

# Testing proposed delineators to demarcate pedestrian paths in a shared space environment

Report of design trials conducted at University  
College London Pedestrian Accessibility and  
Movement Environment Laboratory (PAMELA)

## Executive summary

**Registered office:** The Guide Dogs for the Blind Association, Hillfields, Burghfield Common, Reading, Berkshire RG7 3YG. A company limited by guarantee registered in England and Wales (291646) and a charity registered in England and Wales (209617) and Scotland (SC038979).

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**Guide Dogs**

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**Participant recruitment:** Helen Aluko-olokun, Dee Beach and Jane Fogden

**Design trials:**

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Guide Dogs: Helen Aluko-olokun, Rebecca Atherton, Dee Beach, Elizabeth Cook, Jane Fogden, Gill Kenyon, David Locklin, Susan Sharp, Dominique Stephens and Carol Thomas

**Research analysis:**

University College London: Craig Childs and Professor Nick Tyler

Guide Dogs: Dominique Stephens

**Edited by:** Guide Dogs' Public Policy Department in collaboration with University College London

**Advisory group:**

Commission on Architecture in the Built Environment (CABE)

Department for Transport

Disabled Persons' Transport Advisory Committee (DPTAC)

Joint Committee on Mobility of Blind and Partially Sighted People

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JMU Access Partnership, RNIB

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The full research report, together with this executive summary and the other Guide Dogs reports referenced, are available to download from the Guide Dogs website:

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## Introduction

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Shared surface streets often involve the removal of traditional kerbs and footways and have no, or reduced, demarcation between areas traditionally used by vehicles and pedestrians. The implementation of such schemes is a major concern to blind and partially sighted people who use the kerbs and other tactile demarcations as orientation cues. In addition, the shared surface approach proposes that pedestrians negotiate the street through 'eye contact' with other users, putting blind and partially sighted people at an immediate disadvantage.

The first part of Guide Dogs' research, involving 10 focus groups in UK towns where there are shared surfaces, reported September 2006<sup>1</sup>. It covered the experiences of 67 people in seven focus groups of blind and partially sighted people and three pan-disability focus groups. The research established that the safety, confidence and independence of blind and partially sighted people are undermined by shared surfaces. These concerns have been supported by other disability organisations, and a joint statement on the implications of shared surfaces for disabled people has been agreed.

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The Ramboll Nyvig report<sup>2</sup> advocated the creation of 'safe space' within shared space schemes, where vulnerable pedestrians could remain away from vehicles, giving them confidence to use the street independently. Acknowledging that no aspect of the highway can be completely 'safe', the 'safe space' is the area, equivalent to the traditional footway, where vulnerable pedestrians would feel safer. This would not prevent the rest of the area being shared by motorists, cyclists and those pedestrians able and willing to do so.

The key question is how to demarcate the safe space from the shared area if the traditional kerb is not used. The Ramboll Nyvig report proposed several designs to demarcate the safe space.

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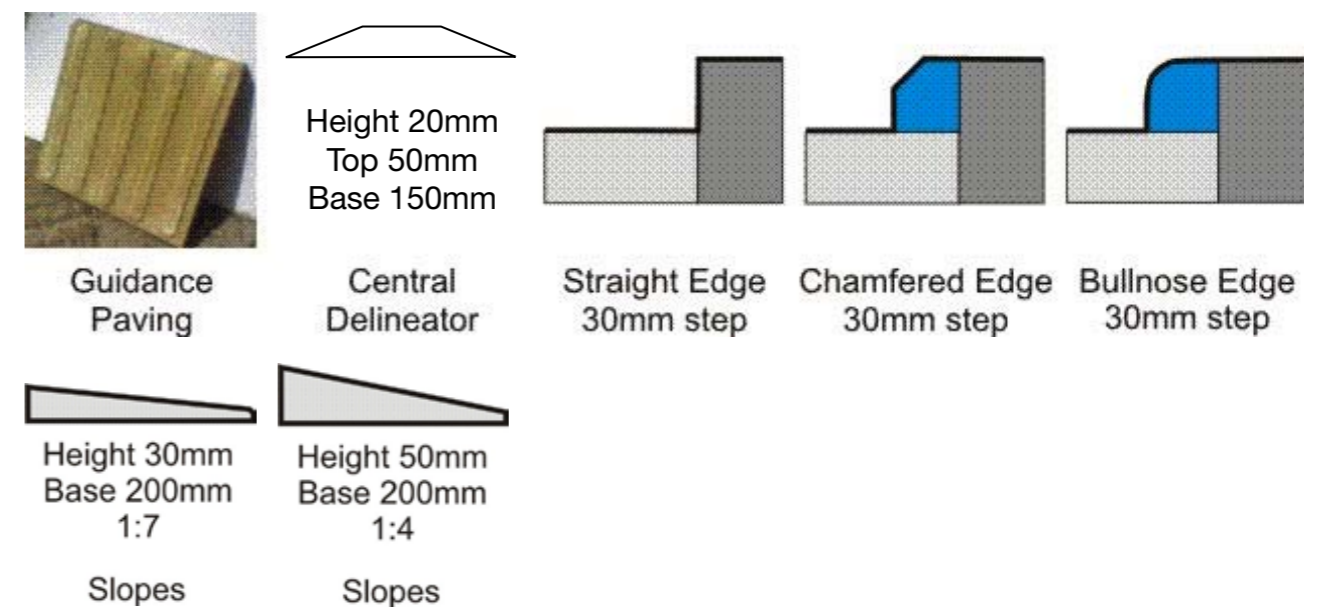
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Participants were invited to propose other methods for demarcating the safe area in shared space schemes, and in addition the research was advertised through networks such as the Access Association and the Institute of Highways Incorporated Engineers Home Zone Group, with calls for proposals from local authorities and design practices known to be working on shared surface schemes. No additional delineators were proposed. The testing that took place therefore only looked at the proposals put forward in the Ramboll Nyvig report. These are similar to those that have been used and/or proposed in UK shared space schemes.

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Central delineator  
30mm step kerb  
30mm bullnose kerb  
30mm chamfered kerb  
30mm by 200mm sloped kerb (1:7 gradient)  
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The guidance paving was in accordance with the Department for Transport's 'Guidance on the use of tactile paving surfaces', with the exception of the width that was tested: a 400mm width was tested rather than the recommended 800mm. The reduced width has been proposed by local authorities reluctant to use 800mm.

The central delineator tested was a trapezoidal strip 20mm high, 150mm wide with sloping sides and a flat top of 50mm. This is prescribed in 'Guidance on the use of tactile paving surfaces' for use to separate the pedestrian and cyclist sides of a segregated shared use cycle path.

## Design trials

These design proposals were tested in trials involving 30 blind and partially sighted people, and 15 people with mobility impairments including people with walking difficulties and manual wheelchair users. Blind and partially sighted participants tested whether the designs could be detected and used for navigation, while mobility impaired participants tested how easy these delineators were to cross and how acceptable they would be in the pedestrian environment.

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It is acknowledged that the design trials involved only some of the groups of disabled people who may be affected by shared surface streets. This was in order to keep the number of trials to a manageable level at this initial stage. Issues relating to other groups, such as people with learning disabilities, would need to be considered in other future research.

The trials took place over two weeks in May 2007 at the University College London's Pedestrian Accessibility Movement and Environment Laboratory (PAMELA). This provided a safe and comfortable environment in which to run trials with vulnerable pedestrians in order to identify which of the designs might warrant further testing through real world trials in the external environment.

The measures used to assess the interaction of participants with each delineator included questionnaires to record participants' views, video analysis, heart rate monitoring and walking speed (together providing Total Heart Beat Index – a measure of the impact of each delineator on each participant).

## Results

The following tables summarise the results of the trials for each delineator. Table 1 shows the results for blind and partially sighted participants:

- The proportion of participants who found the delineator easy to detect.
- The proportion of participants who felt confident using the delineator to navigate within the 'safe space'.
- The proportion of participants who felt safe using the delineator to navigate within the 'safe space'.

Before the trials all blind and partially sighted participants (100%) reported that they are able to use the traditional kerb to help them navigate streets.

Table 2 summarises the results of the trials with mobility impaired participants (people with walking difficulties and wheelchair users). This table shows:

- The proportion of participants who found the delineator easy to cross.
- The proportion of participants who failed to cross the delineator.
- The proportion who considered the delineator would be acceptable for use in the pedestrian environment.

**Table 1: Summary of results for blind and partially sighted participants**

Delineator tested	% who found the delineator easy to detect	% who felt confident using the delineator to navigate within the safe space	% who felt safe using the delineator to navigate within the safe space
Guidance paving	80	70	73
Central delineator	93	73	77
Straight edge kerb upper side	67	33	40
Straight edge kerb lower side*	67	37	40
Bullnose kerb upper side	63	50	50
Bullnose kerb lower side*	60	47	53
Chamfered kerb upper side	77	40	57
Chamfered kerb lower side*	57	40	47
30mm slope down	63	N/A	N/A
30mm slope up	77	N/A	N/A
50mm slope down	83	N/A	N/A
50mm slope up	90	N/A	N/A

**Note:** The 30mm and 50mm slopes were tested for detect only, not detect and navigate.

\* When kerbs were approached from the lower side, as from the carriageway, participants were asked to detect the kerb and then step up and walk on the upper level path using the kerb edge to keep on the path as they would when approaching from the upper side (footway).

**Table 2: Summary of results for mobility impaired participants**

Design features tested	% who found delineator easy to cross	% who failed to cross delineator	% who found delineator acceptable
Guidance paving	60	0	53
Central delineator	87	0	53
Straight kerb down	92	17	42
Straight kerb up	58		
Bullnose kerb down	93	21	79
Bullnose kerb up	64		
Chamfered kerb down	83	7	42
Chamfered kerb up	50		
30mm slope down	100	0	87
30mm slope up	93		
50mm slope down	87	27	60
50mm slope up	53		

## Guidance paving

As shown in Table 1, guidance paving was found to be relatively easy to detect and use for navigation by blind and partially sighted participants, with 80% finding it easy to detect and 70% reporting feeling confident using this to navigate the space. However, 30% of participants did not feel confident using this surface to navigate the space.

In contrast, the guidance paving was found to be one of the most difficult delineators for mobility impaired participants. While none of the mobility impaired participants failed to cross the guidance paving, 40% found this difficult to cross. Just over half said they would find this acceptable in the pedestrian environment, with a further 20% not sure. Over half – 53% – of the mobility impaired participants had their slowest travelling speed when using this design feature, suggesting that it did cause them some difficulty. In addition, the guidance paving produced the highest Total Heart Beat Index in 33% of the participants, again suggesting difficulty.

The location of the guidance paving is also an issue. Its original purpose (as detailed in the Department for Transport guidance) is to ‘guide’ blind and partially sighted people along a route either by walking on the tactile surface or by maintaining regular contact with it through a long cane. During these trials participants were observed to walk with one or both feet on the surface. There is a risk that if contact is lost with the guidance path a person could inadvertently enter a shared area. Given that risk, while guidance paving may be suitable as a surface to follow within a footway or pedestrian area, it would not be suitable to delineate the edge between the ‘safe space’ and the area for vehicles.

At the same time, given the experiences of mobility impaired people, if the surface is laid within the footway area there would need to be sufficient clear space for wheelchair users and people with walking difficulties to move along parallel to it and to reduce the number of crossing movements they would need to make. Another form of delineator would then be required for blind and partially sighted people at the edge of the footway.

## Central delineator

The central delineator was found to be the easiest delineator to detect by blind and partially sighted participants, with 93% finding this easy to detect. Almost three quarters were confident using it to navigate the ‘safe space’ and a similar proportion also felt safe while using this delineator. However this leaves over a quarter of participants who were not confident using this to navigate the safe space.

The central delineator was also found to be relatively easy for the mobility impaired participants, as none failed to cross and 87% reported that they found it easy to cross. The results from the Total Heart Beat Index and travelling speed data were also positive in comparison with other delineators. However despite the positive results only 53% of mobility impaired participants said that they would find the central delineator acceptable in the pedestrian environment.

Further research would be required on this delineator in order to establish whether the problems identified could be overcome. The key recommendation made by both groups of participants is for the delineator to contrast clearly with the background. A wider and more rounded profile was also suggested.

## 30mm kerbs

The 30mm kerb was tested with bullnose, chamfered and straight kerb edges. All three kerbs recorded fails with both the blind and partially sighted participants and the mobility impaired participants. Less than half of blind and partially sighted people were confident using the bullnose edge kerb to follow the path, and the figures for the straight and chamfered kerb edges were lower than this, 33% and 40% respectively when approached from the upper side.

The kerb edge which was the most acceptable to mobility impaired participants was the bullnose kerb, with 79% finding it to be acceptable in the pedestrian environment. However the bullnose kerb was difficult to climb for 36%, and it also recorded the highest number of fails where mobility impaired participants had been unable to cross it independently (21% of participants). Half of the mobility impaired participants found the chamfered edge kerb difficult to climb; 42% the straight edge kerb.

## Slopes

The 50mm by 200mm slope with a 1:4 gradient was found to be relatively easy to detect by blind and partially sighted participants, with 83% finding it easy to detect the slope up when approached from the lower side (carriageway) and 90% to detect the slope down from the upper level path. Confidence using the slope to navigate was not assessed. In contrast, this slope was found to be one of the most difficult design features for the mobility impaired participants. The 50mm slope was considered to be dangerous by many of the wheelchair users. 27% of the 15 mobility impaired participants were unable to climb this slope independently; 47% found it difficult to climb.

The 30mm by 200mm slope with a 1:7 gradient fared better than the 50mm slope with mobility impaired participants, with 93% finding this slope easy to climb. In contrast it did not fare as well as the 50mm slope with blind and partially sighted participants. Over a third of blind and partially sighted participants failed to detect the 30mm slope down and almost a quarter failed to detect the slope up. Again, confidence using to navigate within the space was not assessed.

Further research would be required to establish whether a compromise slope might be acceptable and effective, and to test how effective the slopes are to enable blind and partially sighted participants to navigate the space.

## Conclusion

This research has identified the effectiveness of each delineator in an internal controlled environment. Whilst none of the delineators emerged as meeting the needs of both groups of users in the forms tested, two were identified by the researchers as warranting further research – the central delineator and a slope profile. A focused list of specific issues for testing has been identified for further research. The effects of lighting, weather and additional cognitive loading were not considered and would need to be the subject of further research.



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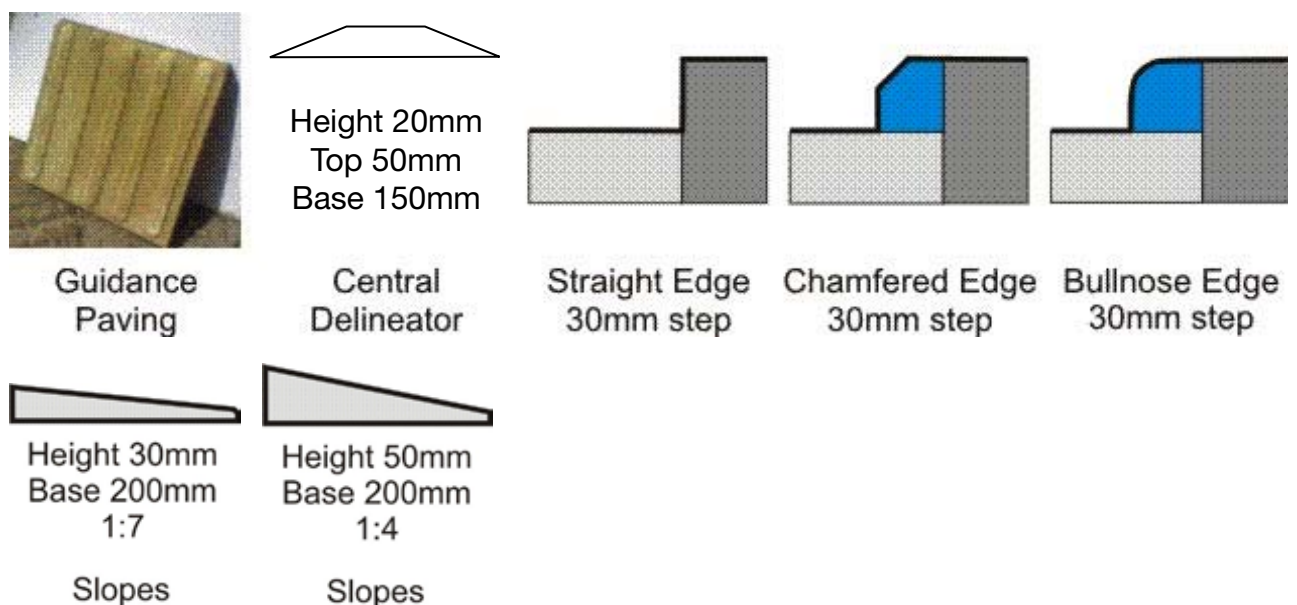
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## Results

The following tables summarise the results of the trials for each delineator. Table 1 shows the results for blind and partially sighted participants:

- The proportion of participants who found the delineator easy to detect.
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As shown in Table 1, guidance paving was found to be relatively easy to detect and use for navigation by blind and partially sighted participants, with 80% finding it easy to detect and 70% reporting feeling confident using this to navigate the space. However, 30% of participants did not feel confident using this surface to navigate the space.

In contrast, the guidance paving was found to be one of the most difficult delineators for mobility impaired participants. While none of the mobility impaired participants failed to cross the guidance paving, 40% found this difficult to cross. Just over half said they would find this acceptable in the pedestrian environment, with a further 20% not sure. Over half – 53% – of the mobility impaired participants had their slowest travelling speed when using this design feature, suggesting that it did cause them some difficulty. In addition, the guidance paving produced the highest Total Heart Beat Index in 33% of the participants, again suggesting difficulty.

The location of the guidance paving is also an issue. Its original purpose (as detailed in the Department for Transport guidance) is to ‘guide’ blind and partially sighted people along a route either by walking on the tactile surface or by maintaining regular contact with it through a long cane. During these trials participants were observed to walk with one or both feet on the surface. There is a risk that if contact is lost with the guidance path a person could inadvertently enter a shared area. Given that risk, while guidance paving may be suitable as a surface to follow within a footway or pedestrian area, it would not be suitable to delineate the edge between the ‘safe space’ and the area for vehicles.

At the same time, given the experiences of mobility impaired people, if the surface is laid within the footway area there would need to be sufficient clear space for wheelchair users and people with walking difficulties to move along parallel to it and to reduce the number of crossing movements they would need to make. Another form of delineator would then be required for blind and partially sighted people at the edge of the footway.

## Central delineator

The central delineator was found to be the easiest delineator to detect by blind and partially sighted participants, with 93% finding this easy to detect. Almost three quarters were confident using it to navigate the 'safe space' and a similar proportion also felt safe while using this delineator. However this leaves over a quarter of participants who were not confident using this to navigate the safe space.

The central delineator was also found to be relatively easy for the mobility impaired participants, as none failed to cross and 87% reported that they found it easy to cross. The results from the Total Heart Beat Index and travelling speed data were also positive in comparison with other delineators. However despite the positive results only 53% of mobility impaired participants said that they would find the central delineator acceptable in the pedestrian environment.

Further research would be required on this delineator in order to establish whether the problems identified could be overcome. The key recommendation made by both groups of participants is for the delineator to contrast clearly with the background. A wider and more rounded profile was also suggested.

## 30mm kerbs

The 30mm kerb was tested with bullnose, chamfered and straight kerb edges. All three kerbs recorded fails with both the blind and partially sighted participants and the mobility impaired participants. Less than half of blind and partially sighted people were confident using the bullnose edge kerb to follow the path, and the figures for the straight and chamfered kerb edges were lower than this, 33% and 40% respectively when approached from the upper side.

The kerb edge which was the most acceptable to mobility impaired participants was the bullnose kerb, with 79% finding it to be acceptable in the pedestrian environment. However the bullnose kerb was difficult to climb for 36%, and it also recorded the highest number of fails where mobility impaired participants had been unable to cross it independently (21% of participants). Half of the mobility impaired participants found the chamfered edge kerb difficult to climb; 42% the straight edge kerb.

## Slopes

The 50mm by 200mm slope with a 1:4 gradient was found to be relatively easy to detect by blind and partially sighted participants, with 83% finding it easy to detect the slope up when approached from the lower side (carriageway) and 90% to detect the slope down from the upper level path. Confidence using the slope to navigate was not assessed. In contrast, this slope was found to be one of the most difficult design features for the mobility impaired participants. The 50mm slope was considered to be dangerous by many of the wheelchair users. 27% of the 15 mobility impaired participants were unable to climb this slope independently; 47% found it difficult to climb.

The 30mm by 200mm slope with a 1:7 gradient fared better than the 50mm slope with mobility impaired participants, with 93% finding this slope easy to climb. In contrast it did not fare as well as the 50mm slope with blind and partially sighted participants. Over a third of blind and partially sighted participants failed to detect the 30mm slope down and almost a quarter failed to detect the slope up. Again, confidence using to navigate within the space was not assessed.

Further research would be required to establish whether a compromise slope might be acceptable and effective, and to test how effective the slopes are to enable blind and partially sighted participants to navigate the space.

## Conclusion

This research has identified the effectiveness of each delineator in an internal controlled environment. Whilst none of the delineators emerged as meeting the needs of both groups of users in the forms tested, two were identified by the researchers as warranting further research – the central delineator and a slope profile. A focused list of specific issues for testing has been identified for further research. The effects of lighting, weather and additional cognitive loading were not considered and would need to be the subject of further research.

# Introduction

## What is shared space?

Several local authorities in the UK have redesigned town centres and high streets using the concept of shared space. Others are in the process of doing so. Shared space aims to create shared 'social' areas for all road users, reduce the dominance of motor vehicles and make streets more people-friendly.

