Guide Dogs

Road and street crossings for blind and partially sighted people:

The importance of being certain

A paper for the Guide Dogs for the Blind Association

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UNIVERSITY OF LEEDS

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1. Introduction

1.1 The Project

In May 2014 The University of Leeds was commissioned by the Guide Dogs for the Blind Association ('Guide Dogs') to conduct desk-based research regarding blind and partially sighted people and their use of road crossings.

The requirements of the study were to investigate the following issues:

1. The importance of road crossings for pedestrians and specifically for blind and partially sighted pedestrians;
2. The extent to which blind and partially sighted pedestrians use or rely on crossings, and to discover their understanding of what a controlled and uncontrolled crossing is;
3. The relative feelings of safety across different types of crossing, and whether blind and partially sighted pedestrians have a preference for one crossing type over another;
4. How blind and partially sighted pedestrians use crossings when travelling independently or accompanied;
5. Their thoughts on the provision of informal crossings, especially considering those implemented in shared space schemes.

In pursuing these goals, it was hoped to achieve a greater understanding of the importance of crossings; whether there is a lack of consistency in their layout; whether it is primarily blind and partially sighted pedestrians who require them or others also vulnerable road user groups as well (e.g. children or the elderly), whether local authorities are replacing formal, pedestrian controlled crossings with informal ones (and if so why); and whether the removal of these crossings will make it difficult (and in some cases prevent) blind or partially sighted pedestrians from going out and about in their locality.

In response to the statement of aims and objectives for the research study, set out in the Request for Tender (RFT), the following programme of work was proposed:

- Inception meeting with Guide Dogs representatives and follow-up seminar;
- Systematic online literature search and production of an Annotated Bibliography;
- Liaison with key stakeholder organisations and calls for relevant research findings via other networks e.g. Accessibuilt mailing list - a discussion forum on the accessibility and barriers created in the built environment;
- Selective expert interviews with relevant experts, including Rehabilitation Officers;
- Writing up and presentation of the findings;

This report represents our write-up of the research. The annotated bibliography and interview summaries will be provided as appendices. Subsequently, and with the approval of the client, we will seek to disseminate this review via publication in a relevant journal.

1.2 Vulnerable road users and pedestrian mobility for blind and partially sighted people

Pedestrians are generally considered to be one sub-group of vulnerable road users, borne out by the fact that they comprise over 20% of those killed on the roads (WHO, 2013). Whilst no specific data on road accidents involving blind and partially sighted people is routinely collected, it would seem clear that there are specific vulnerabilities, risks and dangers that arise for blind and partially sighted pedestrians, which extend beyond those experienced by sighted pedestrians. A small number of studies have sought to quantify this, most notably that of Carroll and Bentzen (1999), whose survey work revealed that a quarter of respondents had been involved in an incident where their cane had been run over and just under 10% had actually been struck by a vehicle. These sorts of incidents can impact on blind and partially sighted people's confidence and perception of safety and security in the public realm, with subsequent impacts on the overall mobility of this group of vulnerable road users. In the largest recent survey of blind and partially sighted people, 'mobility on foot' was by far the most frequently reported travel difficulty amongst respondents (Pavey et al, 2009). Particular problems cited by respondents to this survey included a lack of confidence in going out alone or to unfamiliar places, obstacles in the environment that made navigation more difficult, and fears about busy traffic. Such studies that have been conducted provide some useful indicative evidence but it would be very interesting to conduct new, more systematic research in this area.

Given the link between visual impairment and ageing, with approximately 65% of blind and partially sighted people being over the age of 65, it is interesting to note the patterns in age-disaggregated accident statistics. For example, in the US, the age group with the highest risk of being killed as a pedestrian was those over 75 years old. A review of the UK accident database (STATS19) from 2008-2012 shows that in a sample of 129,438 road accidents involving a pedestrian; older and younger age groups are over-represented (Table 1).

Table 1: Number of accidents per age group (STATS19 database; review of 129,438 accidents between 2008-2012).

Age group	Number of accidents
16 years and under	42653 (33.0%)
65 years and over	15530 (12.0%)
75 years and over	8732 (6.7%)

Furthermore, young and old pedestrians make up approximately half of all incidents relating to crossing the road. In cases, where no pedestrian crossing is provided, the percentage of incidents involving these age groups is higher than in those instances with a pedestrian crossing (Table 2).

Table 2: Number of accidents per age group when crossing the road (STATS19 database, 2008–2012).

Pedestrian Location	Number of accidents	16 years and under	65 years and over	75 years and over
Pedestrian crossing	16509	4769 (28.9%)	1942 (11.8%)	1050 (6.4%)
In carriageway, not on crossing	61732	25972 (42.1%)	7704 (12.5%)	4509 (7.3%)
Central island or refuge	587	185 (31.5%)	101 (17.2%)	61 (10.4%)

Importantly, elderly pedestrians are much more likely to suffer a fatality compared to all other age groups (Table 3). This suggests that when an incident occurs, the older pedestrian is most at risk.

Table 3: Accident fatalities per age group (STATS19 database, 2008–2012).

Age group	Number of accidents	Number of fatalities
16 years and under	42653	202 (0.5%)
65 years and over	15530	846 (5.4%)
75 years and over	8732	607 (7.0%)
17-64 years old	86784	607 (7.0%)

More generally, it is widely acknowledged that reduced walking speed and diminished reaction time amongst elderly people are viewed as particular risk factors, whilst the likely severity of an accident involving an elderly pedestrian will be increased due to age-related physical frailty.

It is important, however, to note that these dangers do not always translate directly into heightened risk, detectable in accident statistics, as it is believed that blind and partially sighted people's fear of getting around often leads them to self-regulate their behaviour in order to avoid these dangers and mitigate the risk. This tends to mean that they suppress their pedestrian activity, either by not going out as much or by using taxis as a means of overcoming the need for mobility on foot, and so safety becomes closely linked with issues of accessibility and physical activity (with consequent knock-on negative impacts on health and wellbeing).

Generic design principles to facilitate blind and partially sighted people's mobility are set out in government guidance, such as those included in The UK's Guidance on the Use of Tactile Paving Surfaces (DFT, 2005), as follows:

- Layouts of all pedestrian areas should be simple, logical and consistent;
- Contrasts in colour and tone should be used to accentuate the presence of certain key features;
- Orientation and way-finding information should be provided by the use of high visibility and, where appropriate, tactile signing;
- Lighting levels should be even and adequate and should minimise glare;
- I mportant information about the environment should be conveyed by the use of non-visual features.

It is important to acknowledge the diversity amongst blind and partially sighted people, and the variation this leads to in individuals' coping strategies. For example, Atkin (2010) found it informative to group blind and partially sighted people into three sub-groups: those who rely on their residual vision, those who use a guiding cane, and those who use a guide-dog. These categorisations are then used to further specify street design features that are required for pedestrians who fall at different points on the spectrum of visual impairment (Atkin, 2010):

Features which benefit all blind and partially sighted people:

- 'Predictability';
- Smooth even paving and streets free of obstructions;
- Pedestrian triggered signalled controlled crossings with audible or tactile indicators;

Features relevant to those with residual vision:

- Clear tonal contrast (e.g., between footway and carriageway, between street furniture and the surrounding paving, etc.);
- Coloured paving;
- Level surfaces;
- Wide footways;

Features relevant to long cane users:

- Footways that are 'not too wide';
- Well-defined curbs;
- Tactile paving, e.g. to alert to the presence of a pedestrian crossing point or to delineate footways from carriageways where there is not a well-defined kerb;

- Unobstructed building lines;
- Guidance paving in pedestrianised areas and around bus stops or other obstructions;
- Guard rails;

Features relevant to guide dog users:

- Wide footways;
- Well-defined kerbs;
- Tactile paving, eg to alert to the presence of a pedestrian crossing point or to delineate footways from carriageways where there is not a well-defined kerb;
- The sound of traffic.

There is therefore, a wide range of visual impairments that need to be considered when designing public spaces that are accessible for all pedestrians.

1.3 The rest of this paper

The rest of this paper seeks to draw together our reading of the literature and our stakeholder interview findings relevant to the topic of the study. We should highlight here that whilst our review of the literature has sought to be wide-ranging and comprehensive, our stakeholder interviews have necessarily been selective and subject to the availability of interviewees during the relatively short period of the study. Consequently, when findings from the interviews are presented they should not be interpreted as the outcomes of a quantitative exercise but, rather, as the qualitative insights of a small number of key stakeholders with highly relevant experience and expertise. Section 2 focuses on crossing conventional roads and streets, whilst Section 3 focuses on issues related to shared space. Section 4 provides a brief overview of technologies, before we draw our conclusions in Section 5.

