Wayfinding By People With Visual Impairments In The Exterior Urban Environment

by

Ricardo Sevilla Carreon

A Masters Thesis

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University of Manitoba
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DEDICATION

I dedicate this work to my parents,
Ricardo and Lydia, and
my sisters, Rosanna and Rhodora
who faithfully supported me and encouraged me
in all my endeavors

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ABSTRACT

Wayfinding By People With Visual Impairments In The Exterior Urban Environment

The purpose of this study was to explore and compare the wayfinding experiences of people with full vision and people with visual impairments. The main objective was to test the street environment to find the areas that limited and facilitated the wayfinding activity of people. Wayfinding is defined as the ability to find one's way to a pre-determined location. It involves cognitive and perceptual processes including the way a person relates to their surroundings (Arthur & Passini, 1992).

The study occurred between 1997 and 1999 and was modeled after Finkel's study (1994) on wayfinding by people with visual impairments in the built environment. The study incorporated 'consumer driven research,' in a modified sense, and included a consumer advisory committee, which took part in several components of the study as well as in the review of all research chapters. Forty-eight adults comprised the study sample who were placed in one of four groups: 15 people aided by a white cane; 15 people with low vision and using no aids; 11 people aided by guide dogs; and 7 people with full vision. They were asked to walk a pre-determined route, in the Osborne Village area of Winnipeg, Canada and later interviewed (in terms of their wayfinding experiences) regarding the route travelled as well as other areas of the city.

Data was collected and coded into various categories such as which elements of the environment were used most often, the areas that were considered to be problematic to wayfinding, and what design considerations

should be taken to improve the pedestrian environment. The results showed that there are many barriers that inhibit wayfinding for people with and without visual impairments. Such barriers are directly linked to the design and layout, as well as to the lack of regular maintenance of pedestrian routes. People, with or without visual impairments, generally confront the same wayfinding problems and have similar wayfinding needs. The study shows that all participants relied on architectural and sensory cues to conduct wayfinding along city sidewalks.

The inclusion of participants in the study was critical in generating realistic solutions to the problems of wayfinding on city sidewalks. Participants offered many suggestions for improvements of the street environment, chiefly the standardization of design and layout and careful maintenance of city sidewalks. Other suggestions included the use of tactile surfaces and contrasting colours which would define the path of travel and enhance the wayfinding activity of people with and without a visual impairment. A number of participants emphasized the need for right angle configuration of street elements and sidewalks to help promote straight line orientation. Participants also recommended a standardized use of audible signals throughout the city. More importantly, the design solutions generated from this study have the potential to accommodate the needs of a wider population and, thus, have relevance in the development of universal design.

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1. INTRODUCTION

Over the past number of years there has been a growing interest to re-evaluate standard methods of design in order to accommodate a wider range of personal needs (Steinfeld, 1994). As populations continue to grow and expected life-spans increase, one of the areas to be addressed is the issue of universal design in the urban environment (Steinfeld, 1994). The current system of streets and sidewalks, for instance, in most urban environments often inhibit movement by people with disabilities (Passini, 1984; Finkel, 1994). Urban streets are typically complemented with a host of visual landmarks and signs to reasonably aid a majority of people to navigate them as efficiently as possible. However, the conventional design of these environments does not facilitate the needs of all people, and the difficulties in wayfinding in these settings are felt acutely by people with visual impairments (Arthur & Passini, 1992).

Wayfinding is defined as the ability to find one's way to a pre-determined destination (Arthur & Passini, 1992). It involves perceptual and cognitive processes including the way a person relates to the spatial environment and to destinations (Passini, 1984). The ability to get around the urban environment is an integral part of people's lives and is a necessity to sustain their social and economic activities and goals.

Presently, most of the streets in downtown Winnipeg, Manitoba, lack any consistent architectural elements which can adequately facilitate the spatial orientation and wayfinding activities of people with visual impairments (Finkel, 1994; Carreon, Hogan, & Wotton, 1996). The difficulty in locating crosswalks, bus stops, and entrances are just some of the problems people with visual impairments confront when walking in the street environment (Genesky, Berry, Bikson, & Bikson, 1979; Carreon et al, 1996). In light of these situations, people with visual impairments are limited not by their physical condition, but by the built environment in which they exist (Finkel, 1994). The standard design of cues and information systems, such as signage, found in the exterior urban environment must be more broadly conceptualized as the means to helping all people move through city streets efficiently and independently.

There is much knowledge to be gained from the perspective of people with disabilities. In order to define how people with visual impairments relate to the street environment it was determined that a comprehensive study of their perceptions and wayfinding experiences was critical. This research focused on describing aspects of existing streets in downtown Winnipeg, which limit or aid their movement. The result should lead to a better understanding of how the built environment affects people in general.

1.0 Statement of Purpose

The purpose of this research is to document factors influencing the wayfinding activities of people with visual impairments and people with full vision within a downtown area in Winnipeg, MB. The study will serve to broaden the scope of city planning and landscape architecture in terms of creating practical street designs relevant to wayfinding. It will also explore the relevance of findings and its potential to lead to the development of universal design. The strategy for research included the participation of disability organizations as an integral part of the research and decision making process. A facet of this study was to examine the basis of consumer/designer partnerships as a necessary component in the planning and development of urban settings. Such partnerships were opportunities to widen the range of decision makers, which can lead to the participatory design of these environments. Considering that the population of people with visual impairments living in Manitoba was 22,220 (Statistics Canada, 1990), with 64.9% at 65 years and older (the highest in Canada), addressing their perspectives on exterior urban environments was warranted.

1.1 Hypothesis and Objectives

The research hypotheses states that: the limitations in an individual's ability to wayfind is not a result of the individual, but of the built environment in which he / she exists. The objectives of this study are listed as follows:

1.1.0 To investigate the influences on wayfinding by people with and without visual impairments in the street environment, including;

a) architectural elements such as building walls, sidewalk surfaces, boulevards, open spaces, narrow passages, curb ramps, and crosswalks

b) fixed and moveable elements such as signs, posts, mail boxes, benches, trees, and newspaper dispensers

c) other variables such as ambient noise and illumination, wind, smell, echo location which are inherent in the setting.

1.1.1 To compare the responses and opinions of participants regarding the route travelled, as well as general issues of wayfinding in the exterior urban environment.

1.1.2 To focus on research findings and recommendations made by participants to develop solutions for design, to evaluate their significance to universal design principles, and gather ideas on future research.

2. LITERATURE REVIEW

2.0 Wayfinding Definition

Wayfinding, according to Arthur and Passini (1992), is the process of reaching a destination, whether in a familiar or unfamiliar environment. It is regarded as spatial problem solving and is comprised of three specific, but interrelated processes:

•**Information processing** including environmental perception and cognition that permits two decision processes;

- **Decision making**, which leads to a plan of action (or decision plan) to reach a given destination;

- **Decision execution**, which transforms the plan into overt behavior and movement at the right place.

When we wayfind in the built environment we are perceiving cues from architectural elements, spatial arrangements, graphics and verbal messages. This involves the ability to cognitively map spaces, which requires an understanding and manipulation of space. Wayfinding is also influenced by prior knowledge or experience, therefore, creating a less demanding decision plan for the traveller (Public Works Canada, 1987).

Some of the environmental information in the urban setting can place a burden on our perceptual and cognitive functioning, leading some people to become disoriented and lost. According to Public Works Canada, 1987, the most common problems in wayfinding can be attributed to:

• **Ambiguous spatial organization of buildings**: Some buildings are hard to read because of the complexity of their design. The forms of a building can often lead to assumptions regarding its spatial organization. Valuable wayfinding information is often not provided because the potential that architectural and spatial elements have as environmental communicators is not exploited or is under-exploited. The message-carrying burden is then placed on a system of signs, which are invariably regarded as an afterthought to building design.

• **Message clarity**: Signs that are not properly positioned or clear in conveying messages may create confusion for the user.

• **Message overload**: Too many signs, visual clutter and other information sources in the surrounding area distract attention from wayfinding activity.

The overall result of these inadequacies creates increased anxiety, stress, frustration, and, sometimes, guilt for not being able to successfully find the desired location.

2.1 Environmental Perception and Design

The subject of wayfinding in the urban context was first dealt with by Kevin Lynch in his book *The Image of the City* (1960). Lynch argued that visual accessibility and the prominence of five key environmental components of a city - paths, landmarks, nodes, edges, and districts - are the design criteria for a highly legible and imageable city environment. Legibility is the degree to which different cities and different parts of cities stand out and can be recognized and organized into a coherent pattern in people's minds (Garling & Evans, 1991). Thus, the five elements, which Lynch described, are pieces which help facilitate people's cognitive mapping process. Familiarity with these elements help solve people's wayfinding tasks (Garling & Evans, 1991). The extent of Lynch's analysis of wayfinding in the city is very general and serves to identify qualities of the city which can guide a person's understanding of it in its context. It did not analyze wayfinding in terms of architectural and sensory cues as described by Arthur and Passini.

As pedestrians travel in open spaces they are able to deduce a system of cues, or landmarks, to serve as guides in their journey (Goldsteen & Elliot, 1994). Each tree, bench, drinking fountain, or store window acts as markers by which the pedestrian measures passage through space. When the objects are situated in an orderly fashion, observation of the objects results in the determination of the pattern in which they are positioned, and decisions can be made on the basis of that pattern. However, the irregular placement of objects in space will require more attention, assessments, and decision-making. Moreover, the absence of nearby objects increases the distance to those markers which are essential in determining one's position.

The manner in which people behave in the environment is influenced greatly by their perceptions of the city. The basic assumption of research and environmental cognition has been that different people interpret their environments differently, according to their backgrounds and experiences (Madanipour, 1996). Based on this theory, there is no one environment, rather environment is a mental construct. Madanipour stressed that basic images inform the cognitive maps and linguistic conceptions of the city. Conceptions of space are different for all people, both in concrete terms and in subjective and symbolic terms. What some people see as a place of security and opportunity might be viewed as a place filled with hazards that should be avoided by others. The differences among people in relation to ethnicity, gender, age, lifestyle, length of residence in an area, and the mode of travel within the city, all affect the way the environment is perceived. The existence of these dissimilarities can indicate that environmental cognition is a product based on the individuals' personal and social experiences and their ability to interact with that environment in the urban setting. In planning spaces, the attraction to generalize about users' interpretation of a place must be balanced against the recognition that there is a multiplicity of possible interpretations.

As individuals develop their personal knowledge and reasoning of a space, the objects and people that exist within that space have an impact on the behaviour of individuals. While perceiving the immediate surroundings, people look for elements of coherence, regularity, and predictability, as well as for complexity and the unexpected. In travelling, there is a concern to understand the arrangement and to gauge one's bearings. There is a desire to make sense of one's position as it changes relative to the fixed elements of the scene (Goldsteen & Elliot, 1994). In the process of interpretation, the individual must balance in their minds aspects of order and predictability against disorder and unpredictability.

Bright, Cook, and Harris (1997) described the application of colour contrast and luminance in buildings as helpful aids to building users, particularly for people with visual impairments. The implementation of appropriate colour contrasts and tone within a setting can enhance spatial awareness and navigation of people with visual impairments. Adequate colour luminance contrast can provide vital visual clues in detecting junctions, edges, and boundaries in a building. The study serves to inform designers about the use of proper colours and luminance at the appropriate time and place within a given setting. More important is that the study emphasizes colour and tone use, which is helpful to most users including people with visual impairments.

The **S.T.E.P.S.** project (Seniors and Persons with Disabilities Task Force for Environments Which Promote Safety) identified hazards associated with pedestrian travel, specifically to seniors and persons with disabilities (Gallagher & Scott, 1997). The project, through consultation with local residences and authorities, made recommendations aimed at increasing the safety of senior pedestrians and people with disabilities. The design suggestions ranged from sidewalk surface treatments to the implementation of tactile warning strips along curb ramps. The study was important because it had recognized consumer consultation as a vital element in helping rectify problems in the design of pedestrian spaces. However, it did not deal with the larger scope of wayfinding in terms of landmarks, signage, and spatial configuration as interrelated components of the environment.

2.2 Describing Visual Impairment

People who are defined as being blind or visually impaired are considered "legally blind." This refers to visual acuity for distant vision of 20/200 or less in the better eye, with best correction or visual acuity of more than 20/200 if the widest diameter of field of vision subtends an angle no greater than 20 degrees. In other words an individual who is classified as legally blind can see no more at a distance of 20 feet than a person with use of full vision can see at a distance of 200 feet. Total blindness means there is no light perception in either eye (American Foundation for the Blind, 1972).

The leading causes of visual impairment are glaucoma, macular degeneration, diabetes, senile cataract, and prenatal influences. The chances of being visually impaired from all, but the last, increase dramatically with advancing age. Senile cataract and glaucoma are most common among the older population (American Foundation for the Blind, 1972).

Jahoda (1993) documented the daily functioning of people with visual impairments and revealed the primary methods used to get around and accomplish mundane tasks. Unlike people who have full vision, people with visual impairments rely on other senses to notice the environment. Information about the surrounding environment is collected mostly through sound, touch, sight (whenever possible), and smell.

Sounds are useful to locate destinations and gauge distance. Vehicular and pedestrian traffic sounds, for instance, help people with visual impairments to determine direction and flow of traffic, when to cross streets, and where crosswalks are located. Residual vision can be used to detect light and colour contrasts, as well as still and moving objects within a given setting. The tactual sense allows a person with a visual impairment to distinguish objects and ground surfaces through touch. Changes to ground surfaces can often complement both hearing and sense of touch depending on the quality of the tactile surface when exposed to the foot or white cane. Echo location is a technique used to hear and feel sounds reflected from an object nearby. This method is not used by many people and requires the ability to isolate informative echoed sounds to be rendered useful. The olfactory sense, or smell, can be useful to discern landmarks along a pedestrian path. For instance, bakeries and restaurants that emit strong aromas inform people with visual impairments where they are in relation to the route (Jahoda, 1993).

Many people with visual impairments travel independently with the use of corrective lenses and / or other aids and methods. Some people with low vision use dark glasses to protect their eyes from the effects of glare and from objects, such as tree branches, which protrude into the path of travel (Jahoda, 1993).

White canes are used by some people with visual impairments to navigate and detect objects in front of them while walking. As the person with a white cane walk, they sweep the cane from side to side and tap it on both sides. The sweeping motion is to detect obstacles in the front of the person using the white cane. The angle of the sweep should be wide enough to protect the body from shoulder to shoulder against obstacles in the way. Tapping to the left and right serves two purposes. First, it enables the person with the white cane to follow the path by sensing for the "shoreline" - the line between pavement and grass or other differentiating composition. And second, it serves to alert people with white canes of curbs, steps, or other obstacles on the ground (Jahoda, 1993). The use of white canes is a method that increases independent travel and safety by informing the user of holes, drop-offs, and other changes in levels of terrain (Blasch & Stuckey, 1995).

Guide dogs, as companions, can help the person with a visual impairment to arrive at specific destinations, board buses, and cross streets. The person aided by the guide dog conducts the actual wayfinding and informs the dog where to turn or stop. For instance, the guide dog is taught to stop at street crossings and will not cross until the person with a visual impairment determines that it is safe to cross. The use of a guide dog as an aid requires the person with a visual impairment to undergo a systematic orientation and mobility training with professional instructors (Jahoda, 1993).