## What is a shared surface?

Shared space developments are frequently implemented through the creation of a shared surface for drivers, cyclists and pedestrians. Shared surface streets involve the removal of traditional kerbs and footways and have no, or reduced, demarcation between areas used by vehicles and pedestrians as would be found in a traditional street layout.

## The issue

The implementation of shared surfaces is a major concern to blind and partially sighted people who use the kerbs and other tactile demarcations as warning and orientation cues. When shared space schemes employ shared surfaces and remove the physical demarcation between the footway and the carriageway, i.e. the kerb, it is very difficult or impossible for people with sight impairment to navigate safely.

## Why is the kerb so important?

Blind and partially sighted participants who have received mobility training will have been taught to try to follow a straight line. The inner shoreline (commonly the building line) and the outer shore line (traditional kerb or delineator of path edge) are used to ensure they do not leave the pedestrian path.

Long cane users use their cane to scan the ground by sweeping it in an arc from one side to the other about two inches past the widest part of the body. This technique locates potential obstructions, for example street furniture, provided there is some element at ground level, and detects distinct changes in level such as a kerb upstand or a step.

Guide dog owners normally travel in a straight line near the centre of the footway. Guide dogs are taught to avoid obstructions and to stop at a kerb edge. It may also be possible to train dogs to recognise and stop at other delineators if they are sufficiently distinct. The guide dog owner decides when it is safe to move forward so would need to be able to recognise the delineator with their feet.

Many people with impaired vision have had no mobility training and travel independently using their remaining vision together with physical and other cues in the environment.

Further information on the range of landmarks and cues used by blind and partially sighted people is given in the appendices.

## Establishing the issues

Guide Dogs became aware that there was a potential problem with the use of shared surfaces to fulfil shared space design briefs in 2005, following increasing reports from blind and partially sighted people across the UK. The common concern was how the redevelopment of local streets using shared surfaces meant that guide dog owners, long cane users and other blind and partially sighted people could no longer travel on their own as it was difficult or impossible to navigate safely in that environment and their confidence was severely affected.

It became clear that research was needed to establish the extent of the problem. Consequently ten focus group meetings were held across the UK in towns where there were shared surfaces: seven focus groups of blind and partially sighted people and three groups involving people with other disabilities. Guide Dogs published the report of this research in September 2006<sup>3</sup>. In all it covered 67 people who had experience of shared surfaces. The research confirmed that the safety, confidence and independence of blind and partially sighted people are undermined by shared surfaces. Subsequently these concerns were also supported by other disability organisations and, as a result, a joint statement on the implications of shared surfaces for disabled people was agreed and published in June 2007.

## Moving the research forward

Having established the difficulties that the removal of the traditional kerb in shared surface schemes presented for blind and partially sighted people, Guide Dogs sought to establish whether an alternative delineator could be introduced which would meet the needs of blind and partially sighted people and yet still fulfil the aims of shared space.

At the same time it was recognised that any alternative delineator would also need to work for people with other disabilities, who would also be using the 'safe' space and might wish to cross the shared area at will rather than at designated crossing points.

## Developing alternative designs for the kerb

Before selection and testing of alternative designs could proceed, we had to first establish whether it was possible to accommodate the requirements of blind and partially sighted people in shared space designs. To that end, we commissioned the international design practice Ramboll Nyvig, and asked them to produce design proposals for us to test.

The Ramboll Nyvig report<sup>4</sup> proposed the creation of 'safe space' within shared space schemes, where vulnerable pedestrians could remain away from vehicles, giving them confidence to use the street independently. Acknowledging that no aspect of the highway can be completely 'safe', the 'safe space' is the area, equivalent to the traditional footway, where vulnerable pedestrians would feel safer. This would not prevent the rest of the area being shared by motorists, cyclists and those pedestrians able and willing to do so.

<sup>3</sup> 'Shared surface street design research project. The issues: report of focus groups', Guide Dogs, 2006.

<sup>4</sup> 'Shared Space – Safe Space', Ramboll Nyvig for Guide Dogs, 2007.

## Selecting designs for testing

The key question was how to demarcate the safe space from the shared area if the traditional kerb is not used. The Ramboll Nyvig report proposed several designs to demarcate the safe space.

A design workshop took place in April 2007 at which the design proposals of Ramboll Nyvig were considered by a small group of designers and planners, plus representatives of Department for Transport and the Disabled Persons' Transport Advisory Committee. CABA Space was unable to be represented but was invited to send suggestions.

Participants were invited to propose other methods for demarcating the safe area in shared space schemes, and in addition the research was advertised through networks such as the Access Association and the Institute of Highways Incorporated Engineers Home Zone Group, with calls for proposals from local authorities and design practices known to be working on shared surface schemes. No additional schemes were proposed. The testing that took place therefore only looked at the proposals put forward in the Ramboll Nyvig report.

Guidance paving 400mm width  
Central delineator  
30mm step kerb  
30mm bullnose kerb  
30mm chamfered kerb  
30mm by 200mm sloped kerb (1:7 gradient)  
50mm by 200mm sloped kerb (1:4 gradient)

These delineators are similar to those that have been used and/or proposed in UK shared space schemes.

## Design trials

### Aims and scope

Guide Dogs wanted to test both whether any of the delineators that had been identified by Ramboll Nyvig might be effective for blind and partially sighted people to navigate shared space street environments, and also that they would not impede access for people with mobility impairments.

By using the University College London's Pedestrian Accessibility Movement and Environment Laboratory (PAMELA) facility the delineators could be tested in a safe, controlled environment in order to identify which of the designs might warrant further testing through real world trials in the external environment.

The trials at PAMELA took place at over two weeks in May 2007 and involved both blind and partially sighted people and mobility impaired people.

## Limitations

As it was an internal controlled environment the effects of adverse weather and lighting conditions were not tested.

In this controlled environment participants were able to concentrate on the task of identifying and using the delineators to navigate, or crossing them. The effects of cognitive loading, i.e. other street activities or other tasks to focus on, were not tested and would need to be considered in further research.

The design trials involved only some of the groups of disabled people who may be affected by shared space streets. This was in order to keep the number of trials to a manageable level at this initial testing stage, focusing on those for whom the physical profiles of the designs could have greatest impact.

This report describes the methodology and results of the design trials and makes recommendations for further research.

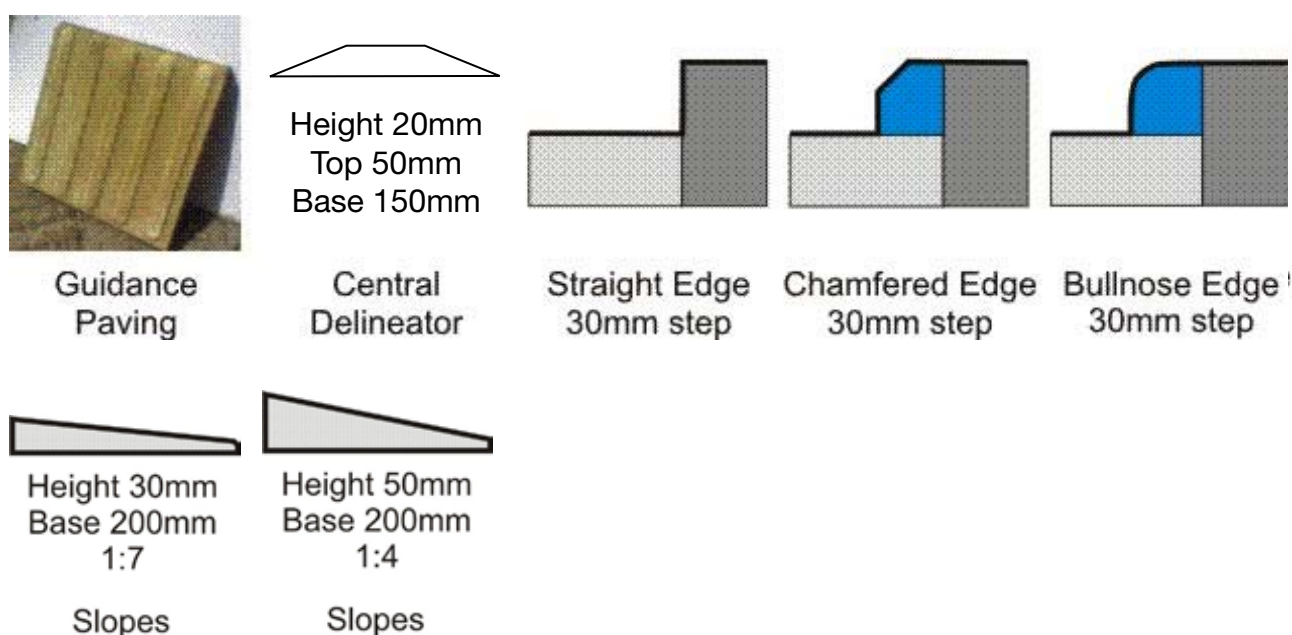
# Design trials methodology

## Design features

The following delineators were tested in the trials:

- Guidance paving 400mm width
- Central delineator
- 30mm step kerb
- 30mm bullnose kerb
- 30mm chamfered kerb
- 30mm by 200mm sloped kerb (1:7 gradient)
- 50mm by 200mm sloped kerb (1:4 gradient)

**Figure 1: Delineators**



In some form, all of these delineators have been used or are proposed for use in shared space street schemes to delineate the edge of the pedestrian path, but have not previously been tested for use in these situations.

The guidance paving was in accordance with the Department for Transport's 'Guidance on the use of tactile paving surfaces', with the exception of the width that was tested: a 400mm width was tested rather than the recommended 800mm. The reduced width has been proposed by local authorities reluctant to use 800mm.

The central delineator tested was a trapezoidal strip 20mm high, 150mm wide with sloping sides and a flat top of 50mm. This is prescribed in 'Guidance on the use of tactile paving surfaces' for use to separate the pedestrian and cyclist sides of a segregated shared use cycle path.

The delineators were tested by both blind and partially sighted participants and mobility impaired participants to determine which, if any, could be detected and used for navigation by blind and partially sighted people whilst not creating an obstacle for people with mobility impairments.

## Lighting

The trials were conducted in a controlled internal environment with lighting levels of 200 lux. The effects of varied lighting levels and the implications for colour contrast were not tested in these trials.

The aim of these trials was simply to identify how effective and acceptable the delineators are in a controlled environment. Further research would be needed to consider the effects of lighting levels and weather conditions such as wet surfaces.

## Participants

### Blind and partially sighted participants

30 blind or partially sighted people took part in the first week of the design trials. Their ages ranged from 25 to 83 and there were equal numbers of males and females.

The 30 blind and partially sighted participants reported normally using the following mobility aids:

- 11 participants use either a guide dog or a cane as they are trained to use both;
- 9 participants use a guide dog;
- 6 participants use a cane only;
- 1 participant (with both visual and hearing impairments) has a personal assistant;
- 3 participants use no mobility aid.

However, after the first few trials had been conducted it became apparent that there was difficulty working guide dogs on the platform. The size and layout of the platform confused the dogs. Therefore, it was decided not to use the guide dogs and participants were asked to use an alternative mobility aid. The types actually used during the trials are listed below:

- 13 participants used a long cane (mainly with roller tip);
- 4 participants used a guide dog;
- 6 participants had sighted guidance;
- 7 participants did not use a mobility aid.

Of the six participants who used sighted guidance during the trials, five were guide dog owners who were unable to use their guide dogs during the trials due to the constraints of the platform. The sixth participant who used a sighted guide was the participant with both visual and hearing impairments. All of the staff providing sighted guidance were experienced at guiding and took care only to support and not to lead the participant or influence their detection of the delineators.

## **Experience of using the street environment**

Before carrying out the design trials each participant was asked about their experiences using the pedestrian environment in both a traditional street layout (one with kerbs) and a shared surface layout.

All of the participants reported that they normally or regularly travel alone in the street environment, except for one participant who had both visual and hearing impairments and who is usually accompanied.

All participants (100%) reported that are able to use the traditional kerb to help them navigate streets. When participants were asked how easy they find it to navigate a traditional street layout (one with kerbs), 93% (28) of the blind and partially sighted participants said they found it easy or very easy. Only 2 participants (1 guide dog user and 1 long cane user) said they found it difficult, citing obstacles and varying surface conditions for their difficulties.

In contrast, of the 21 participants who had previously encountered a shared surface only 4 said they had found it easy to navigate. The remaining 17 participants found it difficult or very difficult to navigate. The type of mobility aid usually used by participants had no effect on this result.

## **Mobility impaired participants**

15 participants with mobility impairments took part in the second week of design trials. The age range of these participants was from 33 years to 75 years. 9 participants were female and 6 were male. 11 participants were wheelchair users and 4 participants had walking difficulties. 10 participants said they normally travel alone, 4 said they travel alone or accompanied and 1 participant always travels accompanied.

During the trials, 11 participants used a manual wheelchair. Of the 4 participants with walking difficulties, 2 used a walking stick, 1 used a rolator (a mobility walking aid with wheels) and 1 had no mobility aid.

## **Experience of using the street environment**

Only 40% (6 of 15) of the mobility impaired participants found it easy or very easy to use a traditional street layout. The comments given by participants about the traditional street environment were mainly negative and about the difficulties they come across such as obstacles, uneven surfaces, steep slopes, steps and uncomfortable tactile paving.

In contrast, 91% (10) of the 11 participants who were familiar with a shared surface found it easy or very easy to negotiate a shared surface street layout. Comments were more positive but some participants said they still experienced difficulties and noted being wary of vehicle drivers.

## Design trials – blind and partially sighted participants

Participants were taken onto the platform accompanied by an interviewer. They were then asked either to detect, or to detect and use each of the delineators which had been laid on the platform to navigate along the path. The aim of this was to determine whether any of these delineators would be useful in helping the individual to identify and remain within the 'safe space', or footway, in a shared space environment. The layout of the delineators on the platform is shown in Figure 2.

### The detect test

The detect test involved leading each participant to within 2m of the delineator. The participant was then asked "to walk forwards as if leaving a building, intending to find a delineator to lead them to the right/left". This delineator marked the edge of the 'safe space', replacing the traditional kerb. If they sensed that they had detected a delineator, they were asked to stop and describe what they had encountered.

Participants were asked to approach and detect the 30mm kerbs and the slopes from both the lower side (as from the carriageway, going up the kerb or slope) and from the upper side (as from the footway, going down the kerb or slope).

Participants were asked to use their normal navigation techniques to approach and detect the delineator.

- Cane users used their canes in the normal way to scan the ground by sweeping the cane in an arc from side to side as they moved forward aiming to detect the delineator.
- Guide dog users were asked to note if their dog stopped at the delineator and also the participant was asked to detect the delineator underfoot. As noted above, because of the difficulties of working dogs on the platform most guide dog owners used an alternative mobility aid, either a long cane (if they were also cane users) or a sighted guide, or used no mobility aid.
- Participants with no mobility aid aimed to detect the delineator underfoot.
- Participants who had a sighted guide for the trials were also asked to detect the delineator underfoot. Their sighted guide was asked not to guide them to it or influence their detection in any other way e.g. orally.

### The detect and navigate test

All delineators except for the 200mm slopes were tested for detect and navigate; that is, to use the delineator as marking the edge of the 'safe space' in order to remain within it. In this test, the participant was again led to about 2m from a delineator and then asked to walk forwards. If they encountered a delineator, they were to follow it (left or right) as far as they could, using the delineator to stay in the space, then turn. This navigation test was repeated for two minutes.

The 30mm kerbs with different edge effects (bullnose, straight and chamfered) were approached from both the lower side (as if from the carriageway, climbing the kerb) and upper side (as if from the safe space going down the kerb).

Participants were asked to use their normal navigation techniques to move along the safe space path using the delineator as a check.

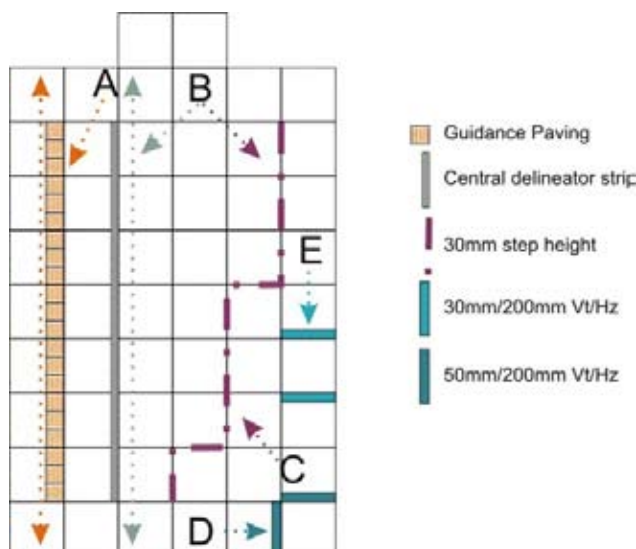
- Cane users used their canes in the normal way to scan the ground from side to side as they moved along the path. The cane should come into contact with the delineator and alert the participant if they were getting nearer to the delineator or had crossed it and moved off the path.
- Guide dog users moved along the path with their dog, noting if their dog stopped at the delineator and also the participants themselves were asked to detect the delineator underfoot if they crossed it and were moving off the path. As noted above, because of the difficulties of working dogs on the platform most guide dog owners used an alternative mobility aid, either a long cane if they were also cane users or a sighted guide, or used no mobility aid.
- Participants with no mobility aid moved along the path detecting the delineator underfoot if they crossed it and were moving off the path.
- Participants with a sighted guide for the trials were asked to follow the path in the same way as those with no mobility aid. Their sighted guide was asked not to influence them.

The 30mm step route contained a number of corners to indicate their use at junctions. Due to limitations in laboratory set up, it was not possible to lay the guidance paving and central delineator routes with corners so these were presented in a straight line.

Due to space constraints on the platform the 200mm slopes were only used in detect tests as there was insufficient space to lay lines of these slopes for participants to follow.

The order in which the delineators were encountered was varied for each participant and there was a rest period between each delineator.

**Figure 2:** The layout of delineators on the platform for blind and partially sighted participants



The letters refer to the start point for each trial and arrows indicate the direction to be taken in each case. In between trials, the 30mm step edge type would be changed between straight, bullnose and chamfered. The straight edge step was achieved by raising some modules 30mm higher than the adjacent ones.

The bullnose and chamfered edge types were achieved using strips of wood cut with the required cross-sectional profile and painted. These wood strips were screwed securely to the concrete pavers.

## Design Trials – Mobility impaired participants

### Repeated crossing test

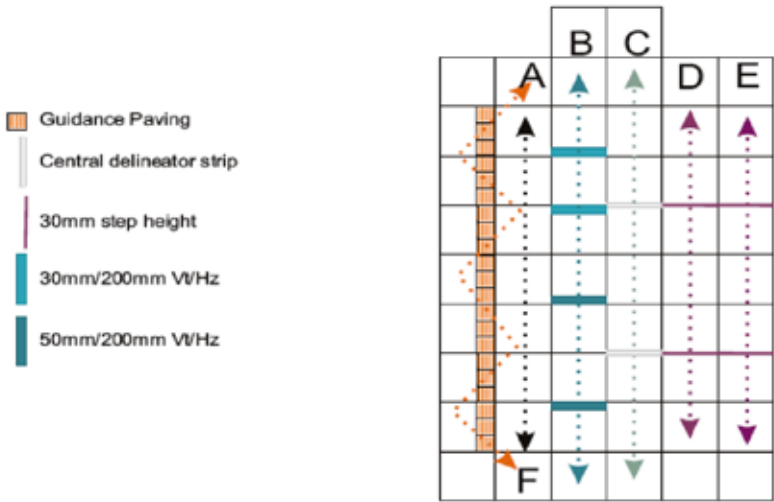
Participants were asked to go onto the platform to test a range of delineators which may be used in a shared space to help blind and partially sighted people to find their way. The aim of this was to determine whether any of these delineators would be particularly difficult or hazardous for mobility impaired people to negotiate.

Participants were asked to cross each delineator in the most suitable or comfortable way for them. They were asked to cross the 30mm kerbs and the slopes from both the lower side (as from the carriageway going up the kerb or slope) and from the upper side (as from the safe space path, going down the kerb or slope).

All the delineators except for the guidance paving were arranged perpendicular to the direction of travel (as shown in Figure 3) and participants were asked to move up and down the laboratory platform, crossing the delineators multiple times in each pass. As the guidance paving was laid in a straight line participants had to zigzag their way down the platform, crossing and re-crossing the paving.

The order in which the delineators were encountered was varied for each participant and there was a rest period between each delineator.

**Figure 3:** Layout of delineators for mobility impaired participants



## Baseline tests

Mobility impaired participants were also asked to conduct a baseline test before and after the design trials. This was completed in order to assess any difficulty moving along the platform, and also to get a heart rate reading for a normal street layout to compare with their heart rate readings when they tested the delineators. At the end of the delineator trials each participant completed a second baseline test.

All participants found the baseline easy or very easy to move along in the first baseline test. Only two participants reported slight problems, which were due to the unevenness of the paving slabs. In the second baseline test at the end of the trials, all participants again found the baseline easy or very easy to move along. Only one participant reported having a few problems. This participant used a rolator (a walking aid with wheels) and found that the paving stones on the platform were a bit uneven, which made the rolator wobble.

## Measures used

Participants' views about how easy/difficult they found each delineator were recorded in a series of questions which were asked at the end of each delineator trial. These questions were designed to measure what each participant thought about each delineator and what could be done to improve them. In addition to these questions, several other measures were used.

For the 'detect' test, the measure used was visual and verbal response. That is, if the person detected the delineator, they stopped walking and described what they had encountered; if they missed the delineator, and/or described the wrong thing, this was classed as a fail. This was recorded at the time and also analysed from video recordings. For both the 'detect' and the 'detect and navigate' test (blind and partially sighted participants) and the 'repeated crossing' test (mobility impaired participants) travelling speed and Total Heart Beat Index (THBI; Hood et al. 2002)<sup>5</sup> were measured.

