

# A VIRTUAL REALITY APPROACH TO PERSONAL SAFETY AND THE DESIGN OF BUILT ENVIRONMENT FACILITIES

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The Suzy Lamplugh Trust Research Institute at the University of Glamorgan is conducting research that focuses on personal safety issues as they relate to the design and maintenance of built environment facilities. The project, funded by Valley Lines (a network of 66 railway stations in South Wales) seeks to investigate the perception and reality of personal safety (against crime and nuisance, as opposed to health and safety) on these stations and their immediate access routes and environments. Customer satisfaction surveys have consistently reported that although recorded incidents of crime and nuisance are relatively low, rail users perceive their risk to be significantly higher and therefore discourages people from using the trains. The project uses interactive virtual reality (VR) scenes as the environmental stimuli for investigating perceptions. VR 'walkthroughs' of a sample of stations have been shown to focus groups representing samples of users and potential users. The standardisation of the 'personal journey' to, from and through the station represented by this approach and its 'dynamic' (rather than static) and interactive nature, make it a realistic avenue for evaluating how people decode the railway environment in personal safety terms. A pilot study for three stations was very encouraging and illuminating. The respondents provided a rich source of data, concerning their personal safety concerns in and around the station environment and the findings broadly support Crime Prevention Through Environmental Design (CPTED) theory. It also highlights the crucial importance of user perceptions in the design and management of built environment facilities. This methodology will also be employed to investigate perceptions of personal safety within the University campus environment, its immediate environment and access routes. Within this community, fear of crime has been shown to exist in locations where, according to recorded statistics, crime is low. Therefore, the objective is to develop applied solutions to improve personal safety on the campus. Finally a package of recommended solutions and a generic model shall be developed that can analyse problems and generate solutions to any campus University.

Keywords: crime, facilities management, personal safety, virtual reality walk-through scenes.

## INTRODUCTION

Personal safety and personal security issues are central concerns to all citizens. Investigating how crime and nuisance and the fear of such incidents relates to the design and management of built environment facilities, is therefore a worthwhile endeavour. This paper discusses Crime Prevention Through Environmental Design (CPTED) and specifically focuses upon a study of Valley Lines railway stations in

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South Wales. It introduces a pioneering approach to representing the environment, in the stimulus form of a virtual reality walk-through scene (VR). It is argued that understanding how users perceive built environment facilities, in relation to their personal safety and security, can contribute much to traditional crime prevention initiatives that are based predominantly upon much criticised official crime statistics. There are obvious potential benefits to those who manage such facilities such as maximising usage levels and profits.

In the twentieth century, the British Criminal Justice System (CJS) has arguably failed to contain or reduce crime and consequently, this ubiquitous issue continues to represent a highly contentious and hotly debated area of study. Home Office data for 1997 estimates total expenditure on the CJS of £12.6 billion per annum, an average prison population of over 61,000 (at a cost of £1,740 million) and a recidivism rate of 58% (Home Office 2000). Since 1918, crime has increased on average by 5.1% per year, reaching 4.5 million incidents in 1997 (Home Office 1999). The British Crime Survey (BCS) (Mirrlees-Black *et al.* 1998) estimates that criminality is as much as four times higher than reported statistics indicate. The 'dark figure' of crime, that which is not reported or recorded, clearly exacerbates the problem of analysing incidents of crime at the spatial level (Maguire 1997). Clearly, the CJS has proven to be largely ineffective in operation and predominantly reactive in nature. It is suggested that analysing the urban 'stage', where crime is clearly located, can contribute to our existing knowledge and understanding of criminality. If design can affect the inclination to offend, and this research argues that it can, then focused research into this highly complex human-environment interaction is essential. Current government policy also suggests that researching this intriguing subject is both necessary and crucial to the design-affects-crime debate.

The paper discusses the spatial dimensions to crime and focuses on a pilot study which investigates the perceptions of personal safety at railway stations in South Wales. VR is used as the environmental stimulus and is also being adapted and applied the built environment facility of the University campus.

