant effect of being overlooked at the rear by one or two houses. While being overlooked represents surveillance rather than permeability, the results suggested that these two factors worked together to influence crime levels. The introduction of the 'rear overlooked' variables to the model reduced the strength of the relationship between corner plots and crime, suggesting that improved natural surveillance may reduce the negative impact of corner plot locations (although no significant interaction was identified within this small dataset).

It was noted above that low recorded crime levels may have reduced the likelihood of identifying statistically significant relationships. In light of this, interesting relationships that did not prove significant in the modelling exercise are still highlighted. The analysis identified that crime risk was generally lower on sinuous compared to linear culs de sac (replicating Johnson and Bowers, 2010). However the differences between linear and sinuous culs-de-sac were cancelled out by inclusion of the leaky versus true cul-de-sac variable in the model. Parking related findings that were statistically significant[ix] in bivariate analysis but were 'cancelled out' by the effect of other variables in the final model included:

- Properties with communal parking experienced higher levels of vehicle crime (theft of and theft from vehicles) and criminal damage than properties with other types of parking.
- Developments which offered dedicated visitor parking experienced less crime that those that did not.
- Communal parking courts with allocated parking spaces experienced less crime than those without allocation.

Several indicators of 'connectivity' were tested including the mean number of connections between each street and minor, local and private roads, the number of junctions required to reach minor and major roads and the design expert's assessment of connectivity across the development. However, no significant relationship was identified between any of these indicators and the risk of crime. It should be noted that this study focused upon discrete

housing estates and not the areas between them, therefore compared to Johnson and Bowers (2010) there was relatively little variation in connectivity across the sample.

The low number of crimes committed across the sample limited the power of the statistical model. However, the findings clearly point to the importance of design features in the explanation of crime, and of these features the predominance of street layout and surveillance.

SUMMARY OF FINDINGS

Through-movement/Connectivity

The impact of connectivity on levels of crime and disorder has dominated the designing out crime agenda, leaving practitioners with little clear guidance as to how to design out crime in practice. Culs-de-sac were encouraged by some (on the grounds of crime reduction) and discouraged by others (on grounds of access to facilities and promotion of non-car travel). Others neither encouraged nor discouraged their use, but stressed the importance of avoiding connecting footpaths (leaky culs-de-sac) and ensuring that they were small, short and linear in design.

Overall the evidence base relating to through-movement/connectivity and levels of crime contains consistent findings. Research conducted with varied methodologies including analysis of police recorded crime, interviews with offenders or staged-activity analysis has supported the hypothesis that high levels of connectivity and through-movement contributes to higher levels of crime, with true, sinuous culs-de-sac experiencing the lowest levels of crime. The exceptions are studies conducted using Space Syntax methodologies[x]. An explanation for this divergence may be found in Space Syntax's classification of road networks which may not reflect their true layouts. The one consistent finding between the studies (irrespective of methodology) was that leaky culs-de-sac were the least safe design of residential housing.

This study confirmed that sinuous, true culs-de-sac experienced the lowest levels of crime and highlighted the clustering of crimes around footpaths, alleyways and access paths to properties. However site observations revealed that designing out footpaths could backfire with residents creating unofficial short-cuts when desire lines are ignored. Footpaths will often be necessary in a development and one site provided an example of well planned footpaths that, by being well used and well maintained and by avoiding the rear of properties, did not create crime opportunities.

Car Parking

The review of literature revealed no conflicting findings regarding the impact of the design of car parking on levels of crime although only a limited number of studies had been conducted. Studies agreed that properties with garages were the least vulnerable to burglary. However, this research revealed that innovative designs for garages may create new vulnerabilities.

Analysis of policy and guidance documents revealed areas of consistency (all appeared to agree that rear parking courts are vulnerable to crime). There were some conflicts regarding the benefits of parking within a property's curtilage. Secured by Design New Homes (ACPO, 2010) and Safer Places (ODPM and Home Office, 2004) agreed that garages, followed by driveways, are the safest places to park vehicles. However, Manual for Streets (Department

for Transport, 2007) suggested that parking within the front curtilage of a property should be avoided as it breaks up the property's frontage and restricts natural surveillance.

