

# Standards for usable and safe environments for sight impaired

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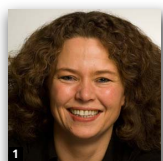
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When revising national standards and guidelines facilitating for sight-impaired people in transport systems, Norwegian authorities needed an assessment of current standards and practices. Two issues concerning design of streetscapes and public transport stops were of particular concern for the authorities: tactile paving seems to be laid out in situations in which more thoughtful design with natural leading elements could better have ensured usability, accessibility and safety for sight impaired; and there is a lack of consistency where tactile paving is laid out, causing potentially dangerous situations. The aim of this paper is to discuss how and why qualities of standards and guidelines, as well as of current practices, contribute to planning and design processes producing such results, and furthermore to arrive at recommendations for improving the situation.

## 1. Introduction

### 1.1 Background and aims

Making transport systems accessible, usable and safe for visually impaired people is an important part of creating an inclusive society. In their efforts towards such a society, many governments have introduced the concept of universal design (UD) in their transportation planning systems (Tennøy and Leiren, 2008). The concept of UD has no one definition and is subject to different interpretations across countries, sectors and disciplines. The United Nations' *Convention on the Rights of Persons with Disabilities* (UN, 2006) offers the following definition (Article 2): 'Universal design means the design of products, environments, programmes and services to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design'.

In order to increase awareness and knowledge of UD throughout the professions, treaties and legislations have translated into standards, guidelines and handbooks for UD provision. The current Norwegian planning framework demands that all new infrastructure investments and buildings must be universally designed (Odeck *et al.*, 2010). The

Norwegian Public Roads Administration (NPRA) and the Norwegian Building Authority (NBA) are responsible for producing standards, guidelines and handbooks ensuring accessible, usable and safe transport environments for all. When revising standards, guidelines and handbooks (hereafter collectively termed 'standards'), NPRA and NBA initiated a joint project to assess current standards.

For visually impaired people, a universally designed travel chain is one in which they can find their way, while not being exposed to dangerous situations. Norwegian standards emphasise that this includes continuous 'lead lines' to follow. A lead line is defined as a chain of natural leading elements and specialised tactile paving that is easy to follow for visually impaired people, in which elements provide visual and tactile information that is easy to recognise and understand (NBA, 2010; NPRA, 2011). The standards distinguish between natural leading elements and specialised tactile paving. Natural leading elements are elements naturally belonging in the environment, such as facades, well-defined kerbs, or tactile differences between surfaces. Useful reference points can be a fountain, a crossing, or changes in the auditory stream of traffic sound. Specialised tactile paving has

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a standardised design, and solely serves the purpose of guiding visually impaired people.

As a commissioned work for the responsible authorities, the Institute of Transport Economics together with Leeds University assessed Norwegian standards, guidelines and handbooks. The authorities were particularly concerned with two issues relating to lead lines: first, the use of standardised tactile paving in situations when design with natural leading elements would better ensure accessible, safe and usable environments for sight-impaired people. This practice was also understood to increase risks, because the too frequent use of tactile paving could cause confusion and reduce awareness. The understanding was that specialised tactile paving should rather be reserved for warning risks (crossings, stairs) and for guiding in especially complex situations (open places, shared spaces, complex terminals). The second issue was a lack of consistency and system faults when tactile paving is laid out, resulting in tactile paving systems often being neither logical nor homogeneous. This could increase risks, as users relying on tactile paving for guidance and warning can be misinformed.

With these two issues in focus, the main questions for the assessment were

- how and why do qualities of current standards and characteristics of current practices contribute to some planning and design processes producing such results?
- how can the situation be improved?

The paper aims at answering these questions, by drawing on the assessment of current standards and practices in Norway. The authors believe that the findings and discussions are relevant for an international audience, because many countries have similar systems and face similar challenges.

## 1.2 Facilitating usable and safe transport environments for visually impaired people

In order for the pedestrian environment to be usable for visually impaired people, it needs to be designed so that they find their way, feel safe, and are not exposed to dangerous situations.