Travelling speed can be affected by many factors, and is a known controllable variable for the participant. While it should be analysed with caution, a reduced travelling speed could be indicative that the participant was having more trouble following one delineator than another. In order to compensate for any deliberate change in the travelling speed, it is better to consider this in conjunction with the effort required to complete the task, as measured here by the Total Heart Beat Index (THBI). Unlike the travelling speed, it is unlikely that the participant will voluntarily be able to change their heart rate during a particular task. The THBI thus provides a more robust indicator of how effort was deployed in coping with each delineator. Of the 30 blind and partially sighted participants, 13 did not wear the heart rate monitor, and there is therefore no THBI data for these 13 participants.

The difficulty presented by an obstacle is a description of the impact that the obstacle has on the individual. An impact of a given magnitude could be important for one person but trivial for another. As a result, there is no absolute measure of impact which can be compared between individuals. However, the impact that each obstacle has on each person may be compared between individuals.

<sup>5</sup> Hood VL, Granat MH, Maxwell DJ, Hasler JP; 'A new method of using heart rate to represent energy expenditure: the Total Heart Beat Index' Arch Phys Med Rehabil, Sep 2002; 83 (9); pp 1266-73

## Learning/fatigue effect

Each participant was given time to recover between trials so that fatigue should not have been a problem for later trials. If this was a dominant effect, we would expect to see slower later trials. Conversely, if the participant became more familiar with the platform and the test procedure, and more confident in the task or comfortable with the delineators, the later trials would be faster than the earlier ones.

There was no apparent general trend of increasing or decreasing travelling speed from the first to the last trials. This would indicate that a suitable time was provided between tests for recovery and hence there was no fatigue effect or increased familiarity with the layout. There was one exception to this: one visually impaired participant walked faster with each successive trial over the 30mm step height (all edge types), possibly indicating an increasing familiarity with the layout (see Appendix 8).

# Design trials: results

## Guidance paving

The guidance paving was in accordance with the Department for Transport's 'Guidance on the use of tactile paving surfaces', with the exception of the width that was tested: a 400mm width was tested rather than the recommended 800mm.

The purpose of the guidance paving, as described in 'Guidance on the use of tactile paving surfaces', is to provide guidance in areas such as pedestrian precincts. The surface was developed so that people could be 'guided' along the route either by walking on the tactile surface or by maintaining contact with it through a long cane.

Several local authorities have proposed using the guidance paving in a shared surface layout to demarcate the edge of the pedestrian area. They have indicated that they would prefer to use less than the 800mm width specified in the guidance and so a width of 400mm was tested.

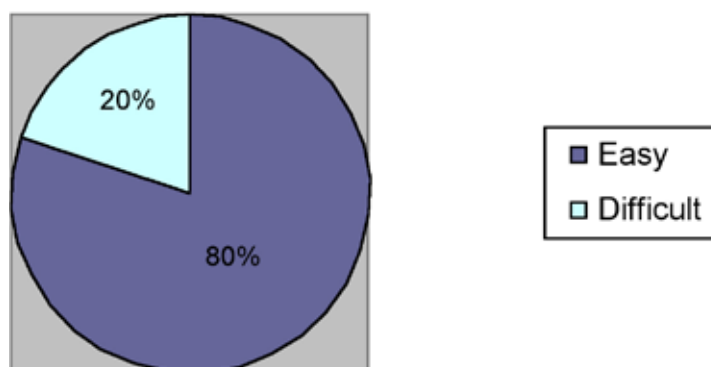
## Blind and partially sighted participant trials

### Detect

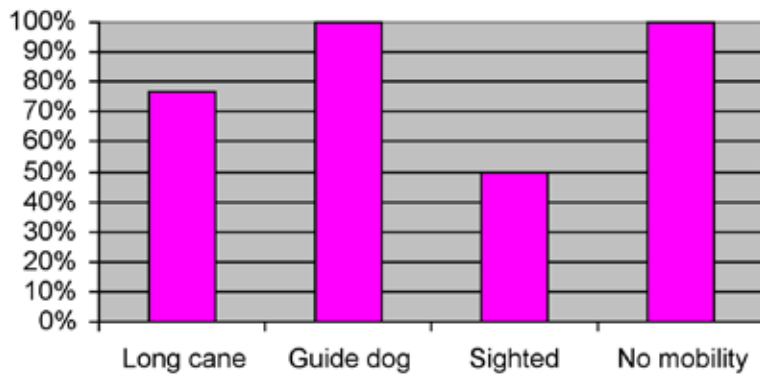
For each delineator, the detect test involved leading each participant to within 2m of the delineator. The participant was then asked "to walk forwards as if leaving a building, intending to find a delineator to inform their decision to turn right/left". This delineator marked the edge of the safe space, replacing the traditional kerb. If they sensed that they had detected a delineator, they were asked to stop and describe what they had encountered.

The majority of participants (80%, 24 participants) found the guidance paving easy or very easy to detect. All guide dog users and participants with no mobility aid found this delineator easy to detect. The majority of long cane users (77%, 10 participants) also found it easy to detect. Participants with sighted guidance had the most difficulty detecting the guidance paving with 50% (3) of them having some difficulty.

**Figure 4:** Guidance paving: Blind and partially sighted participants  
Ease of detection



**Figure 5:** Guidance paving: Blind and partially sighted participants  
Ease of detection by mobility aid used – Proportion of participants who found this easy to detect

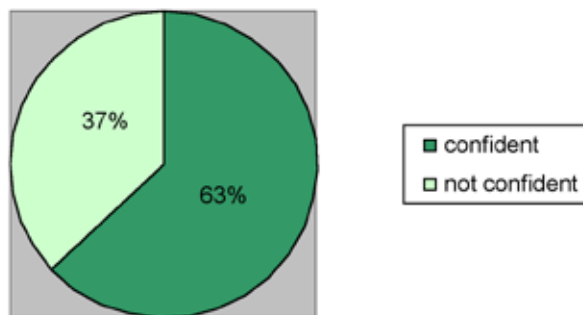


### Detect and navigate

Participants were asked to detect and navigate the space using the guidance paving. That is, to use it as the delineator marking the edge of the safe space in order to remain within it. In this test, the participant was again led to about 2m from the delineator and then asked to walk forwards. If they encountered the delineator, they were to follow it (left or right) as far as they could, using the delineator to stay in the space, then turn, repeating this for two minutes.

While almost two thirds of participants (63%, 19 participants) were confident using this delineator to keep within the space, this left over a third of participants (37%, 11 participants) who reported some problems using it. Most participants (73%, 22) reported that they felt safe using this surface.

**Figure 6:** Guidance paving: Blind and partially sighted participants  
Confidence using to navigate within the space



Results from the video and Total Heart Beat Index analysis were positive. Video analysis indicates that 100% of participants were able to detect and navigate with this delineator, though as noted above their confidence in following it varied. The guidance paving produced the fastest walking speeds for 5 participants, suggesting they felt most comfortable with this delineator, and it also produced a low Total Heart Beat Index for the majority of participants in comparison to some of the other delineators such as the bullnose, chamfered and straight edge kerbs.

It was noted that some participants walked with one or both feet on the guidance paving in order to follow it (see section on 'Overshoot' in 'Issues for consideration').

### **Positive comments:**

"This edge was well defined so I knew immediately what it was and that I needed to stop in order to avoid going into the road. I felt that compared with the other guidance methods this was very good."

[Female partially sighted guide dog owner (used long cane in trials), age 54]

"I could follow it easily. Could not see colour contrast at approach but once found it could see it."

[Male partially sighted participant, no mobility aid, age 51]

### **Negative comments:**

"I found it stressful to follow and it required a lot of concentration. Depends on what other cues you have to rely on – if this was the only thing then I would be very unhappy."

[Male blind guide dog owner (used cane in trials), age 58]

"It just seemed like an uneven pavement so there was no indication that you are crossing into a 'danger zone'."

[Female blind guide dog owner (used long cane in trials), age 65]

"If this was used to separate us from the traffic I would not be confident."

[Male blind long cane user, age 33]

"There is not enough definition. Not as effective as bobble pavers" (blister surface used at road crossings).

[Female blind guide dog owner (used long cane in trials), age 65]

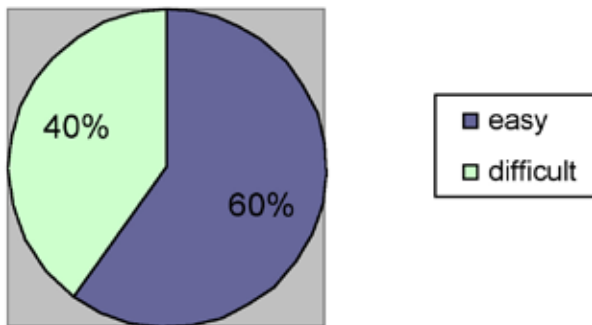
### **Possible improvements**

Of the 17 participants who suggested improvements, 41% (7) felt that the guidance paving needed to be raised to create a more prominent surface; other improvements suggested were enhancing the colour contrast or that the strip of guidance paving should be wider so that it was easier to detect and follow.

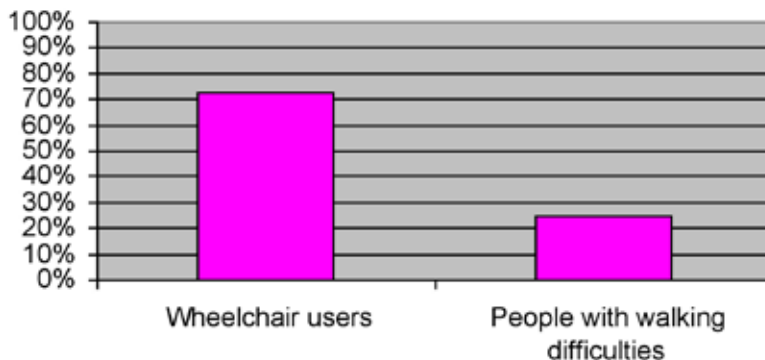
## Mobility impaired participant trials

60% (9) of the mobility impaired participants found the guidance paving easy or very easy to cross, while 40% (6) found it difficult. Most of the participants with walking difficulties reported difficulties (75% – 3 out of 4), compared to 27% (3) of wheelchair users.

**Figure 7:** Guidance paving: Mobility impaired participants  
Ease of crossing



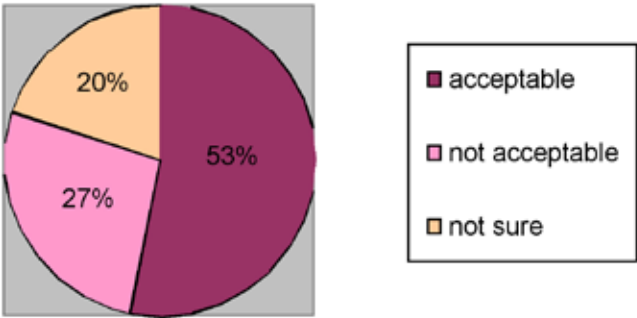
**Figure 8:** Guidance paving: Mobility impaired participants  
Proportion of wheelchair users and of participants with walking difficulties who found this easy to cross



Results from the video analysis confirm that all the mobility participants were able to cross the guidance paving. Therefore in terms of the number of fails, the guidance paving was no worse than many of the other delineators. However, 53% (8/15) of the participants had their slowest travelling speed when using it, suggesting that it did cause them difficulty. In addition, the guidance paving produced the highest Total Heart Beat Index in 33% (5/15) of the participants, which again suggests difficulty. As noted above 40% (6 participants) reported that they found the guidance paving difficult to cross.

When asked whether they would find this delineator acceptable in the pedestrian environment, 53% (8) of participants said they would find this surface acceptable, 27% (4) would not find it acceptable while 20% (3) of participants said they were not sure.

**Figure 9:** Guidance paving: Mobility impaired participants  
Acceptability in the pedestrian environment



The negative comments made by some mobility participants may be partly due to the positioning of the guidance paving on the platform. With only a single day between the tests for blind and partially sighted participants and those for mobility impaired participants, there was not enough time to relocate the guidance paving (which was done for all the other delineators). This meant that the participants had to zigzag down the platform over the guidance paving. Reviewing by video analysis the path taken by each participant, it shows that they all crossed the guidance paving twice as often as they did for any of the other delineators in each pass (a 'pass' being movement from one end of the platform to the other). In addition, since they had to make multiple turns in each pass to cross the delineator repeatedly, it may have been harder work for them than when they negotiated the other delineators.

**Possible improvements**

When asked if they could suggest anything to improve the guidance paving, 20% (3) of participants felt that the surface would be better if it was less prominent and 13% (2) suggested providing some spacing in between the guidance paving so that they could cross at the breaks to avoid discomfort. Other suggestions included having two larger ridges rather than four smaller ones and having ridges that were closer together.

## Central delineator

The central delineator tested was a trapezoidal strip 20mm high, 150mm wide with sloping sides and a flat top of 50mm. This is prescribed in the Department for Transport's 'Guidance on the use of tactile paving surfaces' for use to separate the pedestrian and cyclist sides of a segregated shared use cycle path. For the trials this was constructed in wood. Half of the central delineator was painted white to contrast while the other half was grey which blended in with the background paving surface.

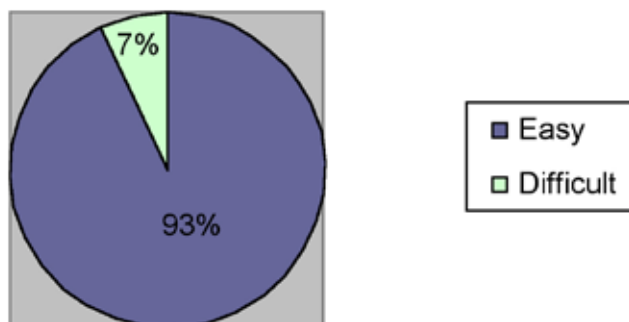
### Blind and partially sighted participant trials

#### Detect

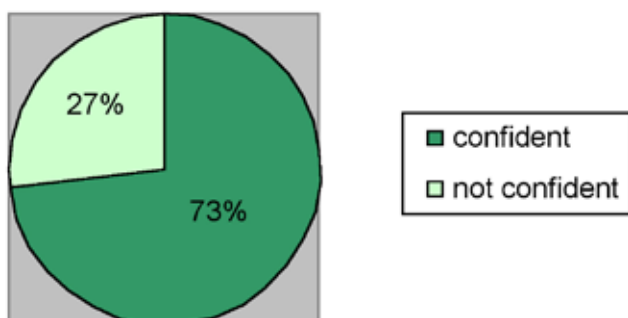
For each delineator, the detect test involved leading each participant to within 2m of the delineator. The participant was then asked "to walk forwards as if leaving a building, intending to find a delineator to inform their decision to turn right/left". This delineator marked the edge of the safe space, replacing the traditional kerb. If they sensed that they had detected a delineator, they were asked to stop and describe what they had encountered.

93% of participants (28 out of 30) found the central delineator either very easy or easy to detect, making it the most popular design feature tested by the blind and partially sighted participants. The two participants who found it difficult were both long cane users.

**Figure 10:** Central delineator profile: Blind and partially sighted participants  
Ease of detection



**Figure 11:** Central delineator profile: Blind and partially sighted participants  
Confidence using to navigate within the space



## Detect and navigate

Participants were asked to detect and navigate the space using the central delineator. That is, to use it as the delineator marking the edge of the space in order to stay within it. In this test, the participant was again led to about 2m from the delineator and then asked to walk forwards. If they encountered the delineator, they were to follow it (left or right) as far as they could, using the delineator to stay in the space, then turn, repeating this for two minutes.

73% (22 out of 30) of respondents reported feeling confident or very confident about following the central delineator and 77% (23) of participants reported feeling safe when using it.

Results from the video and heart rate analysis also suggest that the central delineator was popular with the blind and partially sighted participants. From the video analysis only one of the total number of central delineator trials was failed. The participant who failed managed to detect the design feature but was not able to use it for navigation. This was one of the lowest failure rates out of all the design features. 12 participants also recorded their fastest walking speed when using the central delineator, indicating that they felt most at ease with this edging. In addition, 5 participants had the lowest Total Heart Beat Index when using the central delineator suggesting they were perhaps the least stressed when using this guidance method compared to other delineators.

During the design trials, half the central delineator was painted white which contrasted with the surroundings while the remaining half was painted grey which blended in with the pavement. 47% (14 out of 30) of the participants, those who have some residual vision, picked up on the contrast between the two colours, commenting that the white section was a lot easier to detect and follow than the grey section. Some participants stopped once they had reached the end of the white section not knowing that the grey section was there. This demonstrates that both visual and tactile cues are important for individuals who have some remaining vision.

### Positive comments:

The positive response to this surface is reflected in the comments below:

“As it goes up there is no fear of toppling off the edge and I can walk along it easily.”

[Female blind guide dog owner (had a sighted guide in trials), age 65]

“Fairly easy to follow and detect when it had finished. However a bit uncomfortable to walk with my foot on it.”

[Male partially sighted participant with no mobility aid, age 51]

“I definitely felt the edge – colour contrast was good in the white section.”

[Female partially sighted guide dog owner (used long cane in trials), age 48]

### Negative comments

Participants had very little negative feedback about this feature. Two participants felt that it was too prominent and that they might trip. Three guide dog owners commented that their dogs may not stop at this edging and that they may not therefore feel comfortable using their dog to navigate this delineator. (This could possibly be overcome with dog training.)

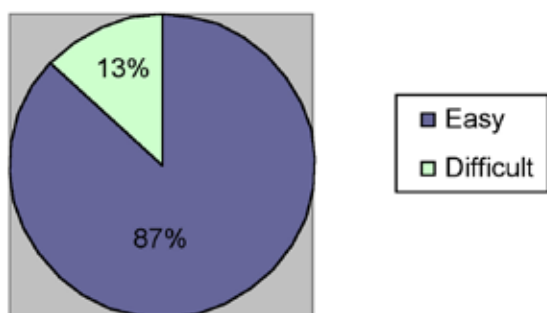
## Possible improvements

The effectiveness of the contrasting white section was evident when participants were asked how to improve the central delineator. 37% (11) participants felt that the whole length of the delineator should be painted white. Other suggested improvements included making the top of the delineator more rounded as some participants felt this would make it less of a trip hazard; and making it wider so that individuals with a longer stride would be more likely to detect it. Some participants felt it should be made more prominent and that it could be used in conjunction with other tactile paving.

## Mobility impaired participant trials

87% (13) of the mobility impaired participants found it easy or very easy to cross the central delineator while 13% (2) found it difficult or very difficult. Of the 2 participants who found it difficult, one was a wheelchair user and one was a participant with walking difficulties using a rolator.

**Figure 12:** Central delineator profile: Mobility impaired participants  
Ease of crossing

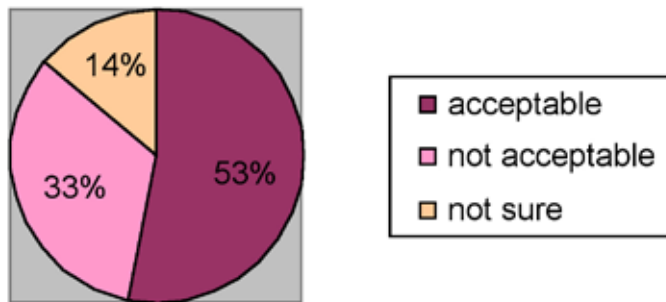


The video analysis also presents positive results for the central delineator, demonstrating that none of the mobility impaired participants failed to cross this design feature. The central delineator produced the slowest Total Heart Beat Index in 20% (3) of participants, suggesting that they found this design feature the least stressful, while 27% (4) recorded their fastest travelling speed while crossing the central delineator. Further indication that this delineator was relatively easier to cross than other delineators can be seen from the fact that this delineator did not produce the highest, or a relatively high, THBI or lowest travelling speed for any of the participants with the exception of one participant. (This participant, who used a rolator, also failed to cross 4 of the 7 delineators: this was not the delineator with which she had the most difficulty.)

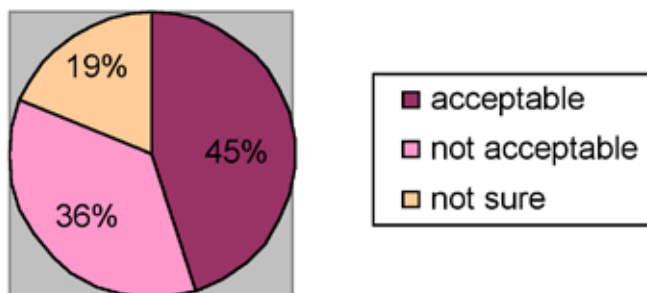
Despite the positive results, when asked whether they would find this delineator acceptable in the pedestrian environment only just over half, 53% (8), of participants reported that they would find this surface acceptable in a pedestrian environment, 33% (5) said they would not find this acceptable and 14% (2) were not sure.

75% of participants with walking difficulties (3) said they would find this delineator acceptable while 25% (1) would not. Of the wheelchair users, 45% (5) said they would find this acceptable, 36% (4) said they would not and 19% (2) of wheelchair users were not sure.