This study confirmed concerns that rear parking courts are vulnerable to crime. Rear parking courts had higher levels of vehicle crime and criminal damage than other types of parking, and also facilitated offenders' access to the rear of properties. Crucially fieldworkers observed that many residents were not using their allocated spaces within these courts, preferring to park on street.

The research highlighted the unintended consequences of parking policies designed to move cars away from property frontages. Across the sample the behaviour of residents demonstrated a desire to park within close proximity to home; often by parking illegally on pavements. Lack of consideration for users in the design and allocation of car parking can lead to expensive retrospective solutions. The study also demonstrated that the appropriate and clear allocation of parking spaces, including suitable provision for visitor parking can reduce crime and prevent neighbour disputes.

CONCLUSION AND RECOMMENDATIONS

Whilst the study achieved its aim of strengthening the evidence base regarding the impact of residential design on crime, the process of conducting the research has highlighted many issues which were not within the original aims, yet have emerged as being as important as the key findings presented. These include the importance of utilising the appropriate methodology to collect information on the design and layout of the development as well as the levels of crime and disorder experienced, and also the importance of considering crime and disorder incidents perhaps not traditionally associated with CPTED such as neighbour disputes, fraud and disorder relating to the short-term letting of city dwellings.

The study revealed some interesting findings relating to car parking and through movement and these are summarised above. For car parking, the findings uncovered crime and disorder problems relating to the inconsiderate allocation of car parking spaces, the lack of allocated visitor parking and the desire within planning policy and guidance to move the car away from property frontages (and the subsequent solutions to these policy demands including rear parking courts, short drives and detached garages at the end of rear gardens). For through-movement and connectivity, the findings confirmed those presented within the vast majority of research studies – that true culs-de-sac experience the lowest levels of crime, followed by through roads (which experienced 93% more crime than true-culs-de-sac), with leaky culs-de-sac experiencing the highest levels of crime (110% more crime than true culs-de-sac). The findings supported those presented within recent research (Johnson and Bowers, 2010) that sinuous, as opposed to linear culs-de-sac, are the safest road layout. Although many policy and guidance documents have traditionally recommended linear culs-de-sac, it is hoped that these findings can be used to revise policy and guidance, and to assist practitioners in ensuring that their advice is supported by current research.

The study utilised a unique and painstaking methodology to capture accurate information on the design and layout of case study sites, on the actual application of design features and the use of the space by residents and passers-by, and on the levels of crime and disorder experienced throughout the developments. Without applying this methodology, it is highly likely that road layouts would have been wrongly classified, many 'informal' footpaths (made by residents to suit their desire lines) would have been missed, and the emergence of previously unconsidered crime and disorder problems would have gone unnoticed. It is hoped

that the importance of this detailed methodology is recognised, replicated and enhanced in further studies relating to the impact of residential design on crime.

Although the findings confirmed many of the principles of CPTED, one of the most interesting and useful findings to emerge was that developments can implement features which counter the basic principles of CPTED, as long as the criminogenic impact of these features is considered and addressed in advance, with pre-planning consultation with Police Architectural Liaison Officers/Crime Prevention Design Advisors (ALO/CPDAs). The findings suggest that developments with high levels of through movement experience the highest levels of crime, yet the development Midlands: Building for Life 2 had high levels of through-movement but experienced no burglary dwelling offences in the three-year period of analysis. This was due to the close consultation with ALO/CPDAs and the careful consideration of the positioning of footpaths which did not run at the rear of side of dwellings – resulting in the development's achievement of Secured by Design status (even with high levels of through-movement). The suggestion emerging being that CPTED principles can be used flexibly (as opposed to the rigid refusal to deviate), allowing the development of safe, yet innovative contemporary developments, if this is conducted in close consultation with police ALO/CPDAs.

The findings from this study present many challenges for policy-makers, planners and crime reduction practitioners, as well as those conducting research within the field of CPTED. The following section highlights key recommendations relating to the paper's key themes of connectivity/through-movement and parking.

- Residential developments should limit connectivity and through-movement. Sinuous, true culs-de-sac are the safest road layout and should be encouraged; leaky culs-de-sac should be avoided.

- Pedestrian desire lines should be identified and well considered footpaths should be designed into the development. To ensure footpaths are well used they should connect the locations residents need to reach, be suitably maintained and adequately lit. Footpaths should not run to the rear or side of properties.

