A Continuous Guidance Route in the City of Borlänge
A study of Four People Who Are Blind and Their Walks Along the Route

Agneta STÅHL [a,b,1] and Mai ALMÉN [c]
[a] *Department of Technology and Society, Faculty of Engineering, Lund University, Sweden*
[b] *CASE (Centre of Ageing and Supportive Environments), Lund University, Sweden*
[c] *Hinderfri Design AB, Sweden*

Abstract. People with impaired vision/blindness acquire information about the street environment through a long white cane that allows them to feel different surface structures or being able to see distinct contrasts between different surfaces. Hence important design details in the pedestrian environment must function reliably, i.e. different kinds of passages across streets and bicycle lanes, separation between pedestrian and bicycle lanes and design of bus stops. Properly designed surfaces satisfy three requirements: guidance, warnings, and choices. Pedestrian pathways must be easy to notice and follow. Gaps in the environment require artificial guidance surfaces, e.g. sinusoidal or rib slabs and must be 60 – 70 cm wide. The slabs of the guidance surfaces are to be placed so that the grooves lie in the direction of the walk and provide a tactile sensation in the hand via the cane. Warning surfaces must consist of chamfered domes. To enable people with minor visual impairments to follow a path, it must have light contrasts with the surroundings, at least .40 according to the NCS system. At the conference we will show how people with visual impairments experience different design details in the pedestrian environment, and what impact they have on their usability and safety.

Keywords. Vision impairment, street environment, guidance, warnings and choices

Introduction

The built-up environment must be planned so as to create continuous guidance routes in order for people who are blind to be able to orient themselves in it. In order for people who are blind to be able to orient themselves, the city environment must be planned so that continuous guidance routes are created. Around the world, attempts are in progress to make the physical environment easier for people with impaired vision to orient themselves in [1], [2]. Consequently international standardizing work to facilitate the planning conducted in various countries, and also to try to achieve a uniformity of design so that people with impaired vision will be able to feel at home in

[1] Agneta Ståhl, Faculty of Engineering, Lund University, P.O. Box 118, SE-221 00 Lund, Sweden; agneta.stahl@tft.lth.se

any environment [3]. Within the framework of the sector responsibility of the Swedish Transport Administration, cooperation with a focus on people with impaired vision was initiated in 2003 between the Swedish Transport Administration, the municipality of Borlänge and the Institute of Technology at Lund University (LTH), resulting in concrete projecting and implementing a continuous guidance route in central Borlänge.

To achieve a uniformity of design, in practical planning this entails complementing natural guidance surfaces with artificial ones in the gaps that arise between the natural guidance surfaces in a continuous guidance route. A guidance route is defined as a continuous series of natural and artificial guidance surfaces, warning surfaces and decision surfaces between the starting and end points, only interrupted by driving and bicycling surfaces [4], [5], [6], [7].

In Sweden, work to design the city environment for people with impaired vision is in progress. In PBL [8] it is prescribed that the city environment should be accessible and usable for, among others, people with impaired vision. The Swedish National Board of Housing, Building and Planning prescriptions and advice [9], [10], [11] contain several paragraphs that specify how various details in the city environment should be designed.

A guidance route is not just a matter of transportation. Natural guidance surfaces also tend to function as orientation points to help people identify exactly where they are while following a route. They are also easier for people to orient themselves by than artificial ones, provided that no loose obstacles are present and that plant life is restrained from growing freely, which makes the guidance surface more difficult to access.

The aesthetic aspect is often discussed in the context of guidance routes and, above all, artificial guidance surfaces. It is a challenge to find tactile surfaces that can be used by people with seriously impaired vision and by people who are blind who use long canes to orient themselves, at the same time being perceived as aesthetically attractive by people with unimpaired vision [12].

Continuous guidance routes contain different types of guidance surfaces, either natural guidance surfaces, e.g. grass against asphalt/plates, walls or border, or artificial guidance surfaces, i.e. built-up surfaces of slates/stone [13], [14]. The latter may also be surrounded by materials of considerably varying structures. In addition, truncated domes used to warn people of danger are available in a number of different shapes and measure constellations of the domes. Consequently, it is important to study, in research as well as in practical implementation, how different tactile structures intended to guide and warn of danger will function for people with serious vision impairments and for people who are blind, and how those surfaces should be laid in the physical environment to prevent gaps in the orientation process.