‘Wayfinding’ is a key issue in visually impaired people’s mobility. It is defined by Farr *et al.* (2012) as ‘the process of finding your way to a destination in a familiar or unfamiliar setting by using cues given by the environment’. This process is so commonplace that it is often perceived as simple. In reality, Farr *et al.* (2012) claim, wayfinding is a deeply complex process, involving cognitive abilities and the use of all senses, as well as interaction between human and environmental factors.

When finding their way around, people need to relate to what Lynch (1960) describes as five elements of mental mapping:

paths (familiar streets, walkways, bus lines); edges (physical barriers of walls, fences, rivers, or shoreline); districts (places with a distinct identity); nodes (major intersections or meeting places); and landmarks (tall, visible structures). Use of sight is generally acknowledged to be the most effective way to gather information about such elements in the environment. However, this presents difficulties for those with a visual impairment, who need to rely more on information through sounds, smells and changes in surfaces. Totally blind people will rely entirely on these non-visual sources.

Visually impaired people often learn about a new area or route together with a sighted companion (Storliløkken *et al.*, 2012). When learning a route, usable reference points and tactile street elements are identified that can be useful in orientation and wayfinding. Hence, when designing pedestrian environments, care needs to be taken to ensure that the environment offers lead lines that are easy to orient along. Within the ideals of universal design, the built environment should be designed such that visually impaired people can orient themselves and find their way without specialised tactile paving.

The risk and safety aspect requires, however, that tactile paving is used in particular circumstances, especially to warn against potentially dangerous situations (crossings, stairs). Where tactile paving is used, homogeneity and consistency are imperative to ensure that the message it conveys is clear, in order to improve safety for users.

Pedestrians are generally considered to be vulnerable road users, borne out by the fact that they comprise over 20% of those killed on the roads (WHO, 2013), and it would seem clear that there are specific dangers for visually impaired pedestrians. To the authors’ knowledge, no data on road accidents involving visually impaired people are routinely collected, but in a previous issue of this journal, Norgate (2012) cites survey work in which a quarter of respondents reported an incident in which their cane had been run over and just under 10% had actually been struck by a vehicle (Carroll and Bentzen, 1999). It is important, however, to note that these dangers do not always translate directly into heightened risk, detectable in accident statistics, as visually impaired people often self-regulate their behaviour in order to avoid these dangers and mitigate the risk. This tends to mean that they suppress their pedestrian activity, and so safety becomes closely linked with issues of accessibility.

The literature is quite coherent regarding which qualities are required to facilitate wayfinding and reduce risks for sight-impaired people in transport environments: simple and logical organisation of the built environment; obstacle-free walkways; warning of danger; smooth, even paving; clearly defined kerbs; cross-walks perpendicular to the kerb; proper lighting; strong

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tonal contrasts; a coherent system of natural leading elements complemented with specialised tactile paving where necessary (Atkin, 2010; NBA, 2010; Norwegian Ministry of Environment, 1999; NPRA, 2011; Ståhl and Almén, 2007; WHO, 2007).

## 2. Theoretical framework

As many have experienced, built environments do not always meet the requirements for being usable, accessible and safe for visually impaired people. This can be due to a number of factors.

The usability, accessibility and safety of streetscapes depend on how they are built, operated and maintained, as illustrated in Figure 1.

This, in turn, depends on how streetscapes are planned and designed. In order for those designing, planning, constructing and maintaining pedestrian environments to be able consciously and coherently to shape physical environments in ways making them usable and safe for visually impaired people, they need to possess the necessary knowledge and expertise. To help provide this, standards are developed, intended to contribute to ensuring that streetscapes are coherently designed, and that usability and safety for visually impaired people are given priority. In order for standards to contribute to usable, accessible and safe environments, they need to be based on sound practical and scientific knowledge on how visually impaired people orient themselves, find their way and use different elements in the environment for this. Furthermore, this knowledge needs to be translated into relevant and usable requirements and recommendations.