- There is a clear need for consistent guidance on parking provision within housing developments; this should recommend that, where possible, vehicles should be parked within garages or within the curtilage of the property.

- Rear parking courts should be avoided. However, where they are essential, they should be overlooked by nearby housing and be small in size.

- Developments must have allocated car parking spaces for visitors and the design and allocation of on-street and communal parking must take care to avoid neighbour disputes.

- Innovative approaches to parking should be well-considered; residents will often adapt and adjust their parking in ways not intended if parking provision does not provide the necessary convenience. Designs for garages should ensure that surveillance from and of the main property should not be restricted, sightlines must be maintained and the physical security of these garages should be maximised.

References

ACPO Secured by Design (2010) *New Homes 2010*. London, ACPO Secured by Design.

Angel, S. (1968) Discouraging Crime through City Planning. *Working Paper Number 75, Center for Planning and Development Research,* Berkeley, University of California.

Armitage, R. (2000) An Evaluation of Secured by Design Housing within West Yorkshire – Briefing Note 7/00. London, Home Office.

Armitage, R. (2006) Predicting and Preventing: Developing a Risk Assessment Mechanism for Residential Housing. *Crime Prevention and Community Safety: An International Journal.* 8 (3), 137-149.

Armitage, R. (2007) Sustainability Versus Safety: Confusion, Conflict and Contradiction in Designing out Crime. *In:* G. Farrell, K. Bowers, S. Johnson and M. Townsley (Eds.) *Imagination for Crime Prevention: Essays in Honour of Ken Pease.* Crime Prevention Studies, Volume 21. Monsey, New York, Criminal Justice Press and Willan Publishing. 81-110.

Armitage, R, and Monchuk, L (2009) Reconciling Security with Sustainability: The Challenge for Eco-Homes. *Special Edition Volume of Built Environment Journal* – Vol. 35, No. 3, pp. 308-327.

Armitage, R., Colquhoun, I., Ekblom, P., Monchuk, L., Pease, K. and Rogerson, M. (2010) *Residential Design and Crime – Final Report*. London: CABE and Home Office.

Atlas, R. LeBlanc, W. G. (1994) The Impact On Crime Of Street Closures And Barricades: A Florida Case Study. *Security Journal*. 5, 140 – 145

Beavon, D.J.K. *et al. (*1994) The Influence of Street Networks on the Patterning of Property Offences. *In:* R.V.Clarke (ed.) *Crime Prevention Studies, Volume 2.* Monsey NY, Criminal Justice Press. 115-148.

Bevis, C. and Nutter, J.B. (1977) Changing Street Layouts to Reduce Residential Burglary: Paper presented to the American Society of Criminology. Atlanta.

Brantingham, P.L. and Brantingham, P.J. (1975) Residential Burglary and Urban Form. *Urban Studies,* 12, 273-284.

Brantingham, P.L. and Brantingham, P.J. (1984) Burglar Mobility and Preventive Planning. *In:* R.V. Clarke and T. Hope (eds.) *Coping with Burglary: Research Perspectives on Policy.* Boston, Kluwer-Nijhoff. P. 77-96.

Brown, B.B. and Altman, I. (1983) Territoriality, Defensible Space and Residential Burglary: An Environmental Analysis. *Journal of Environmental Psychology,* 3, 203-220.

CABE (2008) Delivering Great Places to Live: 20 Questions You Need to Answer. Building for Life. London, CABE.

CABE (2009) This Way to Better Residential Streets. London, CABE.

Cozens, P. (2002) Sustainable Urban Development and Crime Prevention Through Environmental Design for the British City. Towards an effective Urban Environmentalism for the 21st Century. *Cities.* 19 (2), pp. 129-137.

Cozens, P. (2007) Planning, Crime and Urban Sustainability. *Transactions on Ecology and the Environment,* 102, pp. 187-196.

Cromwell, P.F., Olson, J.N. and Avary, D.W. (1991) *Breaking and Entering: An Ethnographic Analysis of Burglary.* Newbury Park, California, Sage.

Department for Communities and Local Government (2008a) *Eco-Towns: Living a Greener Future.* London, Department for Communities and Local Government.

Department for Communities and Local Government (2008b) *The Code For Sustainable Homes: Setting The Standard In Sustainability For New Homes.* [Online]. Available from: http://www.communities.gov.uk/publications/planningandbuilding/codesustainabilitystandards. [Accessed 04 June 08].