2.3 Wayfinding by People with Visual Impairments

Arthur and Passini (1992) pointed out some notable differences in the way people with visual impairments wayfind from people who have use of full vision. For example, people with a visual impairment prepare for a journey in more detail, make more conscious decisions, and use more environmental information than people who have full vision. This is due to the reduced distance perception of the person with a visual impairment, something people with full vision take for granted. Some people with a visual impairment must move through a series of short stages, relying heavily on touch and sound as they travel. The acquisition of cues (auditory-echo location) is primarily confined to close vicinities, restricting some decisions on whether to move forward until a potential warning message is completely understood. In some cases, people with a visual impairment depend on olfactory and heat perception to help locate specific locations along the path of travel.

The difficulties in negotiating the built environment by people with a visual impairment often come from both architectural and extraneous factors found in the setting. People with visual impairments rely heavily on hearing as a way to move around, therefore, this perception should be optimized (Arthur & Passini, 1992). Problems can arise when there is distracting noise, thereby decreasing the accuracy of hearing perception (Genesky et al, 1979; Arthur & Passini, 1992). Complex spatial configurations present other problems for people with visual impairments, since they introduce multiple decision points, thereby increasing wayfinding difficulties (Finkel, 1994). Unfamiliar settings can also add stress to the wayfinding activities, creating situations that may lead to accidents (Arthur & Passini, 1992). Illumination, particularly glare, produced by reflective materials is found to reduce visibility and are problematic for wayfinding (Genesky et al, 1979; Finkel, 1994).

2.4 Wayfinding Research

During the 1970s, several wayfinding studies were conducted in some of Montreal's public buildings by Romedi Passini (1984). These studies involved the participation of people with full vision who were asked to complete a series of wayfinding tasks, along a given route. The sample range in each of the three studies undertaken; 1975, 1978, 1979, included 12, 8, and 16 participants respectively. The methods used by Passini included a wayfinding protocol and an interview evaluating the difficulties of the task and the setting. The protocol method allowed the observer to record all the comments participants were encouraged to make while completing the wayfinding task. These comments centred on the process of problem solving for each of the participants. Interviews at the end of the wayfinding task focused more on the participants' familiarity with the setting and their assessment of the environment with regard to their wayfinding process. Passini's study in wayfinding is important in that it examined the concept of wayfinding in terms of spatial problem solving. The data collected helped Passini make some conclusions about different elements of the environment that were recognized as limitations or aids to the wayfinding activities of participants. Although Passini's studies did establish some principles for assessing environments respecting the wayfinding process, they did not however, contain sufficient sample sizes necessary for statistical importance. Furthermore, people with different functional needs were not equally represented in the samples.

A three year study conducted by the United States Department of Health, Education, and Welfare (Genesky et al, 1979) examined the problems of environmental adaptation by people with low vision. It investigated a wide range of urban settings and common activities which were identified as problem areas for people with low vision. A total of 94 participants were asked to rate and make comments on these particular areas in an interview. The study is significant in that it identified the outdoor environmental conditions and physical barriers which limited the access and mobility of participants. Data were also collected on how participants felt about outdoor illumination and what types of problems they had when crossing streets. The aim of the project was to collect both quantitative and qualitative data which provided a basis for understanding the needs of people with low vision. It did not, however, include other people with varying degrees of visual impairment and deal with wayfinding as a concept of spatial problem solving in great detail.

A descriptive study about the spatial mobility of active people with visual impairments was undertaken by Passini, Dupre, and Langlois in 1986. The research sample, which included 47 participants with various levels of visual impairment, indicated differences in wayfinding methods and information gathering from the environment. The researchers discovered that small scale reference points such as buildings, fences, stairs, and trees were perceptible to the person who is totally blind at close proximity. The study pointed out that total blindness (the absence of any residual vision) can facilitate concentration and the development of other senses. People with residual vision included similar items in their wayfinding strategies and were known to rely on vision during locomotion, as long as there were stable light levels. Cardinal points (north, east, west, and south) direction of the sun, and memory were other techniques proven to be useful by several participants. The study focused on the limitations of the exterior environment and emphasized that design and other elements, such as climate, can affect the wayfinding by people with visual impairments. Different wayfinding strategies were expressed as well as recommendations to improve the built environment.

A study in 1994 by Gail Finkel compared the indoor wayfinding experiences of people with full vision and people with visual impairments. It emphasized the methods by which groups are able to wayfind in the built environment and what aspects of the design were most useful to them. Finkel's research design was based on that used by R. Passini and G. Proulx (1988), in which three tests were used: a walk through, cognitive mapping, and an interview, to identify decision making processes of participants when wayfinding in an indoor setting. Research findings indicated some similarities among the groups with respect to physical and sensory cues in the environment. It also pointed out the relevance of universal design, as a philosophy, which can guide the design process. Finkel's approach to consumer consultation as a research strategy is critical to addressing certain changes needed in the built environment. Moreover, the comparative analysis of four groups shed light on some of the basic commonalties among people in wayfinding.

Bentzen and Barlow (1995) recorded the effects of curb ramps on the wayfinding activities of people with visual impairments. The research showed that people who travel using a white cane were unable to recognize the presence of the street at the curb ramp location because of its gradual 1:12 compliant slope. Curb ramps with more abrupt slopes seemed to facilitate detection better, while angled ramps were found to cause disorientation for respondents. The study showed important findings concerning street design which impacted the safety and wayfinding activities of people with visual impairments. More importantly, it revealed that as a design accommodates one group (people who use wheelchairs) it might not be suitable for another.

2.5 Research Strategies

Participatory Action Research (PAR) is a process which provides the framework to build community involvement in an effort to study consumer needs and design action to meet those needs. Sample (1996) pointed out that in PAR, members of the community (consumers) under study participate actively with professional researchers / practitioners throughout the research process from the initial design to the final presentation of results and discussion of their action implications.

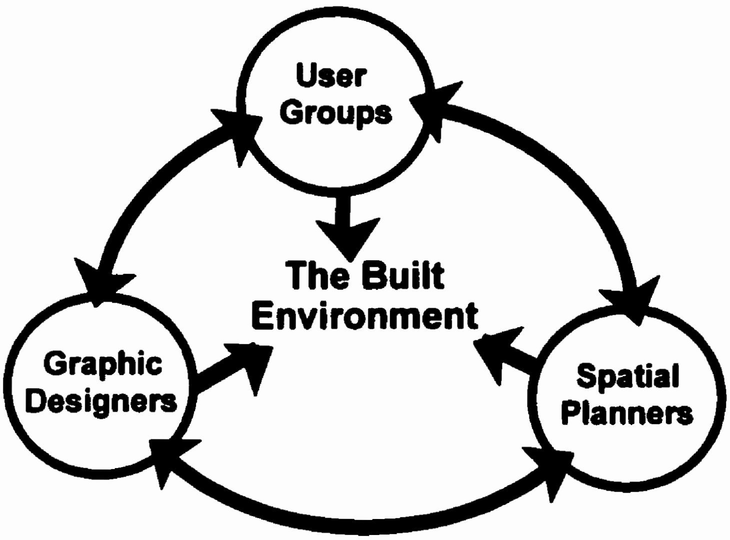
Guerrero (1995) described the benefits of PAR. The collaborative effort, among researchers / practitioners and community representatives combines two bodies of knowledge to drive the design and development of the research. The use of focus groups, for example, help in determining the direction of research to ensure applicability and relevance. Guerrero describes focus groups as important because they enhance the participation of consumers and other community members who are potentially affected by the research.

PAR strategies empower the consumer in every step of the research process since they are able to partake in the identification, prioritizing, planning, design, and implementation of the project objectives. To be empowering, the research must be designed with a group of people who have decided to obtain power, and then must be conducted so that the group learns how to do the research, as well as decide what research needs to be conducted (Sample, 1996). The benefits of

PAR are its underlying concepts to democratize research and establish real solutions directed towards the needs of the people affected by that research.

The PAR process exhibits many good qualities which can facilitate active participation and the introduction of real solutions to the problem. However, this study was not initiated by the PAR process and only some of its principles have been adopted to develop the research. In particular are the methods of participation by consumers in identifying the problems associated with wayfinding on city sidewalk and research planning (site locations, recruitment of participants, review of survey and chapters of the study). The need for community or consumer involvement in this study has led to the development of the Consumer Advisory Committee. The research explored 'consumer driven design,' in which the consumer advisory committee played a role, and will be discussed further in Chapter 3 - Method.

In wayfinding research and design, an integrated approach can be achieved by placing emphasis on user needs and widening decision making at the beginning of the design process. The process, involving a user group (consumers), spatial planners / landscape architects, and graphic designers can be developed into a working relationship that will contribute to effective wayfinding designs (Wilkoff & Abed, 1994; Arthur & Passini, 1992). Unlike the conventional linear method, where wayfinding designs have often become a product of non-interactive relationships between users and designers, the integrated approach encourages consumers to play a vital role in the evaluation of the design throughout the entire design process. Review and clarification of the design will be constant. The illustration below explains the integration of all three groups to establish an effective wayfinding strategy (Arthur & Passini, 1992).



People are the most important component in establishing a wayfinding design strategy and are the reference point from which information regarding the wayfinding process can be understood and translated into a conceptual plan by spatial planners and graphic designers. By identifying range of functional needs, user patterns, and destinations, designers can comprehend how a setting operates and how people should be moved through spaces and directed to their destinations (Arthur & Passini, 1992).

Spatial planners are responsible for organizing space and objects so that they can easily facilitate spatial problem solving for wayfinders. The important skills the planner will need include having a good grasp of the range of user needs, cognitive mapping, and the ability to form architectural elements into meaningful wayfinding information. Graphic designers will need to work closely with planners to help reinforce such information by way of signage (Arthur & Passini, 1992).

The contributions of the graphic designer throughout the project will be significant and is one that should never be left until the end of the design process. They too will need to know about the wayfinding process, in order to relate it into clear and legible information systems. The design and location of signage should reflect the pattern of wayfinding behaviour in order to be effective. Moreover, the graphic designer must be current with technology and other signage methods, such as the use of tactile maps and audible signals, to facilitate wayfinding for as many users possible (Arthur & Passini, 1992).

The integrated approach promotes a sharing of knowledge, not just among design professionals but also between practitioners and the people who will use the environments that are being conceptualized. The benefit of consumer participation in design is that it can lead to pragmatic solutions to real everyday problems. Applied to wayfinding design, it is a process which ensures that the setting and the wayfinding information system within are intricately related. Thus, wayfinding will be greatly enhanced because the built environment and its respective signage systems are mutually reinforced.

2.6 Universal Design

Universal design promotes the design of products and environments which are usable by all people, to the greatest extent possible, without the need for adaptation and specialized design (Connell, Jones, Mace, Mueller, Mullick, Ostroff, Sanford, Steinfeld, Story, & Vanderheiden 1996). Accessible or "barrier-free" design, on the other hand, has a tendency to segregate people and create separate facilities for people with disabilities. For example, a ramp set off to the side of a stairway at an entrance is disability specific. Instead, a universal design approach to this situation would be one which incorporates a well-integrated universal access that can be used by all users, including those with walkers, baby carriages, shopping carts, and wheelchairs. Items that are usable by most people, regardless of their level of ability or disability, or functional requirements can be considered universally usable. This is accomplished through thoughtful planning and design at all stages of any design project. This process need not increase in costs or result in special, clinical or different looking facilities (Mace, 1990).

More designers, consumers, and educators are following the philosophy of universal design as an approach to create sustainable designs and as an alternative to barrier-free design. Universal design attempts to eliminate disability by design and segregation of users by exceeding regulatory codes. The intent of the universal design concept is to simplify life for everyone by making products, communication, and the built environment more usable by more people (Mace, 1990). Universal design, in terms of usability, can be defined in seven basic principles (see Appendix A for detailed guidelines):

1) Products and built environments should have **equitable use** so that users are not stigmatized or segregated. This principle ensures that designs maintain a broader appeal to all users and that they function adequately for as many people possible.

2) **Flexibility in use** pertains to a design's capability to accommodate a wide range of user preference and abilities. It reflects the need for the design to offer choices in methods of use and to facilitate the ways people function according to their different pace, accuracy, or left-hand / right-hand operations.

3) Designs ought to be **simple and intuitive** so that it is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level.

4) Products and built environments should contain **perceptible information** to effectively communicate necessary information to the user regardless of ambient conditions or the user's sensory abilities.

5) Designs should be **tolerant of errors** to minimize hazards and the adverse consequences of accidental or unintended actions.

6) Designs should facilitate use by requiring **low physical effort**. This principle enables people to use designs efficiently and comfortably with a minimum of fatigue.

7) To be effective, designs should provide appropriate **size and space for approach, use**, reach, and manipulation regardless of user's body size, posture, or mobility (Connell et al, 1996).

These principles recognize the need for designers and producers to understand the broad range of human abilities, which are affected by design. Such considerations, for instance, include having knowledge of the differences in strengths, intellectual abilities, perceptions and values of people (Steinfeld, 1994).

Fundamentally, there is no difference between the general thinking of planning, architecture, product design and universal design. In this regard, universal design does not present itself as a new design language but one that promotes just good design (Aslaksen, Bergh, Bringa, & Heggem, 2000). The goal of universal design, in theory, goes beyond the functions of products and environments and strives to address cultural, gender, aesthetic, safety, and environmental issues as well. At the same time, universal design is directly related to an ideology and incorporates key words like equal status, equal treatment, and democratization (Aslaksen et al, 2000).

The difficulty in promoting universal design may lie in its theory to find appropriate designs for as many people possible. In reality, some things have limited usefulness to some populations (e.g., a stereo system for people who are deaf). In addition, user groups with a certain disability may be further divided into sub-groups that have more severe forms of the disability. For instance, people with mild hearing loss would use different techniques and aids from those with severe hearing loss. Thus, the target user groups are too small to be addressed individually. Moreover, the population is geographically distributed, resulting in some groups benefiting from useful designs while others do not. This is the dilemma in promoting the concept of universal design (Vanderheiden, 2000). There must be an understanding that it is unreasonable to design everything so that it can be used by everyone, but it is equally unreasonable to produce special designs for each consumer product to accommodate the different levels of functioning found in our population.

However, this should not be interpreted as an obstacle in implementing universal design in practice. A balancing act must be performed where some special aids and devices will continue to be necessary to fulfill the needs mass market design cannot effectively meet, while other mass market products and environments can be made more useful for people through careful and informed design (Vanderheiden, 2000).

In order to put theory into practice, universal design demands a methodology that can effectively represent a large number of users in the development of solutions. Such solutions can only be brought to surface through careful analysis of the functional requirements of a representative selection of the population. From this, common themes will emerge which can be beneficial to the greater body of knowledge (Aslaksen et al, 2000). In wayfinding design, understanding the commonalties of user needs and drawing from the seven principles of universal design will lead to more broadly conceptualized solutions to the problem.