## 3. Research design and methods

### 3.1 Research design

In order to answer the research questions, a research design was chosen that scrutinised how qualities of the scientific knowledge base, of standards, handbooks and guidelines, as

well as of practice affect qualities of the built environment. This consisted of three distinct parts.

- (a) Examination of the scientific knowledge with respect to whether it offers sound and accessible knowledge regarding
  - how visually impaired people actually orient themselves and find their way with the help of cues given by the environment
  - how characteristics of the built environment affect the usability, accessibility and safety for visually impaired people.
- (b) Studies of Norwegian standards, handbooks and guidelines with respect to whether they
  - recommend use of natural leading elements rather than standardised tactile paving
  - present recommendations that point in the direction ensuring usable, accessible and safe environments
  - are consistent with each other
  - are usable, clear and understandable to practitioners using them
  - include the type of situations often faced by practitioners
  - are in accordance with scientific literature
  - differ from standards developed in other countries and by international bodies.
- (c) Concerning practice, research is directed towards disclosing
  - knowledge and understanding, which form the basis for practice
  - if and how practitioners use standards, whether they find them usable and useful, and if they have suggestions for improvements
  - how procedures of planning and design processes affect results

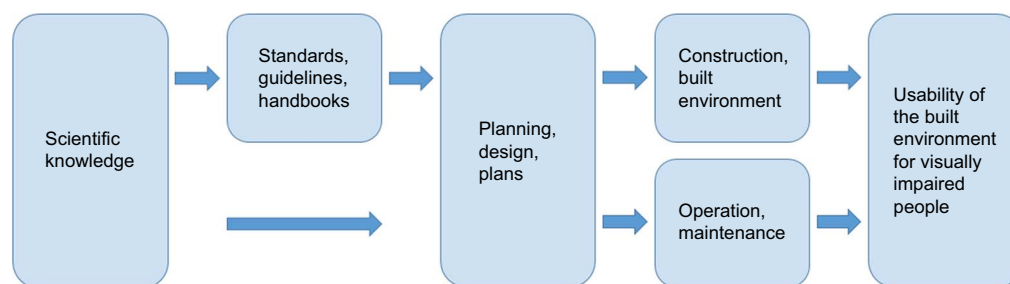


Figure 1. Understanding of relationships between: scientific knowledge; standards, handbooks and guidelines; planning, design and plans; construction and qualities of the built environment;

operation and maintenance; and the usability of the built environment for visually impaired people

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- if other considerations are given higher priority than usability for visually impaired people.

The findings were used in analyses aimed at disclosing how and why these factors can explain deviations between ideals of universal design and the actual built environment. Based on this, recommendations for how the situation can be improved were developed. Extra attention was given to how standards, guidelines and handbooks can improve in ways contributing to safer and more usable pedestrian environments for sight-impaired people.

### 3.2 Methods

Several complementary approaches are applied in order to gather relevant data: literature studies, document studies; interviews with relevant actors; stakeholder seminars; and a case study.

The literature review compiled a large body of research literature concerning facilitation for the visually impaired. In the document studies, standards, handbooks and guidelines produced by Norwegian national and municipal authorities and by user organisations were reviewed, as well as similar documents from Sweden, Denmark, the UK and international bodies. In total, 36 such documents were reviewed.

Semistructured in-depth interviews were conducted with authorities responsible for developing standards, organisations representing visually impaired people, and practitioners involved in planning, designing, building and maintaining built environments. All together, 20 persons were interviewed. Two seminars with relevant stakeholders involved in or working with facilitation for visually impaired people were conducted. In the first seminar (with 26 participants) the authors asked for input and contributions to preliminary findings, while the second seminar (21 participants) served as a quality control of findings and conclusions, and helped to interpret better and understand the findings.

Finally, a case study was conducted, in which the aim was to examine whether and how the mechanisms disclosed through the previous work play out in a specific bus terminal project. More details about the methods are to be found in the project report (Tennøy *et al.*, 2013).