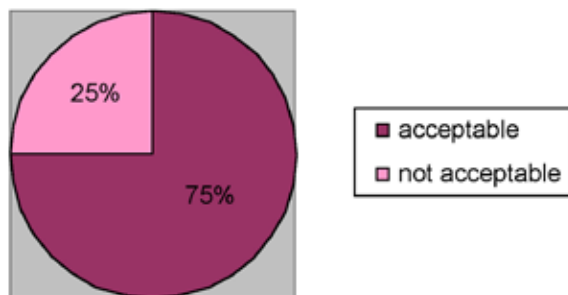
**Figure 13:** Central delineator profile: Mobility impaired participants  
Acceptability in the pedestrian environment



**Figure 14:** Central delineator profile: Mobility impaired participants  
Acceptability in the pedestrian environment for wheelchair users



**Figure 15:** Central delineator profile: Mobility impaired participants  
Acceptability in the pedestrian environment for participants with walking difficulties



### Positive comments

“It was much better than the steps as it was such a gradual slope. Didn’t need to flip back to get over it.”

[Male wheelchair user, aged 72]

“This was the best of all the surfaces as it wasn’t high or steep like the others. Didn’t feel unsteady at all.”

[Female wheelchair user, age 70]

“A bit bumpy. However would prefer this to a step or the kerbs.”

[Female wheelchair user, age 47]

### **Negative comments**

“I kept losing my feet off the footplate because of jolting and it didn’t do my bladder any good either.”

[Male wheelchair user, age 55]

“It felt like a trip hazard, especially without any contrast.”

[Male wheelchair user, age 57]

### **Possible improvements**

Several participants noted that they preferred the section with colour contrast and recommended this.

## 30mm kerb

The 30mm kerb was trialled in three designs:

- Straight edge kerb
- Bullnose kerb
- Chamfered kerb

The straight edge kerb was achieved by raising some platform modules 30mm higher than the adjacent ones. In between trials, the 30mm kerb edge type was changed between straight, bullnose and chamfered.

The bullnose and chamfered edge types were achieved using strips of wood cut with the required cross-sectional profile. These wood strips were painted grey (so as not to contrast) and screwed securely to the concrete pavers.

The order in which participants tested the different kerb edge types varied between participants.

## 30mm straight edge kerb

### Blind and partially sighted participant trials

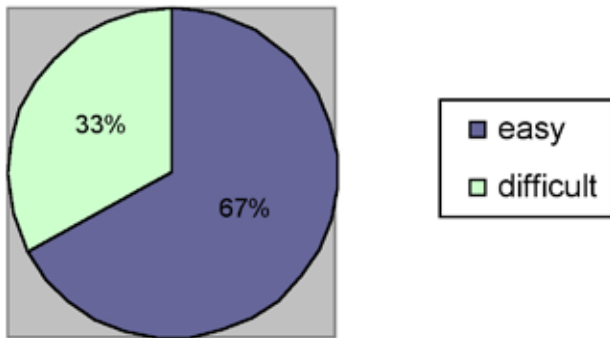
For each delineator, the detect test involved leading each participant to within 2m of the delineator. The participant was then asked “to walk forwards as if leaving a building, intending to find a delineator to inform their decision to turn right/left”. This delineator marked the edge of the safe space, replacing the traditional full kerb. If they sensed that they had detected a delineator, they were asked to stop and describe what they had encountered.

Participants were asked to approach and detect this delineator from both the lower side (as if from the carriageway, climbing up the kerb) and from the upper side (as if from the safe space, going down the kerb).

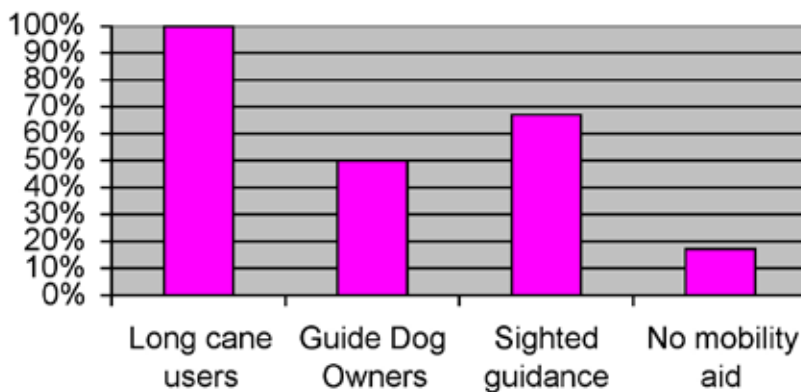
### Detect from the lower side

Participants gave a mixed response when asked how easy or difficult it was to detect the 30mm step from the lower side. 67% (20) of participants found it easy to detect (3 very easy, 17 easy) while 33% (10) had difficulty detecting the edge (8 difficult, 2 very difficult). All long cane users found the edge easy to detect from the lower side. However only one participant with no mobility aid (14%) found this easy to detect; 86% (6) found it difficult. Half of guide dog owners (2) and one third (33%, 2) of those who used sighted guidance also found it difficult to detect.

**Figure 16:** Straight edge kerb: Blind and partially sighted participants  
Ease of detection from lower side



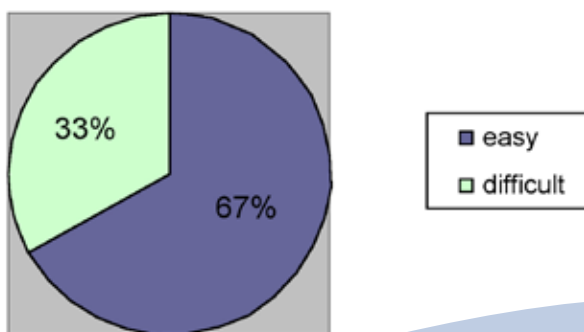
**Figure 17:** Straight edge kerb: Blind and partially sighted participants  
Ease of detection from lower side by mobility aid  
Proportion of participants who found this easy to detect



### Detect from the upper side

As with detecting this delineator from the lower side, the majority (67%, 20) of participants found the 30mm straight edge kerb from the upper side easy to detect. However a third of participants (10) found it difficult or very difficult to detect. Participants who had no mobility aid found the edge the hardest to detect with 57% (4 out of 7) finding it difficult to detect. 31% (4 out of 13) of long cane users also found it difficult to detect as did one guide dog user. Most participants with sighted guidance detected the edge.

**Figure 18:** Straight edge kerb: Blind and partially sighted participants  
Ease of detection from upper side



## Detect and navigate

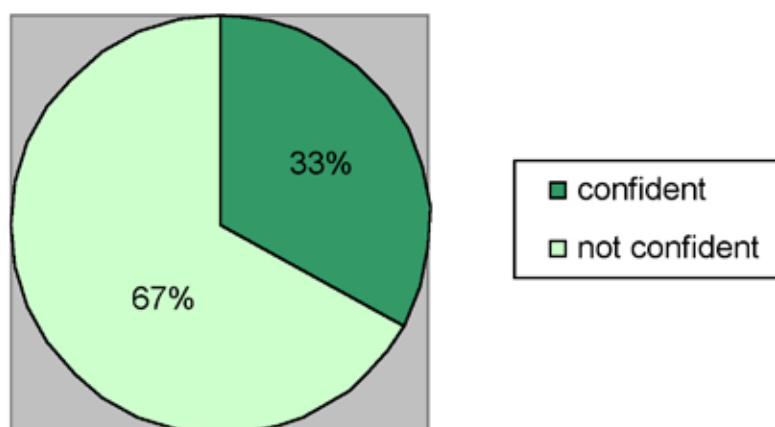
Participants were asked to detect and navigate the space using the straight edge kerb. That is, to use it as the delineator marking the edge of the safe space in order to stay within it. In this test, the participant was again led to about 2m from the delineator and then asked to walk forwards. If they encountered the delineator, they were to follow it (left or right) as far as they could, using the delineator to stay in the space, then turn, repeating this for two minutes.

The kerbs were approached from both the lower and upper surfaces. When approached from the upper side participants were asked to detect the kerb edge and then navigate the space staying on the upper level. When approached from the lower side, as if from the carriageway, participants were asked to climb onto the upper path and move along it staying within the space.

When asked if they had any problems using the edge to stay within the space, the majority of participants (67%, 20) reported that they had problems. 77% (10) participants who used a long cane, 85% (6 out of 7) of those who used no mobility aid and 50% (3) of those who had sighted guidance reported problems. 75% (3) of guide dog owners who used their dogs said they had no problems following the edge; however they were concerned that their dog did not always stop at the edge.

Participants were asked how confident they felt following this edge when they approached the kerb from the lower side, got on to the path and then followed it, and again when they approached the edge from the upper side and then followed it once detected. The results were similar, with the majority of participants not confident about using this edging. 67% (20) of participants were not confident following the path when approached from the upper side and 63% (19) were not confident when they had approached from the lower side and got onto the footway. 60% (18) of participants felt that the edging was unsafe.

**Figure 19:** Straight edge kerb: Blind and partially sighted participants  
Confidence using to navigate within the space when approached from the upper side



Results from the video analysis show that one participant failed to detect the straight edge kerb from the lower side, while two participants were able to detect the edge but were not able to follow it when they had approached from the lower side and then got onto the upper path.

A further two participants were able to detect the 30mm straight edge kerb from the upper side but were not able to use it to navigate. Combining these findings, 12% (5/43)<sup>6</sup> of the straight edge kerb trials undertaken by the blind and partially sighted participants<sup>7</sup> were failed.

The straight edge kerb produced the highest Total Heart Beat Index in 3 participants, suggesting that they found the straight edge kerb the most stressful of all the design features. These 3 participants plus an additional 3 participants (6 in total) had the slowest walking speed when using this edge.

### Positive comments

There were only a few positive comments made. One participant commented:

“It was a very definite edge which the cane and my foot picked up on.”

[Male, partially sighted, long cane user, age 33]

Another participant said:

“Had no problems on the straight although was a bit difficult when changing direction.”

[Male blind guide dog owner (used long cane in trials), age 58]

### Negative comments

The most common problem reported by participants was that they found the change in direction of the path difficult to negotiate. Participants commented that the edge was not distinct enough, with several saying it was dangerous as there was no warning to alert them to it. Other participants felt that the edge lacked contrast.

“I kept falling off, so my steps became tentative and unsure.”

[Female partially sighted guide dog owner (used long cane in trials), age 41]

“Not very easy to detect as a road edge, could just be a piece of broken pavement or something.”

[Male, blind, long cane user, age 53]

<sup>6</sup> The total number of trials undertaken for a delineator includes all attempts to detect, and to detect and follow. For kerb edges this includes approaches from upper and lower levels.

<sup>7</sup> Not including the participants who had sighted guidance because of difficulty estimating the influence of the sighted guide. This was the case in all three 30mm kerb edge delineators.

“It was very stressful, I didn’t like it. I kept going over the edge as it wasn’t high enough.”

[Female, partially sighted long cane user (also hearing aid user), age 65]

“The sudden change of level was a shock.”

[Male, partially sighted, guide dog owner (used long cane in trials), age 91]

“There was no distinction between the path and the road.”

[Female partially sighted guide dog owner (used long cane in trials), age 48]

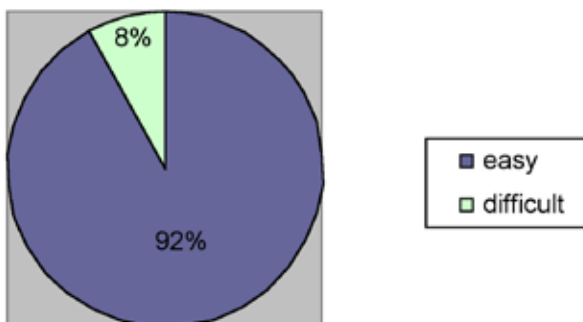
### Possible improvements

Using colour contrast to highlight the step was suggested by 37% (11) participants as an improvement while 27% (8) of participants suggested adding a strip of tactile or texture before the edge to act as a warning. Other participants felt that the step needed to be deeper or that a slope would be a better alternative.

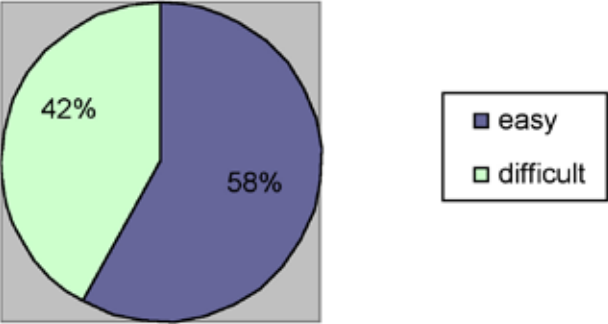
### Mobility impaired participant trials

Only 12 of the 15 mobility impaired participants tested this edging as some participants with walking difficulties did not wish to test all three of the straight, bullnose and chamfered edges and deemed it unnecessary. The down kerb was found to be easy to cross by most participants (92%, 11 out of 12). However only 58% (7) found that climbing the kerb was easy.

**Figure 20:** Straight edge kerb: Mobility impaired participants  
Ease of crossing down kerb



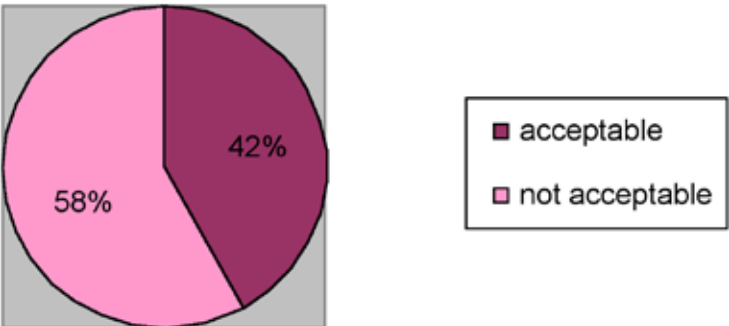
**Figure 21:** Straight edge kerb: Mobility impaired participants  
Ease of crossing up kerb



Analysis of the video data indicates that two participants failed to cross the kerb independently and needed assistance. Two participants demonstrated their slowest travelling speed when using this edging and an additional one participant recorded their highest THBI when attempting to cross this design feature, suggesting these participants had the most difficulty with this compared to other delineators.

Less than half (42%, 5 out of 12) of those who tested the 30mm straight edge kerb felt that this surface would be acceptable in a pedestrian environment.

**Figure 22:** Straight edge kerb: Mobility impaired participants  
Acceptability in the pedestrian environment



**Positive comments**

“It was fine if you could visually see it and you were able to tip backwards with reasonable wheelchair skills.”  
[Female wheelchair user, age 47]

“It was easy, possibly even very easy compared to a normal kerb.”  
[Female wheelchair user, age 33]

“The down kerb is slightly easier than going up but it wasn’t the smoothest of journeys.”  
[Male wheelchair user, age 72]

## **Negative comments**

Most comments were negative. Some commented that they got more of a jolt coming down the 30mm straight edge kerb compared to the bullnose or chamfered kerbs. Two participants found that they had to go up the slope backwards which was time consuming and involved a lot of effort. A wheelchair user found that the jolt when coming down the slope dislodged his feet from the foot plates. Other comments included not being able to go up the kerb without assistance and feeling that the step was a hazard due to its lack of colour contrast.

## **Possible improvements**

Suggested improvements included a sloped kerb or a more rounded edge; a lower kerb; and colour contrast.

# 30mm bullnose edge kerb

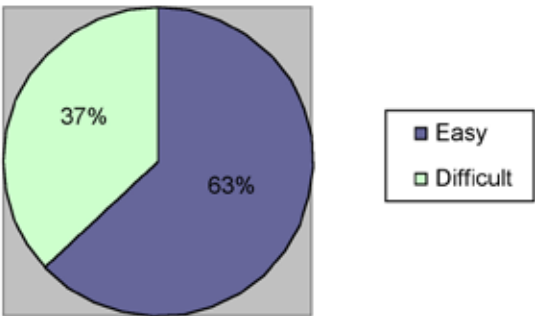
## Blind and partially sighted participant trials

Participants were asked to approach and detect this delineator from both the lower side (as if from the carriageway, going up the kerb) and from the upper side (as if from the safe space, going down the kerb).

### Detect from the lower side

63% (19) of respondents found the bullnose edging easy or very easy to detect from the lower side. However over a third of participants (37%, 11) reported difficulties.

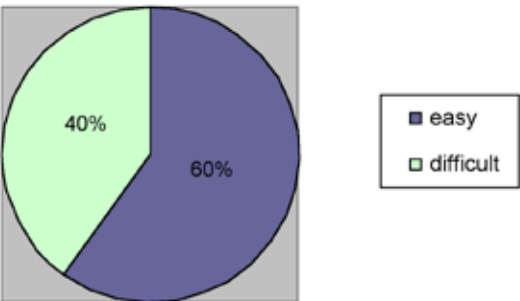
**Figure 23:** Bullnose edge kerb: Blind and partially sighted participants  
Ease of detection from lower side



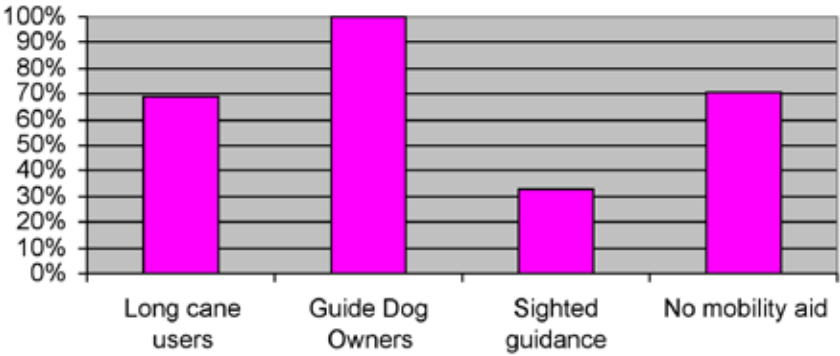
### Detect from the upper side

Again the majority of participants (60%, 18) found it easy to detect the bullnose edge kerb from the upper side but a significant proportion (40%, 12) found it difficult. All 4 guide dog owners felt that detecting the edge was easy while 69% (9 out of 13) of long cane users and 71% (5 out of 7) of participants who used no mobility aid also felt the edge was easy to detect. However, 67% (4 out of 6) of those using sighted guidance found the edge difficult to detect.

**Figure 24:** Bullnose edge kerb: Blind and partially sighted participants  
Ease of detection from upper side



**Figure 25:** Bullnose edge kerb: Blind and partially sighted participants  
Ease of detection from upper side by mobility aid used  
Proportion of participants who found this easy to detect



**Detect and navigate**

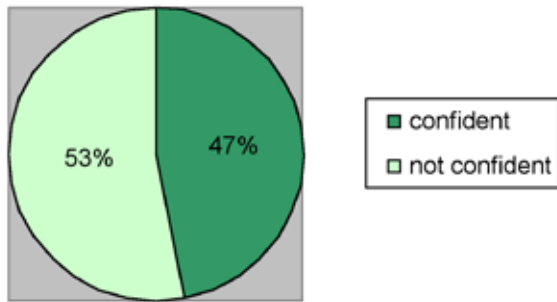
Participants were asked to detect and navigate the space using the bullnose edge kerb. That is, to use it as the delineator marking the edge of the safe space in order to stay within it. In this test, the participant was again led to about 2m from the delineator and then asked to walk forwards. If they encountered the delineator, they were to follow it (left or right) as far as they could, using the delineator to stay in the space, then turn, repeating this for two minutes.

The kerbs were approached from both the lower and upper surfaces. When approached from the upper side participants were asked to detect the kerb edge and then navigate the space staying on the upper level. When approached from the lower side, as if from the carriageway, participants were asked to climb onto the upper path and move along it staying within the space.

The majority of blind and partially sighted participants found the bullnose edge difficult to follow.

Participants were asked how confident they felt following this edge when they had approached the kerb from the lower side, got on to the safe space and then followed it, and again when they approached the edge from the upper side and then followed once they had detected it. The results were similar. Only 50% (15) of the participants felt confident using this edging after they had approached it from the lower side and 47% (14) felt confident when they had approached it from the upper side. Only half of participants felt safe using it.

**Figure 26:** Bullnose edge kerb: Blind and partially sighted participants  
Confidence using to navigate within the space when approached from upper side



Results from the video analysis indicate that one participant failed to detect the bullnose edge kerb from the lower side, while a further 2 participants were able to detect but not follow this edging. One participant failed to detect the bullnose edge kerb from the upper side while a further two participants were able to detect but were not able to follow this edge. Combining these results indicates that 13% (6/47)<sup>8</sup> of the bullnose trials conducted by blind and partially sighted participants were failed.<sup>9</sup> This was the highest failure rate out of all the design features.

The bullnose kerb produced the fastest heart rate in 5 of the 17 (29%) blind and partially sighted participants who wore a heart rate monitor, indicating that they found this design feature the most stressful to use. In addition, the bullnose kerb produced the slowest walking speed in 6 of the 30 (20%) blind and partially sighted participants.

<sup>8</sup> The total number of trials undertaken for a delineator includes all attempts to detect, and to detect and follow. For kerb edges this includes approaches from upper and lower levels.

<sup>9</sup> Not including the participants who had sighted guidance because of difficulty estimating the influence of the sighted guide.

### Positive comments

There were few positive comments. One cane user (who had a rolling tip on his cane) said he could detect the edge with ease, although he thought this may be more difficult for people who use the two-point touch technique.

### Negative comments

The majority of those who were not confident using this edge to follow the path said they felt unsafe because without warning they had stepped right off the edge into the road.

Difficulty in following the kerb edge when it changed direction was also reported by several participants. Two cane users commented that they found it difficult to detect and keep regular contact using the cane.

Other problems reported were lack of depth and contrast and no cues to indicate the approach to the step.

“I found this the most difficult edging. I was tired from all the concentration.”

[Female partially sighted guide dog owner (used a sighted guide in trials), age 41]

“Walking at a normal speed it was very hard to detect the height of the edge. I felt it was unsafe, dangerous and was very easy to step off the edge.”