## **CRIME AND THE ENVIRONMENT**

It has been argued that there are four dimensions to any crime (Brantingham and Brantingham 1981), namely the law, the offender, the target and the place. Environmental Criminology is concerned with place and relies on two related behavioural theories. 'Routine activities theory' argues that for a crime to take place, there must be a motivated offender, a suitable target and the absence of capable guardians (Cohen and Felson 1979). 'Rational choice theory' (Cornish and Clarke 1986) makes the behavioural assumption that offenders are rational in their decision-making and recognise and respond to environmental cues (Pascoe and Topping 1998). Crucially, Herbert and Hyde (1985) note that if the spatial distribution of offences and offender (according to official statistics) were random, then environmental criminology would be of little interest to those researching or operationalising criminal or social policy. Indeed, in recent years 'hot spots' of crime have received increasing interest (i.e. Nasar and Fisher 1993; Lupton 1999).

The study of the spatial patterning or the geography of crime and deviancy is known as Environmental Criminology. Crime patterns have been observed and distinct differences exist in both the urban-rural and suburban-inner city contexts. However, with the seminal work of Jacobs (1961) the area and focus of investigation narrowed

significantly, to implicate urban design. Anecdotally, Jacobs drew attention to specific elements of design that she opined, may jeopardise community safety. Angel (1968), Jeffery (1971) and Newman's 'Defensible Space' (1973) all asserted that urban design was widely associated with enhancing or reducing opportunities for crime.

These theoretical foundations have been widely criticised and this has been discussed elsewhere (see for example Cozens *et al.* 2001a). Following such research CPTED has evolved into a robust sub-division within criminology (Brantingham and Brantingham 1975). Several 'geographies of crime' have investigated the social ecology of crime and focused upon location (Harries, 1974; Herbert, 1982). Herbert and Hyde (1985: 260) claim Environmental Criminology "...places far greater emphasis upon the spatial dimensions of criminal behaviour". While Bottoms and Wiles (1997: 305) define environmental criminology as "... the study of crime, criminality, and victimisation as they relate *first*, to particular *places*, and *secondly*, to the way that individuals and organisations shape their activities by *placed-based* or *spatial factors*". Other terms used include the 'Geography of Crime', the 'Ecology of Crime' and 'Situational Crime Prevention' (SCP).

The highly influential 'Broken Windows' thesis (Wilson and Kelling 1982) stressed the vital importance of maintaining the environment as a physical indicator for levels of social cohesion and informal social control. Subsequent work in this area field has supported these findings (Kelling and Coles 1996). Various researchers have further developed the subject of physical and social signs of incivilities and fear of crime (Skogan and Maxfield 1980; Lewis and Salem 1986; Vrij and Winkel 1991). Such research demonstrates the significance of the physical condition and 'image' of design, and is therefore considered a central concern for the design-affects-crime debate.

The utility of officially derived crime statistics for the purpose of mapping crime trends and formulating CPTED responses, in particular, has been increasing and promises much for the future (Harries, 2000). However, a subjective approach that utilises the perceptions of various users (and potential victims) within the environmental setting offers potentially rich insights into design, facilities management and personal safety issues as they relate to crime and nuisance and the fear of such incidents.

Indeed, Brantingham *et al.*, (1977) and Vrij and Winkel (1991), among others, have discussed the idea that fear of crime may exist in areas which, according to official statistics, are not unsafe. The growth of fear of crime research has been significant (Hale 1996), yet may not have been given the attention it deserves (Harries 2000). Indeed, according to the British Crime Survey recorded crime statistics, may represent only a fraction of total crime (Mirlees-Black *et al.* 1998). The missing data is simply referred to as the 'dark figure of crime' that may not be witnessed or discovered, or remains either unreported or unrecorded. Reasons for under-reporting include; a reluctance to delay one's journey, a lack of confidence that the offender will be apprehended, the absence of someone to actually report the incident to, and the belief that a reported incident will not be taken seriously are such examples.