## 4. Findings

### 4.1 Scientific knowledge

The literature review revealed that research focuses more on tactile paving (e.g. Øvstedal *et al.*, 2005; Ståhl and Almén, 2007; Ståhl *et al.*, 2004, 2010) than on how the built environment should be organised and designed in order for people with sight loss to navigate and find their way. One important exception is Atkin

(2010), presenting results of empirical studies regarding how people with different grades of sight loss and different assistive devices make use of natural cues and standardised tactile paving. Atkin (2010) stresses that visually impaired people will have the best premise for safe orientation if the built environment is predictable, with even surfaces and unobstructed paths. Storliløkken *et al.* (2012) describe how visually impaired people train to be able to manage daily tasks, including daily journeys, with (often newly received) loss of sight. Their book is based on experience-based knowledge, gained during their years as mobility trainers, which, while providing valuable insights and understanding, does not represent systematic research-based evidence. Ståhl and Almén (2007) found that natural guiding elements are superior to specialised tactile paving when it comes to orientation and wayfinding. It is, however, crucial that these natural elements are designed so that gaps are avoided, as these will break the continuous line visually impaired people need in order to orient.

### 4.2 Standards, handbooks and guidelines

Studies of standards, handbooks and guidelines from Norway, Sweden, Denmark, the UK and international bodies revealed that the ideals of universal design are more or less similar in these countries (Danish Road Directorate, 2012; ISO, 2010; NBA, 2010; Norwegian Ministry of Environment, 1999; NPRA, 2011; Standards Norway, 2011; Swedish Transport Administration, 2012; UK DfT, 2005). They all recommend or take for granted that natural lead lines are the first choice and best solution, and they stress that standardised tactile paving should be used only if it is hard to achieve adequate lead lines with the help of natural elements alone and where warning is required (especially to warn against crossings and stairs).

However, standards are not very detailed and specific in their recommendations on how built environments should be designed so that usability, accessibility and safety are achieved with natural leading elements. There is a general lack of descriptions, examples and illustrations of facilitation addressing these issues. The NPRA's handbook (NPRA, 2011) mentions the use of natural guiding elements specifically in one page, while the use of standardised tactile paving has its own sub-chapter consisting of six pages. Tactile paving is mentioned throughout the handbook in various settings, while natural lead lines are not. The ISO standard (ISO, 2010) has one sentence regarding natural lead lines, while the remainder of the standard is dedicated to tactile paving.

Guidance with respect to tactile paving is described in much more detail and with many examples in the standards. Recommendations on when tactile paving should and should not be implemented are often diffuse, or missing. A reader could understand the standards to recommend the use of tactile paving in numerous situations in which expert and practice interviewees stressed that natural leading elements

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should be the first choice. Even though tactile paving is described in much detail, these descriptions represent mainly simple and ideal situations. The standards do not address the many complex situations present in real life. This was emphasised as a problem during interviews with practitioners.

The Norwegian and Nordic standards are relatively coherent when it comes to the physical design of tactile paving, and what the different patterns, that is, guiding path surfaces, warning surfaces and information surfaces, indicate (Danish Road Directorate, 2012; NBA, 2010; Norwegian Ministry of Environment, 1999; NPRA, 2011; Standards Norway, 2011; Swedish Transport Administration, 2012). There are some minor differences in details. This differs from the UK, where no less than seven different tactile patterns, indicating different hazardous situations, guidance and information, are in use (UK DfT and the Scottish Executive, 2005). This may add to the potential for confusion and misinterpretation of the standards (Atkin, 2010).

Furthermore, recommended solutions are rarely sufficiently justified and explained. For instance, concerning pedestrian crossings, it is especially critical that the standards are clear, and that practitioners understand the risks of deviating from the norm. It was found that standards are not clear on the fact that crossings should be placed perpendicular to the kerb. Neither do they explain why: blind people often orient themselves at crossings by placing both feet on the kerb to identify the direction over the crossing (Storliløkken *et al.*, 2012). If the crossing is placed at a curve, a blind person may end up walking obliquely over the crossing and end up in the middle of the intersection not knowing where the sidewalk is (Scott *et al.*, 2011). Needless to say, this is dangerous but is hardly mentioned in guidelines.