[Female partially sighted guide dog owner (used sighted guide in trials), age 48]

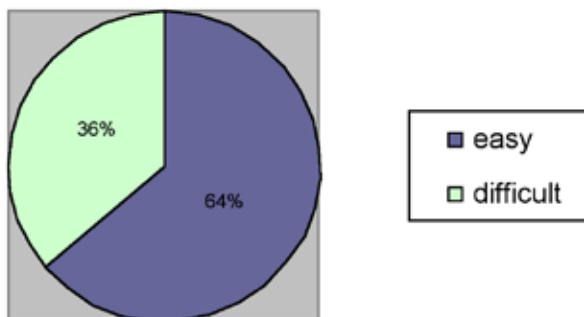
### Possible improvements

When asked what improvements they would make to the edge, 30% (9) of participants said they would add some texture or tactile paving along the edge to give some warning. Adding some colour contrast (23%, 7 participants) and increasing the height (23%, 7 participants) were also popular choices. In addition, 10% (3) of participants said they would prefer a slope to this edging.

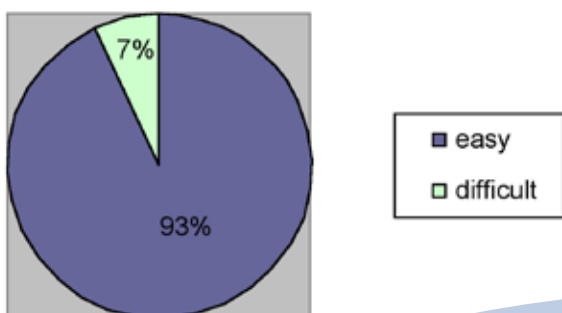
### Mobility impaired participant trials

One participant with a walking difficulty did not test this edge. Of the remaining 14 participants, 64% (9) stated that they found the bullnose up kerb easy or very easy to cross while 36% (5) of participants found the down kerb easy or very easy to cross. This makes the bullnose edging the most popular of the three kerbs (straight, chamfered and bullnose) with mobility impaired participants. The bullnose edging was also found to be the more acceptable of the three edges with 79% (11) of participants saying they would find this acceptable in a pedestrian environment.

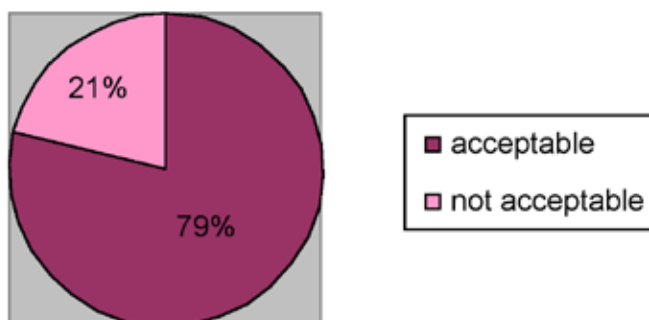
**Figure 27:** Bullnose edge kerb: Mobility impaired participants  
Ease of crossing up kerb



**Figure 28:** Bullnose edge kerb: Mobility impaired participants  
Ease of crossing down kerb



**Figure 29:** Bullnose edge kerb: Mobility impaired participants  
Acceptability in the pedestrian environment



However the video analysis suggests that the bullnose edging incurred the most failures out of the three kerb edges, with 21% (3) participants being unable to cross this design feature. The bullnose edge also produced the highest Total Heart Beat Index of all the design features in two of the participants. Thus, although the majority of participants found this delineator acceptable, some participants nevertheless had significant difficulty negotiating it.

### Positive comments

When asked for comments, some participants felt crossing the bullnose kerb was manageable although it required a lot of effort, which was consistent with the results of the heart rate monitor. Several felt that it was easier than the straight and chamfered edges and the guidance paving.

### Negative comments

There were several negative comments, suggesting that although most participants thought this delineator was acceptable problems were nevertheless identified.

*"It was difficult – needed a lot of strength to pull the chair up and over the edge."*  
[Female wheelchair user, age 49]

*"As I cannot tip I would have to go backwards which is time consuming and annoying."*  
[Male wheelchair user, age 59]

*"It was difficult to start with as my foot landed half on and half off it. If I came across this unexpectedly I could easily trip over it."*  
[Female participant with walking difficulties, age 70]

*"I could not negotiate going up independently and it was too abrupt coming down."*  
[Female wheelchair user, age not provided]

### Possible improvements

Suggested improvements included making the edge a slope rather than a kerb and adding some colour contrast. Others proposed that the edge should be lower.

# 30mm chamfered edge kerb

## Blind and partially sighted participant trials

Participants were asked to approach and detect this delineator from both the lower side (as if from the carriageway, going up the kerb) and from the upper side (as if from the safe space, going down the kerb), as in the other 30mm kerb edges.

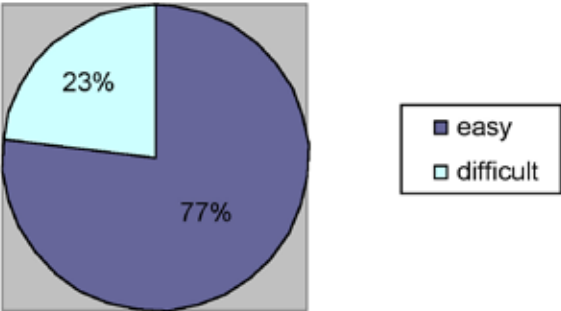
### Detect from the lower side

77 % (23) of participants found it easy or very easy to detect the chamfered edge from the lower side, while just under a quarter (23%, 7) found it difficult.

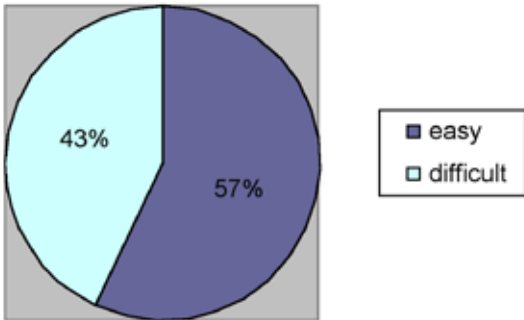
### Detect from the upper side

All three of the 30mm steps prompted similar responses, however blind and partially sighted participants found the chamfered edge from the upper side the hardest to detect with 43% (13) finding it difficult, while 57% (17) found it easy.

**Figure 30:** Chamfered edge crossing: Blind and partially sighted participants  
Ease of detection from lower side



**Figure 31:** Chamfered edge crossing: Blind and partially sighted participants  
Ease of detection from upper side



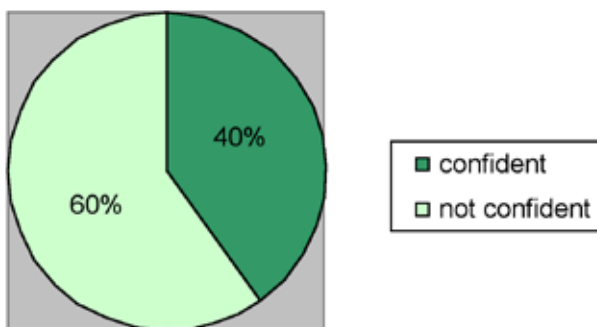
## Detect and navigate

Participants were asked to detect and navigate the space using the chamfered edge kerb. That is, to use it as the delineator marking the edge of the safe space in order to stay within it. In this test, the participant was again led to about 2m from the delineator and then asked to walk forwards. If they encountered the delineator, they were to follow it (left or right) as far as they could, using the delineator to stay in the space, then turn, repeating this for two minutes.

The kerbs were approached from both the lower and upper surfaces. When approached from the upper side participants were asked to detect the kerb edge and then navigate the space staying on the upper level. When approached from the lower side, as if from the carriageway, participants were asked to climb onto the upper path and move along it, staying within the safe space.

Less than half of the participants (40%) (12) felt confident about using this edge to keep to the path, while 47% (14) of participants felt safe using this edging. Participants with no mobility aid were the least confident with 83% (6) of them saying they felt unconfident or very unconfident.

**Figure 32:** Chamfered edge kerb: Blind and partially sighted participants  
Confidence using to navigate within the space



Interpretation of the video data suggests that two participants were able to detect the chamfered edge kerb from the upper side but were not able to follow it due to the corners. In addition video analysis revealed that two participants had difficulty following the edge when they had approached it from the lower side and then got on to the path.

The video data shows that 9% (4/44)<sup>10</sup> of the chamfered edge trials (from both lower and upper side) were failed by the blind and partially sighted participants. In addition, seven participants (23%) demonstrated their slowest walking speed when using the chamfered edge, and the Total Heart Beat Index data indicates that 3 participants were the most stressed when using this design feature.

<sup>10</sup> The total number of trials undertaken for a delineator includes all attempts to detect, and to detect and follow. For kerb edges this includes approaches from upper and lower levels.

## Positive comments

No positive comments were recorded.

## Negative comments

“I didn’t like anything about this edge.”

[Male blind guide dog owner (used long cane in trials), age 41]

“I didn’t detect it on most occasions and when I did I was in the road before I had a chance to stop.”

[Female, partially sighted, long cane user, age 54]

“Very little drop to define the edge of the path and there was no colour contrast.”

[Male, partially sighted participant, no mobility aid, age 51]

“This is something I would avoid. I would have to rely on the dog but the dog did not recognise this.”

[Female, blind, guide dog owner, age 60]

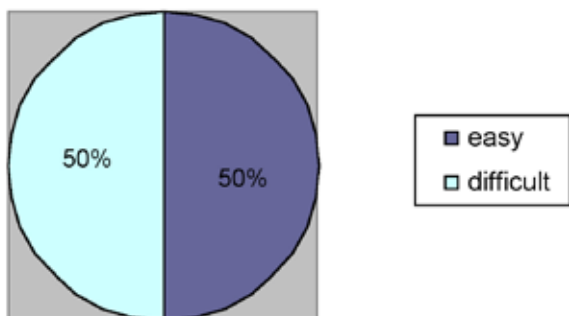
## Possible improvements

Adding a strip of tactile paving before the edge was the most common suggestion as an improvement. 37% (11) made this suggestion. Other suggestions included making the kerb higher, wider and adding some colour contrast.

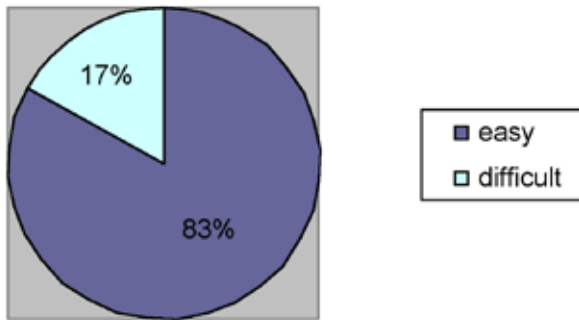
## Mobility impaired participant trials

Out of the 12 mobility impaired participants who tested the chamfered edge, 50% (6) found the up kerb easy to cross while 83% (10) found the down kerb easy to cross. The chamfered edge was found to be the hardest for mobility impaired participants to climb of the three kerb edges tested (bullnose, chamfered and straight) and one of the most difficult of all the delineators tested. In addition, the chamfered edge kerb was found to be one of the least acceptable with only 42% (5) of participants reporting they would find it acceptable in a pedestrian environment.

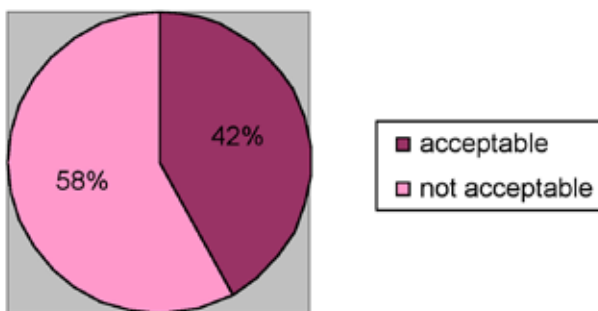
**Figure 33:** Chamfered kerb: Mobility impaired participants  
Ease of crossing up kerb



**Figure 34:** Chamfered kerb: Mobility impaired participants  
Ease of crossing down kerb



**Figure 35:** Chamfered kerb: Mobility impaired participants  
Acceptability in the pedestrian environment



Analysis of the video data suggests that only one participant failed to negotiate this edge independently. Two participants recorded their slowest travelling speed when attempting to cross this design feature, while it produced the highest Total Heart Beat Index in 3 participants.

#### **Positive comments**

There were few positive comments, however one participant did note that:

*"I was surprised as it doesn't look easy but was a lot smoother than I thought."  
[Female wheelchair user, age 33]*

#### **Negative comments**

*"In order to negotiate this edge you have to have some wheelchair skills to tip back in the chair."  
[Female wheelchair user, age 47]*

*"I had to turn around and go backwards up the kerb. In a normal environment this might not be acceptable."  
[Female wheelchair user, age not provided]*

“It was okay to cross but it jars your back.”

[Female participant with walking difficulties, rulator user, age 68]

“I was worried about tipping backwards.”

[Female wheelchair user, age 49]

### **Possible improvements**

When asked what could be done to improve the edge to help them cross it, most participants felt that a slope or more gradual kerb would be an improvement. Several participants thought that the step should be made shallower and one participant mentioned adding some colour contrast to make the edge more visible.

### 30mm kerbs: summary of results for the three kerb edges

The following tables show a summary of the results for the three kerb edges.

Table 1 summarises the results for the blind and partially sighted participants, showing the percentage of participants who:

- found the delineator easy to use;
- were confident using the delineator to navigate and remain within the safe space;
- felt safe using the delineator to navigate and remain within the space.

Table 2 summarises the results of the mobility impaired participants, showing for each kerb edge the percentage of participants who:

- found the delineator easy to climb and cross down;
- failed to cross the delineator unaided.
- found the delineator to be acceptable to use in a pedestrian environment;

**Table 1: 30mm kerbs: Blind and partially sighted participants**

Kerb edge	% who found the delineator easy to detect	% who felt confident using the delineator	% who felt safe using the delineator
Straight edge kerb upper side	67	37	40
Straight edge kerb lower side	67	33	40
Bullnose kerb upper side	60	47	53
Bullnose kerb lower side	63	50	50
Chamfered kerb upper side	57	40	47
Chamfered kerb lower side	77	40	57

Note: When kerbs were approached from the lower side, as from the carriageway, participants were asked to detect the kerb and then step up and walk on the upper level path, using the kerb edge to keep on the path as they would when approaching from the upper side (footway).

**Table 2: 30mm kerbs: Mobility impaired participants**

<b>Design features tested</b>	<b>% who found delineator easy to cross</b>	<b>% who failed to cross delineator</b>	<b>% who found delineator acceptable</b>
Straight kerb down	92	17	42
Straight kerb up	58		
Bullnose kerb down	93	21	79
Bullnose kerb up	64		
Chamfered kerb down	83	7	42
Chamfered kerb up	50		

None of the 30mm kerb edges were rated more than 50% in terms of confidence for blind and partially sighted participants using the edge to navigate the space. The bullnose kerb fared better than the other kerb edges with mobility impaired participants in terms of acceptability in the pedestrian environment, with 79% (11 out of 14) saying it would be acceptable compared to 42% (5 out of 12) for the straight edge and chamfered kerb. However, while 64% (9 out of 14) of mobility impaired participants said they found the bullnose kerb easy to climb, 21% (3) of participants failed to climb this kerb and over a third found it difficult.

## Slopes

Two slopes were trialled. Each was a slope over 200mm at two different gradients:

- 30mm vertical height difference with 1:7 (15%) gradient
- 50mm vertical height difference with 1:4 (25%) gradient

Due to space constraints on the platform it was only possible to lay a short section of each slope. The 200mm slopes were thus only used in detect tests and not for detect and navigate.

### 30mm by 200mm slope

#### Blind and partially sighted participant trials

A slope rising to a vertical height of 30mm over 200mm with a gradient of 1:7 (15%).

For each slope, the detect test involved leading each participant to within 2m of the slope. The participant was then asked “to walk forwards as if leaving a building, intending to find a delineator to mark the edge of the safe space path”. If they sensed that they had detected a delineator, they were asked to stop and describe what they had encountered.

Participants were asked to approach and detect the slopes from both the lower side (as if from the carriageway – going up the slope) and from the upper side (as if from the safe space – going down the slope).

#### Detection of 30mm slope up

13% (4) of the blind and partially sighted participants did not detect the 30mm slope up, as they walked up it, or overstepped it without realising.

77% (23) of participants found it easy to detect the slope up (7 very easy, 16 easy) while 23% (7) of participants found it difficult. The particular mobility aid or lack of mobility aid did not seem to affect detection of this slope.

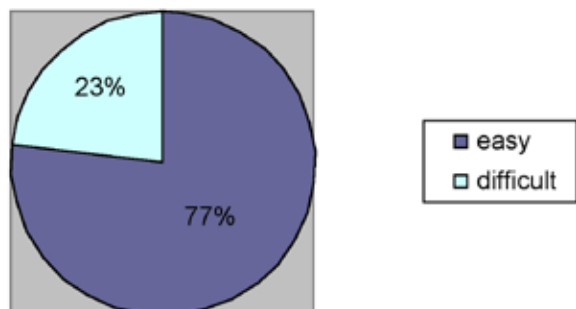
#### Detection of slope down

17% (5) of the participants did not detect the 30mm slope down on at least one occasion, either walking down it, or overstepping it without realising.

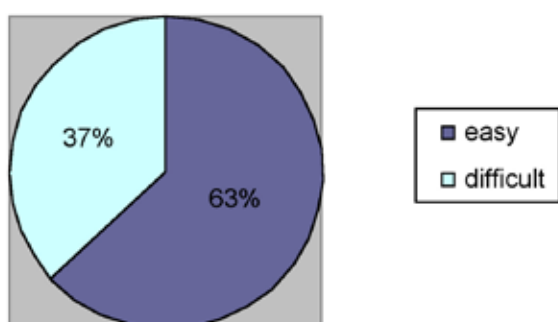
63% (19) of participants felt that the slope down was easy or very easy to detect. However over a third (37% – 11 participants including the 5 who did not detect the slope) found the slope difficult or very difficult to detect.

Participants who did not use a mobility aid during the trials found the slope hardest to detect with 71% (5 of 7) of them finding it difficult. 37% (5 of 13) of long cane users also had difficulty detecting the slope.

**Figure 36:** 30mm slope: Blind and partially sighted participants  
Ease of detection slope up from carriageway



**Figure 37:** 30mm slope: Blind and partially sighted participants  
Ease of detection slope down from footway



### Positive comments

Those who felt the slope down was easy to detect commented that:

“I wasn’t anticipating the down slope but I still found it easily.”

[Female partially sighted guide dog owner (used a long cane in trials), age 30]

“You don’t catch your feet and there is enough of a gap before you would get to the traffic.”

[Female, blind, long cane user, age 65]

The comments made by participants about the slope up also tended to be positive as shown below:

“It was easy on the foot. I knew straight away what it was, no chance of tripping.”

[Male, partially sighted participant, no mobility aid, age 41]

“It was a good edging, easy and definite.”

[Male partially sighted guide dog owner (used a long cane for trials), age 43]

## Negative comments

The main comment given by those who felt the slope was hard to detect was that the slope was too shallow and that it needed to be more prominent.

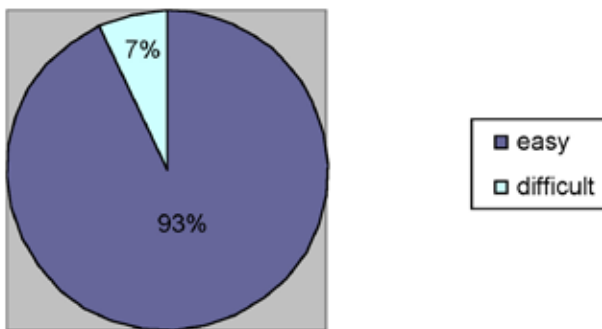
## Possible improvements

Participants felt that to improve the slope some tactile paving or other textured surface should be added at the top of the slope as a warning to the individual that the slope is there. Participants also felt that the slope should have colour contrast. Some participants asked for a steeper gradient, while some felt increasing the depth of the slope would help.

## Mobility impaired participant trials

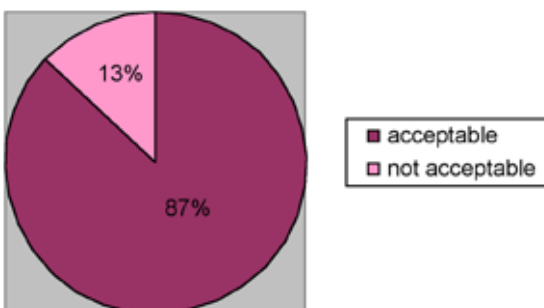
This was the most popular delineator with mobility impaired participants. 93% (14) of participants found the 30mm up slope easy or very easy to cross and 100% (15) found the down slope easy or very easy to cross.

**Figure 38:** 30mm slope: Mobility impaired participants  
Ease of crossing up slope



When asked if they would find this delineator acceptable in the pedestrian environment, 87% (13) of respondents said they would. No participants reported any problems with this delineator.

**Figure 39:** Mobility impaired participants – 30mm slope  
Acceptability in the pedestrian environment



Results from the video analysis also indicate that the 30mm slope was popular with mobility impaired participants as not one participant failed to cross the 30mm slope. Furthermore, the 30mm slope produced the slowest Total Heart Beat Index out of all the design features in 40% (6/15) of the participants, indicating that they were the least stressed when crossing this delineator. Two thirds (67%, 10) of the mobility impaired participants also recorded their fastest travelling speed when using this delineator, suggesting that these participants found this delineator the easiest to cross.

### **Positive comments**

“It was a nice gradual incline – didn’t need to flip the chair to get up it.”

[Male wheelchair user, age 72]

“It was very smooth – just rolled off it, didn’t jar me at all.”

[Female participant with walking difficulties using a rolator, age 68]

“I prefer this 30mm slope as the gradient was less steep and less of a jolt than the 50mm slope.”