Department for Transport (2007) *Manual for Streets*. London, Department for Transport.

Dewberry, E. (2003) Designing out Crime: Insights from Eco-Design. *Security Journal,* 16, pp. 51-62.

Eck, J, E. (2002) Preventing Crime at Places. *In:* L. W. Sherman, D, P. Farrington, B, C. Welsh, D. Layton MacKenzie (eds.) *Evidence Based Crime Prevention.* New York, Routledge.

Fairs, M. (1998) End of Road for Cul-de-Sac. *Building Design,* 1373,1.

Feeney, F. (1986) Robbers as Decision Makers. *In:* D. Cornish and R. Clarke (eds.) *The Reasoning Criminal.* New York, Springer-Verlag. 53-71.

Gabor, T., Baril, M., Cusson, M., Elie, D., Leblanc, M., and Andre, N. *(*1987) *Armed Robbery: Cops, Robbers, and Victims.* Springfield, IL, Charles C. Thomas.

Goldstein, H., Rasbash, L., (1988) A User's Guide to MLwiN, Institute of Education, London.

Hakim, S., Rengert, G. & Shachamurove, Y. (2001). Target Search of Burglars: A Revised Economic Model. *Papers in Regional Science,* 6(4), 445–464.

Hillier, B. (2004) Can streets be made safer. *Urban Design International.* 9. 31-45.

Hillier, B. and Shu, S. (1998) Crime and Urban Layout: The Need for Evidence: Home Office Crime Prevention College. Easingwold.

Hillier, B. and Shu, S. (2000) Crime And Urban Layout: The Need For Evidence. *In*: S. Ballintyne, K. Pease, and V. McLaren (eds) *Secure Foundations: Key Issues in Crime Prevention*, *Crime Reduction and Community Safety*. London, Institute of Public Policy Research. 224-48.

Hillier, B. and Sahbaz O. (2009) Crime and Urban Design: An Evidence-based Approach in R. Cooper, G. Evans, and C Boyko (eds.) *Designing Sustainable Cities*. Chichester, Wiley-Blackwell.

Johnson, S. and Bowers, K.J. (2010) Permeability and Burglary Risk: Are Cul-de-Sacs Safer? *Quantitative Journal of Criminology, 26 (1), 89-111.*

Jones, M., and Fanek, M. (1997) Crime in the urban environment, Proceedings, 1st International Space Syntax Symposium, Vol. II, London, 25.1-25.11.

Lasley, J. (1998) *Designing Out Gang Homicides and Street Assaults* US National Institute of Justice , Washington, DC.

Letkemann, P. (1973) *Crime as Work.* Englewood Cliffs, NJ: Prentice-Hall.

Matthews, R. (1992) Regulating Street Prostitution. *British Journal of Criminology.* 32 (1), 18-34.

Mirlees-Black, C. et al. (1998) The 1998 British Crime Survey – England and Wales. London, Home Office.

Newman, O. (1995) Defensible Space: A New Physical Planning Tool for Urban Revitalization. *American Planning Association Journal,* 61 (2), 149-155.

Newman, O. (1996) *Creating Defensible Space*. Rutgers University, Centre for Urban Policy Research.

Nubani, L. and Wineman, J. (2005) *The Role of Space Syntax in Identifying the Relationship Between Space and Crime*. Paper Presented at the Proceedings of the 5th Space Syntax Symposium on Space Syntax, Delft, Holland.

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

Poyner, B. (1996) Crime Prevention and Sustainability. Paper Presented at *5th International Seminar on Environmental Criminology and Crime Analysis,* Tokyo.

Poyner, B. and Webb, B. (1991) *Crime Free Housing.* Oxford, Butterworth.

Queensland Government (2007) *Crime Prevention Through Environmental Design – Guidelines for Queensland. Part A: Essential Features of Safer Places*. Brisbane,

Queensland Government.

Rengert, G. and Hakim, S. (1998) Burglary in affluent communities: a planning perspective. *In*: M. Felson & Pieser (eds) *Reducing Crime Through Real Estate Development and Management*. Washington DC: Urban Land Institute.