Based on these observations, it was concluded that current standards, handbooks and guidelines are not sufficient to encourage practitioners to emphasise natural lead lines as the preferred solution or to ensure consistency in tactile paving systems.

### 4.3 Practice

Even though standards have their shortcomings, the performance of those planning, designing, constructing, operating and maintaining the built environment also plays a large part in the level of usability achieved for visually impaired people. In general, the practitioners interviewed for the study demonstrated good knowledge of the basic principles in universal design, and they regard it as a part of their professional knowledge base. However, they claim that most people working in this field do not have the same level of knowledge with respect to universal design and facilitating for visually impaired people.

All practitioners agreed that tactile paving is used too frequently and that specialised paving should mainly be used

to warn of danger. Practitioners explain that they would rather try to facilitate the environment without the use of tactile paving. However, they admit to often using tactile paving as the solution when upgrading or building new environments. The explanations for this are often related to the complexity of the situation, and problems of finding good solutions by using natural leading elements. They report that they mainly use standards for double-checking specific requirements, such as minimum and maximum heights of dropped kerbs.

Practitioners explain that they frequently encounter difficult and complex situations in which implementing optimal facilitation might be hard, or even impossible. They complain that standards and the like are often not very helpful in these situations, because they mainly present examples and recommendations fitted for ideal and simple situations. Hence, practitioners often need to develop solutions fitted for the specific context, and without guidance from standards.

Another problem, causing non-optimal solutions, is that matters regarding universal design in general are considered too late in the planning and design processes. Many decisions are made in zoning plan processes. When designers later in the process aim at universal design, they find that earlier decisions greatly hamper the possibilities for designing safe and usable streetscapes. Furthermore, practitioners stress that there are always many considerations to take into account in a project, meaning that there is a constant struggle regarding prioritisation between groups, values and objectives.

Practitioners find that user consultations are necessary, are often useful, and in many ways are a good thing altogether. Still, many also find that such processes may be frustrating in various ways. Some designers treat local users as experts in universal design, and lean on them for advice when dealing with complex design problems. Users are, however, normally not experts in this field, and may give advice that leads to solutions that designers are later criticised for. Several of the practitioners claimed that users involved push for tactile paving in situations when the practitioners found this to be unnecessary or not the best solution. Others had experienced that local users complained to the press or to politicians when they did not get their way, for instance regarding tactile paving. In the stakeholder seminars, it was concluded that these experiences demonstrate the need to clarify the role of users and user consultations in such processes. It was emphasised that designers should not expect users to be experts or to behave as professionals, because this is not in accordance with their role.

The experts interviewed suggested that inconsistencies in tactile paving could be due to poor construction work. One practitioner explained that those doing the actual construction of streetscapes lack the knowledge to understand why tactile

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paving needs to be laid as described in plans and drawings. Hence, extensive supervision during the construction phase is necessary. Most interviewees were, however, more concerned about the lack of knowledge among those responsible for maintenance. They felt that poor maintenance and faults made during reparations contribute to less usable and less safe streetscapes for visually impaired people.

#### 4.4 Experience from the case study

Finally, the case study of a developer with high ambitions regarding universal design revealed that focus on universal design from the start, involvement of competent and confident professionals during design and construction, and knowledgeable supervision throughout the project, increases the chances of arriving at built environments that are usable for visually impaired people.

However, the case study demonstrated how even projects with the best possible basis for universal design may also include solutions that are not optimal. This could be illustrated by two examples. One is the use of tactile paving leading towards a revolving door, which can be a difficult object to pass for visually impaired people. The designers saw, in retrospect, that this was not an optimal solution (that is why alternative doors are required), but explained that standards did not address this issue and that they had not considered whether this was a good solution. Another example regards a pedestrian crossing with different tactile paving design on each side. The explanation for this was that one side of the crossing was completed years before as part of another project, and the design was based on older recommendations. This underlines the fact that cities are continuously built and developed according to varying requirements. The edges of a project always meet the edges of other (previous) projects. Solutions chosen in other project areas might affect the usability altogether. Sometimes it might not be difficult to merge the natural reference points or tactile paving. In other situations, the solutions chosen in other project areas can greatly disturb the usability for the visually impaired.