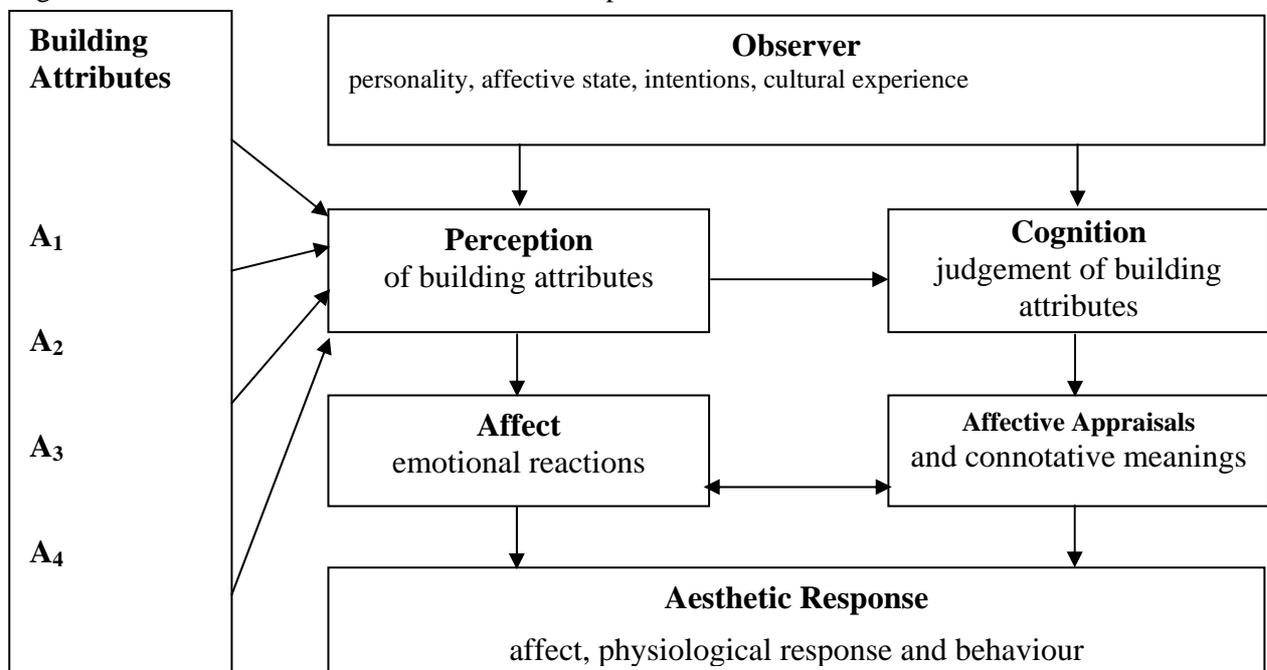
The public transport environment is no different, and crime potentially remains significantly under-reported, an issue recognised by the UK government, who note that; "a large proportion of crime on public transport is not reported" (DETR 1998a). Consequently, the study of the fear of crime has emerged as an important policy

objective. Although reported crime on the railways is low, the perception of crime has consistently been found to be significantly higher in rail-users' customer surveys.

## PERCEPTIONS AND ENVIRONMENTAL STIMULI

The use of static photographs has often been utilised as a source of environmental stimuli, particularly in the field of environmental psychology and the study of building preferences. The investigation of environmental preferences has represented a major focus of research in environmental psychology over the last thirty years (Hubbard 1996). This is not the exclusive concern of environmental psychologists, with geography, architecture and planning also demonstrating a keen interest. However, the "healthy methodological diversity" (Hubbard: 75) has also produced a legacy of discourse. Consequently "...very little is known with any surety about people's attitudes to environments, whether natural or man-made" (ibid.). The contribution that might be provided by this avenue of inquiry is summarised succinctly by Taylor (1991). He claims economists, criminologists and geographers "...are often concerned with larger scale, areal-level dynamics" while, "...environmental psychologists have a more fine-grained concern with individuals and small groups" (Taylor: 952). Furthermore, the preferences of architects and design professionals have been studied and shown to differ from those of the ordinary citizen (Stamps and Nasar 1997). Hubbard (1996: 85) notes "...an architectural stimuli will evoke a range of images and ideas not merely confined to spatial or physical characteristics". Understanding the response process in environmental aesthetics can provide useful insights into both the nature and process of perception, which have informed the design and fine tuning of the research methodology. Nasar (1994) provides a schematic representation of the process of aesthetic response (Figure 1).