The first stage in this work was a study conducted at the Department for Technology and Society as an assignment by the Swedish Transport Administration [15] with the overriding aim of finding structures for guidance surfaces and warning surfaces that can be used by people who are blind using long canes to orient themselves. This study of 13 different combinations of guidance surfaces/warning surfaces, which was conducted in an outdoor environment but within a limited area with no real traffic interfering, produced a great deal of new knowledge. First of all, it was established that people who are blind have great difficulties distinguishing between certain of the guidance surfaces and warning surfaces used today in laying out continuous guidance routes. What characterizes those surfaces is that the feeling from the long cane up into the hand is not sufficiently different in guidance surfaces and warning surfaces. In an artificial guidance surface the signal from the long cane should be soft and sinus-like and can be conveyed from both sinus and rib surfaces of the correct dimensions [6]. In the warning surface, on the other hand, the stick should get stuck between the domes and stop the pedestrian. The warning surface should be laid with domed plates with truncated domes of the correct dimensions.

This study showed that in guidance surfaces ending with truncated domes as warning surfaces people who are totally blind are not, as intended, sufficiently made aware of the danger. However, the study indicated that the test subjects found it somewhat easier to identify the warning surface coming from a smooth surface as opposed to an artificial guidance surface. Yet another essential observation made in this study was that even very small bevelling in the edges of the plates, irrespective of whether they were in the guidance surface or in the surrounding surface, resulted in the long cane getting stuck, causing repeated halts for the pedestrians, which, in turn, had an impact on the walking rhythm as well as the possibility to orient themselves along the guidance surface. Constant halts tend to cause people who are totally blind to lose the direction of the guidance surface and therefore force them to search the surface again for the direction.

In a subsequent study in Borlänge it was also established that people who are blind can identify the warning surface with their long canes facing a crossing street if it is 1 meter deep [16]. No differences were found in the possibility of identifying such a warning surface depending on whether there was an edge or not at the driving surface. It is, however, an important prerequisite that the domes of the warning surface should be chamfered and have the dimensions prescribed [3].

Further studies have proved that it is possible to achieve continuous guidance routes in practical planning [17]. In this study, 3 routes were evaluated in an area in Kristianstad where the ambition had been to create continuous guiding. The starting point for the planning process was that the guidance surface, as far as possible, should be made up of the natural environment, e.g. supporting edges of flower beds, lawn edges, rails, walls, house façades with clearly indicated entries and kerbs. It was also to constitute a warning, e.g. as a kerb at crossing a driving surface. The natural environment had been complemented with artificial guidance surfaces that successfully eliminated some of the gaps that naturally had to arise between the natural guidance surfaces. The experiences from this study also showed that, on the whole, the ambition was successful. Nevertheless, it also revealed that a few gaps still remained in the continuity between the guidance surfaces, mostly at the entries of buildings.

The studies referred to here clearly indicate the need for continued research on people with vision impairments and guidance routes. Such fundamental issues as when artificial guidance routes should be laid, how they should be designed in traffic circles or at raised pedestrian walks, what combinations of materials will convey the intended information and, last but not least, how to build in order to achieve continuity in the guidance routes – all these are important issues to be studied in the actual traffic environment.

1. Aim

The overriding aim of the study was to investigate how the continuous guidance route constructed in central Borlänge up to Resecentrum and further on to Dalarna University College and the premises of the Swedish Transport Administration functions for people who are totally blind. In more concrete terms, the aim was to study how people who are blind are able to orient themselves along the guidance routes (natural as well as artificial), decision surfaces and warning surfaces in Borlänge and whether they experience any gaps in the guidance route.

2. Method

Since the tests were conducted in a real environment, they are realistic even in the sense of providing those normal disturbances caused by the traffic environment that may affect blind people's concentration and, consequently, their ability to locate or follow a guidance route. The guidance routes in this study were planned according to the principles of Borlänge municipality in their efforts to improve accessibility and usability for people with impaired vision. The test route was designed so as to form a clear route from a starting point to a finishing point, to contain both natural and artificial guidance surfaces as well as points of choice and warning and to be interrupted by roads and bicycle crossings.