## 5. Discussion

An aim of this research was to assess how and why qualities of current standards and characteristics of practices contribute to tactile paving being used in situations where natural leading elements would be a better solution, and why there is a lack of consistency in tactile paving systems.

### 5.1 How and why is tactile paving used where natural leading elements would be a better solution?

Seen from the point of view of practitioners, they often face complex situations in which several considerations need to be taken into account, and they seek to solve the situations in the best way they can. They may face situations in which they

introduce changes of elements in already existing streetscapes, or they may be presented with a zoning plan in which non-optimal schemes (with respect to universal design) have already been decided on. The practitioners might anyhow aim at using natural elements to form lead lines that are usable and safe. They rely on their education, previous experience and discussions with knowledgeable colleagues, and they consult standards, guidelines and handbooks. When turning to such documents, they find thorough descriptions on tactile paving, but only brief and vague descriptions on how to solve the situation with the help of natural leading elements. This is one reason why they choose standardised tactile paving.

Practitioners do also encounter local users participating in the design processes pushing for tactile paving. When designers turn to the standards, these are vague and not a good tool for convincing the users that natural leading elements are a better solution in the specific case. If conscientious practitioners turn to scientific literature for help, they will not find compelling evidence there either. Knowing that users may complain to the press or to politicians, and lacking documented evidence or clear recommendations for using natural leading elements, practitioners may choose tactile paving even though they do not find this to be the better solution.

These mechanisms seem, from our studies, to be important parts of the explanations of how and why tactile paving is used more frequently than most of those interviewed find optimal. Another relevant explanation is that many practitioners are not very knowledgeable with respect to these issues, and believe that tactile paving is the better solution. If they turn to available standards, guidelines and handbooks, such beliefs might be affirmed.

### 5.2 Why do inconsistencies in systems of tactile paving occur?

Turning to the problem of a lack of consistency with respect to tactile paving, many of the same elements play a part. Practitioners face complex situations in which many considerations need to be taken into account. When turning to standards and the like, they find recommendations and examples from simple and ideal situations, which are not helpful. Hence, they need to work out how to solve the situation on their own. If they are of a conscientious kind, they may read the standards carefully, or they may turn to research literature in order to work out how visually impaired people orient and what needs to be emphasised when making local adjustments. As found in these studies, this will not be helpful. Hence, the practitioners need to develop on-the-spot solutions based on their personal understanding of how people with sight loss orient and find their way, and how the built environment should be designed in order to be usable for them. Unsurprisingly, the results are deviating designs and hence inconsistent systems of tactile

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paving. Furthermore, as demonstrated by the case study, streetscapes are built continuously, and both standards and ideas of what are good solutions vary over time. This is also an important part of the explanation.

All standards and all interviewees agreed that tactile paving should be used to warn against stairs and crossings. The study revealed quite a severe problem – that the practice of using warning surfaces to demarcate dropped kerbs at crossings varies greatly. There are variations in designs, and in many cases warning surfaces are missing. In one example, a stretch of an urban street was rebuilt with warning surfaces demarcating some crossings but not others. In another example, warning surfaces were missing in connection with a regulated pedestrian crossing being part of the main pedestrian street, rebuilt only 5 years ago. One explanation for this, the authors were told in interviews, was that the responsible authorities did not believe that visually impaired people are able to detect these warning surfaces, or that ‘they do not use them’. Another suggestion was ‘sloppy work and project management in the construction phase’. Unfortunately, the responsible authorities were not available for interviews.