Figure 1: A Probabilistic Model of Aesthetic Response



Source: From Nasar (1994:381), arrows indicate probabilistic relationship.

Significantly, little research has attempted to investigate how CPTED and 'defensible space' dimensions are perceived in the British context. Ham-Rowbottom *et al.* (1999) studied 'defensible space' and found that perceptions varied between user groups such

as burglars, police and residents, relating to detached housing designs. Cozens *et al.* (2001b) investigated the perceptions of a range of characteristic British housing designs and the findings generally support CPTED ideas in that both design and management of housing, were shown to influence the levels of ‘defensible space’, associated with a series of photographs. Similar findings were also reported in a study of the railways (Cozens 2002). However, it is argued that by more realistically representing the wider environment (in this case the immediate access route to railway stations and the stations themselves) with the use of a more interactive and dynamic environmental stimulus will provide more robust and richly detailed data. VR is the suggested way forward in this regard. It is presented in this paper as an example of how VR can be operationally applied to a variety of built environment facilities.

This paper discusses research being undertaken at the Suzy Lamplugh Trust Research Institute at the University of Glamorgan. The study is innovative in its use of virtual reality walk-through panoramas as the environmental stimuli to investigate perceptions of personal safety and security issues. It is argued that the standardised, dynamic and interactive scenes of a selection of typical railways stations (and their immediate access routes) will provide rich insights from respondents in relation to crime, fear of crime and personal safety/security concerns within the railway station facility. Virtual-reality ‘walk-through’ panorama scenes have been completed for a range of stations which are broadly representative of the diverse range of stations on the Valley Lines network. Such a visual stimulus has been used recently, predominantly for marketing purposes – whereby Universities or tourist venues provide such ‘walk-throughs’ for internet visitors interested in inspecting the site before, or instead of, visiting in person. It provides a unique opportunity to present an environment to a large number of potential viewers in a highly standardised fashion. Significantly, the Queensland police also make use of such software in a world-first crime scene reporting programme that they have developed, which simplifies the process of collecting, storing and presenting visually recorded evidence from crime scenes. Witnesses are ‘walked-through’ the 360 degree views of crime scenes in order to refresh their memory of events, or when they might be unable to re-visit a crime scene themselves. Conway, Maver and Grant (University of Strathclyde), have pioneered the use of VRs with an interactive study whereby wheelchair users travel through an environment and comment upon their journey. The study incorporates engineering, which considers the resistance of various surfaces to wheelchair usage as well as inclination and the visual aspects of the environment (Wilton 2001).