A total of four people, three women and one man, were recruited for the study, all of whom were blind with no remaining vision and used to employing a white cane when orienting themselves. It was of crucial importance that these participants should be totally blind, as there should be no doubt that it was the tactility of the ground surface that was studied by means of their ability to orient themselves using the cane. The tests were conducted in October 2009 with one person participating on each test occasion. The following two routes were tested:

Route 1 is about 350 metres long and starts at the corner of Stationsgatan and Borganäsvägen.

Route 2, which is also about 350 metres long, starts at the subway below Ovanbrogatan and ends at a bus stop in Jussi Björlings väg.

The total route tested is consequently about 700 metres long.

The test started with two observers walking along each route with one participant at a time at a slow pace, the aim of which was to describe the logic of the design. In addition, the appearance and purpose of every single detail in the design was carefully described. The participants used their white canes and, at relevant details, their hands and could also pose questions to the two observers. This preliminary test was followed by the real test itself. To be able to capture as much details as possible, objectively as well as subjectively, mixed methods were used [18]. While walking, the participants were instructed to think aloud, describe what they were experiencing and how they identified different details in the environment. During the participatory observation, one of the observers walked beside the participant, while the other one videotaped the entire walk. Prior to the walk, the participants were asked to "think aloud", i.e. describe what they experienced, which was tape recorded.

The analysis was made on the basis of the recorded material. An initial study by the project leaders of the videos recorded for each one of the participants was followed by the analysis itself. The analysis adopts a holistic approach, logically following the respective routes walked and including all the design details (natural as well as artificial guidance routes) of the environment intended to provide guiding, a warning or a choice for people with impaired vision. The purpose of the analysis is to register whether the participant was able to follow the route using natural v. artificial guidance surfaces, identify details in the environment, pass gaps in the guidance route (raised pedestrian passages, roads, open surfaces), interpret the information provided in the environment, find points of reference and observe the warning marks.

3. Results

Our overall impression of the walks is that the participants had to concentrate very hard while walking along the two routes. The tests show that the routes are easily lost if you lose concentration due to other disturbing factors in the environment, or because you simply happen to start thinking about other things. The analyses of the participants' walks clearly reveal the logical and technical thinking and moving required in order to find one's way in the environment. This is, for example, described in the analysis in the following way: “The participant changes direction 90 degrees to the left, continues along the natural grass/asphalt guidance route, identifies an orientation point” etc. This description shows very clearly that for a person who is blind a walk from A to B requires total concentration on the route and that there are no possibilities for “spontaneous detours”. The fact that the white cane and sound information are the two most important aids that a person who is blind can rely on places great demands on making the design details in our walking environments consistent and systematic.

Our impression of the two routes in Borlänge is that the area is relatively well designed on the basis of what people who are blind need in their walking environment. Even though it has been a clear ambition to create continuous tactile guidance routes, the tests show that there are gaps in the guiding, obstacles along the guidance routes and certain deficiencies in the design details. Creating continuous tactile guidance routes in a walking environment is a challenging task. Many details have to be correctly designed, and even small deviations may cause people who use white canes to lose their orientation.

The route descriptions for each one of the test participants highlight both what functions well and what functions less well for them along the two routes. The purpose of the illustrations included here is to present the problems and difficulties experienced by the participants. The text below is intended to point out general phenomena and design details that people who are blind may experience in walking environments such as the test routes in Borlänge, and to discuss measures to improve what can be done to create safe and secure orientation.

Like previous studies the present one shows that people who are blind find it considerably easier to follow and orient themselves along natural guidance surfaces [17]. It is, however, an important prerequisite that the **natural guidance surfaces should be connected** so as not to create any gaps in the guiding process. The participants' way of walking and their comments show that natural guidance surfaces result in a more relaxed and comfortable gait. Natural guidance surfaces are, for example, walls, brick walls, edge supports or fences, and also grass or planted areas next to asphalt or other hard surfaces. The fact that you do not have to concentrate so hard on the details to orient yourself enables you to experience the surrounding environment or think about other things. The studies indicate, for example, that grassy edges that have been trodden on and worn can be followed swiftly and without difficulty. Grass is also experienced as a good material to use your cane on when the adjacent area is concrete or asphalt, but if the grass is high the cane may get stuck. When you orient yourself along natural guidance surfaces, it is important to stay in contact with them with your white cane in order not to risk missing the natural orientation points in the environment, such as doorways, shop entrances etc. In daily life you are not always just out for a walk but often have a specific destination in mind.