2. Road crossings

2.1 Introduction

The UN Convention on the Rights of Persons with Disabilities sets out the rights of a disabled individual, such as a blind or partially sighted person, to freedom of movement, independent mobility, access to the public realm, and access to appropriate mobility aids. In light of this, the provision of appropriate assistance to allow blind and partially sighted people to navigate successfully through their environment, including finding and crossing roads, is a right to which they are entitled. A survey conducted by Guide Dogs (2007) found that 80% of blind and partially sighted individuals report difficulty with crossing streets, with contributing factors including excessive high vehicle speeds, poor and inconsistent driver etiquette, difficulties of the pedestrian judging the speed and distance to an oncoming vehicle, and the inadequate number, unavailability or inappropriateness of crossings. The provision of road crossing facilities, be them either formal or informal could therefore be considered simply as an accessibility right for blind and partially sighted individuals. This section deals with access to, use and preference for different types of road crossing facilities.

2.2 Types of crossing

This paper considers two categories of crossings, defined as formal and informal crossings. Formal crossings are highly structured and provide a clear position where pedestrians should be safe to cross. They can be divided into two subgroups, controlled and uncontrolled crossings.

Controlled crossings use traffic and pedestrian signals to communicate which group of road users have right of way on the roadway at a given time. These crossings have distinct time windows in which pedestrians and vehicles can use the carriageway, so as to minimise conflicts between them, thus mitigating the risk of injury to pedestrians or vehicle occupants. These crossings are controlled by the pedestrian, either through use of a push button on the pedestrian display unit (e.g. pelican crossings) or through the detection of pedestrian presence at the crossing by external sensors (e.g. puffin crossings).

Examples of controlled crossings are listed below:

- Pelican crossings have red, amber and green light signals for vehicles and a red and green man signal for pedestrians. Pedestrians are required to push a button to operate the crossing and wait for the green man signal (red vehicle traffic light), which gives them right of way to cross the road. There is a flashing green man (amber vehicle traffic light) phase in which pedestrians should not commence a road crossing, but those on the carriageway have time to complete it. The blind and partially sighted pedestrian is considered in the design through the provision of a rotating cone on the base of the push button unit, which turns during the green man phase, and a 'bleeping sound' presented during the green man phase also (except in those situations where this sound could cause confusion between nearby crossings).

- Puffin crossings do not have a fixed crossing phase duration. Instead, pedestrians press the button to register an intention to cross. Sensors are used to determine the duration of the green man phase that is required for safe crossing and to detect when the crossing demand is no longer required (e.g. the pedestrian crosses during the red man phase). The use of sensors removes the need for the flashing green man phase of the cycle. The puffin crossing also differs from the pelican crossing in that the red and green man signal is located on the nearside on the pedestrian demand unit. This layout provides pedestrians with a 'stop line' akin to that on the vehicle part of the crossing, at which to wait. The nearside pedestrian signal also offers assistance to those pedestrians who have difficulty detecting it on the opposite side of the roadway. The needs of blind and partially sighted pedestrians are catered for in the same way as the pelican crossing with a tactile rotating cone and a bleeping sound where appropriate.
- Toucan crossings are pedestrian controlled crossings which feature an additional, designated crossing lane and push button unit for cyclists (i.e. red and green bicycle symbols are displayed). The separation between the pedestrian area and the cycle lane is communicated to blind and partially sighted pedestrians through the use of corduroy paving on the route leading to the crossing. In the crossing area itself, the designated pedestrian and cycle lanes are identified through painted lines on the crossing surface. The green man signal can be presented on either the nearside or the far side, although the current tendency tends to be to present the pedestrian signals using the style of a puffin crossing. The green phase is concurrent for both pedestrians and cyclists.
- Pegasus crossings are similar to Toucan crossings, but with an area and signal provided for horse riders instead of cyclists.
- Signalised crossings at junctions (which can also be used mid-block).

At controlled crossings, tactile cones are used to communicate to the blind and partially sighted, and hearing impaired pedestrian when the traffic has been signalled to stop, and thus they have right of way. Guidance indicates that these should be included on all pedestrian displays including push buttons (e.g. pelican crossings) and pedestrian demand units (e.g. puffin crossings) (Department for Transport, 2006). Furthermore, for each crossing type that uses a vehicle traffic light signal, the pedestrian demand unit should be positioned such that the user faces the oncoming traffic to operate the button (in the case of the pelican crossing) or observe and respond to the tactile rotating knob (pelican and puffin crossings). This guidance regarding demand unit location was presented in a Department for Transport Local Transport Note (2/95) (Department for Transport, 1995), specifically to assist blind and partially sighted pedestrians. This was further repeated in a more recent Transport Advisory Leaflet (1/02) (Department for Transport 2002), which offers guidance regarding puffin crossing installation. The reasoning behind this is to allow the user (whether sighted or not) to have both the pedestrian demand unit and the oncoming traffic in their field of view at the same time. The Transport Advisory Leaflet (1/02) further discourages the installation of duplicate pedestrian signals on the nearside, left of the crossing "because it would encourage pedestrians to look in the opposite direction to the oncoming traffic." However, it should be noted that this guidance does not account for the difficulty of a blind or partially sighted pedestrian in finding a single control box location during busy periods at a pedestrian crossing. In some cases, it might be considered more beneficial to install a second control box, even if this is required to face away from traffic.

For uncontrolled, formal crossings, the right of way to the crossing area for vehicles and pedestrians is not controlled by pedestrian or traffic signals. Instead, pedestrians and drivers react to each other's presence based on learnt rules regarding who has priority.

The zebra crossing is the main example of this type of formal crossing:

- Zebra crossings use black and white strips painted on the roadway with accompanying flashing amber beacons. The pedestrian has priority and the vehicle driver is required to give way. Pedestrian use of these facilities varies, with some choosing to wait until traffic has become stationary before stepping out. The blind and partially sighted participants in our stakeholder interviews emphasised that their detection of a stopped vehicle was essential for providing the peace of mind to initiate their road crossing.

All formal crossing points are required to have dropped kerbs to assist mobility-impaired individuals and red tactile paving for the blind and partially sighted, as outlined in the Guidance on the Use of Tactile Paving Surfaces (Department for Transport, 2007).

Informal pedestrian road crossings are specific kerb or street furniture layouts that are installed to assist pedestrians in crossing the roadway, where the provision of a controlled crossing cannot be justified. The crossing is provided for the benefit of the pedestrian and confers no obligation on the driver to give way to a waiting pedestrian. In many cases, the layout of the area still provides a clear indication to the driver that pedestrians are likely to be crossing in the vicinity.

Informal crossings can take a number of different forms, including those listed below (I'DGO, 2013):

- Dropped kerbs – are provided to allow level access to the carriageway. The installation of these areas should be targeted to maximise pedestrian visibility to vehicle drivers, minimise pedestrian detour distance, and fit with pedestrian desire lines.
- Pedestrian refuges ('islands') – if road width allows, a central area is provided for pedestrians to stand between the carriageways. These areas are often equipped with additional markers (e.g. bollards), dropped kerbs and tactile paving (Department for Transport, 1995; LTN 2/95).
- Raised crossing areas – a reversal of the dropped kerb set up, with the road area raised to the level of the kerb.
- Kerb build-outs – extend the pavement into the roadway.

All informal crossings should be installed with beige or buff-coloured tactile paving for the assistance of blind and partially sighted pedestrians, as described in the Guidance on the Use of Tactile Paving Surfaces (Department for Transport, 2007). Whilst this is often observed, anecdotal evidence would suggest that this is not always the case.

2.3 Official Guidance on Installation of Crossings

In the UK, the decision on what type of pedestrian crossing facility to install is taken with reference to guidance issued by the Department for Transport (Local Transport Note 1/95), which considers

such factors as location, visibility, pedestrian and vehicle volume and composition, pedestrian waiting times without a crossing, crossing difficulty, expected vehicle delay with the installation of a crossing, road capacity, accident risk on the road, site-specific characteristics, installation and maintenance costs, and local public, council and police opinion. The assessment criteria have advanced beyond the previous PV2 model (Department for Transport, 1995; LTN1/95 and LTN2/95 mentions the use of this measure of pedestrian-vehicle conflicts as a design criterion). There is evidence to suggest that the availability of sufficient funding has a considerable impact on the final decision to install a crossing (Lancashire County Council, 2014). This case-by-case flexibility afforded in the decision process can have both positive and negative impacts, depending on the way in which it is used.