The application of universal design will become more critical in light of dramatic changes expected in our demographics. For example, in Canada, 15% of the population has some form of disability (Statistics Canada, 1990). The baby boom generation is beginning to move towards the retirement stage and it is estimated that seniors will comprise 23 % of the population by the year 2041. Universal design also presents an opportunity for economic development. The creation and production of consumer products that are easier to use by a wider range of user needs can improve competitiveness in the world export market. Moreover, the development of public infrastructure, cultural, and recreational sites that are universally functional for as many people as possible can improve tourism and contribute to general economic welfare. As life spans increase and the inadequacies of assistive technologies and environments are becoming more apparent, there will be a growing interest in universal design as an alternative to accessible design (Steinfeld, 1994). Creating designs, which do not segregate users, but instead encourages universality, is seen as beneficial and economical to society in the long run.

2.7 Summary of Literature Review

When we wayfind in the built environment we are perceiving vital cues from our immediate surroundings. Such cues include architectural features, spatial arrangements, graphics and verbal messages, as well as sensory information.

People with visual impairments often prepare for a journey in greater detail and use more environmental information than people who have full vision. People with a visual impairment rely on tactual and auditory perception, as well as sight (when it is possible) to move in a series of stages to arrive at their desired destination. Some of the biggest challenges to wayfinding by people with a visual impairment are related to the way the exterior environment is planned and designed.

The wayfinding studies, cited in this literature review, indicated the significance of environmental cues and the impact of spatial arrangements to wayfinding by people with and without a visual impairment. What is not represented in these studies, though, is how these elements may impact wayfinding by people with a visual impairment who use aids / personal assistance (such as white canes and guide dogs) and people with full vision in an outdoor pedestrian setting. Thus, the intent of this research is to explore the perspectives of these individuals and determine what implications their views may have on the conventional methods of pedestrian circulation design. The study will also examine the potential these design implications may offer towards universal application.

3. METHOD

3.0 General Research Methods

The research design is based on a study by G. Finkel (1994), which examined wayfinding by people with and without a visual impairment inside a public building. Finkel utilized three tests (a walk through a designated site, cognitive mapping, and an interview) as a way of analyzing the wayfinding processes of participants. The study placed emphasis on architectural features and the effect of mobility aids used by people with visual impairments. Finkel recognized mobility aids as the way to define the three sample groups of people with visual impairments in the study (1994).

The proposed study concentrated on similar issues with the exclusion of the cognitive map exercise. As in Finkel's study, a comparative study is represented involving people who use white canes, people with low vision without aids, people with guide dogs, and people with full vision. A combination of quantitative and qualitative methods has been used to evaluate performance and opinions of participants (Sommer & Sommer, 1986; Sproull, 1988; Finkel, 1994).

3.1 Consumer Advisory Committee

The research explored 'consumer driven research' in a modified sense. It was necessary to establish partnerships with consumers who will be impacted by the research goals and objectives (Guerrero, 1995). The participation of people with visual impairments in the study was beneficial in helping to manage and direct the research focus. It was intended that through collaboration, the consumer advisory committee would maintain part ownership of the project and its final report. Representatives from the Manitoba League of Persons with Disabilities Inc. (MLPD), the Inter-organizational Access Committee (IOAC), and the National Federation of the Blind: Advocates for Equality (NFB:AE) were asked to review the study's goal and objectives. Formal letters were sent to each of these organizations to request their participation in the study. These letters were made available in large print, disk, and Braille formats (see Appendix C).

The mandate of these organizations is to achieve a community that is equally accessible and usable by people with disabilities (see Appendix B for an exact description of organizations). The MLPD represent people with different disabilities, however, the IOAC is focused on the needs of people with visual impairments.

An initial meeting was conducted to formally introduce the goals and objectives of the study to representatives from the MLPD, the IOAC, and the NFB:AE. Once these representatives had approved the research outline, they were asked by the researcher if they were interested in forming a consumer advisory committee to help direct the study. A three-person committee was struck with one volunteer representing each one of the three groups with a visual impairment that had participated in the study (one who used a white cane, one with low vision without use of an aid, and one assisted by a guide dog).

Members of the consumer advisory committee were consulted to review necessary documents and information sent to potential participants and other parties. The committee reviewed the study's sampling process, field study procedures, as well as the survey used for all interviews. They had also helped establish a list of possible locations in the city for the field study component, later used for the sample screening process.

The advisory committee was instrumental in the acquisition of many participants for field testing. Members of the committee had great knowledge of people with a visual impairment in the city through association and other community projects. Because of this, the researcher was able to accumulate a list of potential participants.

The field study pre-test was also conducted with the assistance of the consumer advisory committee, which will be discussed in greater detail in this chapter. Each member of the committee completed a walk-through of the pre-selected route with the research team as part of the pre-test. An important element of the pre-test is that it prepared the research team of what to expect on the route during field study sessions. The guidance provided by committee members during the pre-test also helped the research team understand, for instance, how to give proper directions or assist a person with a visual impairment cross a street. This information was particularly helpful during the initial walk-through of the route with each of the participants during the field study. Each committee member also participated in the interview portion of the pre-test. Afterwards, members were able to critique the format of the field study, including the questions asked in the survey. This allowed the researcher to make any adjustments prior to the actual field study.

All chapters of this study were reviewed and critiqued by members of the consumer advisory committee. The committee was particularly helpful in providing assistance in reference to the proper terminology used in this document. Proper language and terminology were essential to adequately describe persons with disabilities as users of the built environment.

The consumer advisory committee was given progress reports by the researcher throughout the duration of the study. A total of three meetings took place between the researcher and committee members, however, most of the communication took place through email correspondence.

3.2 Sample

There were four categories of people that comprised the sample: people who use white canes; people with low vision who use no aids; people who are assisted by guide dogs; and people with full vision. All persons were able to follow directions and walk independently with or without mobility aids (white cane, corrective lenses, or guide dogs). They were between the ages of 18 to 65, resided in Winnipeg, were not a member of the study's consumer advisory committee, and were available for the field testing period. The total sample size included 48 participants and was broken down accordingly;

15 people with visual impairments who use white canes

15 people with low vision with no mobility aids

11 people with visual impairments aided by guide dogs

7 people with full vision

Recruitment for all four groups was achieved through advertisements posted at the University of Manitoba and through the assistance of the consumer advisory committee (see Figure 1 for flow diagram of sampling process). Persons who had expressed interest in participating in the study were sent an introductory letter and a brief outline of the project objectives (see Appendix D). These letters were made available in large print, disk, and Braille formats for people who requested them. Persons who passed the screening interview were contacted to be ensured of research confidentiality and for field study scheduling (see Appendix E). Formal consent forms were signed by all persons who agreed to take part in the research (also made available in large print, disk, and Braille formats upon request) prior to field study (see Appendix F).

Figure 1. Flow diagram of sampling process

Introduced sampling process to
Consumer Advisory Committee

↓

Approval of sampling process
by Consumer Advisory Committee

↓

Advertised for participants

↓

Sample of consumers with visual
impairments and with full vision

↓

Sent contact letters, project outline, and
screening questions to interested persons

↓

Telephone contact:
screening interview administered to people
willing to participate in the study

↓

Confirmation of eligibility based
on sample criteria

↓

Once selected, eligible person will be
placed into appropriate groups

↓

Formal consent signed by participant

↓

Scheduled participant in
for field testing times

3.3 Research Site

The selection of the research site was made with the advice of the consumer advisory committee. It was proposed that the site be a pedestrian route near or around downtown Winnipeg and was least familiar with the majority of participants in the study. The research was to examine the different ways participants react to wayfinding cues of the environment without reverting to familiarity of the site itself. In order to help the sample selection process, a total of three sites were selected and matched with the sample screening interviews. The site least known by all applicants was the one selected for the study. A formal request letter was sent to The City of Winnipeg Streets and Transportation Department which detailed the location and time frame of the study (see Appendix G). Officials from this branch were asked whether or not construction was to occur in the proposed research site.

Other criteria for the site included a diversity of elements such as: buildings, sidewalks, roads, street elements (lamp posts, signs, garbage bins, trees), crosswalks, bus stops, and public services. It was necessary to examine how these elements impacted the wayfinding activities of participants. The distance of the route was less than half of a kilometer from start to finish.

The site chosen was within the Osborne Village area, which is situated just south of the Assiniboine River and five minutes away from downtown Winnipeg (see Figure 2). The site was open to the natural elements, had consistent vehicular and pedestrian traffic, and covered a distance of three blocks. It also exhibited a mixture of commercial and residential settings and has a good cross section of the city's population represented in the area. The area had an assortment of apartment buildings, houses, shops and restaurants, and occupants ranging from university students to seniors. Another characteristic of this area were the many different activities which occurred along the sidewalks such as busking, peddling, hot-dog carts, and the gathering of "squeegy kids." The site also included a variety of spatial arrangements consisting of linear paths, open and enclosed areas, signage, and street furnishings. It was important to explore how these areas limited or aided the wayfinding activities of participants. The combination of these elements ensured a degree of rigour necessary for evaluating performance in the testing of the site.

A site analysis followed to determine the research route with a number of key decision points with specific characteristics. These points included turns and all areas crossing streets or alleyways. Decision points allowed the researcher to observe whether a participant had made the appropriate turns to proceed or not (see research site in Figure 3). Sixteen decision points were selected along the pre-determined route. The observation of participants' responses at these points helped the researcher draw conclusions about which elements in these particular areas made wayfinding difficult or easy for participants (Finkel, 1994).

The field study on the selected route was conducted only on dry days, between July 14th and September 30th, 1997. It took place between Monday to Saturday in two time slots: 9:30 am to 12:00 PM and 1:30 PM to 5:30 PM. The designated times helped determine how the flow of vehicular and pedestrian traffic and other activities influenced wayfinding. Participants were placed in only one of these time slots. Attempts were made to ensure that a balanced ratio within groups were represented in the two time periods.

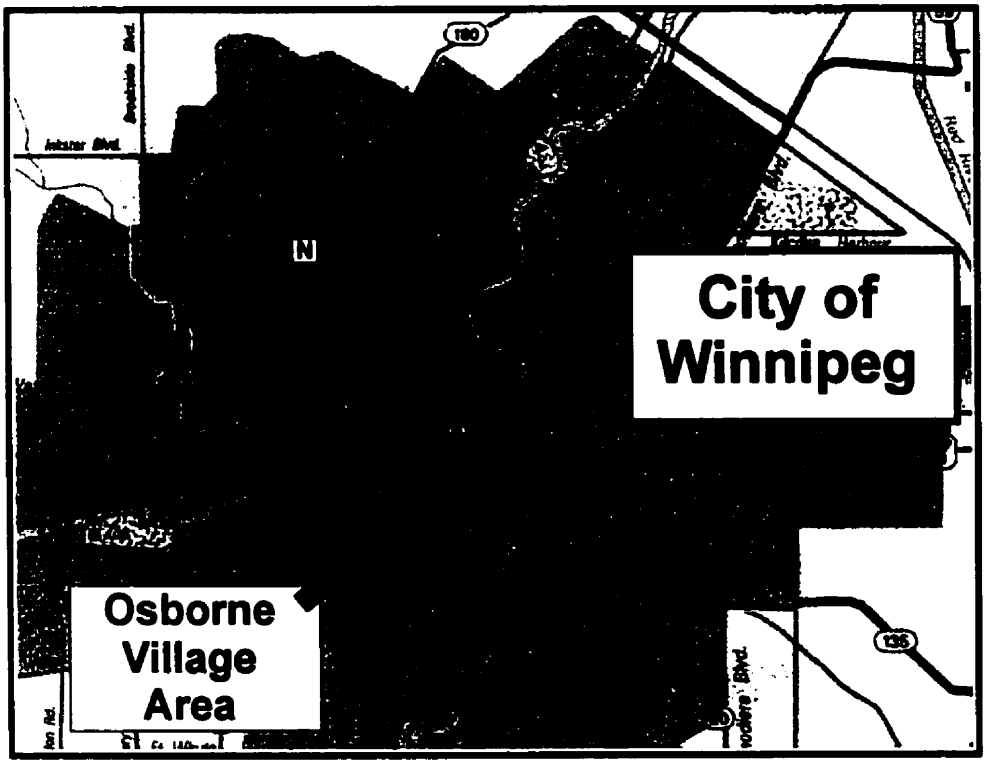


Figure 2. Research site context map:
Osborne Village, Winnipeg, MB

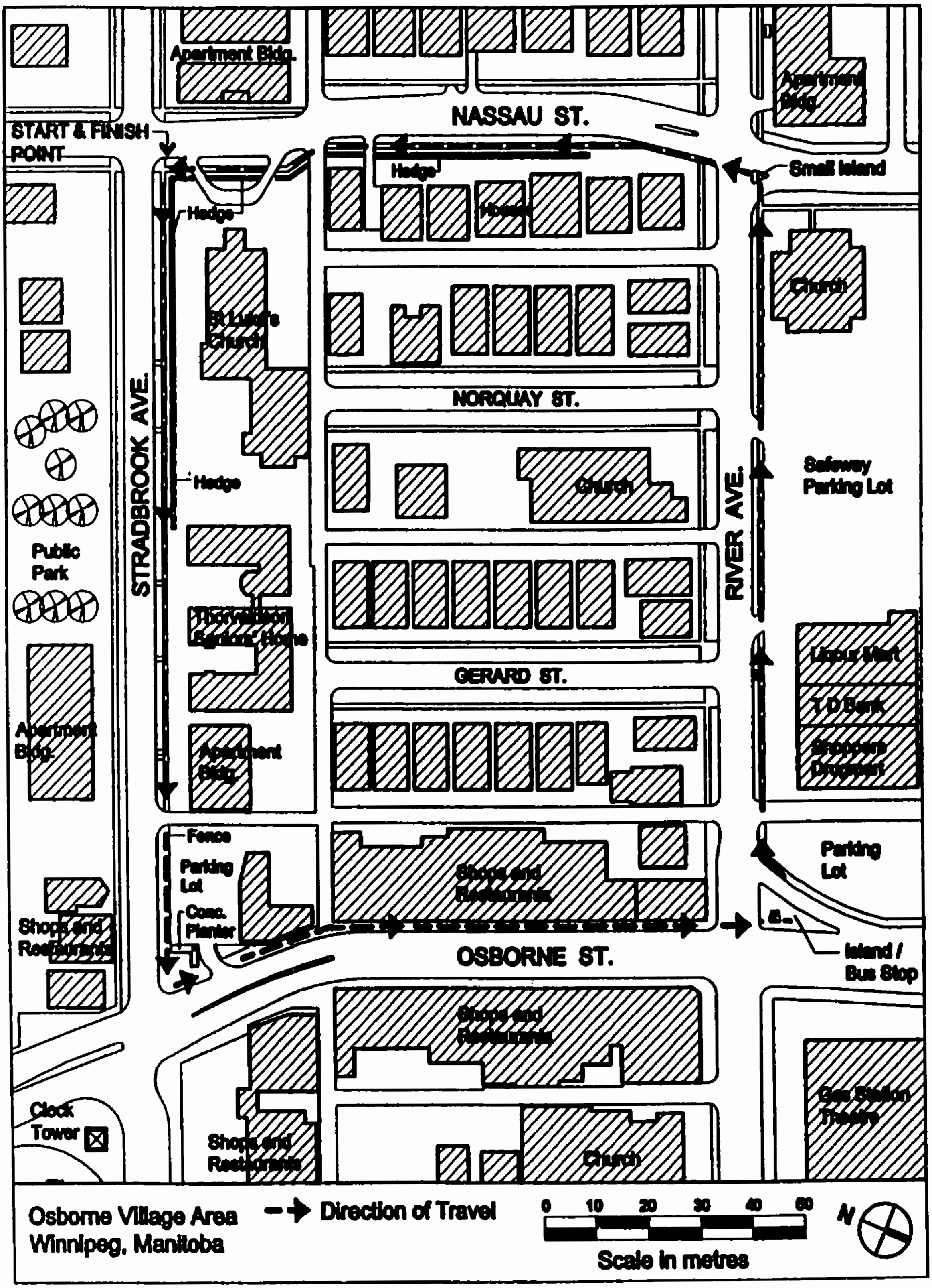


Figure 3. **Route of research site: Osborne Village area**

3.4 Instrumentation

The field study included the use of data sheets to record, time, date, weather conditions, light and noise levels within the site, as well as participants' code number. Light and sound measurements, as well as the duration of participants' travel and the deviations committed along decision points were all recorded on separate data sheets (see Appendix H). A research assistant was employed to record light and sound measurements. The following electronic equipment were used in the walk through (see Appendix I for details):

1 tape recorder with a microphone to record participants' comments during walk-through and interview session

1 light meter to measure illumination on the site

1 sound level meter

1 stopwatch to measure length of participants journey on route

An interview guide was used at the end of the walk-through session to record comments by participants concerning the impact of the pre-selected route and city streets on their wayfinding, as well as wayfinding in general (see Appendix J).