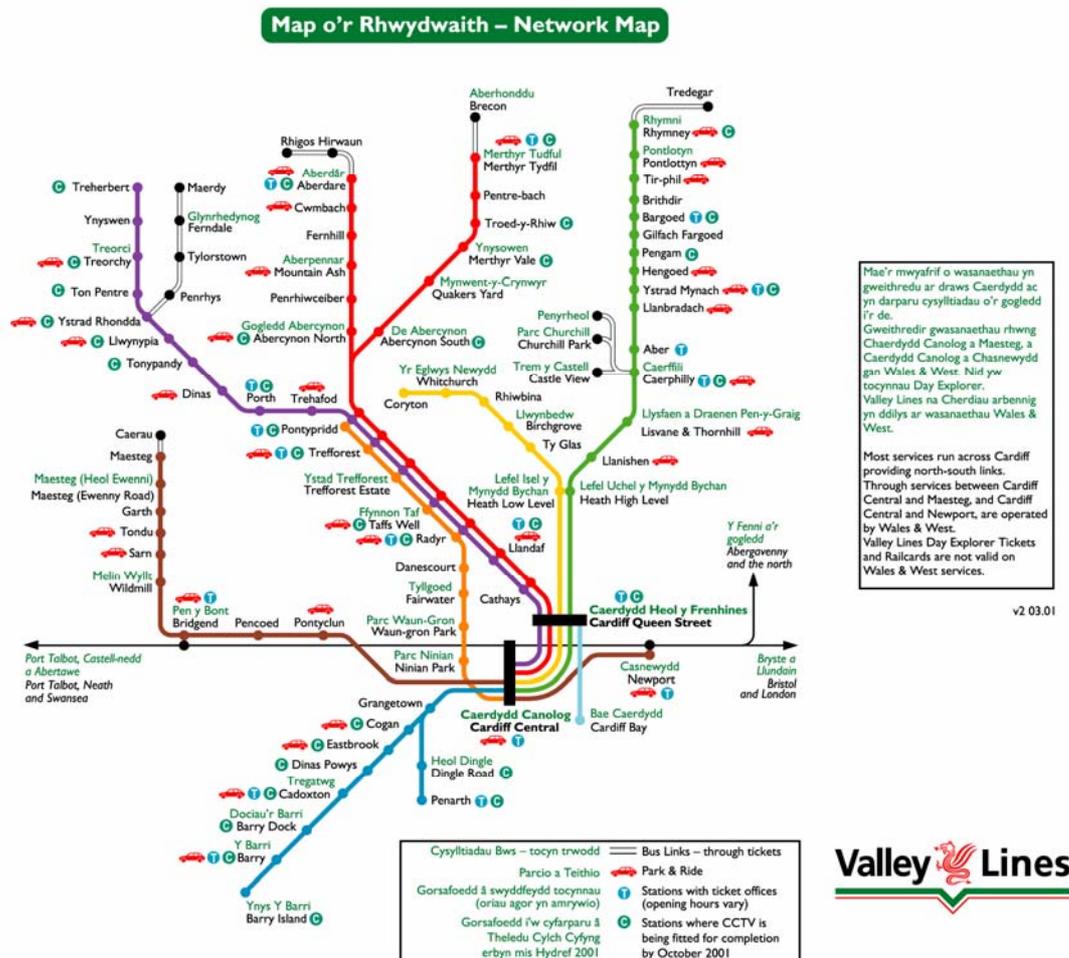
## **THE RESEARCH STUDY - A VIRTUAL REALITY APPROACH**

Valley Lines railways is situated in the South Wales Valleys (U.K) with Cardiff, the capital city, as its epicentre and is part of the newly formed Wales and the Borders franchise (see Figure 2). The network has 7.3 million users per year and is a small, but significant transport network for business, commerce, leisure, retailing and recreational activities for the city and its surrounding communities. Customer satisfaction surveys consistently reveal that fear of crime and nuisance is a significant factor in dissuading both potential rail users from travelling on the railways and existing users from using the service more extensively.

Within the community, fear of crime can result in the withdrawal of the community and a reduction in the number of people that might actively assist in the self-policing of a neighbourhood – known as ‘eyes on the street’ (Jacobs 1961) Likewise, perceptions of crime on the railways has been shown to affect levels of usage and

passenger confidence (Brantingham *et al.* 1991). Indeed, Crime Concern and Transport and Travel Research (1997) recently reported that 43% of women and 18% of men felt that rail travel in the UK was ‘unsafe’. They also suggested that a 15% increase in all train journeys could be achieved if a range of communal security measures were successfully implemented.

Figure 2. Valley Lines Rail Network Map



Source: Valley Lines, 2001.

Investigating how the design and management of stations affects public perceptions is therefore a worthwhile avenue for investigation. Indeed, the crucial role of perceptions in understanding CPTED has been highlighted with regard to residential housing (Ham-Rowbottom *et al.* 1999; Cozens *et al.* 2001b) and public transport alike (Brantingham *et al.* 1991; Parliamentary Travel Safe Committee, 1998; Cozens 2002). Recently, the Legislative Assembly of Queensland (Australia) commented that: “the public’s perception of crime is an important determinant of people’s usage of public transport” (Parliamentary Travel Safe Committee 1998: 16).