The assessment tool provided in the Department for Transport guidance (LTN 1/95) requires the number of blind and partially sighted users of a crossing area per day to be recorded and there are numerous instances where this document appears to have been referred to by a local authority when deciding on whether to implement a crossing. However, it is not always clear how to use this figure and the need to consider the specific context of each case can often lead to such factors receiving less attention. Unlike the consideration of young and old pedestrian needs separately from the needs of the 'average' pedestrian, the assessment tool contains little in the way of specific guidance related to crossing provision for blind and partially sighted individuals. Furthermore, this approach does not account for the blind and partially sighted pedestrians who might have abandoned the area due to difficulties in using the available (or in some cases, unavailable) pedestrian crossing facilities. To this end, a consultation of local blind and partially sighted pedestrians should be considered for inclusion as an essential component in the assessment toolkit.

The Department for Transport have issued (1991) and updated guidance (Manual for Streets, 2007) on the provisions required for blind and partially sighted users of formal pedestrian crossings. The use of auditory and tactile knob cues to assist pedestrians in crossing the road are identified as key features that can increase the accessibility of areas to a blind and partially sighted pedestrian. Furthermore, the Department for Transport guidance specifically outlines the needs to consult 'local visually-impaired residents' before the installation of these cues. It is, however, claimed by a number of organisations acting as advocates for blind and partially sighted pedestrians that many local councils often neglect (or perhaps consider after the event) the direct consultation of those users who most rely on non-visual crossing cues. It should also be noted that consideration of only local users perhaps misses the needs of blind and partially sighted pedestrians who may be less familiar with the overall layout of the area. The importance of consulting pedestrian groups emphasises the need to consider the context of a particular pedestrian crossing installation, rather than implementing a single, uniform strategy.

The provision of guidance documents does not always ensure that they are appropriately used. This can lead to inappropriate implementation of formal crossing guidance relating to blind and partially sighted pedestrians, or inconsistencies across location. For example, our recent review of facilities on Vicar Lane in Leeds highlighted a three-arm junction featuring three puffin crossings using an audible bleep on one crossing. The guidance would seem to suggest that this set-up could cause confusion between crossings for a blind and partially sighted pedestrian. This potential problem is compounded by the asynchronous phases between the three crossings.

2.4 The importance of road crossings

Road crossings are important to aid pedestrians, especially vulnerable user groups, in travelling from one side of the road to another. The WalkEurope project (Methorst et al., 2010) identified road crossings as a key public safety issue as the act of crossing a road imposes a substantial cognitive load (mental challenge) on the pedestrian and thus it is important to provide crossing facilities that are safe, comprehensible and convenient. It was argued that formal crossings achieve this goal more effectively than informal or unsignalised crossings and that vulnerable road users, including blind and partially sighted pedestrians, benefit from the provision of formal crossings. According to Methorst et al. (2010), crossing facilities need to be provided that consider the volume and speed of the traffic and the conspicuity and visibility of the vehicle and pedestrian users. They should also be designed so as to reduce conflicts and resulting conflict severity through the separation of road users by infrastructure design, improved conspicuity, speed limits and speed control, vehicle design, and driver and pedestrian education.

The blind and partially sighted interviewees consulted as part of this study were unanimous in their opinion that road crossings are 'vital' for allowing them to cross the road and therefore travel on foot through their environment. One interviewee stated that he simply would not be able to cross busy, main roads without the provision of controlled crossing points. In addition to basic accessibility requirements, the blind and partially sighted interviewees commented that road crossings offered them both safety and peace of mind when crossing the path of traffic.

Crossing points, especially formal crossings also serve a purpose in addition to their use to cross the road. These points are beneficial because they act as a reference point in the environment for the blind and partially sighted pedestrian, even if they do not intend to cross the road. This means that the pedestrian is able to use a crossing as a navigation cue when travelling in an area that they have prior experience of.

2.5 The use and reliance on road crossings

The initial task of finding and identifying the type of road crossing is one that blind and partially sighted pedestrians can find challenging. Blind and partially sighted interviewees commented on the utility of sound cues to alert them to the location of a crossing and the importance of correctly installed tactile paving. The auditory and tactile cues were noted for being useful when implemented effectively, but discontinuities in their use had the potential to cause confusion, such as reported instances of bleeping sounds being present on multiple crossings in the vicinity of each other, the failure to install tactile paving that reaches the building line, or irregular positioning of the tactile, rotating cone, such that the user has to face away from the traffic to use it. There were also reports that the rotating cone is not always installed at a controlled crossing. The WalkEurope project (Methorst et al., 2010) identified a number of conflicts when designing road crossings to cater for all pedestrian user groups, specifically noting the difficulty traversing the tactile paving areas for those with mobility impairments. Hamilton-Baillie (2008) further notes the global urban confusion

that can be created through the use of multiple bleeping crossing facilities. These two examples alone emphasise the challenges of providing inclusive mobility which is safe and acceptable to use for all pedestrians. However, it should be noted that the current guidance regarding these assistance features was developed in consultation with disabled users so as to reach a compromise on what is the most bearable and effective.

Our interviewee from the Rehabilitation Officer Network discussed the approach to teaching blind and partially sighted people to navigate through their environment. In her role, she specifically teaches her clients to seek out formal and informal crossing points rather than attempting to cross the road along their 'desire line'. One interviewee stated that he very rarely attempts to cross the road away from a pedestrian crossing to allow a more direct route to his location and would choose to extend his route to ensure he could cross safely. The rehabilitation officer also explained that blind and partially sighted people are taught that where there are controlled crossings available, they should be relied upon, and use should be made of any available audible and tactile cues that are provided. The provision of a tactile cone was considered useful by all interviewees; however, not all blind pedestrians make use of them. One blind and partially sighted interviewee commented that they would not use the tactile cone when the bleeping noise was provided for their assistance. Interestingly, there were complaints that the rotation of the tactile cone is difficult to detect by elderly users or those wearing gloves, and one interviewee suggested that a novel design had been tested and evaluated previously, but faced barriers to implementation.

There was evidence from the interviews to suggest the blind and partially sighted pedestrians rely on the provision of controlled crossing facilities in areas of high traffic volume or large road widths, where hearing acuity may be insufficient to allow them to detect an appropriate gap to cross safely. Blind and partially sighted pedestrians can experience high levels of stress when crossing a road, associated with the difficulty in achieving the confidence or certainty that they will be safe. An incident that undermines this confidence can be damaging to the individual's overall mobility.

It is also useful to note the effects that a crossing can have on blind and partially sighted pedestrians' mobility, both in terms of acting as a reference point in the external environment and also allowing them independence in their navigation (i.e. removing the need for sighted assistance from another pedestrian). The extent of reliance on controlled pedestrian crossings is highlighted by the feelings of the blind and partially sighted pedestrians when these facilities breakdown. The interviewees reported low perceived safety and security, high stress and a resulting over-reliance on the rotating cone (which may also be disabled) or on other pedestrians.

2.6 Preferences between crossing-types

A comprehensive literature search has revealed few systematic studies of the preferences of blind and partially sighted pedestrians between different crossing types, although the Department for Transport publication, Manual for Streets (2007) clearly states that "signalised crossings are preferred by blind or partially sighted people". A number of local authorities also recognise the importance of formal crossings being provided, with Southwark County Council stating that formal

crossings are "crucially important to both physically impaired people (like crutch or wheelchair users) who need level places to cross the street, and visual impaired people who need clearly defined crossing places." The Southwark Streetscape Design Manual (Southwark County Council, 2013) emphasises the need for formal crossings to assist blind and partially sighted people with navigating through the external environment, and advises designers to use formal crossings (both controlled and uncontrolled) as a means of encouraging vulnerable road users to cross the road in a particular location (Southwark County Council, 2013).

The preferences of blind and partially sighted pedestrians for different crossing types could be inferred from usage statistics gathered in a survey conducted by Guide Dogs (2007). It was found that 51% of a sample of 1428 blind and partially sighted individuals often used a pedestrian crossing with traffic lights, 28% often used a pedestrian crossing without traffic lights, and 38% often crossed a road without a pedestrian crossing facility. The participants more often reported difficulty in crossing the road without a formal crossing. Within the same sample, 23% of people never used a pedestrian crossing with traffic lights, 33% never used a pedestrian crossing without lights, and 43% never or rarely crossed the road away from a pedestrian crossing facility. These statistics would imply a preference for a controlled, pedestrian crossing facility, however it should be noted that these figures do not account for the availability of these crossing types to the people surveyed.