## 6. Main recommendations

The second aim of the study was to arrive at recommendations on how to improve the current situation, through changing standards and/or practices. An important finding in this work is a lack of systematic and research-based knowledge on how people with sight loss actually orient and find their way in complex pedestrian environments, how they use elements of the physical environment in these processes, and hence how the built environment ought to be designed in order to be usable for people with sight loss. The strongest recommendation is thus that more systematic research on these issues should be conducted, and to make this knowledge available to those developing standards, guidelines and handbooks, as well as to practitioners. Institutions engaged in mobility training for the blind and visually impaired may be useful partners in such work.

Standards, guidelines and handbooks should present more comprehensive and specific descriptions on how to design usable built environments, allowing easy and safe wayfinding for the visually impaired, and, furthermore, how the use of natural leading elements could be used to reinforce this. The balance between tactile paving and natural leading elements should be shifted towards natural leading elements.

The standards should contain more, better and concrete discussions, examples and illustrations of good facilitation. Furthermore, they need to explain and justify recommended solutions. Otherwise planners and designers may ignore details that are important for visually impaired people, or may misunderstand the intentions of recommendations. There is

thus a particular need for clarification and explanations regarding recommendations for crossings.

Most practitioners requested better guidance for complex situations. The standards should also contain guidance on how visually impaired people orient and find their way, and how the built environment can be designed to help and support them on their everyday journeys, with and without the use of tactile paving. Knowing how visually impaired people orient, it may be easier for practitioners to familiarise themselves with their situation and hence facilitate a better and more usable environment.

The national efforts to harmonise different standards, handbooks and guidelines should continue. This is especially important with regard to warning of hazards. Readings of standards from different countries disclosed significant deviations. This calls for international harmonisation, for instance by strengthening the influence of ISO standards.

Norwegian authorities discuss how to deal with the shared space concept when revising their standards. They are recommended to learn from experiences in the UK, where removal of the traditional kerb in shared spaces has been recognised to increase risk for sight-impaired people and to reduce their ability to navigate in such spaces (Child *et al.*, 2009; Norgate, 2012; Thomas, 2008, 2011).

Another recommendation regards improving the knowledge of practitioners involved in planning, designing, constructing, operating and maintaining the built environment. This could be done through training programmes mandatory for those involved in facilitation, and with recurring courses on a frequent basis. Furthermore, there is a need for highly qualified experts in this field. Another approach could be to put in place a system for certifying professional mobility consultants, who have received special training, as is already done in the UK.

Recommendations concerning processes include that universal design is considered early in processes, in order to prevent non-optimal frames with respect to usable solutions. Another lesson learnt is that the role of users participating in planning and design processes needs to be clarified. Finally, deeper and more thorough research than that presented here is needed regarding how planning and design processes proceed, to clarify the mechanisms contributing to the built environment being designed in ways that are usable and safe for visually impaired people.

## REFERENCES

- Atkin R (2010) *Sight Line: Designing Better Streets for People with Low Vision*. Helen Hamlyn Centre, Royal College of Art, London, UK.
- Carroll J and Bentzen BL (1999) American Council of the Blind