Rengert, G.F. and Wasilchick, J. (2000) *Suburban Burglary: A Tale of Two Suburbs – Second Edition.* Springfield, Illinois, Charles C. Thomas Publishers.

Rubenstein, H. et al. (1980) The Link Between Crime and the Built Environment. The Current State of Knowledge. Washington, DC, National Institute of Justice.

Rudlin, D. and Falk, N. (1995) *21st Century Homes: Building to Last.* URBED, London.

Shu, S., Huang, J. (2003) Spatial configuration and vulnerability of residential burglary: a Case study of a city in Taiwan, in J. Hanson (Ed.), *Proceedings*, 4th International Space Syntax Symposium, London.

Shu, S. (2000) Housing Layout and Crime Vulnerability. *Urban Design International, 5, 177-188.*

Stungo, N. (1998) Culs-de-sac hit the Skids. *Building Design,* 1377, 2.

Suttles, G.D. (1968) *The Social Order of the Slum.* Chicago, IL, University of Chicago Press.

Taylor, R. (2002) Crime Prevention Through Environmental Design (CPTED): Yes, No, Maybe, Unknowable and All of the Above. In: R.B. Bechtel and A. Churchman (eds.) *Handbook of Environmental Psychology*. New York, John Wiley and Son.

Taylor, R. and Gottredson, S.D. (1987) Environmental Design, Crime and Prevention: An Examination of Community Dynamics. *Crime and Justice: An Annual Review of the Research,* 8, 387-416.

Tseloni, A and Pease, K (2004) *Repeat Personal Victimisation, Random Effects, Event Dependence and Unexplained Heterogeneity*, British Journal of Criminology, 44, 931-945.

Van Der Voordt, T.J.M. and Van Wegen, H.B.R. (1990) Testing Building Plans for Public Safety: Usefulness of the Delft Checklist. *Netherlands Journal of Housing and Environmental Research* 5(2), 129-154.

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

Wiles, P. and Costello, A. (2000) The 'Road to Nowhere': The Evidence for Travelling Criminals, Home Office Research Study 207. London, Home Office.

Yang, X. (2006) Exploring The Influence of Environmental Features on Residential Burglary Using Spatial-Temporal Pattern Analysis. Unpublished PhD dissertation, University of

Florida. Available at: www://etd.fcla.edu/UF/UFE0013390/yang_x.pdf. [Access 17 Feb 2010].

Zavoski, R., Lapidus, G., Lerer, T., Burke, G. and Banco, L. (1999) Evaluating the impact of a street barrier on urban crime. *Injury Prevention* 5, 65-68.

---

[i] For one development, of the 31 crimes recorded, only 7 specified the actual block (of 5) which the crime took place at, and of that 7 offences, only 4 actually recorded an apartment number. For another development, only 15 of the 34 recorded offences specified an apartment number.

[ii] A Sinuous cul-de-Sac is defined by Johnson and Bowers (2010) as: Property is located on a road which leads to a dead-end AND is non-linear in geometry so that there is little visibility down the road from the road to which it is connected OR the road is linear in geometry BUT the road to which you turn off to access the cul-de-sac is NOT a through road. A Linear cul-de-Sac is defined as: Property is located on a road which leads to a dead-end AND is linear in geometry so that there is visibility to the end of the cul-de-sac from the road to which you access the cul-de-sac AND the street is one turn off a through road.

[iii] Integration being an indicator of how easily you can reach a specific line – the average number of spaces needed to pass through to reach a specific line for all axial lines in a system.

[iv] Statistically significant at 1% level.

[v] It should be noted that the completeness and accuracy of modus operandi fields varied and this was missing for a large proportion of crimes.

[vi] The OACs classification was developed by Office for National Statistics (ONS) and utilises information from the census to classify areas see www.areaclassification.org.uk.

[vii] Crimes committed against non residential addresses (e.g. offices) and non-private residences (e.g. Children's homes, nursing homes) were excluded from this total.

[viii] Socio-economic classification, property density and crime levels in the wider area did not prove significant predictors of crime counts within the development. This is likely to be a consequence of the observation above that the largest share of variation in crime across the sample is found at the property level, therefore these development level variables did not prove influential in the model.

[ix] At the 5% level.

[x] It should be highlighted that one study (Nubani and Wineman, 2005) revealed findings which conflicted with the remaining Space Syntax studies.