The interviewees sampled as part of this work provided information on crossing type preferences amongst the blind and partially sighted population. The consensus from the blind and partially sighted individuals (and their advocates) involved in the interviews was for the provision of formal crossings instead of informal crossings, and more specifically, controlled crossings instead of uncontrolled, zebra crossings. This fits with the guidance provided by Southwark County Council above, regarding the use of formal crossings to allow 'vulnerable pedestrians' to cross the path of traffic. In fact, one blind and partially sighted interviewee commented that the "minimum specification for a road crossing in an urban area" should be a pelican crossing with audio and tactile cues. Interestingly, the comment directly conflicts with DfT guidance in the Consultation on the draft Traffic Signs Regulations and General Directions 2015, which identifies the additional safety advantages of a puffin crossing over a pelican crossing, and the outlines the trend for local authorities to use puffin rather than pelican crossings both currently, and as a likely approach for the future. It should be noted, however, that the distinctions between pelican, puffin and signalised crossings seem often to be unclear to many pedestrians and, hence, that this interviewee may have been focusing on the provision of a controlled, pedestrian crossing with audible and tactile cues, rather than the need for a pelican crossing specifically. The movement towards the use of puffin crossings was viewed as positive by blind and partially sighted interviewees, with one in particular requesting more widespread installation of these facilities. They recognised that these crossing facilities can benefit both the pedestrian and the motorist by extending the crossing period for a slow moving pedestrian, but also by reducing it if the pedestrian clears the crossing quickly. One blind interviewee was happy to use a puffin crossing without checking the status of the rotating cone.

In addition to the preference for a controlled formal crossing, blind and partially sighted interviewees and representatives from advocacy organisations identified the importance of tactile and audible cues, especially in busy areas. Again, the benefits of these features were user certainty

and perceived safety. In fact, the rehabilitation officer commented that they design walking routes for their clients which seek out these types of crossings where available, even if it requires the pedestrian to walk a longer distance. However, there was awareness that the use of an audible signal was not always feasible in areas with multiple pedestrian crossings. One blind interviewee expressed difficulty using crossings without the audible cue due to finding it harder not to drift off of the ideal path across the crossing.

Blind and partially sighted interviewees commented on two key factors that are critical to them when crossing the road: safety and peace of mind. Whilst statistics illustrate that both controlled and uncontrolled types of formal crossing perform at similarly high levels for ensuring pedestrian safety, there is a distinction in the level of stress that their use causes. One blind interviewee specifically noted high stress when using zebra crossings, both due to difficulties in identifying whether a vehicle had stopped and also due to concern about cyclists ignoring the right of way rules on the crossing. He expressed a strong preference for a controlled crossing due to the certainty this provides regarding whether the traffic has stopped, but still expressed concern that cyclists do not obey traffic signals at these crossings. The ability to control the traffic flow was also identified as a reason for a preference for a controlled crossing over an uncontrolled crossing by the interviewee from the national charity that works towards creating safe, attractive and enjoyable streets for pedestrian use. However, it should be noted that blind and partially sighted interviewees did not suggest that they found it too difficult to use a zebra crossing, and that they would rather a zebra crossing be present than no crossing at all.

There was complaint from a long-term blind and partially sighted pedestrian about the difficulty and perceived lack of safety when interacting with a Toucan crossing. This was emphasised by the rehabilitation officer, who expressed concern that blind and partially sighted pedestrians could be frightened by the arrival of a cyclist at speed (because they do not need to dismount), especially when the positioning of the two button units is such that the blind and partially sighted pedestrian is likely to be stood in the path of the cyclist.

Blind and partially sighted interviewees reported difficulties in using informal crossings, with the same outcome reported in a community street audit by the interviewee from the national charity. Problems were related to the presence of tactile paving at the kerb side only, rather than directing the user to the crossing, meaning that the crossings were more difficult to find as well as use. However, there was an appreciation that it was not feasible to place controlled formal pedestrian crossings in every location that they may wish to cross the road, and the preference was for them to be placed at key navigation points such as crossroads and junctions. The blind and partially sighted interviewees were able to use the informal crossings if they were present.

There was also agreement amongst all interviewees that the type of crossing provided should depend on the context in which it is being installed. Blind and partially sighted interviewees would accept an informal crossing in an area with low traffic flow, especially where there are likely to be periods without cars and so a gap in the traffic could be detected. Interview evidence suggested that blind and partially sighted individuals find gap judgement between moving vehicles difficult in the heavily-trafficked, complex and noisy urban environment, and as a result, the preference is for the

signalised crossing assistance in this setting. Another blind and partially sighted user commented on the difficulty of perceiving car noise that is relevant to a particular crossing area in a busy, urban environment, and the challenge of detecting a stationary, idling vehicle. Zebra crossings were viewed as more appropriate in low traffic flows. There was concern from one blind interview that there was a trend for installing zebra crossings rather than controlled crossings. Informal crossings were considered useable in areas with very low vehicle flow rates.

The distance travelled during a road crossing is also an issue for blind and partially sighted pedestrians, with the need to move long distance across busy roads being a particular concern. The prevailing opinion amongst the blind and partially sighted interviewees was for multiple-stage rather than single-stage crossings. Diagonal crossings were viewed as particularly dangerous due to difficulties navigating from the building line and on to the crossing with the correct orientation. The rehabilitation officer specifically advised her clients not to attempt a diagonal crossing.

Overall, the preference is for blind and partially sighted individuals to be provided with a controlled formal crossing, especially where vehicle flow rates are high. The importance of the provision of a properly designed pedestrian crossing increases as the environment in which it is situated gets busier. There were numerous mentions of the need for correctly installed tactile paving guidance and a tactile, rotating cone. The presence of an audible, bleeping sound was appreciated were it was appropriate both to assist in crossing the road but also for locating the crossing point. The additional cues provide the user with added security and peace of mind. Where controlled crossings were not installed, the preference was for a zebra crossing, with an informal crossing (e.g. tactile paving and a pedestrian island) being preferred if neither type of formal crossing were provided. Multiple interviewees commented that any provision of crossing facilities, even informal ones, is preferable to none at all.

2.7 Support with road crossing

The interviewees were asked how the mobility of blind and partially sighted individuals was impacted by them travelling with a sighted companion. In most cases, it was considered likely that the sighted individual would take responsibility for the navigation of both people, and this allowed blind and partially sighted people to cross the road safely and more quickly. However, a blind and partially sighted interviewee felt that it was important that they could take responsibility for navigation if required, and thus the presence of a sighted companion (or other pedestrians) was not sufficient reason to neglect the installation of correct guidance cues for blind and partially sighted pedestrians. This highlights a key factor that planners must account for when designing a space in which pedestrians are required to cross the path of traffic; that is, that blind and partially sighted pedestrians should not be assumed to be accompanied by a sighted individual, or be in the proximity of a sighted individual who is able to assist them.

One issue that is evident from the interview data is the differing ways that sighted people crossed the road compared to blind and partially sighted people, and thus the need to provide differing support to these pedestrian groups. The rehabilitation officer emphasised how it is not possible for blind and

partially sighted pedestrians to cross the road easily along their desire lines and the importance of teaching them good road safety behaviours such as stopping at the kerbside, checking the traffic in both directions, and listening for vehicle noise. She highlighted the importance of training not just the blind or partially sighted pedestrians, but also their support network (e.g. their family) to ensure that the individual crosses a road in a consistent manner when travelling alone or with a sighted individual, thus instilling in them a safe approach to crossing the road in all situations. The absence of driver training regarding the crossing behaviour of blind and partially sighted pedestrians was highlighted as an area which could provide safety benefits if addressed.

One concern expressed for blind and partially sighted people and their advocates was of a tendency for local authorities to make the assumption that all individuals have some residual sight when considering their provision of crossing facilities. This misperception extends to over-estimating the navigational capabilities of a blind or partially sighted individual using a white cane or guide dog. This may lead to an over-reliance on the provision of colour-contrasted surfaces at the expense of tactile paving. This is evidently a flawed assumption, as many blind people remain mobile, and thus road and road crossing design should cater to all levels of the visual impairment spectrum, including those who can see nothing at all. People with different extents of visual impairment will rely on different cues to decide when it is safe to cross the road. These distinct groups of pedestrians should all be considered in street design.