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- survey of intersection accessibility. *The Braille Forum* **38(7)**: 11–15.
- Child CR, Boampong DK, Rostron H, Eccleshall T and Tyler N (2009) *Effective Kerb Heights for Blind and Partially Sighted People*. Accessibility Research Group, University College London, London, UK.
- Danish Road Directorate (2012) *Traffic Areas for All – Handbook of Accessibility*. Danish Road Directorate, Denmark, Draft.
- Farr AC, Kleinschmidt T, Yarlagadda P and Mengersen K (2012) Wayfinding: A simple concept, a complex process. *Transport Reviews* **32(6)**: 715–743.
- ISO (International Organization for Standardization) (2010) ISO/DIS 23599: Assistive products for blind and vision-impaired persons – Tactile walking surface indicators. ISO, Geneva, Switzerland, Draft paper.
- Lynch K (1960) *The Image of the City*. Harvard-MIT Joint Center for Urban Studies, MIT Press, Cambridge MA, USA.
- NBA (Norwegian Building Authority) (2003) *Guidance to technical regulations to the Planning and Building Law*, Issue 3. NBA, Oslo, Norway.
- Norgate SH (2012) Accessibility of urban spaces for visually impaired pedestrians. *Municipal Engineer* **165(4)**: 231–237.
- Norwegian Ministry of Environment (1999) *Accessibility for All*. Circular T-5/99. Norwegian Ministry of Environment, Oslo, Norway.
- NPRA (Norwegian Public Roads Administration) (2011) *Handbook 278: Universal Design of Roads and Streets*. NPRA, Oslo, Norway.
- Øvstedal LR, Lindland T and Lid IM (2005) On our way establishing national guidelines on tactile surface indicators. *International Congress Series* **1282(2005)**: 1046–1050.
- Odeck J, Fearnley N and Hagen T (2010) Economic appraisal of universal design in transport: Experiences from Norway. *Research in Transportation Economics* **29(1)**: 304–311.
- Scott AC, Barlow JM, Guth DA *et al.* (2011) Nonvisual cues for aligning to cross streets. *Journal of Visual Impairment and Blindness* **105(10)**: 648–661.
- Ståhl A and Almén M (2007) *How People who are Blind Orient Along a Continuous Tactile Guiding Surface*. Swedish Transport Administration, Publication 2007:112, Kristianstad, Sweden.
- Ståhl A, Almén M and Wemme M (2004) *Orienting Using Tactile Guiding Surfaces – Blind Test Tactility of Surfaces with Various Materials and Structure*. Swedish Transport Administration, Publication 2004:158, Borlänge, Sweden.
- Ståhl A, Newman E, Dahlin-Iwanoff S, Almén M and Iwarsson S (2010) Detection of warning surfaces in pedestrian environments: The importance for blind people of kerbs, depth, and structure of tactile surfaces. *Disability and Rehabilitation* **32(6)**: 469–482.
- Standards Norway (2011) NS 11005:2011: Universal design of developed outdoor areas. Standards Norway, Oslo, Norway.
- Storliløkken M, Martinsen H, Tellevik JM and Elmerskog B (2012) *Mobility Training of Children, Young and Adults with Visual Impairments*. Tapir Academic Press, Trondheim, Norway.
- Swedish Transport Administration (2012) *Requirements for Road and Street Design*. Swedish Transport Administration, Publication 2012:179, Borlänge, Sweden.
- Tennøy A and Leiren MD (2008) *Accessible Public Transport. A View of Europe Today – Policies, Laws and Guidelines*. TØI report 952/2008. Institute of Transport Economics, Oslo, Norway.
- Tennøy A, Øksenholt KV, Fearnley N and Matthews B (2013) *Evaluating Standards and Practices for Facilitating Visually Impaired People's Mobility in the Built Environment*. TØI report 1260/2013. Institute of Transport Economics, Oslo, Norway.
- Thomas C (2008) Shared space – safe space? *Municipal Engineer* **161(1)**: 59–60.
- Thomas C (2011) Briefing: Minimum effective kerb height for blind and partially sighted people. *Municipal Engineer* **164(1)**: 11–13.
- UK DfT (Department for Transport) (2005) *Inclusive Mobility: A Guide to Best Practice on Access to Pedestrian and Transport Infrastructure*. DfT, London, UK.
- UK DfT and the Scottish Executive (2005) *Guidance on the Use of Tactile Paving Surfaces*. DfT, London, UK.
- UN (United Nations) (2006) *Convention on the Rights of Persons with Disabilities and Optional Protocol*. Adopted 13 December 2006 and opened for signature on 30 March 2007. See <http://www.un.org/disabilities/default.asp?id=259> (accessed 16/11/2013).
- WHO (World Health Organization) (2007) *Global Age-Friendly Cities: A Guide*. WHO, Geneva, Switzerland.
- WHO (2013) *Pedestrian Safety – A Road Safety Manual for Decision-Makers and Practitioners*. WHO, Geneva, Switzerland.

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