3.5 Procedure

3.5.0 Field study:

The field study used a variety of quantitative and qualitative methods to accurately record how respondents use the built environment. The procedure involved the individual participant, the researcher, and a research assistant who was hired to help with data collection. The walk-through and interview session was based on the work completed by Finkel (1994). The average time to complete field testing with each participant was one and a half to two hours.

a) Prior to the field study, the participant was briefed on the objective of the research and how the field study was to be used. Matters concerning safety, confidentiality and procedures of the observation were also discussed with the participant.

b) An initial walk-through of the pre-selected route with the participant informed him/her where the route started and finished, how long it was, and what he/she was expected to do. Participants were told that the route was a loop which started and finished in the same location. The researcher also asked all participants in what manner they wished to be guided through the site during the initial walk through. Both the researcher and research assistant had to ensure that they minimized intervention in the walk through (Phase I) of the field study component to avoid tainting data. It was also critical to maintain objectivity throughout the study (Sommer & Sommer, 1986; Sproull, 1988).

c) The field study consisted of two phases:

Phase I involved the participant travelling through the site alone with the researcher and research assistant following to make key observations. Before the participant walked the course, he/she was asked to carry a tape recorder and microphone to allow the researcher to record their comments as they navigated the route. Recorded comments were later used to analyze and locate common themes mentioned by participants during the first phase. The researcher made provisions to intervene in the test only if the participant had missed certain important decisions, such as making turns to continue, or if there were safety factors involved. A record of the deviations made at decision points and the elapsed time of travel by participants was made. Light and noise intensity levels were also recorded at each decision point. The average time to complete Phase I was 30 minutes.

Phase II was an interview with participants about their experience and opinions of the route travelled, and other matters concerning wayfinding in the exterior urban environment. The researcher asked participants what elements on the route aided or limited their wayfinding activities. As well, the researcher inquired about the common problems participants' had when wayfinding on streets, and which architectural/sensory cues they relied on most. Participants were also asked what areas needed to be addressed to make streets more effective for wayfinding. The interview guide included demographic questions as well as scale-rating and open-ended questions (see Appendix J). Interviews were administered orally and tape recorded to help the researcher locate themes that were particular to wayfinding in the exterior setting. The average time to complete Phase II was 45 minutes.

d) At the conclusion of each field study, the researcher thanked all participants who took part in the study and asked whether they wished to be notified about the research results.

3.5.1 Recording of information

In Phase I of the field study, data concerning deviations and elapsed time taken at each of the decision points were recorded on a recording sheet. The researcher's observation regarding the participants' walk-through of the entire route were also recorded on the same sheet (see Appendix H-1). Comments made by all participants during the first phase were recorded by a small microphone and tape recorder and was later transcribed for data analysis. Light and noise levels at each decision point were measured by instruments (see Instrumentation) and recorded on a separate sheet by the research assistant (see Appendix H-2).

The interview in Phase II was recorded in an interview guide (see Appendix J) by the researcher. The entire interview was also tape recorded and later transcribed for data analysis.

3.5.2 Pre-test

All field study procedures, including use of all instruments, site walk- through, data collection, and administration of the interview were pre-tested with the consumer advisory committee plus one person with a full vision. Each person who had taken part in the pre-test represented one of the groups in the study sample. The research assistant was informed and trained with respect to the field study objectives prior to the pre-testing. For presentation purposes, photographic and video records were done in the pre-test Phase only with the permission of participants.

3.5.3 Analysis of data

Scale-rated answers were calculated for the mean values of each group and compared with the other groups. Tape recorded comments made by participants were transcribed and analyzed to locate common themes relevant to the study. A tally of these themes was charted for group comparisons. A record of the deviations made at decision points and the elapsed time of travel by participants was made. This data was used to calculate the mean for each group at each decision point, which was than compared with other groups. The total mean for all groups at each decision point was also calculated. Light and noise intensity levels were also recorded at each decision point. The average reading of these levels was later compared with the average deviation and time taken at the same decision points. The study investigated whether there was a correlation between these sets of data. Comparisons were made between all subjective (participants' tape recorded comments) and objective data (measurements at decision points) recorded throughout the route.

3.6 Ethical Considerations

This research was approved by the Faculty of Architecture Ethics Committee, University of Manitoba, prior to the field study. Formal requests were sent to all parties requested to participate in the research and approval from all parties were attained prior to the field study. Letters were sent to the following organizations;

The Manitoba League of Persons with Disabilities Inc. (MLPD)
The Inter-organizational Access Committee (IOAC),
The National Federation of the Blind: Advocates for Equality (NFB:AE)
The City of Winnipeg Streets and Transportation Department

Persons who were interested in participating in the field study were sent an initial contact letter which outlined the research objectives, questions regarding eligibility, and approximate time commitment required if they had decided to participate. The researcher had contacted all persons interested to explain the study objectives and answered any questions they had about the study. Upon the approval of the sample list, all participants were asked to sign two copies of the consent form - one copy was kept by the participant and the other by the researcher.

Confidentiality was protected by identifying transcripts, data sheets, audio tapes, and interview guides by numbered codes rather than by participant's name.

4. RESULTS

4.0 Description of Participants

4.0.0 Gender

The group aided by white canes was comprised of 40% males and 60% females. The group with low vision but with no aids consisted of 60% males and 40% females, while the group aided by a guide dog had 55% females and 45% males. The participant group with full vision included 86% females with only 14% males represented (see Figure 4). Overall the sample was comprised of 44% males and 56% females.

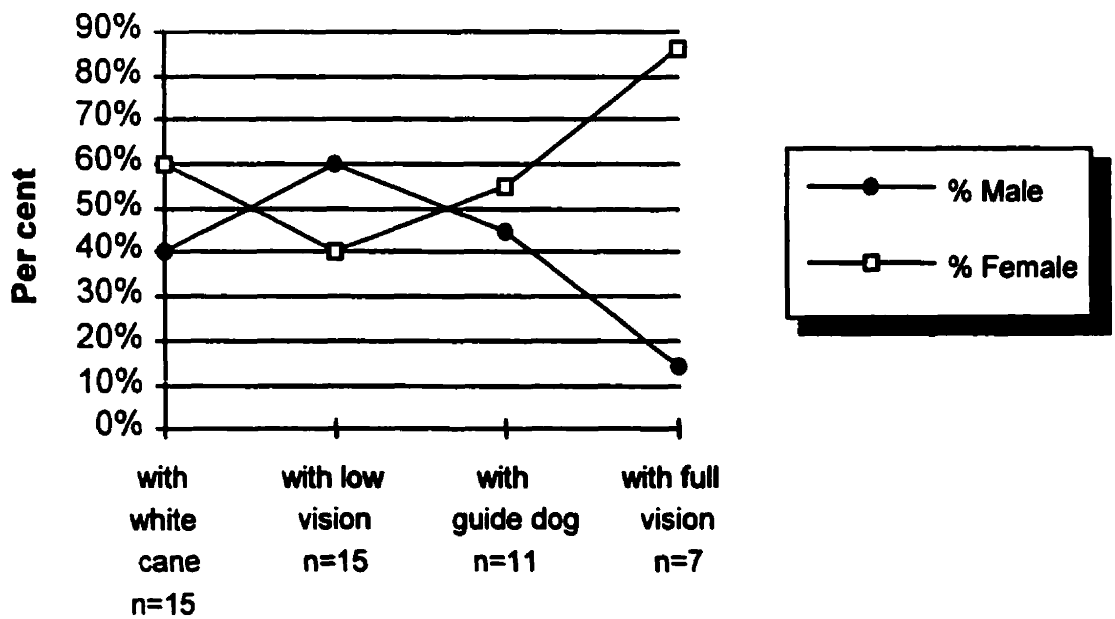


Figure 4. Gender of participants per group

4.0.1 Age range

The majority of the participants in all groups were between 26 and 55 years old. This age range represented 93% of participants with low vision with no aids, 82% of people who used guide dogs, 60% of people who were aided by white canes, and 57% of participants with full vision (see Figure 5).

4.0.2 Level of vision

For the purpose of the study, the group which had participants with full vision (use of corrective glasses were accepted) have more than 10% vision and was considered as not having a visual impairment. Of the three groups with visual impairments 39% had no vision and 61% had between 1-10% vision. Of the participants who were aided by white canes, 53% had no vision and 47% had vision between 1-10%. All participants in the group with low vision with no aids had vision between 1-10%. In the group which had participants aided by guide dogs, 73% had no vision while 27% had vision between 1-10%. The majority of participants with a visual impairment commented that their vision loss was not progressive (see Table 1).

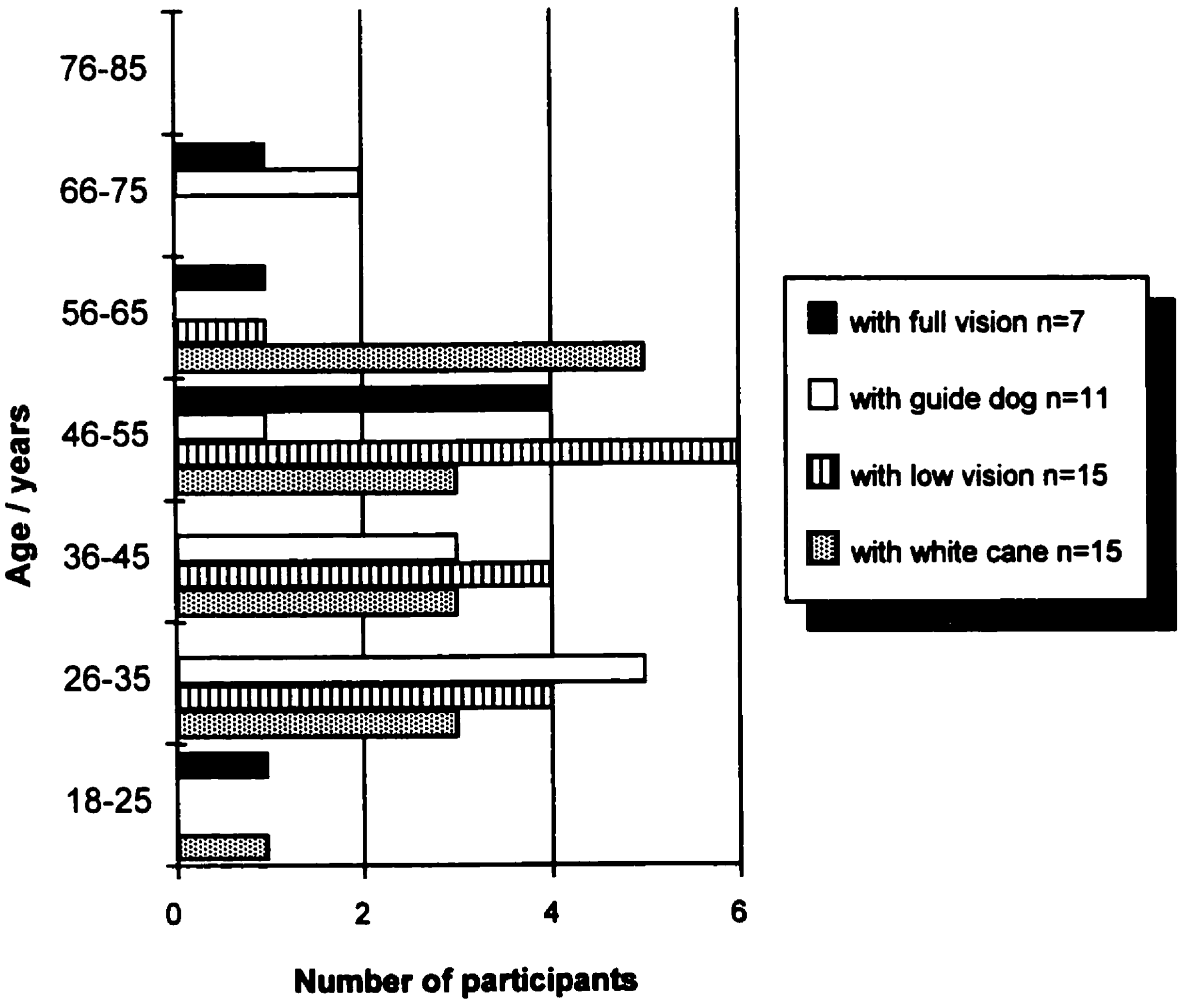


Figure 5. Age of participants per group

Level of vision	with white cane n=15	with low vision n=15	with guide dog n=11	full vision n=7	**Total** n=41
0%	53%	0	73%	0	39%
1-10%	47%	100%	27%	0	60%
Progressive	40%	33%	18%	0	32%
Not progressive	60%	67%	82%	0	68%
Onset of visual impairment. How long?					
Less than 1 year	0	0	0	0	0
1-2 years	13%	0	0	0	5%
3-5 years	20%	7%	9%	0	12%
6-10 years	0	7%	9%	0	5%
More than 10 years	7%	13%	0	0	7%
Since birth	0	7%	0	0	2%
Had mobility training	87%	53%	100%	0	78%
Did similar wayfinding studies in the past	87%	40%	91%	0	70%

Table 1. Description of visual impairment, mobility training, and experience in wayfinding studies

4.0.3 Mobility training

All of the participants who were aided by guide dogs had reported that they had had mobility training, while 87% of the participants with white canes and 53% of participants with low vision and with no aids had mobility training.

4.0.4 Experience in wayfinding studies

In having done similar wayfinding studies, all but the participants with full vision had had some experience in the subject. The participants with guide dogs had the highest representation in this category with 91% of that group having previous involvement in a similar study. Participants with white canes represented 87%, while 40% of the people with low vision with no aids had some experience with wayfinding studies.