In planning the use of natural guidance surfaces it is important to achieve **continuity in the guidance route**, or else there will be gaps that cause persons with impaired vision to lose their orientation. The fact that some of the participants in this study lost their orientation along the test routes was not in itself just the effect of a lack of continuity in the guidance route. The participants often used a pendulum technique to orient themselves along natural guidance routes, whereas a gliding technique is required in order to identify artificial guidance surfaces. They missed transitions to artificial guidance surfaces because they continued to use the pendulum technique instead of quickly going over to the gliding technique. This is a major problem, and there are no design-technical solutions. Nevertheless, more and more people who are blind claim that they are increasingly going over to the gliding technique when using the white cane to orient themselves, since it is less of an effort for the shoulders. Moreover, white canes have been equipped with new types of ferrules with a rolling ball instead of a fixed one, which enables the cane to glide over a surface more easily.

On the basis of this study we can establish that **wide guidance surfaces** (70 cm) are experienced as better than narrow ones (42 cm). Another important result is that wide artificial guidance surfaces are not experienced as good under any conditions. In certain situations, a wide guidance surface is thus no asset if the surrounding material is, for example, small paving stones or coarse gravel. There must also be a **sufficiently large smooth surface, ca 60 cm wide, on either side of the artificial guidance surface**. In the area tested, the guidance surface was directly connected to columns in several places, which caused some of the participants to collide with them and consequently lose their orientation. The bus stop in Stationsgatan is an example of an interesting solution, where the guidance route with an artificial guidance surface and warning surfaces leads up to, and through, the windbreak, thus enabling the participants in this study to find the bus stop and the windbreak without difficulty, Photo 1 and 2.

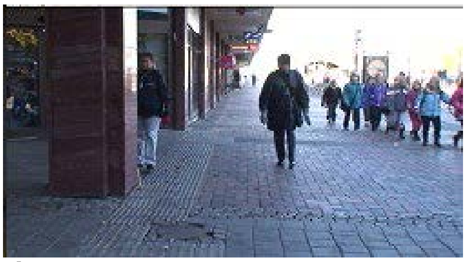
Photo 1.

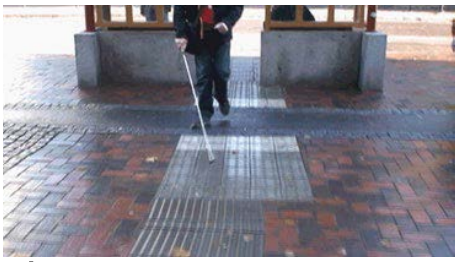
Photo 2.

As for the **detail design of sinus slabs** as guidance surfaces, different varieties are produced in Sweden today. One variety with a sinus curve ending in a top at the edge of the slab is installed with the top of the sinus curve on a level with the surrounding surface material, Photo 3. Another variety, where the sinus curve slopes into a valley, is installed so that the valley of the sinus curve is on a level with the surrounding surface material, which means that the top of the sinus structure is 5 mm above the surrounding surface material, Photo 4.

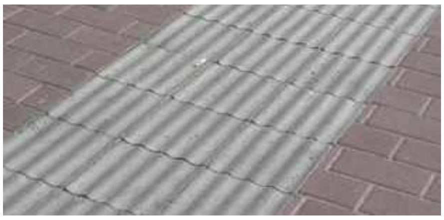
Photo 3.


Photo 4.

This study demonstrated even more clearly than previous ones that the participants found it easier to identify slabs where the **sinus curve is higher than the surrounding material** than those where the top of the sinus curve is on a level with the surrounding surface material [15]. The florist in Stationsgatan and the information sign for Missionskyrkan in Borganäsvägen are examples of places with slabs where the top of the sinus curve is higher than the surrounding material. The restaurant in Borganäsvägen and the walking path up to the windbreak at the bus stop in Jussi Björlings väg may serve as examples of places with slabs where the top of the sinus curve is on a level with the surrounding material.