[Female wheelchair user, age 38]

### **Negative comments**

No negative comments were recorded.

### **Possible improvements**

Although the majority of participants felt the slope was acceptable as it was, 33% (5) of participants felt that adding some colour contrast would further improve the delineator, while one individual suggested making the slope wider.

## 50mm by 200mm slope

### Blind and partially sighted participant trials

A slope rising to a vertical height of 50mm over 200mm with a gradient of 1:4 (25%).

For each slope, the detect test involved leading each participant to within 2m of the delineator. The participant was then asked “to walk forwards as if leaving a building, intending to find a delineator to mark the edge of the safe space”. If they sensed that they had detected a delineator, they were asked to stop and describe what they had encountered.

Participants were asked to approach and detect the slopes from both the lower side (as if from the carriageway – going up the slope) and from the upper side (as if from the footway – going down the slope).

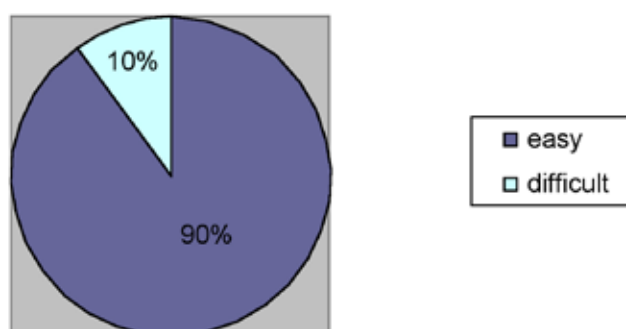
#### Detection of slope up

With one exception, all participants were able to detect the 50mm slope up. This was confirmed by the results from the video analysis. 90% (27) of participants found the slope easy or very easy to detect while 10% (3) found it difficult or very difficult to detect. Two of those who found it difficult used no mobility aid, while the third participant had sighted guidance (a guide dog owner unable to use their guide dog in the trials).

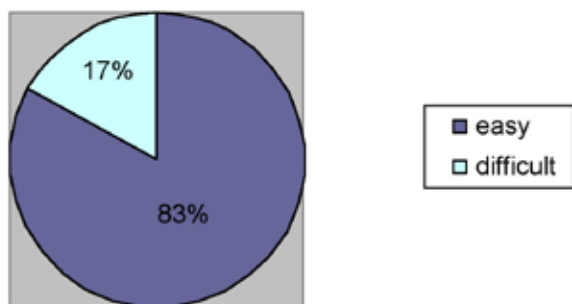
#### Detection of slope down

As with the 50mm slope up, the majority of blind and partially sighted participants (83%, 25) found the slope down easy (43%, 13) or very easy (40%, 12) to detect. However, 3 participants (10%) failed to detect the slope down on at least one occasion, and a further 7% (2) found it difficult or very difficult to detect. Those who failed to detect or found it difficult to detect the slope were mainly those who had no mobility aid, although one guide dog owner who used their dog in the trials also found it difficult.

**Figure 40:** 50mm slope up: Blind and partially sighted participants  
Ease of detection



**Figure 41:** 50mm slope down: Blind and partially sighted participants  
Ease of detection



### Positive comments

Those participants who found the slope easy to detect commented that:

“It was a good slope up – more of a slope than a dropped kerb which is good.”  
[Male, partially sighted, long cane user, age 53]

“It was easy to detect and understand what it is.”  
[Male, partially sighted participant, no mobility aid, age 51]

### Negative comments

There were a number of negative comments about the slope. Three participants commented that the slope down was too steep and another two participants felt that it was dangerous. Other participants felt that more of a lead up was needed (space on the platform was restricted at this point) and one participant felt that the slope down would not be easily detected at a normal walking pace.

“It was very easy to miss – you can tell you have stepped up but didn’t realise that was the edge.”  
[Female, partially sighted guide dog owner (used a long cane for trials), age 48]

“If walking at a faster pace I would possibly miss it.”  
[Male, partially sighted participant, no mobility aid, age 51]

One participant commented:

“It was extremely easy although I could have fallen over as the gradient was quite high.”  
[Female blind guide dog owner (used long cane in trials), age 50]

**Possible improvements**

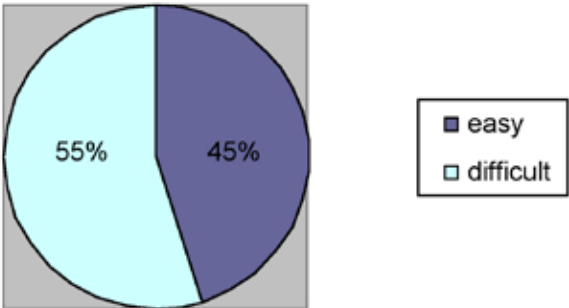
When participants were asked to suggest any improvements that could be made to the slope, the most popular suggestions included adding some colour contrast (33%, 10) and using a strip of tactile paving (13%, 4) in front of the slope as a warning. Two participants also suggested making the slope broader with increased depth from front to back of slope so that even those with a long stride would still detect the edge. 20% (6) of participants felt the up slope was fine as it was, and 27% (8) felt the down slope did not need any improvement.

**Mobility impaired participant trials**

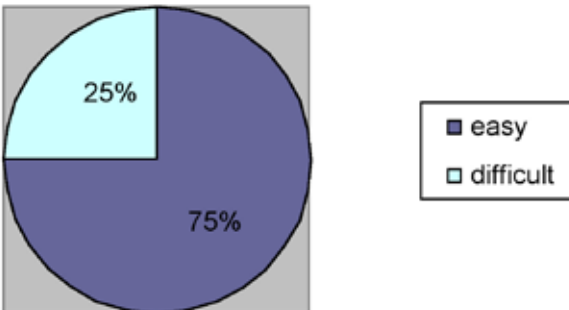
In contrast with the blind and partially sighted participants, the 50mm slope up was one of the least popular delineators with mobility impaired participants with only 53% (8) finding it easy or very easy to cross, while just under half of participants found it difficult. 55% (6) of the wheelchair users found it difficult to cross this up slope compared with 25% (1) of the participants with a walking difficulty.

On the other hand, the questionnaire responses indicate that the 50mm slope down was one of the most popular delineators, with 87% (13) of mobility impaired participants finding it easy or very easy to cross. All 11 wheelchair users found this slope down easy or very easy to cross while 50% (2) of the participants with walking difficulties also found it easy.

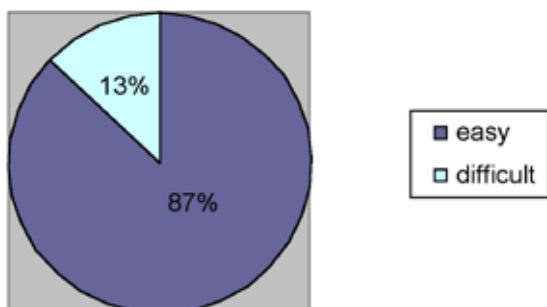
**Figure 42:** 50mm slope up: Mobility impaired participants  
Ease of crossing wheelchair users



**Figure 43:** 50mm slope up: Mobility impaired participants  
Ease of crossing participants with walking difficulties

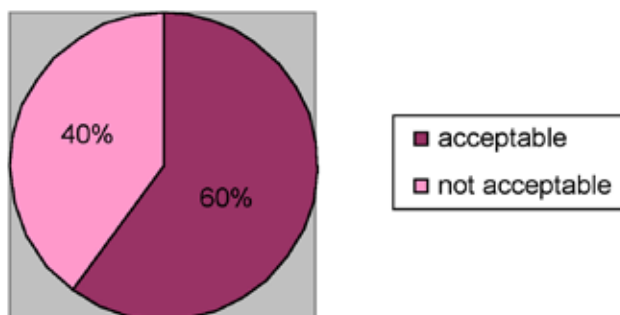


**Figure 44:** 50mm slope down: Mobility impaired participants  
Ease of crossing



60% (9) of participants felt that they would find this delineator acceptable in a pedestrian environment while 40% (6) said they would find it unacceptable.

**Figure 45:** 50mm slope: Mobility impaired participants  
Acceptability in the pedestrian environment



Analysis of the video data revealed that 27% (4/15) of the mobility impaired participants failed to climb the 50mm slope. This was the highest failure rate out of all the delineators for the mobility impaired participants. In addition, two participants had their slowest travelling speed when using this delineator and one participant recorded his highest Total Heart Beat Index for this feature.

### Positive comments

There were no recorded positive comments.

### Negative comments

Those who found this slope difficult to cross or unacceptable in a pedestrian environment said this was because the slope was too steep and was, in their view, dangerous.

“I managed to get the front wheels up the slope but needed assistance to lever the back wheels over it.”

[Female wheelchair user, age 40]

“This slope caught my heel so I totally lost my balance. I had to put extra pressure on the walking stick which then put extra pressure on my thumb.”  
[Female participant with walking difficulties, age 70]

“Almost tipped over when going forwards – had to go backwards as way too steep.”  
[Male wheelchair user, age 55]

“The footplates got caught on the up slope.”  
[Male wheelchair user, age 57]

### **Possible improvements**

Participants felt that the slope should have better colour contrast to alert them to its presence, while others suggested that it should be shallower and broader.

# Design trials: Issues for consideration

## Corners

For some of the delineators, the ability of blind and partially sighted participants to negotiate corners was tested. This was not possible for the guidance paving or central delineator as these were laid in a straight line due to space constraints on the platform.

The 30mm kerbs, straight edge, bullnose and chamfered, were laid with corners (see Figure 2). This was to assess the effect of corners and junctions when participants are following a delineator.

The corner, where the kerb edge delineator passed in front of the participant, would be encountered at a junction where the pedestrian would either turn to follow the path around the corner or cross the carriageway.

In these trials, when encountering a corner (where the delineator passed in front of the participant), most participants detected the change, but took a moment to determine whether they needed to turn left or right. Often, these participants overshot the delineator before realising that it was there and retraced their steps to get back onto the path.

When the delineator had a corner turning outwards and away from the participant (effectively widening the path), several participants did not detect this and continued to walk in an approximately straight line. They remained on the safe space side of the delineator but did not follow the delineator or remain in contact with it.

## Overshoot

Several instances of participants overshooting the delineator were observed. Blind and partially sighted participants frequently stepped over the 30mm kerb by a couple of steps (about 1m) before realising where they were and backtracking. Some participants walked with one or both feet on the guidance paving in order to follow it. This included participants with a long cane who were observed to be walking on the guidance path and thus the cane arc from left to right overshot the delineator. Therefore the 'safe space' would need to include the width of the delineator, plus a space to accommodate the person and their mobility aid to both sides of the delineator.

This raises the question of whether specific delineators could be used as a route guidance path, within the footway or 'safe space'; or at its edge as a differentiator between where there may be vehicles and where there should not be any vehicles travelling. If used as a route guidance path within the 'safe space', there would need to be some other indicator to inform blind and partially sighted people of the edge of the 'safe space' and sufficient space for them to be able to walk on either side of the delineator. If used as a differentiator, overshooting the delineator would be a problem for blind and partially sighted people.

For delineators which have the same level on either side (guidance paving and central delineator), an issue raised was that it could be difficult for the person to know which side to walk on or keep to, depending on the approach to these delineators.

## **Use of guide dogs in PAMELA trials**

During the first few trials it became apparent that there was difficulty working guide dogs on the platform. The size and layout of the platform confused the dogs. Therefore, it was decided not to use the guide dogs after these first few trials and participants were asked to use an alternative guidance method.

Guide dogs have been used effectively in other trials conducted by University College London at the PAMELA facility. Initial consideration of the possible reasons why guide dogs worked well in some trials but not in this set of trials suggests that the number and arrangement of the various delineators tested may have resulted in a platform that was too congested and confusing. To overcome this would require fewer delineators to be tested on the PAMELA platform at any one time.

# Comparison of results of blind and partially sighted participants and mobility impaired participants

## Guidance paving

As shown in Table 3, guidance paving was found to be relatively easy to detect and use for navigation by blind and partially sighted participants, with 80% (24 of 30) finding it easy to detect and 70% (21) reporting feeling confident using this to navigate the space. However, 30% of participants (9) did not feel confident using this surface to navigate the space.

In contrast, the guidance paving was found to be the most difficult to cross by mobility impaired participants. While none of the mobility impaired participants failed to cross the guidance paving, 40% (6 of 15) found this difficult to cross. Just over half (8 of 15) said they would find this acceptable in the pedestrian environment, with a further 20% (3 of 15) not sure. Over half – 53% (8 of 15) of the mobility impaired participants had their slowest travelling speed when using this design feature, suggesting that it did cause them some difficulty. In addition, the guidance paving produced the highest Total Heart Beat Index in 33% (5 of 15) of the participants, again suggesting difficulty. As mentioned in previous sections, this may partly be due to the layout of this delineator on the platform (see ‘Design trial results: guidance paving’).

The location of the guidance paving is also an issue. Its original purpose (as detailed in the Department for Transport guidance) is to ‘guide’ blind and partially sighted people along a route either by walking on the tactile surface or by maintaining regular contact with it through a long cane. During these trials participants were observed to walk with one or both feet on the surface. There is a risk that if contact is lost with the guidance path a person could inadvertently enter a shared area. Given that risk, while guidance paving may be suitable as a surface to follow within a footway or pedestrian area, it would not be suitable to delineate the edge between the ‘safe space’ and the area for vehicles.

At the same time, given the experiences of mobility impaired people, if the surface is laid within the footway area there would need to be sufficient clear space for wheelchair users and people with walking difficulties to move along parallel to it and to reduce the number of crossing movements they would need to make. Another form of delineator would then be required for blind and partially sighted people at the edge of the footway.

## Central delineator

The central delineator was found to be the easiest delineator to detect by blind and partially sighted participants, with 95% (28 of 30) finding this easy to detect. Almost three quarters (22 of 30) were confident using it to navigate the ‘safe space’ path and a similar proportion (23 of 30) also felt safe while using this delineator. However this leaves over a quarter of participants (8 of 30) who were not confident using this to navigate the safe space.

The central delineator was also found to be relatively easy for the mobility impaired participants, as none failed to cross and 87% (13 of 15) reported that they found it easy to cross. The results from the Total Heart Beat Index and travelling speed data were also positive in comparison with other delineators. However despite the positive results only 53% (8 of 15) of mobility impaired participants said that they would find the central delineator acceptable in the pedestrian environment, with just under half saying it would not be acceptable.

## 30mm kerbs

The 30mm kerb was tested with bullnose, chamfered and straight kerb edges. All three kerbs recorded fails with both the blind and partially sighted participants and the mobility impaired participants. Less than half of blind and partially sighted people were confident using the bullnose edge kerb to follow the path, and the figures for the straight and chamfered kerb edges were lower than this, 33% (10 of 30) and 40% (12 of 30) respectively when approached from the upper side.

The bullnose edge was the most popular of the three kerbs with mobility impaired participants, 79% (11 of 14) of whom found it to be acceptable in the pedestrian environment. However the bullnose kerb was difficult to climb for 36% (5 of 14) and it also recorded the highest number of fails where mobility impaired participants had been unable to cross it independently (21%, 3 participants). Half of the mobility impaired participants (6 of 12) found the chamfered edge kerb difficult to climb; 42% (5 of 12) the straight edge kerb.

## Slopes

The 50mm by 200mm slope with a 1:4 gradient was found to be relatively easy to detect by blind and partially sighted participants, with 83% (25 of 30) finding it easy to detect the slope up when approached from the lower side (carriageway) and 90% (27 of 30) to detect the slope down from the upper level path. Confidence using the slope to navigate was not assessed. In contrast, this slope was found to be one of the most difficult design features for the mobility impaired participants. The 50mm slope was considered to be dangerous by many of the wheelchair users. 27% (4 of 15) mobility impaired participants were unable to climb this slope independently; 47% (7 of 15) found it difficult to climb.

The 30mm by 200mm slope with a 1:7 gradient fared better than the 50mm slope with mobility impaired participants, with 93% (14 of 15) finding this slope easy to climb. In contrast it did not fare as well as the 50mm slope with blind and partially sighted participants. Over a third of blind and partially sighted participants failed to detect the 30mm slope down and almost a quarter failed to detect the slope up. Again confidence using it to navigate within the space was not assessed.

**Table 3: Summary of results for blind and partially sighted participants using the delineator to navigate within the ‘safe space’**

<b>Delineator tested</b>	<b>% who found the delineator easy to detect</b>	<b>% who felt confident using the delineator to navigate within the safe space</b>	<b>% who felt safe using the delineator to navigate within the safe space</b>
Guidance paving	80	70	73
Central delineator	93	73	77
Straight edge kerb upper side	67	33	40
Straight edge kerb lower* side	67	37	40
Bullnose kerb upper side	63	50	50
Bullnose kerb lower side*	60	47	53
Chamfered kerb upper side	77	40	57
Chamfered kerb lower side*	57	40	47
30mm slope down	63	N/A	N/A
30mm slope up	77	N/A	N/A
50mm slope down	83	N/A	N/A
50mm slope up	90	N/A	N/A

Note: The 30mm and 50mm slopes were tested for detect only, not detect and navigate.

\* When kerbs were approached from the lower side, as from the carriageway, participants were asked to detect the kerb and then step up and walk on the upper level path, using the kerb edge to keep on the path as they would when approaching from the upper side (footway).

**Table 4: Summary of results for mobility impaired participants**

<b>Design features tested</b>	<b>% who found delineator easy to cross</b>	<b>% who failed to cross delineator</b>	<b>% who found delineator acceptable</b>
Guidance paving	60	0	53
Central delineator	87	0	53
Straight kerb down	92	17	42
Straight kerb up	58		
Bullnose kerb down	93	21	79
Bullnose kerb up	64		
Chamfered kerb down	83	7	42
Chamfered kerb up	50		
30mm slope down	100	0	87
30mm slope up	93		
50mm slope down	87	27	60
50mm slope up	53		

# Further research

On the basis of these trials, two of the delineators tested warrant further research: the central delineator and the slopes.

## Central delineator

The central delineator was the most popular design feature, faring relatively well in trials with both the blind and partially sighted and mobility impaired participants. However, over a quarter of blind and partially sighted participants (8 of 30) were not confident using this to follow the path. While 87% (13 of 15) of the mobility impaired participants found the central delineator easy to cross, and none of the mobility impaired participants failed to cross it unaided, only just over half said that they would find it acceptable in the pedestrian environment with a further 20% (3 of 15) not sure. Further research is recommended on this delineator to establish whether the problems identified could be overcome.

The main improvement recommended by both blind and partially sighted and mobility impaired participants was colour contrast. In the trials, half of the central delineator was painted white to contrast against the grey background paving while half was grey. There were strong recommendations to ensure all of the delineator contrasted. Other suggested improvements included making the top of the delineator more rounded and making it wider.

The technical issues regarding laying the central delineator in materials more suited to a street environment would need to be addressed alongside those relating to installation on bends and corners. The effect of these layouts on the ability of blind and partially sighted participants to follow a path thus delineated, and any effect on the ability of mobility impaired participants to cross the delineator, would need to be tested.

If this central delineator was modified to make it more effective for blind and partially sighted participants to follow while still ensuring high ease of crossing for mobility impaired participants, and this was supported by subsequent research, it may be possible to use this delineator in a shared space street. Level crossing points may still be needed at regular intervals to serve those wheelchair users and people with walking difficulties who find the delineator difficult to cross. These flush crossing points would require the appropriate blister tactile paving as used on a dropped kerb in a street with traditional kerbs.

### Issues for research: central delineator

- Cross-sectional shape of the delineator including increasing the width and making the profile rounder.
- Use of the delineator at bends and corners and the effect of these on their use by both blind and partially sighted and mobility impaired people.
- Colour contrast under different lighting arrangements.
- Performance under wet and dry weather conditions.
- The effect of additional cognitive loading.
- The installation of the delineator in materials suited to a street environment.

## Slopes

The slopes also warrant further research. The slopes were only tested for detection by blind and partially sighted participants, their effectiveness as a delineator to navigate and keep to a safe space was not tested.

While the blind and partially sighted participants preferred the 50mm by 200mm slope (with a gradient of 1:4), the mobility impaired participants preferred the 30mm by 200mm slope (with a gradient of 1:7). Both slopes were tested over 200mm.

Consequently, if either one of these slopes was to be suitable for implementation within a shared surface area, it seems that some sort of compromise between the two may be needed. This should be tested. As suggested by many participants, a broader slope may be the key. For instance, introducing a broader 50mm slope may make it less hazardous for wheelchair users, but still detectable for blind or partially sighted individuals. Similarly, if a broader 30mm slope was implemented, it may make it more detectable for blind and partially sighted people while remaining easy to cross for mobility impaired users. The use of colour contrast was also recommended by participants.

### Issues for research: slopes

- The effectiveness of the slope to enable blind and partially sighted people to follow a path.
- The optimum height, depth and gradient of a slope to enable it to be easily detected and effectively followed by blind and partially sighted participants are easy to cross for wheelchair users and people with walking difficulties. For instance:
  - a slope of 50mm vertical height over 300mm depth with a gradient of 1:6;
  - a slope of 30mm vertical height over 300mm depth with a gradient of 1:10;
  - a slope of 50mm vertical height over 400mm depth with a gradient of 1:8.
- Use of the slope at bends and corners and the effect of these on their use by both blind and partially sighted and mobility impaired people.
- Colour contrast under different lighting arrangements.
- Performance under wet and dry weather conditions.
- The effect of additional cognitive loading.

## Participants

All participants said they were willing to be contacted regarding taking part in further design trials.

## **Additional issues for research**

### **Guide dogs**

The problems identified with working guide dogs on the PAMELA platform would need to be investigated before future trials are undertaken. It has been suggested that fewer and a simpler arrangement of designs for testing may make it easier for guide dogs to be used. This should be established through pilot stage trials before finalising arrangements for future trials.