4.1 Phase I - The Journey

4.1.0 Time results

During the first phase, the elapsed time of the journey was recorded for all participants asked to walk through a pre-selected route. Overall, the average time to complete the course was 12:34 minutes (see Figure 6). Participants with full vision had an average time of 10:48 minutes. Participants with low vision and with guide dogs clocked an average time of 11:40 minutes each, while participants aided by white canes had an average time of 14:59 minutes.

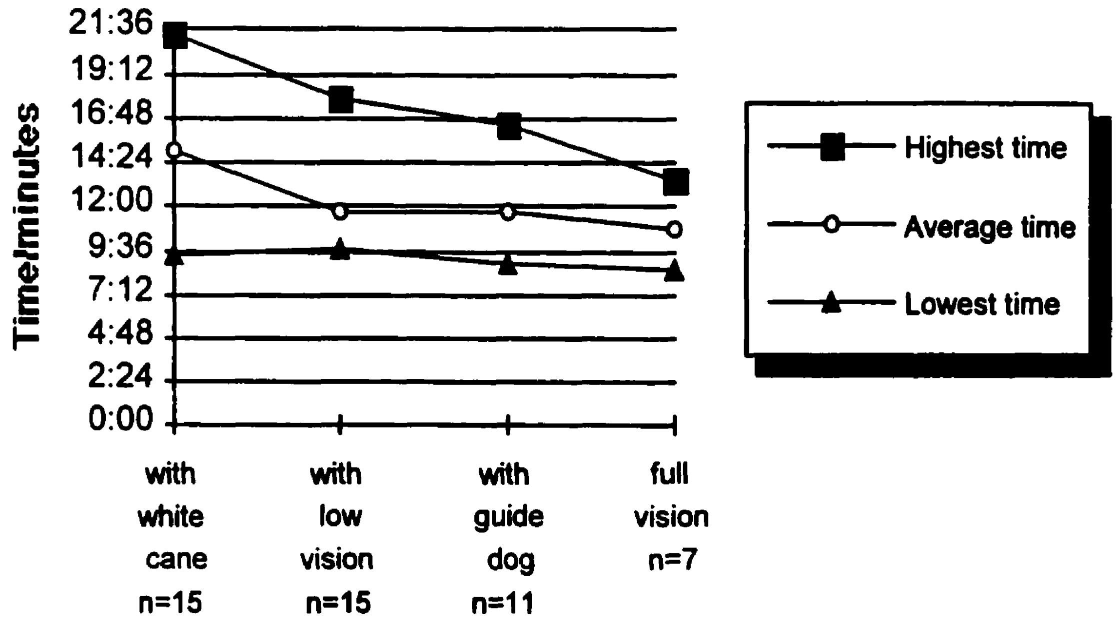


Figure 6. Average time taken during the journey: Phase I

4.1.1 Light and sound levels

To examine the effects of exterior light and surrounding noise on wayfinding, instruments were used to measure both light and sound intensities during Phase I of the study. Most of the individual studies were conducted on workdays during working hours (between 9:00 AM and 5:30 PM) to evaluate the maximum effects of light and noise levels. The average light level for the sample was 4105 Fc (Foot candles), while the sound level averaged 66.81 dB (decibels).

4.1.2 Tape recorded comments - cues

Each participant was asked to make comments on a tape recorder as they proceeded through the route. They were encouraged to mention the particular environmental cues they relied on to find their way, as well as comment on other elements which limited their wayfinding activity on the route. The comments made by participants during Phase I, regarding environmental cues, were divided into four categories; architectural cues, fixed exterior cues, moveable exterior cues, and other sensory cues. The list of elements in each of the categories are as follows;

a) Architectural cues:

driveways, streets, building walls, fences, shrub edges, curbs, ramps, boulevards, openings, ground texture, concrete planters and spatial configuration (right angles, grid pattern)

b) Fixed exterior cues:

signs, light standards, traffic boxes, bus shelters, trees/grates, and traffic lights

c) Moveable exterior cues:

garbage receptacles, newspaper boxes, sandwich boards, hot dog carts, people, cars, bicycles, and flower boxes

d) Sensory cues:

sound, smell, wind, illumination, colour contrast, and echo location

Based upon the comments made by each participant, Table 2 reveals the total percentage of participants in each group using cues within the four categories along the pre-selected route. All the participants who used white canes and with full vision relied primarily on architectural cues when navigating the route. This was followed closely by people with guide dogs at 91% and by people with low vision at 87%. People in both of these groups indicated that they had also relied on architectural cues throughout the route. The most commonly mentioned architectural cues among all participants were street corners, curb ramps, and edge conditions such as bushes, building walls and parking lot curbs. These street elements provided wayfinders some boundaries that gave definition to the pedestrian route and aided in directing the wayfinder. They acted as important guiding systems in the street environment and are apparent to the wayfinder through sight, sense of touch, or by way of sound reflection. Participants from all groups also indicated that architectural cues also comprised the landmarks and guides they remembered to retrace the route.

Fixed exterior cues were used more by participants with low vision with no aids and people with full vision. The most commonly used cues these participants identified were street signs, light posts, trees, fixed concrete planter boxes, and bus shelters. The moveable exterior cues respondents mentioned in this category were newspaper dispensers and trash receptacles. Groups with participants aided by white canes and with low vision and no aids respectively had 27% and 20% using this exterior cue for wayfinding. These participants had pointed out that fixed and moveable objects were useful as cues only when they did not impede their movements. The low percentages shown from all groups indicate that these two categories were less reliable as wayfinding cues.

Table 2 also shows that all participants aided by guide dogs relied primarily on sensory cues to travel the route while 93% of the group, which used white canes, utilized sensory cues when travelling the pre-selected route.

	Architectural cues	Fixed exterior cues	Moveable exterior cues	Sensory cues
with white cane n=15	100%	40%	27%	93%
with low vision n=15	87%	67%	20%	73%
with guide dog n=11	91%	45%	18%	100%
full vision n=7	100%	57%	14%	29%

Table 2. Percentage of participants who used each category of cues: Phase I, the journey

In the category of sensory cues alone, Table 2 indicates that these cues were used more by participants with visual impairments than by those without visual impairments throughout the journey. In the entire study sample, 67% of the participants used sound as the primary sensory cue (see Table 3). The groups which had participants with guide dogs and with white canes had the most people who relied on sounds when wayfinding on the pre-selected route. Most comments referred to vehicular and pedestrian traffic noise as sources for direction. The second highest used sensory cue during the daytime, illumination, only accounted for 15% of all participants. Although only 13% of all participants noted that colour contrast was essential to wayfinding the route, some participants, particularly those with low vision, later admitted in the scale rated questions that colour contrast is an important source of cues when wayfinding.

	Sound	Smell	Wind	Illumination	Colour contrast	Echo location
n=48	67%	8%	4%	15%	13%	8%

Table 3. Percentage of sample that used sensory cues during the journey: Phase I

4.1.3 Difficulties at decision points

The Osborne Village area is characterized by many shops, restaurants, and services. Osborne Street is considered a major thoroughfare and has a continuous flow of both vehicular and pedestrian traffic.

Deviations from the pre-determined route were observed and recorded along 16 specific decision points (refer to Figure 7 - route map). Decision points used in the route were located at intersections crossing an alley, major street, or vehicular yield turns, as well as points where left turns were required to head in the counter-clockwise direction of the route. A "deviation", as defined by the researcher, is committed when a participant veers from the designated route at a decision point. For instance, making right or left-hand turns at an intersection when the participant should have continued straight ahead is a deviation. Not recognizing vehicular traffic when crossing an intersection, taking short cuts or disobeying traffic rules were also classified in the research as deviations. Participants were expected to cross streets at proper crosswalks and obey traffic signals at all times.

Decision points helped clarify which elements in the street environment aided or impeded the wayfinding process. The observations made in Phase I were meant to examine the different cues each person used to negotiate these particular spaces. More importantly, decision points were critical junctures in the route as they were indicators of deficiencies or adequacies in street design.

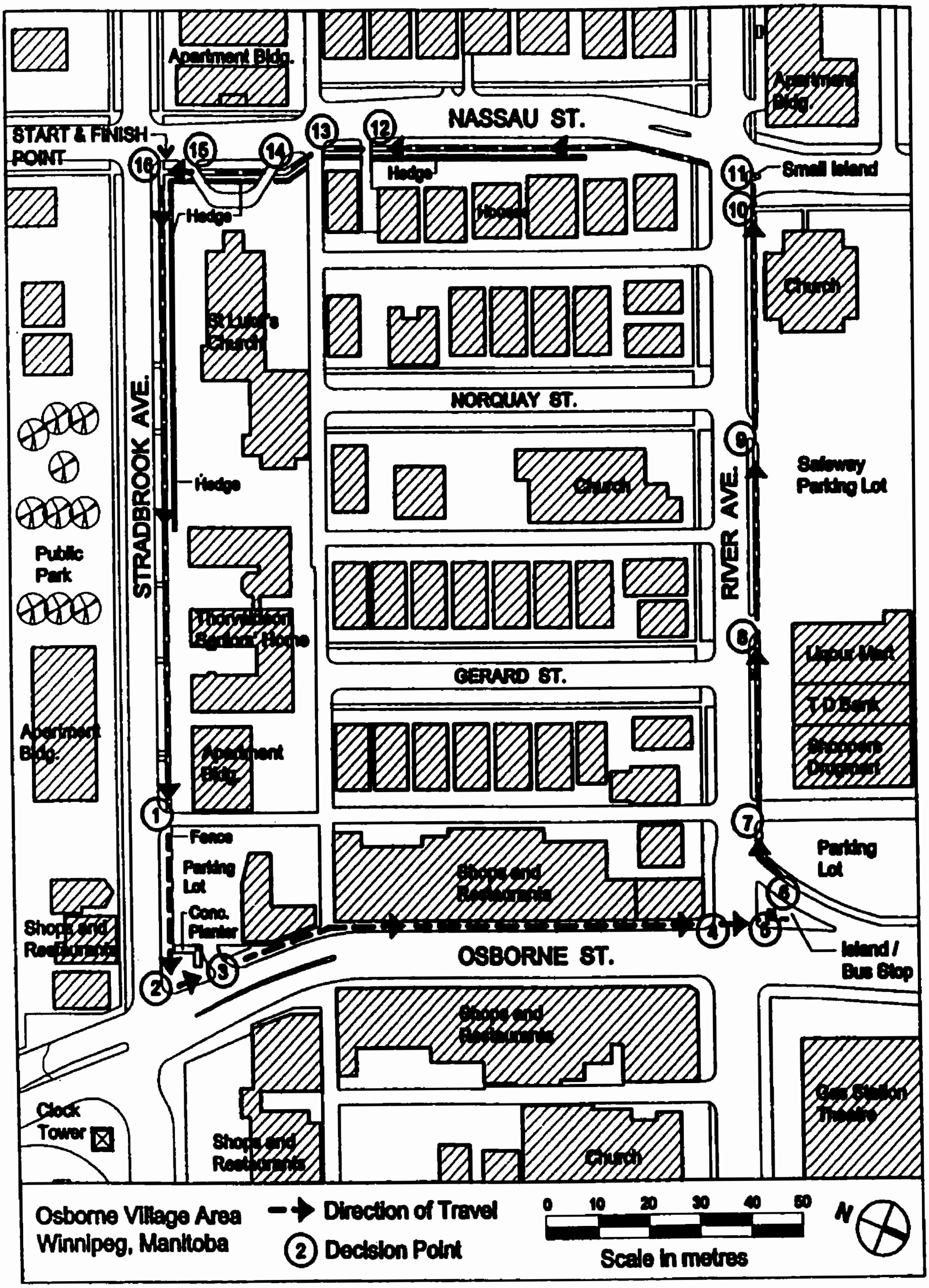


Figure 7. Plan of decision points along the research route: Phase I

The pre-selected route was discovered to be least helpful in facilitating wayfinding for participants with guide dogs, which produced a 20% deviation rate overall (see Table 4). This was followed by participants with white canes, which had a 7% deviation rate. Participants with low vision and no aids and participants with full vision had the least amount of deviations in the journey accounting for only 3% each.

A significant number of deviations were committed by all groups, particularly at decision points 4, 5, 6, 7, and 11 (see Figure 8). These points were situated around the Osborne Street and River Avenue intersection and were evidently the most difficult areas to traverse because of heavy vehicular and pedestrian traffic, and loud noise surrounding them. These areas also included crosswalks on and off of the two islands located along the route.

Decision points 6 and 11, respectively, accounted for 25% and 17% of the deviations for the entire sample. These two areas were located on the two traffic islands and were discovered to be the most difficult to negotiate among the decision points. Participants were observed to experience difficulties at these locations simply because they were harder to locate. Details on these decision points will be discussed later.

Decision Points	with white cane n=15	with low vision n=15	with guide dog n=11	full vision n=7	Percentage of deviations per decision point
DP 1	0	0	0	0	0
DP 2	13%	0	0	0	4%
DP 3	6%	0	27%	0	8%
DP 4	0	6%	36%	0	10%
DP 5	13%	6%	18%	14%	13%
DP 6	20%	20%	45%	14%	25%
DP 7	0	0	45%	0	10%
DP 8	6%	0	27%	0	8%
DP 9	0	6%	18%	0	6%
DP 10	6%	0	18%	0	6%
DP 11	27%	0	27%	14%	17%
DP 12	0	0	9%	0	2%
DP 13	13%	6%	9%	0	8%
DP 14	0	0	18%	0	4%
DP 15	6%	0	3%	0	8%
DP 16	0	6%	0	0	2%
TOTAL	7%	3%	20%	3%	

Table 4. Total percentage of deviations participants made: Phase I, the journey

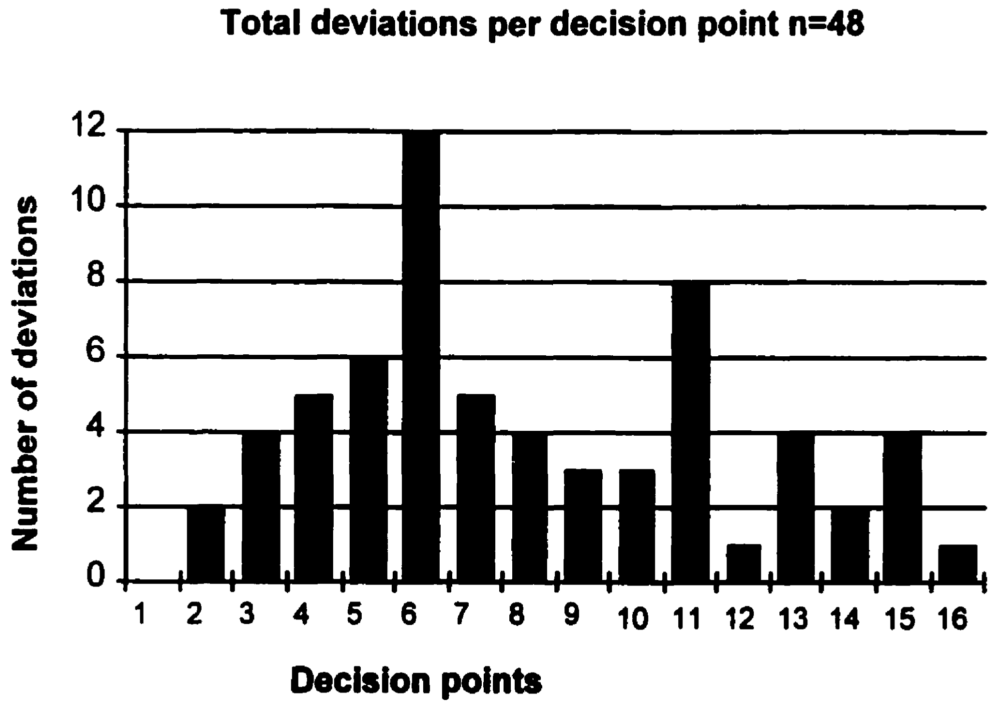


Figure 8. **Total deviations made at decision points: Phase I, the journey**

Decision point 4, located at the corner of Osborne Street and River Avenue, is the area where participants had to cross River Avenue (see Figure 9). The elements surrounding decision point 4 had led participants with guide dogs to significantly produce more deviations than any other group. The only other group with deviations at this point was with participants with low vision and no aids. The curb ramp, at decision point 4 did not line up with the path of travel coming from Osborne Street. Locating the curb ramp was difficult as there were very few distinguishing features (tactual or auditory) which would have aided participants with guide dogs and with low vision to sustain straight line orientation. Many of the dogs were also startled and disoriented by the amount of noise and traffic in the area. People with white canes and with full vision, however, were not as affected by the decision point as the other two groups. Participants with white canes approached the point more cautiously and felt the edge of the curb with their canes to arrive at the proper location to cross. People with full vision relied largely on visual cues to gauge their location and find the curb ramp.