One fundamental detail in creating safe guidance routes is the design of the **transition from a guidance surface to a warning surface**. Previous studies have identified difficulties in detecting warning surfaces in the form of cupola slabs following artificial guidance surfaces consisting of sinus slabs or ribbed slabs [16]. These findings are also confirmed by the present study, where the depth of the warning surface was up to 140 cm in places, i.e. more than the recommended minimum depth of 100 cm. Our study also shows that the detail design of the cupolas has an impact on detection. Cut cupolas were easier to identify, since the cane tended to get stuck between the cupolas. Disturbing ground installations in the entire, or parts of, the guidance surface, such as manhole covers, constitute another detail that makes both detection and orientation more difficult, Photo 5. In this study the continuous walk of the participants was disturbed by manhole covers, e.g. in the vicinity of the florist in Stationsgatan, Photo 6.


Photo 5.


Photo 6.

This study clearly highlights the problems caused by obstacles along the guidance route, not least along planned natural, or even artificial, guidance surfaces. When the tests were conducted, flower boxes just beside the artificial guidance surface along Stationsgatan distracted some of the participants so that they lost contact with the guidance surface. The same type of problem was caused by people who had stopped to have a chat on the pavement and by clothes racks along Borganäsvägen, both in the pedestrian street and along pavements in the area. On several occasions, participants walked straight into people and clothes racks along the walking path. Garbage cans and newspaper stands outside houses and buildings also posed a problem for participants while orienting themselves along walls with the white cane, Photo 7. One big problem often quoted by people with impaired vision is bicycles that have been inappropriately placed in the walking paths. On one occasion a participant walked into three bicycles parked outside Resecentrum, tipping one of them over. Fortunately the participant was not injured, Photo 8 to 12.

Photo 7.

Photo 8.

Photo 9.

Photo 10.

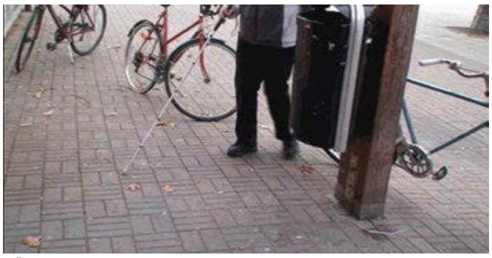

Photo 11.

Photo 12.

It is therefore important to design clearly **demarcated bicycle stands** in the immediate vicinity of the entrances of public premises and other buildings to prevent people from parking their bicycles just anywhere, and often where people with impaired vision are supposed to orient themselves along natural or artificial guidance surfaces. In planning, there must also be **coordination between outdoor restaurants, flower arrangements and the natural and artificial guidance surfaces planned**. In the test area, a good example of such coordination is the space intended for an outdoor restaurant in Borganäsvägen, Photo 13.

One of the most crucial design details for people with impaired vision when they orient themselves in a walking environment is **clearly marked edges**. When edges are phased off along long stretches, e.g. along entrances, it is often impossible to identify the kerb with the white cane. Some of the participants found it hard to identify the edge at the entrance to the pedestrian section of Borganäsvägen and had to walk across this surface slowly and cautiously, Photo 14.

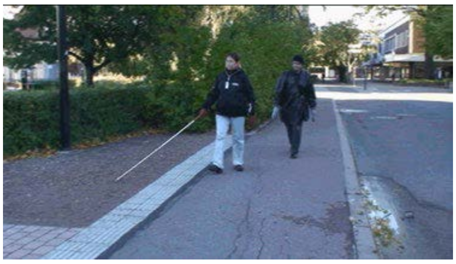

Photo 13.

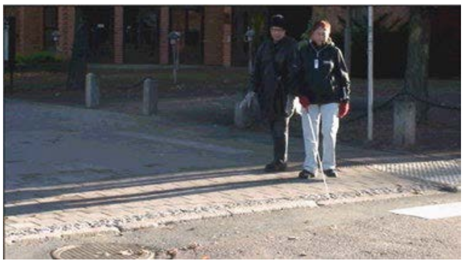

Photo 14.