### **Lighting and weather conditions**

The trials were carried out in an internal controlled environment. The initial research aimed simply to identify the effectiveness of the delineators in this controlled environment and add on additional factors in further research. The effects of weather and adverse lighting conditions would need to be considered in future trials.

### **Cognitive loading**

In the trials undertaken, participants were able to concentrate on the task of identifying and following the delineators, or crossing them. Cognitive loading, i.e. the effects of other street activities or other tasks to focus on, should be considered in further research.

### **Other disability groups**

These design trials involved only some of the groups of disabled people who may be affected by shared space streets. This was in order to keep the number of trials to a manageable level in this initial stage. Issues relating to other groups, such as people with learning disabilities, would need to be considered in future research.

If through research it could be demonstrated that one or more delineators was effective for both blind and partially sighted participants and participants with mobility impairments, this would provide a basis for follow up research to ensure that they could also be used by other disabled people, and indeed generally by pedestrians.

### **Validation with the external environment**

The PAMELA facility provides a safe and comfortable environment in which to test designs with vulnerable pedestrians. Results will need to be verified through real world trials in the external environment.

# Conclusion

The design trials tested a range of delineators that were proposed for use to demarcate a pedestrian path in a shared space street. The delineators were tested by both blind and partially sighted participants and mobility impaired participants, to determine which of the proposed delineators could be detected and used to demarcate the edge of the footway by blind and partially sighted people, whilst not creating an obstacle for wheelchair users and people with walking difficulties.

The central delineator fared relatively well in trials with both the blind and partially sighted and mobility impaired participants in comparison to the other delineators tested. However, over a quarter of blind and partially sighted participants were not confident using this to follow the path. While 87% (13 of 15) of the mobility impaired participants found the central delineator easy to cross, and none of the mobility impaired participants failed to cross this unaided, only just over half (8 of 15) of the group said that they would find this acceptable in the pedestrian environment with a further 20% (3 of 15) not sure. Further research is recommended on this delineator to establish whether the problems identified could be overcome.

The slopes also warrant further research. Two slopes were tested: a slope of 30mm height over 200mm and a slope of 50mm height over 200mm. While the blind and partially sighted participants found the 50mm slope (with a gradient of 1:4) easier to detect, the mobility impaired participants preferred the 30mm slope (with a gradient of 1:7). Further research has been identified as necessary in order to consider whether a compromise between the two slopes could be achieved, and to test how effective the slopes are to enable blind and partially sighted participants to navigate the space.

The guidance paving was the second choice for blind and partially sighted participants (after the central delineator) although 30% (9 of 30) of blind and partially sighted participants did not feel confident using this to follow the path. This was one of the most difficult delineators for mobility impaired participants, with 40% (12 of 15) finding this difficult to cross

The guidance paving, as specified in 'Guidance on the use of tactile paving surfaces', is intended to provide guidance in areas such as pedestrian precincts. In these locations it is normally possible for wheelchair users and people with walking difficulties to avoid having to cross this surface to any great extent. If this was used to demarcate the edge of the footway it would be more difficult to avoid crossing it.

The guidance paving surface was designed so that blind and partially sighted people could be 'guided' along the route, either by walking on the tactile surface or by maintaining contact with it through a long cane. During the trials participants were observed to walk with one or both feet on the paving. The risk of inadvertently entering the shared area when contact with the guidance paving is lost means that while guidance paving may be suitable as a surface to follow within a footway or pedestrian area, it would not be suitable for use at the edge of the 'safe space'. If it is laid within the footway area as a guidance path there would need to be sufficient clear space for wheelchair users and people with walking difficulties to move along parallel to it, and an additional delineator would be required to mark the edge of the 'safe space' for blind and partially sighted people.

30mm kerbs were tested with three edges: straight, bullnose and chamfered. Less than half of blind and partially sighted people reported that they were confident using the bullnose edge kerb to follow the path, and the figures for the other kerb edges were lower than this. For mobility impaired participants, 64% (9 of 14) found it easy to climb the bullnose edge kerb, 58% (7 of 12) the straight edge kerb and 50% (6 of 12) the chamfered edge kerb. A higher kerb with colour contrast would be preferred by blind and partially sighted participants, but this would be more difficult to cross for wheelchair users and people with walking difficulties and would require regular flush crossing points with associated appropriate layout of blister tactile paving.

## Further research

This research has identified the effectiveness of each delineator in an internal controlled environment. The effects of weather and variable lighting conditions were not tested. Participants were able to focus on the task of identifying and following the delineators without the effects of cognitive loading, i.e. the effects of other street activities or other tasks to focus on.

Whilst none of the delineators emerged as meeting the needs of both groups of users in their forms tested, two of them were identified by the researchers as warranting further research: the central delineator and a slope. A focused list of specific issues for testing has been identified for further research (see 'Further research' section starting on page 65). The effects of lighting, weather and additional cognitive loading should be considered in further research.

# Appendix 1

## Questionnaire for blind and partially sighted participants

Summary of the questions participants were asked after the trial of each delineator.

### Detect tests

Start the participant approximately 2m from the delineator.

### Instruction to participant:

Please walk forward as if you are leaving a building until you have found a delineator to inform you to turn right/left or marking the edge of the path. Once you have detected the delineator please stop and describe what you have reached.

### Interviewer to record if participant stopped at delineator.

**Q1: What have you reached/detected?**

**Q2: How easy was it to detect/find the delineator?**

Very easy

Easy

Difficult

Very difficult

### Comments

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**Q3. Can you suggest anything to improve the delineator which would help you find it?**

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**Q4: Do you think you would find any difference finding this delineator during the day or at night?**

Yes

No

**If yes what?**

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## Detect and navigate test

Start the participant approximately 2m from the delineator.

### Instruction to participant:

Please walk forward as if you are leaving a building until you have detected the delineator marking the edge of the safe space path. Once you have found the delineator please proceed along the path using the delineator as you would a kerb until the path ends. Then turn round and repeat this route in reverse. We will ask you to continue to repeat this for two minutes.

### Q1: How easy was it to detect the delineator and use it to navigate, staying within the safe space?

Very easy

Easy

Difficult

Very difficult

### Comments

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### Q2: Did you have any problems using this delineator?

e.g. identify where you are and choose the direction you are going?

No problems

A few problems

Many problems

Too many (couldn't use)

**(Ask to describe these.)**

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### Q3: What, if anything, did you find most difficult about walking along the route?

**(Ask to describe these.)**

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### Q4. Can you suggest anything to improve the delineator which would help you to use it to navigate?

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**Q5: Do you think you would find any difference using this delineator during the day or at night?**

Yes

No

**If yes what?**

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**Q6: How confident did you feel using this delineator to stay within the safe space path?**

Very confident

Confident

Unconfident

Very unconfident

**Why?**

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**Q7: How safe did you feel using this delineator to stay within the safe space path?**

Very safe

Safe

Unsafe

Very unsafe

**Why?**

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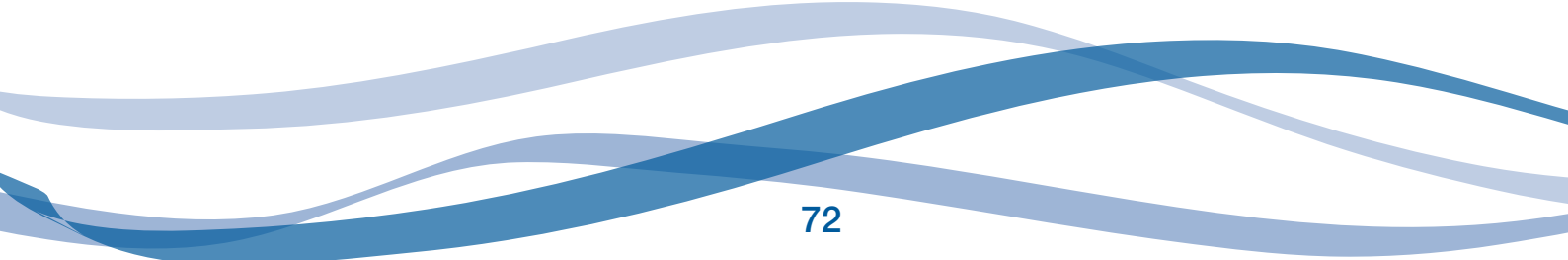
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**Q8. Can you suggest anything to improve the delineator to make you feel more confident or safer?**

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# Appendix 2

## Questionnaire for mobility impaired participants

**Summary of the questions participants were asked after the trial of each delineator.**

### **Instruction to participant:**

Please move along the path crossing the delineator. When you reach the end of the path, turn and come back. We would like you to continue for two minutes but you can stop at any time if it is too difficult.

### **Q1: How easy or difficult was it to cross this delineator?**

Very easy                      Easy                      Difficult                      Very difficult

### **Comments**

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### **Q2: Did you have any problems crossing this delineator?**

No problems              A few problems              Many problems              Too many (couldn't use)

### **(Ask to describe these.)**

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### **Q3: Would you find this delineator acceptable in the pedestrian environment?**

Yes                      No                      Not sure

### **Comments**

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### **Q4: Can you suggest anything to improve the delineator which would help you cross it?**

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# Appendix 3

## Navigation techniques used with blind and partially sighted people in the street: long cane mobility

### Introduction

Approximately two million people in the UK self define as having a sight problem or seeing difficulty (Government Disability Survey, DSS 1996/7). Of these, 378,000 are registered blind or partially sighted. Many people with sight problems travel independently using either their remaining vision and/or a mobility aid (a cane or a guide dog).

There are different types of white canes: a symbol cane to indicate to other people that the holder has a sight problem, a guide cane which is held diagonally across the body and affords some protection against obstacles and a long cane which is used to scan the ground.

This scanning takes the form of sweeping the cane in an arc from one side to the other about two inches past the widest part of the body. This technique locates potential obstructions, for example street furniture, provided there is some element at ground level, and detects distinct changes in level such as a kerb upstand or a step. The cane user may employ the two-point touch technique, where the cane tip only comes into contact with the ground at the two widest points of the arc. During the arc movement the tip should be as low as possible. However, an increasing number of people are using a long cane with a roller tip. The roller tip maintains contact with the ground as the cane is swept and can indicate textural surface changes, as well as the features detected by the more traditional type of long cane. Ideally the long cane user would travel in the centre of the pavement, however not all users are able to do this.

People with a visual impairment use a range of landmarks (fixed objects in the environment) and cues (which can help but may not always be there) to orientate themselves in the environment and navigate around it. These landmarks and cues could be surface/texture (picked up by the feet or the cane), auditory, visual or olfactory. For example:

- Surface/texture – kerbs, building lines, slopes/gradients, tactile paving such as the blister paving at crossings and the guidance path surface, surface texture under foot such as gravel or cobbles.
- Auditory – traffic, sound shadows (of bus stops etc.), audible signals at controlled crossings, sounds from shops (automatic doors, music etc.), talking signs.
- Visual – contrast between the grass and road, yellow and white lines on the road, contrasting tactile paving (buff or red against a grey pavement), colours of shops to identify, fixation points (skyline).
- Olfactory – smell of the florist, fish and chip shop, soap shop etc.

The level of vision (if any) and the person's individual abilities will determine which landmarks and cues they use.

## **Orientation methods used by a long cane user:**

Combinations of the techniques outlined below are utilised by the visually impaired person to remain orientated.

- Following inner shoreline (shops, garden frontages etc.) and outer shoreline (commonly the kerb) with the cane to remain on the path.
- Following the outer shoreline (commonly the kerb) using the cane to locate an objective i.e. a bus stop.
- Using the kerb edge to locate road junctions (cane drops off the edge and the client knows to stop).
- Using the kerb edge to establish/maintain a straight line.
- Using tactile paving to locate safe/safer road crossing points, controlled crossings and to identify the limit of the footway.
- Using building line 'ends' as cues to predict forthcoming road junctions.
- Using traffic flow to aid straight line of travel.
- Using other auditory (sound) and olfactory (smell) clues to aid navigation or pinpoint locations.

**Veronica Bowron: Guide Dogs Rehabilitation Officer**

# Appendix 4

## Role of the guide dog

The Guide Dogs for the Blind Association currently supports around 4,600 guide dog partnerships in the UK. The role of the guide dog is to guide its blind or partially sighted owner in a 'straight line' (given direction), unless directed otherwise, avoiding any obstacles in the way. The owner gives encouragement and commands which inform the dog of the direction in which to travel. The guide dog is trained to stop at steps and kerbs, find doors, carriageway crossings and places that are visited frequently. The guide dog will lead its owner across the carriageway but it is up to the owner to determine where and when to cross safely.

The guide dog can be made familiar with locating objectives (e.g. the bus stop or shop) by accurate direction. This process can be accelerated through the help of a sighted person, and by being given positive rewards when it finds the objective on future occasions. Over a period of time the guide dog will learn the common routes that the owner takes. However, the owner needs to be aware of their environment to assist the dog and inform it which way to go. Such awareness includes the use of environmental cues such as sounds and smells and landmarks such as kerb edges, ends of building lines, enclosed areas etc.

### **Orientation methods used by a guide dog owner:**

- Using the approach and location of the kerb edge to plan routes – a route would involve planning from kerb to kerb until required to turn (i.e. fourth down kerb turn right; second up kerb turn left; 25 paces on right is the supermarket).
- Using the location of the kerb edge to orientate/check the straight line of travel.
- Using sound clues ('sound shadows') to aid the location of an objective.
- Using other sound clues to aid orientation i.e. travel direction of traffic.
- Use of tactile paving to indicate safe/safer crossing points.
- Following the behaviour of the dog to recognise certain locations in the environment.

The art of orientation when working with a guide dog focuses less on tactile information (although this is essential for kerbs and safe crossing points), but utilises (in fluctuating degrees) sounds, smells, contrasts and memory as well as the behaviour of the dog.

The instigation of a tactile marker, be it tactile paving or other delineator, is only useful if it comes into contact with the guide dog owner's feet. As the dog is trained to avoid obstacles, it has a free range of working positions on the pavement (as long as it is going in the right direction) and consequently it may well avoid any contact with a mid pavement divide. In this situation, a guide dog owner will miss the information that the delineator would have provided. With tactile paving, this must be in the line of travel otherwise it will also be missed.

Guide dog owners rely on consistency in the non-visual design features they encounter, whether for warning or information. This is essential if blind and partially sighted people are to be able to travel within the UK and receive the same information about the environment.

A guide dog will recognise physical changes in the environment (kerb) or an obvious stimulus (post, gate, door, tree, people etc.). However, the most important aspect of safe mobility is the ability of the blind or partially sighted traveller to problem solve. This can be done via interpretation of the dog's behaviour in relation to the immediate environment, or recognition due to tactile information that a fault has occurred in their travel.

**Pete Smith – Guide Dogs District Team Manger for East Anglia**

# Appendix 5

## Description of the Pedestrian Accessibility and Mobility Environment Laboratory (PAMELA) at University College London

### **PAMELA**

The Pedestrian Accessibility and Mobility Environment Laboratory is a facility for high quality rigorous multi-sensory research in the pedestrian environment under controlled conditions. It is run by the Accessibility Research Group, part of the Centre for Transport Studies, in the Civil, Environmental and Geomatic Engineering Department, within University College London.

The facility includes a physical reconfigurable platform which provides a surface that can be changed in terms of its surface material, topography and disposition of lateral and vertical obstacles.

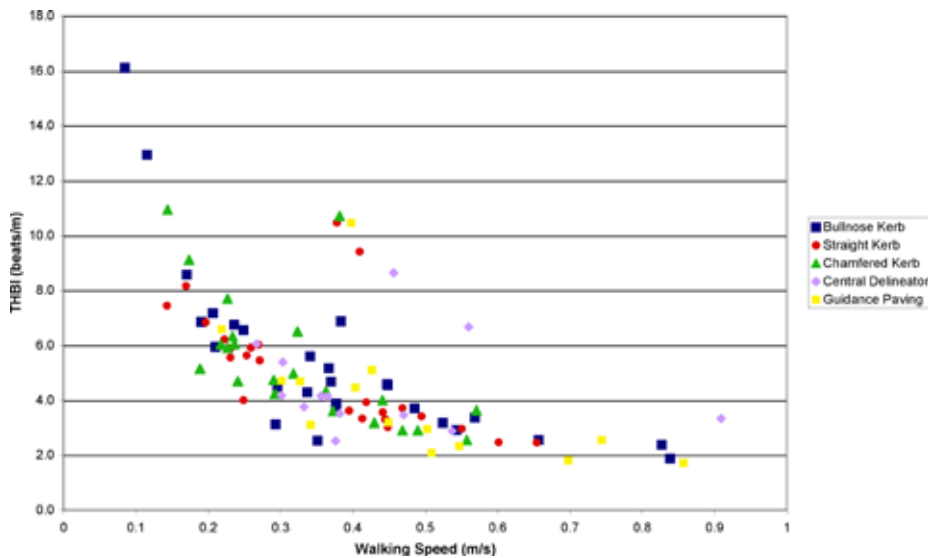
The platform is complemented by a variable lighting system which has the capability of providing a wide range of lighting conditions. In addition there is an ambient noise system which can reproduce sounds such as traffic, trains, aircraft and other ambient noises such as birdsong and backgrounds such as those found in pedestrian environments, and includes the capability to record three-dimensional sound and reproduce it ambisonically within the laboratory. This is a unique facility in the world and provides a cornerstone for international research in pedestrian environments.

Already, research undertaken in PAMELA has been incorporated into standards of accessibility measurement by the Department for Transport and London Underground, and reports of the fundamental research outputs in terms of accessibility evaluation have been reported at the TRANSED 2007, Walk21 2006, the British Association Festival of Science 2006 and in journals including Transportation Research (forthcoming).

For more information visit [www.arg.ucl.ac.uk/pamela2](http://www.arg.ucl.ac.uk/pamela2) or contact [pamela@transport.ucl.ac.uk](mailto:pamela@transport.ucl.ac.uk)

# Appendix 6

**Figure 46:** Travelling Speed vs Total Heart Beat Index for VI group

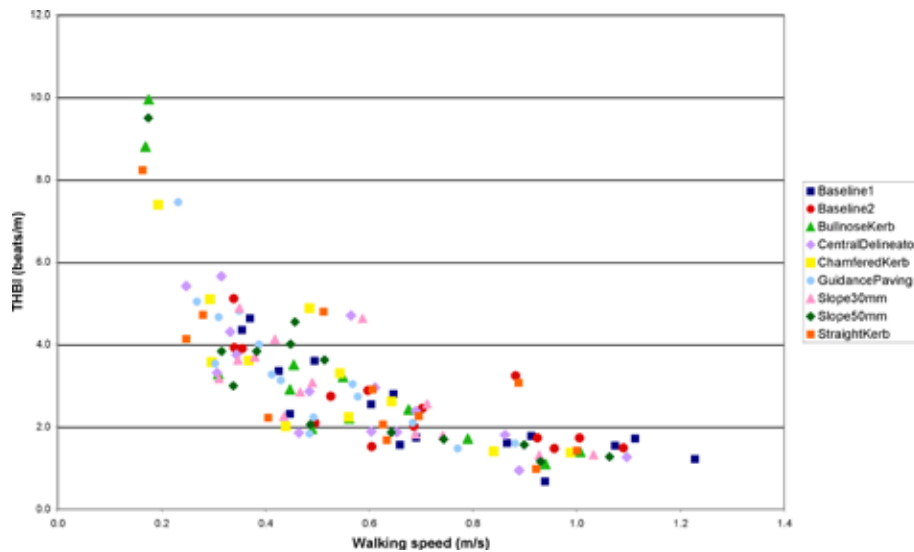


This figure shows how the effort of walking along a particular delineator varies according to the travelling speed for the VI group. Bernardi et al. (1999)<sup>11</sup> showed that for lower walking speeds there is an increased physiological cost. If one delineator was easier to follow than another, we would expect the values recorded for that delineator to have comparable travelling speeds with lower THBI. The results appear to be distributed across the full range, indicating that although some people have had more problems with one or more delineator, there is no clear best or worst delineator.

<sup>11</sup> Bernardi M, Macaluso A, Sproviero E, Castellano V, Coratella D, Felici F, Rodio A, Piacentini MF, Marchetti M, Ditunno JF; 'Cost of walking and locomotor impairment'; J Electromyogr Kinesiol. 1999 Apr; 9 (2); pp 149-57

# Appendix 7

**Figure 47:** Travelling Speed vs Total Heart Beat Index for MI group



This figure shows how the effort of travelling along a particular delineator varies according to the travelling speed for the MI group. Slower speeds show a higher cost of travelling. As would be expected, the baseline trials, although highly variable, are not included in the group of the slowest travelling speeds. This slowest group, at around 0.2m/s, includes the straight kerb, the bullnose kerb, the chamfered kerb, the guidance paving and the 50mm slope (1:4). This indicates that the 30mm slope (1:7) and the central delineator were the least problematic obstacles.