Decision point 4 was also situated at the busiest intersection in the entire route with the highest average in sound levels at 75 dB. The lack of an audible signal at this crosswalk prolonged the crossing for people aided by guide dogs. Several of the participants with guide dogs and with low vision with no aids commented that an audible signal placed at decision point 4 would provide the identifiable sound cue which is needed to safely cross the street.

Figure 9. Decision point 4: corner of Osborne St. and River Ave. (Phase I)

Moving from decision point 4 to the large island, respondents had to immediately turn left at decision point 5 (see Figure 10). Here, participants had to maneuver between a bus shelter and a gray traffic box to continue to decision point 6. Participants from all groups had deviations at this location. The island had many tight areas and was filled with street elements including sign posts, light standards, a newspaper box, a bus shelter, as well as people waiting for buses or to cross Osborne Street. Thus, the situation on the island did not adequately facilitate movement and wayfinding for some of the participants, particularly those with guide dogs who showed a higher number of deviations among participants. In addition to this, several of the guide dogs were confused by the amount of activity in the area. People with white canes had problems traversing through the maze of people and street elements which led them to commit the third highest percentage of deviations.

Participants with full vision had the second highest percentage of deviations at this point. Most were attributed to the fact that these participants neglected to pass through decision point 5 to continue on to decision point 6, as detailed in the initial walk-through. It was observed that it was not so much the effects of street design as it was creating a short cut to the next location, which motivated these deviations. People with low vision had the fewest deviations at this decision point, although some were confused by the condition of this location and had forgotten where they needed to make the left-hand turn. However, several people in this group, who did not commit a deviation, did mention that the bus shelter and traffic box were effective vertical markers, which helped them navigate through decision point 5.

The average sound level for this area is 73.52 dB, which was higher than the overall average of 66.81 dB. Many of the participants pointed out that the island itself was too cluttered and that something should be done to simplify its design and layout to facilitate wayfinding.

Figure 10. Decision point 5: large island at the corner of Osborne St. and River Ave. (Phase I)

Decision point 6 was the crosswalk from the large island and involved crossing an uncontrolled vehicular yield turn into River Avenue (see Figure 11). Decision point 6 generated the largest percentage of deviations for all groups. The difficulty most participants found at this location was that the crosswalk itself was at a 60-degree angle to the right of the island sidewalk (coming from decision point 5), confusing many of the participants in locating it among the moveable and fixed objects. The angled crosswalk was found to be undetectable by several participants and many could not recall if it was a straight or angled crossing. As a result, participants missed the curb ramp on the other side of the roadway.

Guide dogs were also misled by the angled crosswalk and assumed that the crosswalk was actually straight ahead from decision point 5. This led to many of the participants with guide dogs to have a high percentage of deviations at decision point 6. Participants with white canes and with low vision had the same percentage of deviations and were also observed to have difficulty locating the position of decision point 6. Most of the participants with a visual impairment mentioned that crosswalks situated in right angles would have been preferable and easier to locate then those at 60 degrees.

Crossing the uncontrolled yield turn was also observed to be difficult for some participants, as it was unpredictable if the cars merging into River Avenue were going to stop for them to cross safely. The average sound level was measured at 70.42 dB. The high levels of sound in the area were not a big factor compared with the problems of locating decision point 6 for participants with a visual impairment.

Figure 11. Decision point 6: crosswalk off large island at the corner of Osborne St. and River Ave. (Phase I)

Several participants aided by guide dogs also had difficulty at decision point 7, which was an intersection crossing an alleyway. The problem seemed to be a lack of definition or differentiation between this sidewalk and the roadway, leading some participants and their guide dogs to walk into the adjacent parking lot. People with white canes and with low vision and no aids had no difficulty passing though this point. Similarly, people with white canes were able to traverse through and continue on to the next decision point. Several participants with low vision and with full vision did mention that the yellow parking curbs to the right helped to visually define the path because of their bright contrasting colour.

Decision point 11 is a curb ramp on the second island on the route located at the corner of River Avenue and Nassau Street (see Figure 12). Participants were once again asked to cross River Avenue, this time in a southerly direction. This area proved to be difficult for both participants with guide dogs and with white canes. Some of the participants with a visual impairment commented that the island was too small and the surface of the curb ramps were difficult to distinguish (tactually or visually) from the road itself. Participants with guide dogs and with white canes waited the longest to cross at decision point 11 mentioning that it was difficult to tell when to cross due to the unpredictable sound changes in the area. The average sound level for this point was measured at 65.08 dB. Several participants suggested that an audible crosswalk signal would be beneficial at this crossing. The crosswalk itself does not provide orientation and had a raised curb, instead of a curb ramp, at the opposite side of the street. This led some of the participants with a visual impairment to walk towards oncoming traffic on Nassau Street while searching for the curb ramp. In several instances during the field study, participants had to be assisted in crossing the street to line up properly along the curb and crosswalks. A few participants had mentioned that this location needed its curb ramp and crosswalk to be more defined.

The only group, which had no deviations at this location, was the one with participants with low vision. They were observed to have no problems locating and crossing from decision point 11, although some had commented that it needed to be more well defined both tactually and visually. People with full vision made several deviations at decision point 11 based on their willingness to by-pass the small island and cross the street without waiting for the pedestrian signal.

Figure 12. Decision point 11: small island at the corner of Nassau St. and River Ave. (Phase I)

Conversely, the study revealed that decision points 1, 2, 12, and 14 had less, or no deviations. Decision point 1 ran along Stradbrook Street and involved crossing a back alley. Several participants with a visual impairment mentioned the noticeable slope downwards at decision point 1, which helped indicate a transition and the intersection. The sidewalk approaching decision point 1 was also straight, flat, and well defined by grass on either side helping participants to stay on a straight path.

Decision point 2, located at the corner of Stradbrook and Osborne Street, was a clearly defined corner where participants were to turn left to continue the route (see Figure 13). Although the corner was situated at a busy intersection most participants were able to distinguish the turn. Decision point 2 was discovered to be relatively easy to negotiate even though the average sound level at this location was 71.43 dB, significantly higher than the overall average of 66.81 dB. The sidewalk was well defined with a brick pattern and edged by a fence and concrete planter on the left-hand side. The definition, provided by the sidewalk approach and traffic sound cues at this decision point, enabled participants to recognize it as the juncture where they must turn left to continue. The well defined path at decision point 2 seemed to have compensated for the loud surrounding traffic noise and enabled participants to find their way.

Figure 13. Decision point 2: corner of Stradbrook Ave. and Osborne St. (Phase I)

Decision points 12 and 14, along Nassau Street, were found to be easier to negotiate due to lighter traffic and fewer obstructions along the path (see Figure 14). The decision points crossed a residential driveway and church turn around. The sidewalk was well defined by hedges on the left-hand side and a grass boulevard to the right. Most participants appreciated the simple and straight forward path as well as the lack of disruptive noises and traffic activity in the area. Sound levels at decision points 12 and 14 were averaged at 63.5 dB. and 60.11 dB. respectively. Sound levels at decision points 12 and 14 were noticeably less than those indicated at decision points 4, 5, and 6, and lower than the overall average of 66.81 dB.

Figure 14. Decision points 12 and 14: along Nassau St. (Phase I)

4.2 Phase II - Interview

The interview in Phase II was comprised of scaled and open-ended questions that focused on how accommodating the pre-selected route and city streets are to wayfinding. The questions used a five point rating system where one defined the least accessible, not useful, or usually a problem. The most optimum rating, five, referred to very accessible, very helpful, or not a problem. A three indicated only a moderate rating and is regarded as need for more improvement to facilitate wayfinding. Open-ended questions were asked to discuss in greater detail reasons for the scaled responses.

4.2.0 Rating the adequacy of the route for wayfinding

In the interview, participants were asked to rate the pre-selected route in terms of its capacity to facilitate their wayfinding needs (see Table 5). An overall mean of 3.57 was given by the entire sample. The highest rating came from participants who have full vision, which gave the route a mean score of 4.36. The participants with low vision with no aids gave the route an average rating of 3.67, while the average score given by participants with guide dogs was a 3.5. The lowest mean rating, 3.17, was given by the group which had participants who used white canes. All groups gave the route a 'high' to 'above average' rating. Although there were apparent difficulties with several elements of the route, most participants had commented that the route was relatively adequate for them in terms of wayfinding. Most had admitted though that it still needed to be more wayfinding friendly to the pedestrian, particularly in its sidewalk conditions and traffic islands.

	Rate the adequacy of this route	Rate the adequacy of city streets
with white cane n=15	3.17	2.67
with low vision n=15	3.67	3.4
with guide dog n=11	3.5	3.22
full vision n=7	4.36	4.29
Overall Mean	**3.57**	**3.26**

Table 5. Mean scores concerning the adequacy of the route and city streets for wayfinding: Phase II

4.2.1 Limiting factors on the route

Question 1c) of the survey asked: Were there any other factors which may have limited your proper navigation of the route (e.g., surrounding noise, traffic, glare)? The open-ended question prompted 35% of the sample to state that they did not like the uneven sidewalks in portions of the route (see Figure 15). The two islands were also considered obstacles for some people resulting in 27% of the sample disapproving of these components of the route. Loud noises at the busy intersections were considered, at times, a hindrance to navigation by 23% of the participants. Osborne Street, particularly where there was street furniture and trees, presented difficulties to wayfinding for 21% of all participants. People discussed the need for curb ramps and crosswalks to line up with the path of travel. Approximately 21% of the respondents commented that this presented a problem when preparing to cross River Avenue. Crossing vehicular yield turns were considered hazardous by another 21% because they were not controlled by traffic signals or were not predictable.

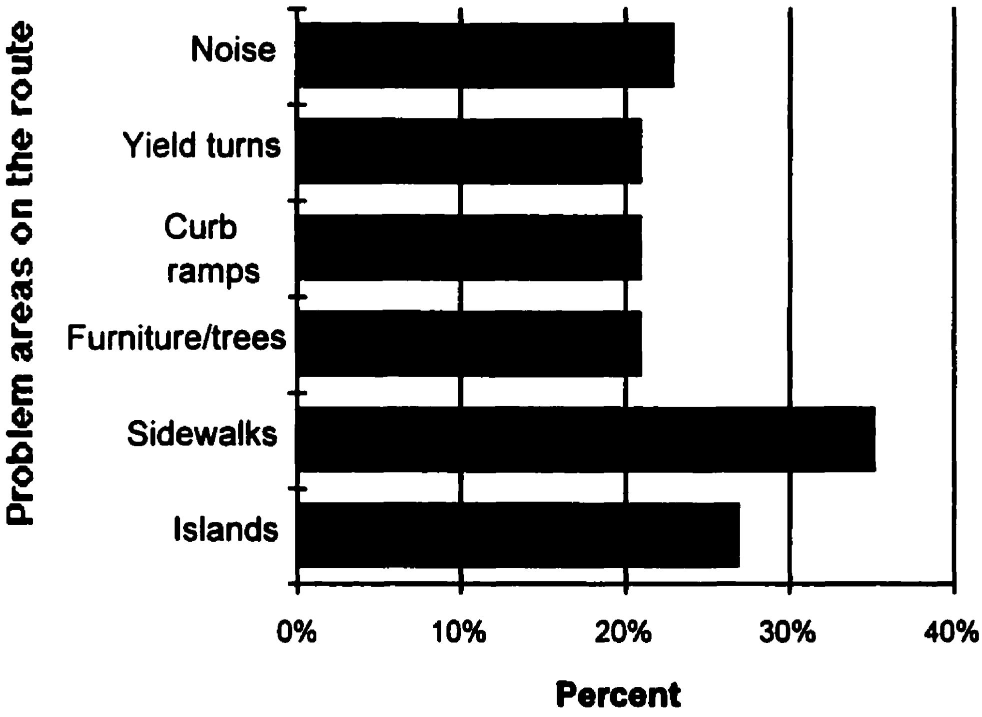


Figure 15. Percentage of sample expressing difficulties along the route: Phase II

4.2.2 Rating the adequacy of city streets for wayfinding

In part II of the survey participants were asked to rate city streets in terms of their capacity to facilitate wayfinding for them on a scale of one to five. The overall mean was 3.26 regarding the usefulness of city streets to wayfinding (see Table 5). The highest average rating, 4.29, came from the participants who have full vision. Participants with low vision rated this question a mean score of 3.40, while participants with guide dogs gave a mean rating of 3.22. The lowest mean again came from the participants with white canes who gave this question a mean rating of 2.67. Again, most participants felt that city sidewalks were above average in rating but insisted that more improvements were required to better facilitate pedestrian wayfinding and movement.

4.2.3 Limiting factors on city streets

Participants were asked what problems they typically experience when walking on city streets. Sidewalks were considered the least effective street element for locomotion and wayfinding by 40% of the sample (see Figure 16). Many of these participants mentioned the need to regularly maintain sidewalks throughout the city. The lack of proper curb ramps at city intersections was another problem pointed out by 31% of all participants. Respondents with visual impairments discussed the need to standardize and define these curb ramps in order to be more useful for wayfinding. Sidewalks which are not regularly cleared in the winter time also presented hazardous travelling areas for 25% of the total sample, while 19% said that street furniture was often a obstacle for them.