Another point of note was the differing support required for a blind or partially sighted individual who is familiar with an area compared to someone who is visiting the area for the first time. The interviewees discussed a navigation strategy in familiar areas that relied on the learning of features such as bus stops, lamp posts, and crossing positions. In these cases, the removal of a crossing could pose difficulties, but still be coped with by a familiar user. This process would be more challenging for an individual who does not have a learned route through an area with a mental map of the layout of street features. As a result, it would seem necessary to ensure that street design can cater for the 'worst-case', that is, navigation by a blind or partially sighted pedestrian who is unfamiliar with the area. The provision of an audible signal was noted as an especially useful cue for finding a crossing in an unfamiliar area. The correct installation of tactile paving is also essential, both in terms of finding a crossing and providing a mental picture of the layout of an area. A concern was registered by two blind interviewees that installation often occurs but not in line with the tactile paving guidance (i.e. with the tactile tail to the building line omitted).

3. Shared space

3.1 Introduction – the concept of shared space

The first part of this report has addressed road and street crossings in the traditional sense, in the context of roads and streets with clearly delineated pedestrian footways. In this section, we now discuss the implications of movements away from this design philosophy, towards one based on the shared space concept. The UK guideline on shared spaces in urban street environments defines a shared space as "a street or place designed to improve pedestrian movement and comfort by reducing the dominance of motor vehicles and enabling all users to share the space rather than follow the clearly defined rules implied by more conventional designs (DfT, 2011). It is argued that, by removing the demarcations between pedestrian space and road user space and designing for lower traffic speeds, this will naturally lead to greater freedom for the pedestrian and greater caution on the part of motorists, due to increased uncertainty regarding each other's movements. As a consequence, this will result in streets that better combine their 'place and 'movement' aspects and serve to refresh urban townscapes.

As Kaparias et al. (2013) clearly point out, "on the one hand, opponents of the concept claim that shared space is likely to introduce more pedestrian–vehicle conflicts and might be expected to lead to more accidents and thus a worse safety record … Proponents of shared space, on the other hand, suggest that the concept introduces ambiguity, which makes both drivers and pedestrians more vigilant and engineers conflicts into the design rather than excluding them" (Kaparias et al, 2013).

With conflicts built into the design of shared space, it is argued that the Risk Compensation Effect causes car users to become more cautious (e.g. by slowing down). Risk compensation (Adams, 2010) refers to the observation that people adjust the level of caution they practice in their behaviours in accordance to the level of risk they perceive around them. That is, people exercise more caution when risk levels are high and act less cautiously when they perceive themselves to be protected (Fyhri, 2012).

In our interviews, proponents of shared space argued strongly that traffic speed was the biggest problem when it comes to resolving pedestrian and vehicle conflicts and that shared space seeks to bring the 'design speed' of the street down to a level where vehicles and pedestrians can interact with some degree of parity - a speed thought to be approximately 16-19 miles per hour depending on the specific context. In their view, formal crossing infrastructure, especially the pedestrian-controlled crossing actually serves to legitimise traffic speed. That is, by providing designated places where traffic is required to stop to allow pedestrians to cross, a message is conveyed to the motorist that in between those designated points, they are permitted to drive at faster speeds – up to, and often beyond, the designated speed limit. One goal of shared space is therefore to influence drivers' expectations and behaviour through their surroundings, with the argument being that low 'design speed' results in more appropriate vehicle speeds and therefore safer interactions with pedestrians throughout the area. It is envisioned that these design changes will lead to drivers responding to social protocols and environmental cues, rather than traffic signals and regulatory measures.

Whilst the history of the shared space concept can be traced back to the Buchanan Report in the early 1960s, the earliest implementations were in the Netherlands in the 1970s (under the guidance of Monderman) in the context of residential shared streets, under the name of Woonerf. Karndacharuk et al (2014) explain that those early schemes had the following typical design and operational characteristics:

- Pedestrians have priority to use the full width of the road while drivers are urged not to drive faster than walking speeds;
- There is little demarcation between carriageway and footpath. The entire width is often constructed in a continuous surface with special pavers;
- Through vehicular traffic is discouraged. Vehicle speeds and flows are restricted by street design (e.g. horizontal curves and the location of bollards and parking spaces);
- There are streetscape elements to encourage users to stay within the space;
- The access points to the residential shared street area are clearly marked.

Subsequently, these principles were adopted in neighbouring countries and in the UK (as Home Zones), Australia, New Zealand and Israel. The implementation of the shared space concept has since then moved from being focused around residential streets, to including shopping areas and town centre streets (Hamilton-Baillie, 2004, 2008a, 2008b).

3.2 Streets and roads

Shared space is not, however, the only means of giving priority to pedestrians and as a consequence, to the 'place' aspect of streets rather than to vehicles and the efficiency of vehicular movement aspect. Alternatives discussed in the literature include 'Liveable Street' (Appleyard, 1980; Appleyard et al., 1981; ODT, 2002), 'Living Street' (Bain, Gray, & Rodgers, 2012; LAC, 2011), 'Civilised Street' (CABE, 2008; LCC, 2010) and 'Complete Street' (Kingsbury, Lowry, & Dixon, 2011; Laplante & McCann, 2008; North Carolina Department of Transportation, 2012), and 'Road Diet' (Huang, Stewart, & Zegeer, 2002; Rosales, 2006). Interestingly, these alternative approaches seek to achieve their means without specifically aiming to remove the segregation indicator between vehicles and pedestrians. Other concepts in the literature which are more similar to shared space are those of self-explaining roads (SER), CSS and Context Sensitive Design (CSD).

3.3 Shared Space and Visual Impairment

Whilst the objectives of the shared space concept are commendable, such as achieving a global reduction in traffic speeds, there is however some controversy regarding its impacts on pedestrian safety, particularly for blind and partially sighted people, elderly people and children. Imrie (2012) goes as far as to refer to shared space as "another variation of disabling design in the built environment, and a reaffirmation of disabled people's relative invisibility in relation to the crafting of our designed spaces" (Imrie, 2012). The European Blind Union has issued a call to action for street planners and designers in Europe to modify all environments to keep roads and streets accessible

and safe for blind and partially sighted and deaf blind people (EBU, 2007), claiming that the introduction of shared spaces is leading to "many blind people losing their rights to walk and travel in their communities".

Whilst there is a distinction between a shared space and a shared surface, the shared space concept is often interpreted as the need for a shared surface. The removal of the kerb in shared space is one key factor identified as causing difficulty for blind and partially sighted people. Kerbs are a trusted conventional means for blind and partially sighted people to orientate themselves and navigate. They provide a clear demarcation between pedestrian and vehicle areas and a dropped kerb provides a useful indication that the person has reached a crossing point. For blind and partially sighted pedestrians, the kerb can either be followed as a navigation aid using their white cane, or it can be used by their guide dog, which recognises its presence as a separation between the pedestrian and vehicle areas of a space, and its removal (or 'dropping') as a crossing point.

A survey of 500 blind and partially sighted individuals revealed that 91% had concerned over using shared surface streets (TNS-BMRB, 2010). Of the 61% of respondents who had experienced a shared surface environment, 44% reported actively seeking alternative routes to avoid a shared space area, with a further 18% being reluctant to use the area. In terms of accident rate, 7% of those who had used a shared surface area had been involved in an accident, with a further 42% experiencing a near-miss. Worryingly, 81% felt that their independent mobility would be negatively affected by the introduction of shared surfaces. A number of visual impairment advocacy organis ations, strenuously make the case that blind and partially sighted people rely on traditional street design and demarcation in order to keep them safe and to orientate, and that to remove these aspects leads to increased danger, reduced confidence and suppressed travel. The European Blind Union proposes that local authorities ensure that areas are provided with a kerb "between the pavement and road, clearly marked by tactile indicators with good colour contrast to assist partially sighted people" (EBU, 2007). This does not in itself argue against the shared space concept, but instead against its implementation as a shared surface. This was a view also shared by a blind interviewee in this study; he noted a shared space scheme in Coventry that had retained the kerb (albeit at a lower height than 60mm, thus retaining problems with guide dog identification).