CPTED and Situational Crime Prevention (SCP) argue that the physical environment can be manipulated to reduce the opportunities for crime by its very design and management. By optimising opportunities for surveillance, clearly defining boundaries (and preferred use within the space) and creating and maintaining a positive ‘image’, design and management can discourage offending by virtue of the fact that offenders are potentially more visible to ‘law-abiding’ others, and therefore,

more at risk of apprehension. Both SCP and CPTED assume that the motivated opportunistic offender makes a ‘rational choice’ (Clarke 1992) in any decision to offend, often within the confines of their daily ‘routine activities’ (Felson 1994) and that design will influence this decision-making process. British Transport Police (BTP), who are responsible for policing all of the railways in the UK, recorded 459 crimes on the Valley Lines’ 66 stations (not including crime on the train itself), which equates to 6.26 crimes per 100,000 journeys. This figure is relatively low in comparison to the wider geographical milieu coexisting beyond the railway environment. Although not strictly comparable, the recorded crime rate for the South Wales police force area in 1999 was 10,251 crimes per 100,000 population (Home Office, 2000). However, the incidence of crime is not easily understood by using such statistics – because such offences are both low in number, and they do not reveal any clear patterns that might usefully be investigated. Furthermore, incidents such as anti-social behaviour, youths loitering and mis-behaving, the presence of drunks are not recorded. How the environment is perceived is obviously not included within BTP statistics.

## THE RAILWAY STUDY RESEARCH FINDINGS

### General Study

Unprompted, the respondents of two focus groups (young and ‘mature’ adults) were each asked to provide up to three reasons for not using Valley Lines or for not using it as much as they might (ie using the car or bus service instead). In rank order with number of mentions, the main barriers to use are listed in Figure 3.

Figure 3.

Main Barriers to Using the Railways		
1	Overcrowding at peak periods	12
2	Unreliable service	9
3	Inconvenience v. bus and / or car	9
4	Expense	7
5	Safety	5
6	Poor communication	4
7	Infrequent service	3
8	Sunday timetable	2
9	Lack of late service	2
10	State of rolling stock	2
11	Indirect routes	1

Safety, while not a primary problem at this stage, is a significant deterrent to use for some people, particularly groups such as younger women who may wish to go to the centre of Cardiff for a night out:

“The service is unreliable, you can wait hours for a train on a Sunday and there’s safety last thing at night having to walk from the station.” R1

It may also act as a deterrent to older people who may decide to stay at home or use the car rather than take a train into the city centre

“I don’t use the train very often and there aren’t many people about and I’m frightened of getting on the wrong train. Where I live it’s easier by bus.” R2

Another problem arises with undesirables: drunks, rugby crowds, flashers, youths on trains or loitering in and around stations “I get scared on the train sometimes if I’m working late or doing overtime. In the summer I’m not scared, but in winter it’s dark. You might get a drunk if it’s quiet. If I see a man get off in front of me I might go to the next stop and make a ‘phone call. It’s a long walk from the station.” R1

When safety issues were probed specifically, while respondents were viewing the walk-through scenes, distinct anxieties, fears and concerns were recorded in relation to each of the station settings.

### **Station Study**

The respondents were shown VRs of two railway stations. One station was familiar to them, and the other was not. This ‘home and away’ approach was used to consider the effect of familiarity upon perceptions of personal safety. Research has consistently found that levels of fear of crime and environmental preferences may be affected by familiarity.

**Pentrebach Station** - a station with low patronage levels in a relatively isolated and deprived semi-rural area. This station illustrates the problems that might be encountered by people using a station ‘unknown’ to them. Concerns stated included:

Not visible from the road

Not linked to civilisation

Trees and undergrowth obscuring visibility

Untidy and old-fashioned

Lots of alleys and dark corners

Narrow pathways

Lack of signage

A brick shelter

No ticket office or staff

**Cardiff Queen Street Station** - is a busy, well lit, and staffed station in the capital city; but not without its own problems:

Lack of staff/disinterested/unhelpful staff

Overcrowded/dangerous platforms

Dark corners/untidy/dirty

Youths hanging around/drinking

“I’ve been on Queen Street late and there was no one else on the platform. It was very dark and lonely and I didn’t feel safe. The staff will have bugged off hours ago.” R2

**Radyr Station** - a relatively busy station in an affluent area with a range of concerns expressed by respondents. In particular the immediate approaches to the station were seen to be problematic:

A steep unlit lane

Overgrown trees and bushes obscuring visibility

Slippery pavements

Too far from safe havens

The configuration of the station (footbridge, poor lighting, dark corners and underpass) was also a concern:

“Radyr is down a lonely lane ... the station is well lit, but it’s a long way to the car park ... there are a lot of potential threats...lots of shadows...a big bank of trees...then a bridge.” R2

In terms of priorities this research indicates the need to target such as overcrowding, reliability, convenience and ticket prices ahead of personal safety. However, safety is an issue:

Particularly for women.