## Appendix 8

**Table 5: Total Heart Beat Index for each person (heart beats/m):  
Blind and partially sighted participants.**

Delineator	Participant							
	8	9	11	12	14	15	16	17
Guidance paving	2.9	2.3	3.1	4.7	5.4	2.1	4.7	3.2
Central delineator	2.9	3.5	2.5	4.2	4.7	3.8	4.2	4.1
Bullnose kerb lower	4.3	6.9	3.1	SG	3.6	SG	8.6	16.1
Bullnose kerb upper	3.9	7.2	2.5	SG	4.6	SG	12.9	4.5
Chamfered kerb lower	2.9	6.3	4.7	SG	7.0	SG	4.7	3.2
Chamfered kerb upper	2.9	4.2	5.1	SG	5.8	SG	6.0	3.6
Straight kerb lower	3.3	5.6	4.0	SG	5.2	SG	6.8	5.5
Straight kerb upper	3.5	8.2	7.4	SG	5.8	SG	6.2	3.0

Delineator	Participant								
	18	20	21	24	25	26	27	28	29
Guidance paving	SG	2.1	SG	2.6	4.5	1.8	SG	6.6	1.7
Central delineator	SG	6.7	SG	3.3	3.5	6.0	SG	5.4	NR
Bullnose kerb lower	0.3	6.9	SG	3.7	5.2	2.6	3.7	6.8	1.9
Bullnose kerb upper	0.4	D/F	SG	3.2	6.6	2.9	3.4	5.9	2.4
Chamfered kerb lower	SG	D/F	SG	2.6	10.9	4.0	7.7	6.0	NR
Chamfered kerb upper	SG	D/F	SG	3.6	9.1	5.0	4.3	5.9	NR
Straight kerb lower	SG	D/F	SG	3.0	5.9	3.9	3.6	5.9	3.4
Straight kerb upper	SG	D/F	SG	2.5	6.0	3.6	3.7	5.6	2.5

Where a participant followed the delineator, figures are given for the heart rate.

Note: some participants chose not to wear a heart rate monitor.

Note: Participant 17 used the trial with the bullnose kerb from the lower side as a training session, learning to detect the edge. This means that the task performed was different in this trial to the other trials. The important difference was that he edged very slowly along the delineator, continually testing how it felt underfoot, thus barely walking at all, whereas for the other trials he actually walked along the path using the delineator. The THBI is the ratio of heart beats taken to distance travelled, therefore this reading of THBI is artificially high in comparison to his other results.

**D/F** – detected, but failed to follow (i.e. use the delineator to navigate). If the participant managed to follow the delineator, by definition they detected it. If they managed to detect, but not continuously follow a delineator, it has been recorded as ‘D/F, detected, but failed to follow’.

**NR** – heart rate monitor failed to record heart rate data. The heart rate measurement equipment was initially incorrectly applied for participant 29; this was rectified giving data for later tests.

**SG** – the participant was guided by a sighted guide. The effect of this on the heart rate was difficult to assess so these figures were omitted.

**Lower/Upper** – denotes the level from which the participant approached the kerb delineator. As all participants navigated using the delineator from the upper side of the path, whether approached from the lower or upper side, the 'follow' results can be considered as a repeat condition, with the exception of the initial time to detect the delineator.

# Appendix 9

**Table 6: Travelling speed for each person (m/s):  
Blind and partially sighted participants**

Delineator	Participant							
	1	2	3	4	5	6	7	8
Bullnose kerb lower	0.2	0.4	D/F	F	D/F	0.3	SG	0.3
Bullnose kerb upper	D	D	D/F	F	D	0.4	SG	0.2
Straight kerb lower	0.2	D	D/F	F	D	0.2	SG	0.4
Straight kerb upper	0.2	D	D/F	D	D	0.3	SG	0.4
Chamfered kerb lower	0.2	0.3	D/F	D	D	0.2	SG	0.5
Chamfered kerb upper	0.2	0.3	D/F	D	D	0.3	SG	0.5
Central delineator	0.3	0.6	D/F	0.6	0.4	0.3	SG	0.5
Guidance paving	0.4	0.4	0.6	0.6	0.5	0.3	SG	0.5

Delineator	Participant							
	9	10	11	12	13	14	15	16
Bullnose kerb lower	0.2	0.1	0.3	SG	0.3	0.5	SG	0.2
Bullnose kerb upper	0.2	0.2	0.4	SG	0.3	0.5	SG	0.1
Straight kerb lower	0.3	0.2	0.3	SG	0.4	0.4	SG	0.2
Straight kerb upper	0.2	0.2	0.1	SG	0.2	0.4	SG	0.2
Chamfered kerb lower	0.2	0.2	0.2	SG	0.3	0.3	SG	0.3
Chamfered kerb upper	0.3	0.2	0.2	SG	0.3	0.4	SG	0.2
Central delineator	0.4	0.3	0.4	0.3	0.3	0.5	0.3	0.4
Guidance paving	0.6	0.2	0.3	0.3	0.2	0.4	0.5	0.3

Delineator	Participant							
	17	18	19	20	21	22	23	24
Bullnose kerb lower	0.1	0.3	0.3	0.4	SG	0.5	0.3	0.5
Bullnose kerb upper	0.3	0.4	0.3	D/F	SG	0.4	0.4	0.5
Straight kerb lower	0.3	SG	0.3	D/F	SG	0.4	0.3	0.6
Straight kerb upper	0.5	SG	0.4	D/F	SG	0.5	0.4	0.6
Chamfered kerb lower	0.4	SG	0.4	D/F	SG	0.3	0.3	0.6
Chamfered kerb upper	0.4	SG	0.4	D/F	SG	0.3	0.3	0.6
Central delineator	0.4	SG	0.4	0.6	SG	0.7	0.4	0.9
Guidance paving	0.5	SG	0.5	0.4	SG	0.6	0.4	0.7

Delineator	Participant					
	25	26	27	28	29	30
Bullnose kerb lower	0.4	0.7	0.4	0.2	0.8	SG
Bullnose kerb upper	0.3	0.5	0.6	0.2	0.8	SG
Straight kerb lower	0.3	0.4	0.4	0.2	0.5	SG
Straight kerb upper	0.3	0.4	0.5	0.2	0.7	SG
Chamfered kerb lower	0.1	0.4	0.2	0.2	0.6	SG
Chamfered kerb upper	0.2	0.3	0.4	0.2	0.5	SG
Central delineator	0.5	0.3	SG	0.3	0.8	SG
Guidance paving	0.4	0.7	SG	0.2	0.8	SG

**D** – detect, but follow not tested.

**F** – participant failed to detect the delineator.

**D/F** – detected, but failed to follow the delineator.

**SG** – the participant was guided by a sighted guide. The effect of this on the travelling speed of participants was difficult to assess so these figures were omitted.

**L/U** or **Lower/Upper** – denotes the level from which the participant approached the kerb delineator. As all participants navigated using the delineator from the upper side of the path, whether approached from the lower or upper side, the ‘follow’ results can be considered as a repeat condition, with the exception of the initial time to detect the delineator.

Where there is data, the participant detected and followed the delineator. Where data is missing, this is because the participant had sighted guidance along the course (participants 7, 12, 15, 18, 21, 27 and 30), or they lost the route and there was insufficient data to measure (participants 3, 4, 5, and 20), or because a follow test was not completed (participants 1, 2, 3, 4, 5).

# Appendix 10

**Table 7: Total Heart Beat Index for each person (heart beats/m):  
Mobility impaired participants**

Delineator	Participant							
	1	2	3	4	5	6	7	8
Baseline1	2.8	2.3	3.6	1.5	1.7	0.7	1.6	1.8
Baseline2	2.5	0.5	2.9	1.7	1.7	NR	1.5	3.3
Guidance paving	4.8	0.3	3.1	3.0	2.1	1.5	3.3	2.7
Central delineator	3.0	0.3	4.3	2.4	1.8	1.0	1.9	4.7
Bullnose kerb	3.2	Fail	Fail	2.4	NT	1.0	1.7	3.5
Chamfered kerb	3.3	0.3	Fail	2.6	NT	NR	1.4	4.9
Straight kerb	2.9	Fail	Fail	2.3	3.0	1.0	2.1	4.8
Slope 30mm (1:7)	4.1	0.3	2.9	2.6	1.3	NR	1.8	4.6
Slope 50mm (1:4)	4.0	Fail	Fail	3.6	1.6	1.7	1.7	4.6

Delineator	Participant							
	9	10	11	12	13	14	15	
Baseline1	2.5	4.6	3.4	1.2	1.7	1.6	4.4	
Baseline2	2.7	5.1	3.9	1.5	2.0	1.5	3.9	
Guidance paving	4.0	7.5	4.7	1.6	2.2	1.8	5.0	
Central delineator	2.9	5.7	3.8	1.3	1.9	1.8	5.4	
Bullnose kerb	Fail	10.0	2.9	1.4	2.2	2.0	8.8	
Chamfered kerb	5.1	NT	NT	1.4	2.2	2.0	7.4	
Straight kerb	NT	NT	NT	1.4	1.7	2.2	8.2	
Slope 30mm (1:7)	3.1	4.9	3.6	1.3	1.8	2.3	3.7	
Slope 50mm (1:4)	Fail	9.5	3.8	1.3	1.9	2.1	Fail	

**Fail** – where the participant could only overcome the obstacle with assistance.

**NT** – not tested.

**NR** – heart rate monitor failed to record heart rate data.

Where there is data, the participant managed to overcome the delineator as an obstacle.

Participant 10 has higher values of THBI for the 50mm slope (1:4) and the 30mm bullnose kerb than for the other delineators (the chamfered and straight edge kerbs were not tested).

Person 15 has higher values of THBI for the bullnose and straight 30mm kerbs than for the other delineators.

Considering the number of fails, the bullnose, chamfered and straight kerbs all recorded fails, as did the 50mm slope (1:4).

# Appendix 11

**Table 8: Travelling speed for each person (m/s):  
Mobility impaired participants**

Delineator	Participant							
	1	2	3	4	5	6	7	8
Baseline1	0.7	0.5	0.5	1.1	1.1	1.0	0.9	0.9
Baseline2	0.7	0.5	0.6	1.0	0.9	1.0	1.0	0.9
Guidance paving	0.4	0.3	0.4	0.6	0.7	0.8	0.4	0.6
Central delineator	0.6	0.3	0.3	0.7	0.9	0.9	0.7	0.6
Bullnose kerb	0.6	Fail	Fail	0.7	NT	0.9	0.8	0.5
Chamfered kerb	0.5	0.3	Fail	0.6	NT	0.8	0.8	0.5
Straight kerb	0.6	Fail	Fail	0.7	0.9	0.9	0.6	0.5
Slope 30mm (1:7)	0.4	0.3	0.5	0.7	0.9	1.0	0.7	0.6
Slope 50mm (1:4)	0.5	Fail	Fail	0.5	0.9	0.9	0.7	0.4

Delineator	Participant							
	9	10	11	12	13	14	15	
Baseline1	0	0.4	0.4	1.2	0.7	0.7	0.4	
Baseline2	0.5	0.3	0.3	1.1	0.7	0.6	0.4	
Guidance paving	0.4	0.2	0.3	0.9	0.5	0.5	0.3	
Central delineator	0.5	0.3	0.3	1.1	0.6	0.5	0.3	
Bullnose kerb	Fail	0.1	0.5	1.0	0.6	0.5	0.1	
Chamfered kerb	0.3	NT	NT	1.0	0.6	0.4	0.2	
Straight kerb	NT	NT	NT	1.0	0.6	0.4	0.2	
Slope 30mm (1:7)	0.5	0.4	0.4	1.0	0.7	0.4	0.4	
Slope 50mm (1:4)	Fail	0.2	0.3	1.1	0.6	0.5	Fail	

**Fail** – where the participant could only overcome the obstacle with assistance.

**NT** – not tested.

# Appendix 12

**Table 9: Proportion of failed trials out of the total possible trials:  
Mobility impaired participants**

<b>Delineator</b>	<b>MI group</b>	
	<b>#fail/#possible</b>	<b>%</b>
Bullnose kerb	3/14	21
Straight kerb	2/12	17
Chamfered kerb	1/12	18
Central delineator	0/15	0
Guidance paving	0/15	0
Slope 30mm (1:7)	0/15	0
Slope 50mm (1:4)	4/15	2

The cumulative number of fails for each delineator compared to all possible trials for mobility impaired participants.

A fail was recorded where the participant could only overcome the obstacle with assistance.

# References

'A new method of using heart rate to represent energy expenditure: the Total Heart Beat Index', Hood VL, Granat MH, Maxwell DJ, Hasler JP; Arch Phys Med Rehabil, Sep 2002; 83 (9); pp 1266-73.

'Cost of walking and locomotor impairment'; Bernardi M, Macaluso A, Sproviero E, Castellano V, Coratella D, Felici F, Rodio A, Piacentini MF, Marchetti M, Ditunno JF; J Electromyogr Kinesiol. 1999 Apr; 9 (2); pp 149-57.

'Guidance on the use of tactile paving surfaces', Department for Transport, 1999

'Shared Space – Safe Space', Ramboll Nyvig for Guide Dogs, 2007.

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## Previous research relating to tactile surfaces and the pedestrian environment for blind and partially sighted people

'Elderly people and tactile surfaces', Savill, T [TRL, UK]; Whitney, G Imprint Wokingham, Berkshire: Transport Research Laboratory (TRL), 2001.

Abstract: A number of tactile surfaces are recommended for use in the UK to provide visually impaired people with information and essential warnings in the pedestrian environment. This research examined how well the meanings attributed to these surfaces can be remembered by people over 65 years of age. Two weeks after receiving a booklet about the surfaces and a short training session, the participants were asked if they could identify the meanings of the surfaces. Most participants were able to remember at least five of the six surfaces.

'The pedestrian environment - user friendly or 'no-go' for blind and partially sighted people?', Sharp, S [DETR, UK]; Savill, T [TRL, UK] Series 'Setting the Pace'. 8th International Conference on Transport and Mobility for Elderly and Disabled People, Perth, Western Australia, September 1998. Volume 1 ( p267-72) Imprint Leederville: Indomed Pty Ltd, 1998.

Abstract: The pedestrian environment can be difficult for blind and partially sighted people to negotiate safely. In the UK in the 1980s, work began to establish a range of tactile surfaces which could be introduced into the pedestrian environment to provide essential information and warning to visually impaired people. In all, seven surfaces were identified. This year, revised guidelines are being issued to Local Authorities which summarise how each of the surfaces should be used. This paper shows how tactile surfaces, when used appropriately, can ensure that pedestrian areas are truly user-friendly and no longer 'no-go' areas.

'Delineation for cyclists and visually impaired pedestrians on segregated, shared routes', Savill, TA [TRL, UK]; Gallon, C [Meercat Research Ltd]; Mchardy, G [Tonbridge & Malling Borough Council] Series TRL Report (TRL287) Imprint Crowthorne: Transport Research Laboratory (TRL), 1997.

Abstract: Visually impaired pedestrians have reported problems with detecting the tactile central delineator used to separate cyclists from pedestrians on shared, segregated routes. This was reported to be due in part to the new types of long cane now used by a growing number of visually impaired people. This research tested the profile at the prescribed minimum and maximum heights (12 and 20 mm) with the existing thermoplastic material and other materials together with five experimental profiles. The delineating strips were tested by visually impaired people, cyclists and other pedestrians. It was concluded that the existing profile can be detected when installed at a height of 20 mm especially when formed from block paviors or a material called 'imprint'.

'Tactile surfaces for visually impaired pedestrians', Gallon, C [Cranfield Institute of Technology UK]; Oxley, P [Cranfield Institute of Technology UK] included in 'Comotred 92. Mobility and transport for elderly and disabled persons. Volume 1 - English version. Proceedings of the 6th international conference, Eurexpo-Lyon, France, May 31 - June 3, 1992

Abstract: This paper summarizes research conducted by the centre for logistics and transportation (CCLT) over the past four years, concerning tactile surfacing to aid visually impaired people. In 1989, CCLT began research to determine how many different textured surfaces could be reliably distinguished by visually impaired people. Also, the research examined the extent to which the surfaces might cause problems to other footway users. Five different tactile surfaces were found to be of use in providing warning and guidance for visually impaired people. In 1990, these surfaces were tested in 'real life' pedestrian environments to assess their usefulness. More recent research investigated the use of tactile surfaces in improving the safety of railway stations for visually impaired pedestrians. Also, CCLT has conducted research concerning the frequency and types of accidents experienced by visually impaired pedestrians.

'Tactile surfaces in the pedestrian environment: experiments in Wolverhampton', Gallon, C [Cranfield Institute of Technology, Logistics and Transportation. Centre, UK] Series TRRL Contractor Report (CR317) Imprint Transport and Road Research Laboratory (TRRL), 1992 .

Abstract: Tactile surfaces are special footway surfaces designed to provide visually impaired pedestrians with information regarding their immediate environment. The research described in this report was conducted to establish how effective the tactile markings researched in an earlier study (see IRRD 841863) were in a real pedestrian environment. The surfaces tested comprised: (1) rubber dot tile; (2) modified DTp blistered paving; (3) concrete corduroy pattern paving slab; (4) 18mm latex compound; and (5) concrete bar pattern paving slab. The research which began in April 1990, fell into three main parts. The first part comprised a series of consultative meetings with representatives from Wolverhampton Metropolitan Borough Council, CENTRO West Midlands, British Rail, TRRL, the Department of Transport (DTp), and manufacturers of surfaces to view various sites and discuss layouts. The second part of the study consisted of a series of experiments to evaluate the surfaces with participation from a group of visually impaired, ambulant disabled, and wheelchair users. The third part of the research was a study to establish the public's views of the tactile surfaces.

'The development of training methods to enable visually impaired pedestrians to use tactile surfaces', Gallon, C; Fowkes, A; Simms, B Imprint Cranfield, Bedfordshire: Cranfield Institute of Technology, Centre for Logistics and Transportation, 1992.

Abstract: Tactile surfaces are special footway surfaces that provide environmental information and warning to visually impaired people. The research was concerned with developing: training techniques to enable visually impaired people, who use existing mobility aids, such as guide dogs, long canes and short canes, to use tactile surfaces. Two approaches to training were assessed: hands-on training, where people were taught to use tactile surfaces in a city centre environment, and training in the home where people were taught how to use an information pack which described the tactile surfaces. Both methods of training took into account the use of different mobility aids. The results of the research show that the amount of time spent training people in situ can be substantially reduced if people have been introduced to the idea and concept of the tactile surfaces, by first using the information pack. A visual record of the experimental research has enabled a video to be produced which demonstrates the research programme and the most appropriate methods of training visually impaired people, with different mobility- aids, to use tactile surfaces.

'Tactile footway surfaces for the blind', Gallon, C [Cranfield Institute of Technology UK, Centre for Transportation Studies]; Oxley, P [Cranfield Institute of Technology UK, Centre for Transportation Studies]; Simms, B [Banstead Mobility Centre, Queen Elizabeth Foundation, UK] 1991.

Abstract: In November 1988 the Transport and Road Research Laboratory commissioned the Centre for Transport Studies, Cranfield Institute of Technology, to carry out research to determine how many different textured surfaces could be effectively and reliably distinguished by visually handicapped people. The research would also examine the extent to which the surfaces might cause problems to other groups of footway users; particularly ambulant disabled people and wheelchair users. Initially, a fact finding study was undertaken to establish previous relevant research and to identify different surfaces already in use internationally. Secondly, a survey was conducted to establish the travel habits of visually impaired people and what sort of problems they encounter. The third part of the research was the process of selecting a small number of different surfaces from the 20 that had been identified in the first part of the study. Finally, the selected surfaces were then used in experimental work designed to assess how well visually impaired people would learn and remember, over time, the messages attached to the various surfaces. The research identified five surfaces that were distinct from each other and easily detectable underfoot, and generally acceptable to other footway users. Also, the research indicated that most visually impaired people were able to learn and remember, over time, the meanings attached to each of the surfaces. The study concluded that five different tactile surfaces should be tested in real life situations. These should have distinct meanings: surface 1, a latex 18mm depth should be used for information (eg to a bus stop); surface 2, a rubber/concrete bar Pathfinder, 5.5mm profile should be used for guidance; surface 3, concrete corduroy paving, 6.5mm profile should be used for warning; surface 4, a rubber dot Pathfinder, 5mm profile to warn of the edge of railway platforms; and surface 5, a modified version of the Department of Transport's blistered paving, 4.5mm profile should be used to warn of dropped kerbs at road crossings.

'Tactile surfaces experiment' Gallon, C [Cranfield Institute of Technology UK]; Oxley, P [Cranfield Institute of Technology UK] included in 'Transport for people with a mobility handicap'. Proceedings of seminar F held at the PTRC Transport and Planning 18th summer annual meeting, University of Sussex, 10-14 Sept 1990.

Abstract: In Great Britain there are some 200,000 people registered as blind or partially sighted: a figure which the Royal National Institute for the Blind has shown to be a considerable under-estimate of the true incidence of visual impairment in the population. Their estimate is of one million people or about two per cent of the population. This much higher level is supported by data from the recently published opcs surveys of disability which found 1.7 million people with a degree of visual impairment among the adult population. Given the large numbers, it is not surprising that central and local government and many transport operators are concerned about improving information for and the safety of visually impaired people when they go out. The government has already produced national guidelines for a tactile surface to be used at controlled pedestrian crossings. Beyond this, however, there is a need for similar guidelines both for surfaces that warn of possible hazards (for example, steps or platform edges) and that act as guidance (for example, through pedestrian areas, to important public buildings, to bus stops, etc.) This paper reports on survey and experimental work carried out by the centre for transport studies under contract to the transport and road research laboratory (TRRL) during 1989. The objectives of the research were: (i) to identify the problems encountered by visually impaired people when they travel; (ii) to investigate the number of different surface patterns that can be distinguished by visually impaired people without causing confusion; and (iii) to establish whether or not these different surfaces could be learnt and remembered. The paper reports on the three stage research study comprising: (a) the results of 200 interviews with blind and partially-sighted people covering inter alia their levels of mobility and the problems they encounter when they go out; (b) the testing of 20 different types of tactile surface and the selection of six surfaces which satisfied criteria of easy recognition by visually-impaired people without causing undue problems to other footpath users, and (c) the results of a controlled learning experiment designed to test how well (or otherwise) a sample of blind and partially sighted people could learn and remember over time the meanings given to the six surfaces. The paper concludes with recommendations on the types of surfaces and the purposes for which they should be used and identifies further (mainly on-site) testing that is necessary to establish national standards on surface type and layout.