Interestingly, Karndacharuk et al (2014) note that "shared street design in Israel specifically incorporates a safe zone free of vehicles on either side of the shared street, which provides for the disability and other vulnerable users" (Karndacharuk et al, 2014). Similarly, the Elliott Street shared space scheme in Auckland, which they go on to describe and assess, has a minimum 1.8 m-wide Accessible Route provided on each side of the street, demarcated by 600 mm-wide tactile delineator bands specifically to warn blind and partially sighted people of the risk of moving vehicles beyond the 'safe zone'[2]. As they point out, these sorts of variations on the Shared Space concept serve to redefine user segregation, from the conventional separation of pedestrians using the footpath and vehicles using the carriageway, to the separation of blind and partially sighted people (and others reluctant to share the space with motor vehicles, such as mobility impaired, the elderly and young children) using the safe zone and everyone else (including motorists) using the remaining shared space. No consideration, however, is given to crossing from the safe zone at one side of the street to the safe zone at the other side.

2. Exhibition Road shared space area also has 'safe zones' delineated with tactile paving to segregate the 'pavement' from the 'carriageway'. The safe zones are different widths on each side of the road.

A principle advocate of shared space argues that there should not be a need for the speed limit to be displayed in shared space areas and that the design of the area should be sufficient to lower speeds of the vehicles travelling through. This design speed would actually be lower in most cases than the speed limit proposed for shared spaces by the European Blind Union (EBU, 2007).

Whilst the advocates of shared space focus on the issue of traffic speed as being key to whether or not vehicles and pedestrians can successfully mix and interact, our interviews highlighted the twin importance of both speed and volume for blind and partially sighted people. That is, even if vehicles are travelling at speeds less than 20mph, the presence of a flow of traffic in a space that vehicles and pedestrians are sharing is likely to create great uncertainty and extreme caution amongst blind and partially sighted people, who often rely on hearing that a vehicle has stopped before initiating a road crossing. Indeed, this approach to crossing only when vehicles have stopped is a strategy taught by rehabilitation officers. Therefore, in shared space schemes where there is a focus on reducing vehicle speeds, with less attention to vehicle flows, blind and partially sighted individuals would continue to experience difficulty in deciding when it is safe to initiate a crossing without a means to control the traffic flow. This is perhaps compounded by the issue of eye contact.

The importance of the use of eye contact in shared space schemes is highlighted in both the literature and our interviews (e.g. Hamilton-Baillie 2008; and Thomas, 2008). In the absence of traffic signs and signals, uncertainty is created and people have to resort to human interaction, seeking eye contact with other road users (Hamilton-Baillie 2008) i.e. if the pedestrian does not make eye contact with the driver, then the driver will assume that they do not want to cross their path. In the view of shared space advocates, replacing rules and regulations with social norms and conventions can be much more effective on the ground level than government strategies that can equate to undesirable interference (Rosenbloom 2004). There is an obvious problem for the blind and partially sighted pedestrian in acting upon this fundamental principle of a successful shared space, that is, their difficulty (or inability) to provide the required eye contact. This poses a challenge for these spaces because the suggested interaction technique between pedestrians and motorists is inaccessible to one of the most vulnerable groups of pedestrians. A sighted interviewee commented that drivers had not given her right of way when she had, as an informal experiment, deliberately withheld eye contact in a shared space area, while a blind interviewee said that he actively avoids behaving in a way that could be interpreted as making eye contact, and simply chooses to move slowly towards the crossing with his white cane in front of him.

The interviews showed that in most cases blind and partially sighted pedestrians and their advocates were not opposed to the use of shared space areas in areas with low vehicle traffic such as residential zones and cul-de-sacs[3]. In these areas, the vehicles are infrequent, move slowly, and are often familiar with the pedestrians in the area, and hence might be aware that a blind or partially sighted pedestrian uses the space. There was a feeling that a design approach that could bring about a change in the culture of interaction between drivers, cyclists and pedestrians would be positive, and it was recognised that a global reduction in vehicle speed was likely to be positive for pedestrians on the whole.

3. There were instances of blind interviewees being strongly against the concept of shared space, largely due to negative experiences with schemes in their local area. In these cases, it would seem that not only the absence of road crossings and kerbs but also the absence of education of both motorists and pedestrians about how to use the space has led to sub-optimal use.

The concern arises when the shared space concept is applied across other road contexts, in the opinion of some, without consideration by traffic engineers and planners about how to adapt the concept to the specific area. There is no doubt that challenges arise in the implementation of shared space when transportation goals for an area may directly conflict with each other i.e. the necessary removal of controlled crossings to reduce vehicle speeds and create uncertainty in shared space vs. the guidance regarding the importance of providing formal crossings for blind and partially sighted individuals (Southwark County Council, 2013). In the absence of guidance on how to manage these conflicts, it seems that it is sometimes the case that the simpler option or the option that is considered appropriate for the majority wins out.

A prevailing opinion amongst blind and partially sighted interviewees and those from organisations that represented them was that local authorities who initiate, design and promote shared space schemes do not understand the barriers to mobility that are imposed by sight loss. The rehabilitation officer and one blind interviewee expressed concern that there is insufficient training on the capabilities and mobility needs of blind and partially sighted pedestrians. Common misconceptions include the following:

- Blind and partially sighted individuals have sufficient residual sight to navigate and thus can cope with the removal of kerb delineation;
- Blind and partially sighted individuals have sufficient residual sight to detect vehicle presence, vehicle movement, and their desired crossing start and end points;
- Blind and partially sighted individuals are able to force their way across the path of traffic;
- Blind and partially sighted individuals will be able to detect that they are in a shared space area, and so will be confident enough to trust that drivers will be more aware of pedestrians and ultimately give way to them;
- Guide dogs can assist their owner in crossing the road in the absence of a kerb;
- Guide dogs can assist their owner in crossing the road in the presence of oncoming vehicles that are moving.

As a result, when the blind and partially sighted user is considered in the design phase of a shared space scheme, they are often provided with inappropriate measures such as the use of colour-contrasted surfaces to delineate vehicle and pedestrian areas. Whilst these measures will be useful for some, this does not cater for the full range of visual impairments that may be present in pedestrians. The provision of training more widespread training relating to inclusive design was recommended by multiple interviewees.

Finally, the interview with the rehabilitation officer highlighted difficulties in teaching blind and partially sighted individuals to use a shared space. The absence of reference points (including the removal of kerbs and colour-contrast) was noted as causing particular difficulties for efforts to teach navigation through these largely open spaces. This interviewee was in favour of the introduction of some form of tactile guidance paving (which she believed to be under-used currently), and emphasised that it could be presented in such a way as to be consistent with the 'look' of the shared space area. The 'open space' problem was also noted by a blind interviewee who commented that if he turned off of his path, particularly whilst crossing, it was difficult for him to re-find his route.

3.4 Implementation of shared space

The implementation of the shared space concept, rather than the concept itself is often the cause of the problem. A review of shared space schemes in the Netherlands showed a huge variation in the application of this concept (Havik, Melis-Dankers, Steyvers, & Kooijman, 2012); a trend that the interview data suggest is also present in the UK.

Table 4 – Observed frequency of shared space characteristics in the Netherlands (10 schemes considered). Adapted from Havik et al, 2012

Characteristic	Observed frequency (# schemes)
No kerbs or any demarcations between vehicle and pedestrian 'areas'	2/10
No kerbs, only colour-contrast between vehicle and pedestrian 'areas'	7/10
Walking surface not sufficiently colour-contrasted from vehicle 'area'	10/10
Cyclists using pedestrian 'area'	8/10
Walking route not free of obstacles	7/10
Usable traditional guidance cues or guidance paths absent	8/10
Tactile warnings at crossing and hazards e.g. steps absent	8/10
Traffic light crossings absent, zebra crossing present	4/10
Traffic light crossings and zebra crossing absent, informal crossing present	3/10
No formal or informal crossing present	3/10
Tactile warnings absent at crossing	5/7
Obstructed line of sight between pedestrians and oncoming vehicles	0/10
Presence of signage to indicate entry into a shared space	1/10
Change in pavement structure upon entry into the shared space area	9/10
Parking restricted to designated areas only	0/10

These figures demonstrate considerable variation in the implementation of the shared space concept, although 9 out of 10 involved the removal of the traditional kerb, and hence involved a shared surface. The removal of the kerb, absence of crossings, and absence of tactile guidance cues are important reasons for why a blind or partially sighted person might have difficulty navigating through such an environment.