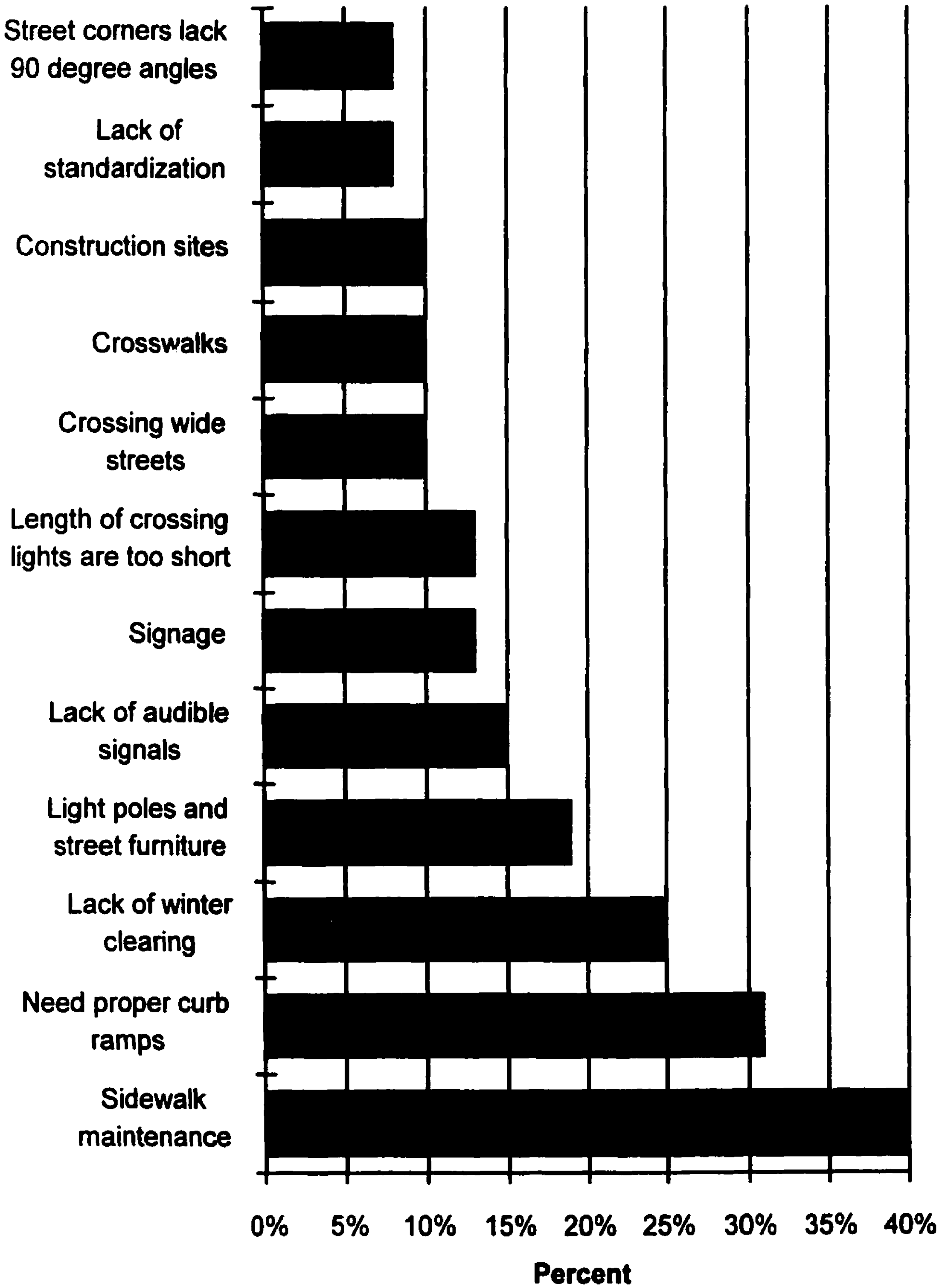


Figure 16. Percentage of sample expressing difficulties on city streets: Phase II

4.3 Exterior Cues

In examining the usefulness of exterior cues for wayfinding, participants were asked to rate several street elements on a scale of one to five (see Figure 17). A one represented not helpful and a five represented very helpful to wayfinding.

4.3.0 Landmarks

Landmarks received the highest mean score, 4.4. Some of the most common definitions of a landmark are large buildings that are visible from a distance, street elements such as street corners, sounds, and ground surfaces. All four groups rated this component of the landscape very high due to its reliability for wayfinding. Participants who have full vision gave landmarks a mean score of 4.86, while participants with low vision and no aids averaged 4.67. Respondents with guide dogs and with white canes gave an average rating of 4.14 and 4.1, respectively. Participants with full vision and with low vision and no aid typically described tall buildings and large signs, when seen far away, as helpful landmarks. Such objects were identified as important guides that enabled these participants to gauge their surroundings. Participants with guide dogs and with white canes typically relied on landmarks closer to the path of travel such as ground texture, sounds, and corners.

Street intersections seem to provide a nodal landmark, which many participants recognize because it is a juncture which has many distinct characteristics (crosswalks, traffic lights, audible signals, curbs, traffic noise). In some instances these areas are articulated by contrasting colour and ground textures. On the pedestrian level, landmarks are those elements which are well defined and noticed through sound, touch, and vision.

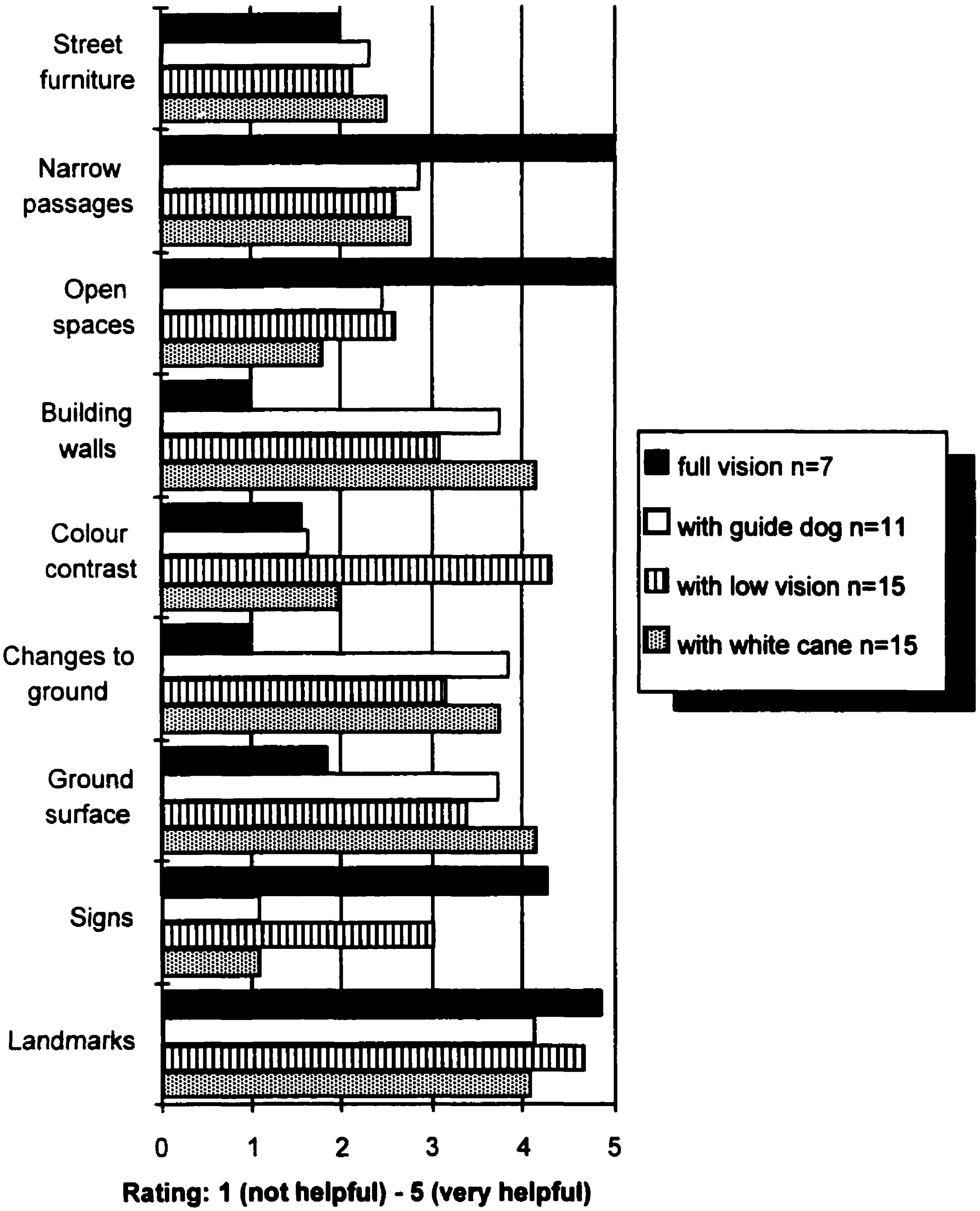


Figure 17. Mean rating of exterior cues: Phase II

4.3.1 Signs

Signs were discovered to be less of an issue for participants with guide dogs and white canes then for participants with full vision and with low vision. The mean score for all four groups were: 4.86 for participants with full vision, 3.03 for participants with low vision, and 1.1 for participants with white canes and with guide dogs. The average score given by the entire sample was 2.17, which is below the moderate point in the scale rating. Respondents with low vision and no aids, and with full vision commented that some street signs needed to be larger and have greater colour contrast. People with full vision relied on clearly readable signs. Concerns were raised by participants regarding the placement and standardization of signs to optimize the information that they provided.

4.3.2 Ground surface

The use of ground surface for wayfinding was more relevant to participants with a visual impairment than those with full vision. The average rating for ground surface as an important cue was 3.49. Participants with white canes provided a mean score of 4.17, while participants with guide dogs had an average of 3.73. An average rating of 3.4 was given by participants with low vision, while participants with full vision gave a low rating of 1.86. Participants with a visual impairment relied on the tactile nature of ground surfaces as useful tools for maintaining a straight line of travel. Ground surface was also described as a good landmark by participants with white canes. Participants with full vision did not rely on ground surface as much as they did on vertical elements of the street, such as buildings and other landmarks apparent from a distance.

4.3.3 Changes to ground surface

The question concerned whether changes to ground surface was useful in wayfinding resulted in a mean score of 3.2 by the entire sample. The average rating concerning the usefulness of changes to ground surface was: 3.86 for participants aided by guide dogs, 3.77 for participants with white canes, 3.17 for participants with low vision, and 1 for participants with full vision. The primary reason given by participants with a visual impairment was that changing ground surface provided a good guidance system. Many participants in the sample also mentioned that different ground surfaces provided useful landmarks and are a source for sound cues that signify transitions occurring along the path. People who use white canes mentioned that they can distinguish the auditory qualities different ground textures provide with the tap of their canes. Some of the participants with guide dogs are also able to hear different textures when they walk on them. The variability of ground textures enabled participants with a visual impairment to detect grass boulevards, driveways, and the edge of curb ramps. Similarly, participants with full vision had admitted that grass boulevards tend to be useful visual guides that help them to stay on course.

4.3.4 Colour contrast

In evaluating the usefulness of colour contrast, participants with low vision and no aids relied on it more than the other groups and gave this question an average rating of 4.33. Participants with white canes, with guide dogs, and with full vision gave colour contrast a mean score of 2, 1.64, and 1.57 respectively. A mean score of 2.58 was given to colour contrast by the entire sample. The participants with low vision commented that colour contrast gave more definition and clarity to elements, such as signs and traffic signals. White lines provided good delineation of crosswalks, while yellow parking curbs help define an edge condition. Although a low rating is shown, participants with full vision later clarified that colour contrast and proper lighting are important factors in wayfinding as it is helpful in differentiating elements in the environment.

4.3.5 Building walls

Building walls, as an important wayfinding tool, were given an average rating of 3.28 by the sample, above the mid-point on the scale. The mean scores for each group was: 4.17 for participants aided by white canes, 3.77 for participants with guide dogs, 3.1 for participants with low vision with no aids, and 1 for participants with full vision. The participants with full vision commented that building walls were not necessarily used as a wayfinding device. Building walls, similar to fences and shrub lines, provided a good edge condition for the participants with white canes. Several of these participants mentioned its usefulness as a guide to maintain a straight line of travel, while others used it for echo location. Participants with whites canes indicated that, through echo location, they are able to discern particular sounds reflected off building walls and bus shelters that help guide them to certain locations, such as entrances, or to sustain a good distance from buildings.

4.3.6 Open spaces

Respondents were asked whether open spaces provided them with any navigational sources. Overall, participants gave open spaces a mean score of 2.67, below the moderate scale rating. The highest average, 5, was given by participants with full vision. An average rating of 2.6 was given by participants who have low vision and no aids, while participants with guide dogs gave it a mean score of 2.45. Participants aided by white canes gave the lowest average score of 1.8. Participants with a visual impairment commented that open spaces provided them with little information regarding directions and that it was easy to get disoriented. The lack of well defined paths and guiding elements make wayfinding difficult in open spaces, particularly for people with guide dogs and with white canes. Participants with guide dogs and with white canes commonly described such guiding elements as helpful cues in navigating open spaces. Participants with full vision mentioned that open spaces are typically not a problem to negotiate when wayfinding since they are able to visually locate destination points from afar.

4.3.7 Narrow passages

The average scores given by each of the four groups regarding the use of narrow passages were: 5 for participants with full vision, 2.86 for participants with guide dogs, 2.77 for participants with white canes, and 2.6 for participants with low vision with no aids. Overall the sample gave narrow passages a mean score of 3.06. Participants with a visual impairment gave a low rating because of the problems of congestion and clutter associated with narrow passages. Many of these participants generally preferred wide sidewalks with enough room to maneuver. Others, however, appreciated the defined linear direction (the 'corridor effect') that a narrow passage provides. Participants with full vision had a similar response to narrow passages as they did with open spaces and said that they were not a problem to navigate in.

4.3.8 Street furniture

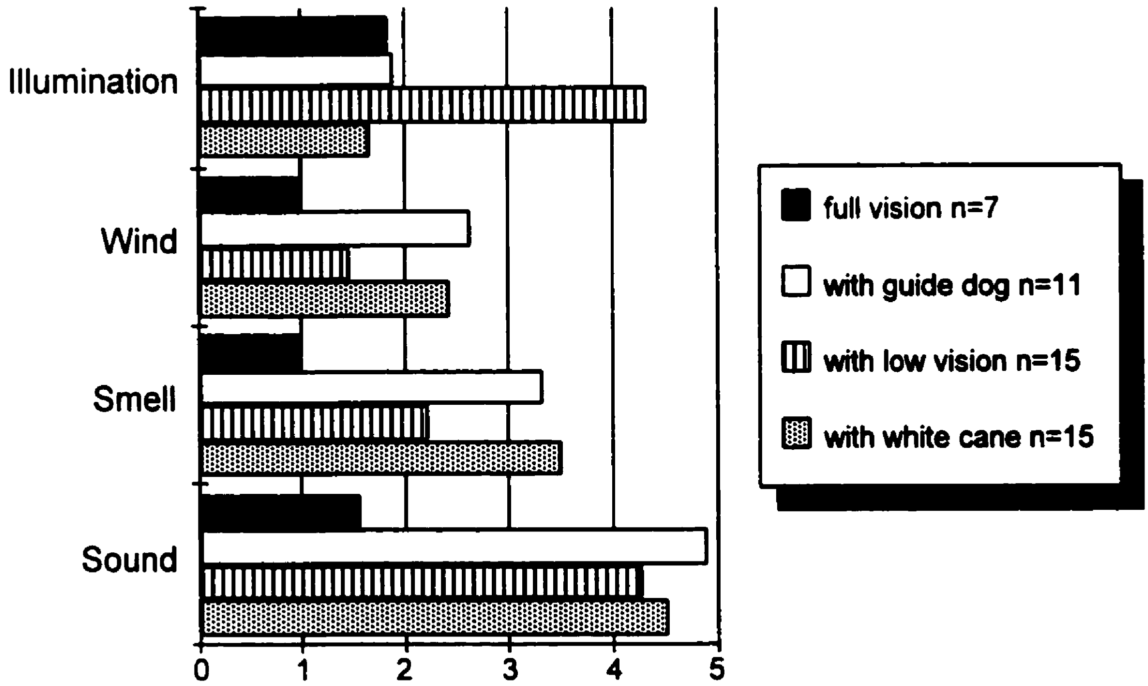
A question concerning the usefulness of street furniture for wayfinding was given an average score of 2.27 by the respondents. The mean scores given for this street element are: 2.5 for participants with white canes, 2.32 for participants aided by guide dogs, 2.13 for participants with low vision with no aids, and 2 for participants with full vision. The low rating given to this question was attributed to the lack of consistent placement of street furniture along city sidewalks. The majority of participants, with or without a visual impairment, commented that street furniture tended to be more of a hazard to their movement than a convenient wayfinding cue. Respondents indicated that the problems they face with street furniture can be attributed to the way these elements are haphazardly placed along sidewalks. People with full vision felt that the location of some street furniture do present unsafe situations for them at times. More attention can be placed on these deficiencies so that they can facilitate safer pedestrian movement and wayfinding.