It is also important in designing the details of the environment to warn people with impaired vision that they are about to **cross a bicycle path**. Likewise it is equal important that bicyclists are aware of that pedestrians (people with vision impairments) might cross the bicycle path. Our study, where the participants crossed a number of bicycle paths, clearly demonstrated that on most of those occasions they were not fully aware of exactly where the bicycle path began. After orienting themselves on a natural guidance surface along a walking path, they crossed with relative ease. The transition is not marked to enable bicyclists to perceive that it has been planned for blind people to cross their path at this very spot. This constitutes a safety risk for people who are blind as well as for the bicyclists themselves. Where pedestrians cross a bicycle path a suitable solution might be to arrange a zebra crossing with clear signing. The design of such a solution on test routes like the ones in this study must be further investigated.

4. Conclusions

The conclusions drawn in this study again underline the importance of **increased training** to improve *usefulness* when planning and designing continuous guidance routes, and consequently education centres for vision impaired people should also be made aware of this problem [15]. This is an issue that we have emphasized on the basis of experiences from previous studies, and we have participated in seminars with representatives of these centre.

We conclude from these seminars that an exchange of knowledge between planners/researchers on the one hand and rehabilitation staff on the other is essential. Planners can share their knowledge of why and how we install various design details to improve conditions for people with impaired vision, and rehabilitation staff their knowledge of how people with impaired vision orient themselves and what they are able to cope with. We believe that such exchange of knowledge and increased training need to be raised to a level where the Swedish Transport Administration, for example, assumes a leading role.

References

[1] Benzen BL, Barlow JN, Tabor LS. 2000. Detectable Warnings – Synthesis of U.S. and International practice. Washington DC, U.S. Access Board.

[2] U.S. Department of Transportation, (2001). Designing sidewalks and trails for access Part 2. Best practices design guide. Washington DC, U. S. Department of Transportation, Federal Highway Administration.

[3] [ISO] International Organization for Standardization. 2012. 23599:2012(E), Assistive products for blind and vision impaired persons – Tactile walking surface indicators.

[4] National Board of Housing, Building and Planning. 2005. Easier without obstacles.

[5] The Swedish Transport Administration. 2012. Demands for design of roads ans streets. Publication 2012:179, pp 74-261.

[6] CEN/TS 15209. 2008. Technical Specification, Secretariat: BSI. Tactile paving surface indicators produced from concrete, clay and stone.

[7] The Swedish Road Administration. 2008. Catalogue with examples of eaily eliminated obstacles. Publication 2008:18.

[8] National Board of Housing, Building and Planning. 2010. The planning and building law 2010:900.

[9] National Board of Housing, Building and Planning. 2013. Building regulations mandatory provisions and general recommendations, BFS 2011:6 with amendments up to BFS 2013:14.

[10] National Board of Housing, Building and Planning. 2011. Regulations and general recommendations on accessibility and usability in public spaces for people with limited mobility or orientation capacity in public spaces and in areas for constructions other than buildings, BFS 2011:5 (ALM 2).

[11] National Board of Housing, Building and Planning. 2011. Regulations and general recommendations on the removal of easily eliminated obstacles to and in premises to which the public has access and in public spaces, BFS 2013:9 (HIN 2).

[12] Blasch BB, LaGrowe SJ, Delaune WR. 1996. Three aspects of coverage provided by the long cane: Obstacle, surface and foot placement preview. Journal of Vision Impairment and Blindness 90:295-301.

[13] Johansson R. 1989. Ledstråk för synskadade - Val av ytmaterial (Swedish). Stockholm, Swedish Transport Research Board, TFB 105.

[14] Övstedal L, Lindland T. 2002. Ledelinjer i gategrunn, Rapport 1 Norske og europeiske erfaringer (Norwegian). Trondheim, SINTEF, Bygg og miljö, Veg og samferdsel, Sintef rapport STF22 A02337.

[15] Ståhl A, Almén M. 2013. A continuous guiding route in Borlänge. A study of four people who are blind and their walks along the route. The Swedish Transport Administraiton, publication 2013, pp 12.

[16] Ståhl A, Newman E, Dahlin-Iwanoff S, Almén A, Iwarsson S. 2010. Detection of warning surfaces in pedestrian environments: The importance for blind people of kerbs, depth, and structure of tactile surfaces. Disab Rehabil 32(6):469–482.

[17] The Swedish Road Administration, Region Skåne. 2007. How do blind people orient themselves along a continuous guidance route? Publication 2007:112.

[18] Creswell JW. 2007. Designing and conducting mixed methods research. Thousand Oaks (CA): Saga Publications.