3.5 Crossing in Shared Space

One goal of shared spaces is to have pedestrians crossing the street wherever they choose, rather than in groups at pre-defined crossing points. Crossing the street within a shared space context, where the principle is to have an absence of traffic signals and controls becomes a question of motorists, cyclists and pedestrians managing their interactions with one another in whatever way is possible. It is argued that where schemes are successful in reducing traffic speeds, these interactions should be more manageable and crossing should be straight-forward. For instance, the shared space scheme in Norrköping city centre, in Sweden, succeeded in reducing mean average speed from 28-32 km/hr to 16-21 km/hr and, presumably as a consequence, 70% of pedestrians surveyed after the project was completed said they could cross the road without having to stop for traffic (Jacobson 2009).

Whilst it is interesting to note that many of the cyclists and pedestrians did say the shared space improved the area, a report highlighted that a significant proportion of people actually felt less safe. The shared space proponent we interviewed argued, however, that this is the intention of shared space areas, and so should not be considered a negative consequence; that is, when people feel less safe they engage in risk compensation and modify their behaviour so as to act with a heightened degree of caution. Nevertheless, it was found that pedestrians and cyclists in Norrköping tended to stay behind the thin tactile separating the road from the pavement. This could negatively impact upon safety as pedestrians and cyclists come into more conflict.

3.6 Courtesy Crossings

Amongst the interviewees, there were a range of opinions on the merits of shared space schemes, however, there was agreement that courtesy crossings (crossings with no formal legal status, but with highly visible areas that clearly indicate a likely pedestrian crossing point) were a good idea (when considered against the provision of no crossing facilities). The village of Poynton in Cheshire is often cited as an example of a successful shared space scheme, and favourable reports can be found from both sighted and blind and partially sighted users about their ability to move within this space. This scheme, like many others, includes a number of informal, courtesy crossing points. Shared space advocates argue that providing vehicle speed is reduced to sufficiently low levels, then these can be used successfully by all, as drivers will be more aware of pedestrians' movements.

One blind and partially sighted interviewee commented that he felt that the implementation of the shared space concept has forgotten a critical feature of the shared space principles proposed by Monderman, that is that courtesy crossings are applicable only where vehicle flows are lower than 100 per hour. He quoted instances where he believes they are in operation in areas where flow rates are in excess of 30-40 vehicles per minute, and where vehicle drivers appear unaware of their purpose. The interviewee gave evidence of courtesy crossings (with raised crossing areas and different coloured surfaces), which did not fulfil the needs of the blind and partially sighted pedestrian. There has been successful lobbying to reinstate a signalised crossing in an area of Warwick where numerous courtesy crossings were installed as a replacement for a Puffin crossing.

The interviewee provided anecdotal evidence that both blind and partially sighted and sighted pedestrians choose to walk longer distances specifically to use the crossing (due to the high traffic volume on the road). Similar concerns were raised by the rehabilitation officer, who commended the introduction of courtesy crossings such as raised tables to reduce vehicle speed, but suggested that drivers do not always identify them as crossing points. She quotes an example of zebra crossing stripes being painted on to the raised table to enable its purpose to be achieved. Other concerns noted regarding courtesy crossings were the possibility that a blind or partially sighted pedestrian can pass over them without knowing they are there (for example with a lack of a change in surface height or absence of tactile paving e.g. on a pedestrian refuge), that guide dogs would neither recognise the crossing point (due to the absence of a kerb) nor allow their owner to cross (if the traffic had slowed but not stopped for this purpose), and that vehicle speeds were not always reduced sufficiently.

3.7 Formalised Crossings

In principle, inclusion of signalised crossings is contradictory with the ethos of shared space. This was emphasised by interviews with a shared space advocate and a representative from a national charity that works towards creating safe, attractive and enjoyable streets for pedestrian use (although the latter highlighted the need to educate drivers about how to use areas without crossings). Nevertheless, there are some instances cited within the literature of shared space schemes that have included traditional crossing facilities. These include a busy Netherlands roundabout (with traffic flows of some 20,000 vehicles per day) in the Laweiplein in Drachten. This scheme incorporates zebra crossings and informal speed table crossings and it has been observed that "almost all drivers gave way to pedestrians and cyclists at informal crossing points, reflecting improved drivers behaviour and reduced vehicular dominance...[and that] pedestrians and cyclists crossed at defined crossing points, reinforcing a user segregation environment" (Karndacharuk et al, 2014). However, the relatively high volume of vehicular traffic means that the majority of road space will be being used by this traffic for the purpose of movement, even if at relatively low speeds. Together with the retention of pedestrian crossing points, some have concluded that this, and other schemes with similarly high traffic volumes and retained pedestrian crossing points – such as the Exhibition Road site (RBKC, 2012, 2013a, 2013b) and Elwick Square in Ashford in the UK (DfT, 2010a; Moody & Melia, 2011) are not actually examples of shared space, as pedestrian and vehicle segregation is perpetuated and the ability for pedestrians to move around freely is limited (Hamilton-Baillie, 2008b; NHL, 2007).

In their study designed to measure vehicle-pedestrian conflicts in shared space contexts, Kaparias et al (2013) note that "a clear decrease in conflicts is observed at a pedestrian crossing location that has undergone a simplification in design (from staggered to straight across), and a small increase is seen at a location that retained the previous staggered crossing layout. Overall, it can be suggested from this study that the redevelopment of urban streets according to the principles of shared space seems to result in reduced rates of pedestrian–vehicle traffic conflicts. In particular, shared space elements appear to target slight conflicts mainly; more serious occurrences are tackled better by more drastic measures giving priority to pedestrians (e.g., converting a road to access-only).

However, it seems that some features coupled with shared space may increase conflict numbers (e.g., the use of conventional staggered crossings), and it is imperative to investigate those results further.

There was agreement between two blind interviewees that controlled pedestrian crossings should be available for use in shared space, preferably with audible and tactile signals. This is supported by The European Blind Union, who argue that the inability of a blind or partially sighted person to successfully establish eye contact in shared space areas means that pedestrian crossings must be provided which have "tactile paving, and both the paving and the traffic light posts should be clearly marked and in a colour which is easily visible to partially-sighted people" (EBU, 2007). This organisation also advocates the use of an audible signal at the crossing point and a tactile indicator on the crossing post to provide additional assistance. One interviewee raised concerns that shared space areas have been designed and applied based on average flow rates during a day, rather than accounting for the inevitably higher flow rates at peak, which has led to inappropriate provision of crossing facilities for blind and partially sighted pedestrians. Furthermore, it has been noted that some of these schemes considered accessibility for this pedestrian group with the assumption that a sighted individual will be available to assist them during their travel.

3.8 Inclusivity

Where one group's preferences would appear to be at odds with others – such as seems to be the case in shared space contexts - the challenge then is to find ways to resolve these conflicts, and this links to the process of Inclusive Design.

The UK Commission for Architecture and the Built Environment (CABE) set out 5 key principles of Inclusive Design to follow:

- Place people at the heart of the design process;
- Offer choice where a single design solution cannot accommodate all users;
- Avoid Steps;
- Ensure that doors are highly visible and, where-ever possible, open automatically;
- Make space for everyone.

In particular, 'placing people at the heart of the design process', means that the process should be one that involves users and, by doing so, seeks to achieve an outcome that includes the widest range of users possible. One crucial aspect of this is the stage at which the blind and elderly community are involved in the process. The danger is that this occurs too late in the process, at which point any case for making changes could be viewed as obstructive or to be too substantial to incorporate at that stage. Imrie (2012) raises the question (in the context of shared space in particular) of "how would one's understanding of mobilities change if modern culture were to revolve around, or at least acknowledge, the disabled person as 'the model subject' (see Pullin, 2009)" (Imrie, 2012). It was argued by the proponent of shared space schemes that blind and partially sighted people were continuously consulted in the design stage of these projects, and that even when the schemes are not entirely successful from the perspective of these users; it is not through an absence of consideration.

In the interviews, there were a number of comments about the need to recognise that all pedestrians have an increased right to independent mobility in the shared space concept, and as such they must be provided with appropriate facilities to allow them to move independently. These facilities included features such as safe places to cross, clear indication of whether the pedestrian is travelling on the traditional footway or carriageway, and a defined space that pedestrians can occupy (especially blind and partially sighted pedestrians) where they can be sure that vehicles will not be moving around.