Particularly for younger people likely to wish to visit the city centre at night and to socialise.

On the trains: crowding, undesirables.

On the stations: particularly in terms of threats from other people and a general fear of dark / hidden corners.

Threats appear greater for the young and for women, at night and in winter and lack of rail staff appears to exacerbate these fears. If money was no object (and it clearly is) and the station infrastructure was being built from scratch (which it clearly isn’t) the “golden rules” might be:

Staffed stations

Visible and helpful staff

As effective a communication system as possible and more reliable trains (if no staff)

Awareness of communication points

‘Yob’ free stations / immediate environment

Safe surfaces

Safe underpasses (well lit) and easier to use bridges (well lit and safe steps) and lifts

Undergrowth cut back and a general openness

Stations visible from/to a point of safety (eg a road, a pub, a parade of shops)

Modern and well kept, tidy stations

Transparent shelters

Special provisions for the safety of women on trains and on stations, particularly after dark

Need to demonstrate the resolve of Valley Lines on the safety issue.

A range of yes / no questions were also presented to specifically probe the perceptions of CPTED and 'defensible space' dimensions of surveillance, territoriality and 'image' associated with each station. Not surprisingly, perhaps, Cardiff Queen Street was perceived to be the most 'defensible', followed closely by Radyr, while Pentrebach was perceived to be considerably less 'defensible'. Differences between the sample groups were minor and did not appear to follow any discernible pattern.

## **SAFETY ON THE UNIVERSITY CAMPUS**

The University campus is embedded in the local social environment and the facility is used and accessed by the community. Issues such as crime and nuisance are concerns for local residents, students and members of staff. The VR methodology will be refined and applied to this built environment facility. How the respondents respond to the dynamic and interactive images of a selection of simulated virtual reality scenes promises to be appropriate and revealing. The investigation will provide insights into perceptions of personal safety and security issues on campus and will probe potential ways to improve campus safety. The 'subjective' perceptions of both physical and social dimensions will be investigated in conjunction with 'objective' statistics on crime/violent acts on campus. Additional questionnaires will be distributed to gain quantitative data on perceptions of personal safety on campus. The data will be analysed using a variety of techniques, including SPSS and NVivo.

The research will result in the development and refinement of a range of appropriate solutions designed to tackle the major areas of concern that emerge from the fieldwork. The research should enhance understanding of the personal safety issues and assist in developing practical and cost-effective solutions that reflect the perceptions of a range of user groups on campus. The research findings should lead to transferable solutions that can be applied to any university campus in the UK or beyond. The University of Glamorgan could potentially set a standard for personal safety on University Campuses and will potentially be a safe environment within which the SLTRI operates.

## **CONCLUSIONS**

The UK government has recognised the crucial role of design in facilitating or discouraging criminality. Indeed, the Planning Out Crime circular 5/94 (DETR, 1994), various policy guidance notes and the Crime and Disorder Act (1998) are all testament to this commitment and it has been asserted that "...there is now an established link both between design and crime and the reduction of fear" (DETR 1998b). How these design elements are perceived, however, can certainly be better understood. The use of more dynamic and interactive environmental stimuli can provide rich and meaningful data that would not have emerged via an 'objective' analysis of the official crime statistics. Investigating 'objective' indicators for crime *and* 'subjective' user perceptions of personal safety and security issues, in relation to built environment facilities, arguably represents a more holistic approach. The utilisation of VR as an environmental stimuli to probe user perceptions is certainly a innovative way forward, but the initial findings from the study of the railway station environment, suggest that the development of such technology can assist all those who are responsible for design, planning and management of built environment facilities.

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