4. New technologies

4.1 Existing new technologies

Much research and development into technological solutions to enhance mobility for blind and partially sighted people has been undertaken over the past two decades, incorporating beaconing systems, GPS navigation systems, ultrasound-based obstacle detection RFID tagging and, more recently, smartphone applications (RNIB, 2009). This has led to some exciting developments such as the beaconing systems exhibited in Vienna on the occasion of the 2012 ITS World Congress (Ways4All, 2012), the launch of several smartphone applications to support blind and partially sighted people's navigation (such as Blind Square and Seeing Assistant Move) and the "Neatebox" installation on a pedestrian crossing signals, whereby smartphone users can download a free app which can be used to trigger the button at the crossing. They are then told by their handheld device when it is safe to cross the road. Other interesting innovations that are currently under investigation include 'smart shoes', footwear which can be programmed to vibrate to provide navigational cues.

However, there are reasons to be cautious. One limitation of much of the research has been the lack of user-involvement and testing within the process; with the focus being very much on the functioning of the technology itself. Furthermore, where technological solutions rely on users equipping themselves with devices that can be expensive, complex to use or even unwanted by the user, there are natural concerns regarding levels of uptake. Indeed, research looking at uptake and continued use of assistive technologies highlights some worrying issues about relatively low take-up and relatively high rates of subsequent abandonment of the technology (Bennett, 2002), with only 2% of 1428 blind and partially sighted individuals using an electronic travel aid of some kind (Guide Dogs, 2007). This pattern was also seen in the responses of the three blind and partially sighted interviewees, none of whom currently use technological assistance during their daily navigation (one had an application installed on their smartphone). There were a number of reasons given for this lack of uptake, most notably, a lack of awareness of which smartphone apps could assist them, concerns about the accuracy of GPS-based systems for guidance of slow-moving pedestrians, and the importance of a blind or partially sighted person acquiring learned knowledge of the area for themselves, including locations of features such as building entrances, trees and crossing and recognition of familiar sound cues. This shows that whilst this pedestrian group might be open to the possibility of technology-based navigation assistance, it is important to provide alternative, effective navigational cues for those individuals who are resistant to the use of technological aids for navigation.

Nevertheless, it is interesting to examine the implications of new and emerging technologies that have the scope to impact on blind and partially sighted pedestrian mobility and, more specifically, on the safety and comfort associated with crossing the road. The blind and partially sighted interviewees were in agreement that there was a need for technology to assist with navigation, and they could foresee the use of smartphone apps for this purpose in the near future. One interviewee mentioned that it was important to develop technologies that could assist in navigation in the internal environment (e.g. shopping malls) as well as the external environment.

4.2 New technologies on the horizon

For the future, communications devices and protocols are being developed for vehicles and pedestrians to allow 'smart' devices to 'talk' with one another. This might be via smartphone or via other connected devices (as per the 'Internet of Things'). It will be important over the coming months and years to explore the scope for such technology to be harnessed by blind and partially sighted people, for instance as a means of communicating with drivers (as a substitute for eye-contact) and therefore subsequently increasing their level of certainty when making a decision to cross a road. Projecting further forward, it is possible to imagine a scenario in which such devices, perhaps in combination with the proliferation of autonomous vehicles, may render the sorts of controlled crossings we see on our streets today obsolete; moving perhaps instead towards infinite numbers of virtual crossings at which pedestrian-based communication devices instruct the communications devices on board autonomous vehicles to slow or stop the vehicles to allow crossing to take place. Notwithstanding the ongoing reasons to be cautious about the role of technologies referred to above, blind and partially sighted people, and their advocates, would benefit from engaging with the development of these technologies to ensure that they generate as much benefit for this group of people as possible.

5. Conclusions

The following set of points represents our conclusions. We believe that these serve as a useful list of issues which it would be interesting to pursue further in the forthcoming set of focus groups involving blind and partially sighted people.

- Systematic data relating to road accident risk for blind and partially sighted people does not exist, but the indications are that a real risk does exist and that this gives rise to stresses and fears which can, in turn, cause blind and partially sighted people to suppress their pedestrian mobility;
- I t would be interesting to explore this further, to gain some qualitative insights into the risks blind and partially sighted people perceive in relation to crossing the road, their experiences of collisions or near-misses with vehicles, and the impacts these have on behaviour;
- Crossing the road is a key public safety issue and, as such, pedestrian crossing facilities
  - appropriately located and designed - are generally viewed as having strong benefits for pedestrians, in particular vulnerable road users such as blind and partially sighted people;
- Government guidance on the assessment of the need for a crossing requires the number of blind and partially sighted users of a crossing area per day to be recorded but what should be done with this figure is left unclear – there is scope for the provision of more specific guidance for the consideration of the needs of blind and partially sighted individuals separately from the needs of the 'average' pedestrian, along the lines of that which is provided for young and old pedestrian needs;
- For blind and partially sighted people in particular, controlled crossings are important as a means of negotiating the dangers of crossing roads and streets and providing a level of certainty about when it is and is not safe to cross, and are of particular importance in busy, complex and uncertain environments;
- The context of the road being crossed and of the individual's visual impairment are both important factors - where streets are lightly trafficked, and/or where the individual has some useful vision and/or good hearing, road crossings will be less important than in contexts of heavily-trafficked roads and/or individuals with no vision and/or some hearing impairment;
- I t would be interesting to further explore these issues of context, and how they impact on behaviours;
- When teaching blind and partially sighted people mobility skills and/or new routes, Rehabilitation Officers/Mobility Instructors will seek to devise routes that incorporate road crossings, even if this extends the journey by some way, and will emphasise to the blind and partially sighted person (as well as their family and friends) the importance of using road crossings effectively;
- There is very little evidence on blind and partially sighted people's practice of using road crossings, though such evidence as there is points strongly toward these people relying on and observing road crossings to a much greater extent than do sighted people;
- There is little evidence relating to people's preferences between different types of road crossing, though such evidence as there is points toward a preference for controlled
- (i.e. signalised with a push-button) crossings over uncontrolled (i.e. Zebra) crossings, with preferences between Pelican and Puffin crossings being mixed;

- I t would be interesting to further explore these issues of use and reliance on road crossings, and preferences between different types of crossing;
- As stated above, there is very little evidence on blind and partially sighted people's practice of using road crossings and the extent to which they use them independently or with help or accompaniment, though it seems clear that informal support at road crossings is important, whether that be subtle and unspoken support drawn from the simple fact of other people crossing, the word from a passer-by to say that the lights have changed (or that it is or is not safe to cross), the casual accompaniment of a passer-by or the organised companionship of a friend, relative or carer;
- Shared space remains a controversial subject for blind and partially sighted people and groups representing them, both in a general sense and with specific relation to road crossings;
- Whilst our interviews demonstrated a degree of understanding – even some degree of consensus – on the aspirations surrounding the principles of shared space, there is considerable disagreement regarding its implementation and whether, in practice, shared space can achieve those aspirations - particular areas of disagreement include the removal of kerbs, the removal of controlled crossing facilities and the extent to which drivers can be relied upon to safely moderate their driving behaviour;
- For the proponents of shared space, the reduction of traffic speeds is perhaps the key benefit which, they argue, leads to a much easier environment for crossing the street, as well as a greater sense of place;
- For blind and partially sighted people though, our interviews indicate that both traffic volumes and speeds are important factors in crossing the street, such that even where traffic speeds are reduced, the volume of traffic leaves it difficult to cross;
- Much is made of the use of eye-contact for managing pedestrian-vehicle interactions in shared space, but indications are that where visual impairment renders this difficult or impossible the risks of conflict are heightened and the scope for the blind and partially sighted pedestrian to cross the road with any certainty are greatly diminished;
- I t would be very interesting to further explore these issues of crossing within shared space-type contexts, including how people cope with low-speed, high-traffic volume situations, and blind and partially sighted people's experiences of making or substituting for the lack of eye-contact as a means of negotiating with motorists;
- There is very little evidence relating to crossings in shared space, but where formal crossings are provided in shared space, it is felt by many commentators that it ceases to be shared space - feedback on 'courtesy crossings is somewhat mixed;
- I t would be very interesting to further explore people's experience and views of these sorts of crossings within shared space contexts and the extent to which they help.
- There is a perception that local authority officers and others involved in designing the built environment do not always fully understand the barriers to mobility that are imposed by sight loss, and that increased training related to inclusive design would help make for better schemes that incorporate blind and partially sighted pedestrians' concerns;
- Both current and future technological development has the potential to enhance the safety and mobility of blind and partially sighted pedestrians, though caution needs to be exercised with regard to the extent it might be relied upon;
- I t would be very interesting to further explore blind and partially sighted people's experiences and views about the use of technologies to support their mobility and, in particular, their crossing of roads.

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