4.4 Sensory Cues

In evaluating the usefulness of sensory cues used for wayfinding, participants were asked to rate sound, smell, wind, and illumination in a scale of one to five (see Figure 18). A one signified not helpful, while a five represented very helpful to wayfinding.

4.4.0 Sound

Out of the four categories of sensory cues, sound was the most important cue for the participants with a visual impairment. The group, which had participants with guide dogs, gave sound an average rating of 4.91, while participants with white canes gave it a mean score of 4.53. Participants with low vision also rated sound with a high average rating of 4.27. Participants, which had use of full vision, relied on sounds less for wayfinding and gave it a mean score of 1.57. The sounds typically used by the participants with a visual impairment ranged from traffic noise to the sounds of pedestrians. These sources provide the necessary information for locating destinations, as well as finding directions when walking on city streets. Participants did mention that too much surrounding noise, such as construction sites and heavy vehicular traffic, can often disrupt wayfinding. However, most felt that street sounds generally are helpful to them.



Rating: 1(not helpful) – 5 (very helpful)

Figure 18. Mean rating of sensory cues generally used: Phase II

4.4.1 Smell

Olfactory cues, or smell, were used most frequently by participants with white canes and with guide dogs. Participants with white canes gave an average rating of 3.5, while an average score of 3.32 was given by participants with guide dogs. Gas stations, bakeries, and restaurants were typically mentioned as landmarks, or helpful cues for finding destinations. Groups which had participants with low vision and participants with full vision relied less on smell as a wayfinding cue and respectively gave it an average rating of 2.23 and 1. The entire sample gave smell an average score of 2.7.

4.4.2 Wind

Only the participants with guide dogs and with white canes stated that they used wind as a wayfinding cue. This question was given an overall average rating of 1.97, below the mid-point of the scale. The mean scores given were: 2.64 for the participants with guide dogs, 2.43 for participants with white canes, 1.47 for participants with low vision, and 1 for participants with full vision. The low scores relate to how participants consider wind as an impediment to their ability to hear important sound cues from the surrounding environment. A few of the participants with guide dogs and with white canes, however, commented that wind can help define openings along buildings or provide directions.

4.4.3 Illumination

The question regarding the use of illumination as a helpful wayfinding cue was rated by participants with low vision an average of 4.33. The other three groups had given this element a relatively lower rating: 1.91 for participants with guide dogs, 1.86 for participants with full vision, and 1.67 for participants with white canes. The average score for the sample was 2.58, below the moderate point in the scale. Participants with low vision and no aids commented that proper light levels are essential for seeing contrasts and detail from the environment. Travelling with sufficient illumination was considered more important for these participants. Several of the participants with full vision did comment that proper illumination was also essential to see things along the path, even though a low rating was given by this group overall.

4.5 Other Techniques Used for Wayfinding

In an open-ended question concerning other techniques used for wayfinding, some participants who used white canes along with participants with low vision indicated that counting streets, houses, and even the number of paces taken were useful methods to get to a destination point. Memory was important in wayfinding for many people with or without a visual impairment and useful when revisiting the same site or negotiating similar ones. Others also mentioned using a monocular to view signs, distant traffic signals, and route numbers on approaching buses.

4.5.0 Information systems

Participants were asked to rate the usefulness of information systems for wayfinding in a scale of one to five (see Table 6). A one represented not helpful, while five signified very helpful. The information systems included tactile signs, Braille and tactile maps, and asking other people.

	with white cane n=15	with low vision n=15	with guide dog n=11	full vision n=7
Tactile signs	2.93	2.9	3.73	1
Braille and tactile maps	3.47	1.4	2.91	1
Asking other people	3.5	3.7	3.73	4.5

Mean Scores	Tactile signs	Braille/tactile maps	Asking other people
	2.82	2.33	3.76

Rating: 1(not helpful) - 5(very helpful)

Table 6. Mean rating of information systems: Phase II

4.5.1 Tactile signs

Tactile signs were found to be more useful for participants with guide dogs than any other group, giving this information system an average score of 3.73. Participants with white canes and those with low vision gave tactile signs a mean rating of 2.93 and 2.9, respectively. An overall rating of 1 was given by the participants with full vision. Participants with a visual impairment generally thought that tactile signs were useful tools for receiving information, provided they were made more available and easy to locate. The entire sample gave tactile signs a mean score of 2.82.

4.5.2 Braille and tactile maps

The question concerning the usefulness of Braille and tactile maps received a mean score of 2.33 from the entire sample. The explanation provided by participants with a visual impairment was quite similar to the ones given to tactile signs, suggesting that these information systems need to be more standardized and easy to find. The response from the participants with white canes resulted in a high mean score of 3.47. Participants with guide dogs gave an average rating of 2.91, while participants with low vision and with full vision gave a mean score of 1.4 and 1, respectively.

4.5.3 Asking other people for directions

There was a preference, by all four groups, to ask other people for directions although several of the participants have admitted that they do not always get accurate information from other pedestrians. Many, however, still relied on this method for receiving quick information, such as asking for the name of streets, or which bus just arrived at the bus stop. The mean scores given for this information source was: 4.5 for participants with full vision, 3.73 for participants aided by guide dogs, 3.7 for participants with low vision, and 3.5 for participants with white canes. This method was given an overall rating of 3.76 by the entire sample.

4.6 Problems with Travelling on City Streets

Participants were asked to rate a series of items associated with travelling on city sidewalks in a scale of one to five. The topics discussed in this section included things which might be construed as problems such as surrounding noise, glare, vehicular traffic, and pedestrian traffic (see Figure 19). A one signified usually a problem while 5, the optimum, is not a problem.

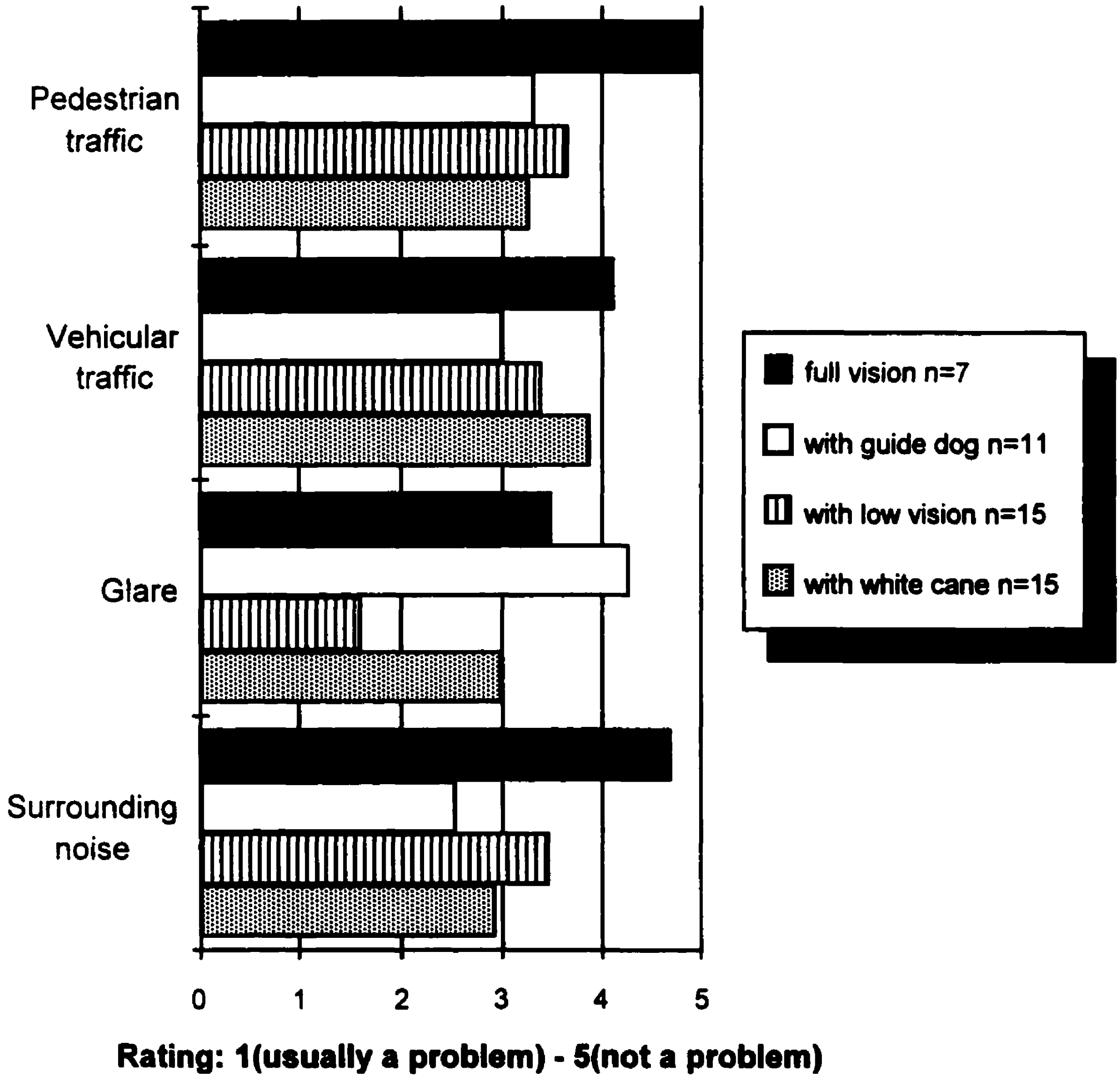


Figure 19. Mean rating of problems associated with city streets: Phase II

4.6.0 Surrounding noise

Participants commented that although loud noises can be a problem to them when walking on city sidewalks, most surrounding noises are still useful for wayfinding. For some of the participants with white canes and with low vision and with no aids, surrounding noise is preferred since it provides constant information from the street environment. On the other hand, construction and heavy traffic typically produced noise, which can cancel out informative sound cues used for wayfinding. This seemed to be a common problem among many of the participants with a visual impairment. Overall, the question regarding surrounding noise as a problem received an average rating of 3.27. The participants with guide dogs gave this question an average rating of 2.55. Participants with white canes and with low vision gave surrounding noise an average score of 2.93 and 3.47, respectively. The participants with full vision gave a mean score of 4.71 and stated that surrounding noise does not limit their wayfinding activity and is helpful to use when crossing busy streets.

4.6.1 Glare

Glare was found to be a common problem for most of the participants with low vision and no aids. They commented that bright sunlight and reflection can disrupt depth perception and their ability to view signs and traffic signals. Bright light can often create a 'white-out' effect, which can affect one's wayfinding activity. People with low vision gave glare an average rating of only 1.6. Participants with white canes gave a moderate mean score of 3, while participants with full vision gave an average rating of 3.5. Participants with guide dogs gave the highest mean score of 4.27. The sample gave an overall rating of 2.92.

4.6.2 Vehicular traffic

Vehicular traffic was not considered a serious problem for wayfinding by most of the participants. The sample gave an average rating of 3.57. The mean scores given by each group were: 3 for participants with guide dogs, 3.4 for participants with low vision, 3.9 for participants with white canes, and 4.14 for participants with full vision. Some of the participants with a visual impairment reported that vehicular traffic is typically problematic at major crosswalks and yield turns, however they do rely on vehicular traffic sounds for cueing in the street environment.

4.6.3 Pedestrian traffic

Participants were asked whether pedestrian traffic was a problem when they are wayfinding on city sidewalks. There were some benefits to pedestrian traffic and most participants commonly felt that they were helpful rather than a hindrance to wayfinding. Several of the participants, with and without a visual impairment, described other pedestrians as an aid to provide sound cues when crossing streets or give assistance. Some participants had explained that they followed people on sidewalks in order to steer clear of any obstacles, while others listen for voices to pin-point a destination such a crosswalks or doorways. Loiterers and pedestrians who block entrances seem to be a general problem amongst participants with white canes and with guide dogs, while participants with guide dogs are at times approached by children who want to pet their dogs. Participants rated pedestrian traffic with the following scores: 5 for participants with full vision, 3.67 for participants with low vision, 3.32 for participants with guide dogs, and 3.27 for participants aided by a white cane. Generally, participants felt that other pedestrians were not viewed as a problem to wayfinding and responded by giving an average rating of 3.66.

4.7 Advice to Landscape Architects and City Planners

An open-ended question was asked regarding what advice participants would like to give to landscape architects and city planners to make city streets more effective for pedestrian movement and wayfinding (see Table 7).

Suggestions	with white cane n=15	with low vision n=15	with guide dog n=11	full vision n=7	Total sample /per cent n=48
Standardization of street components	47%	60%	36%	14%	44%
Use more audible signals	60%	40%	36%	29%	44%
Maintain sidewalks	27%	40%	45%	43%	38%
Use curb ramps	40%	33%	36%	29%	35%
Improve signage	13%	40%	45%	14%	29%
Use colour contrast	20%	53%	0	14%	25%
Use tactiles on curb ramps	13%	33%	27%	14%	23%
Use right angles and grid patterns	13%	7%	36%	0	15%
Line curb ramps and crosswalks with path of travel	20%	20%	9%	0	15%
Design straight paths without clutter	20%	13%	0	14%	13%
Have regular snow clearance	7%	0	18%	14%	8%
Consult consumers	0	0	18%	0	4%

Table 7. Percentage of participants suggesting to Landscape Architects and Planners of areas to consider: Phase II

The need to standardize street design and its components was mentioned by 44% of the respondents. A number of participants reported that a consistent design of curb ramps, signs, and the placement of street furniture can make sidewalks predictable and easier to move through. Several had also stressed the necessity to simplify street layout and to incorporate more right angles, and grid patterns to facilitate straight line orientation.

Audible pedestrian signals were regarded by 44% of the sample as an important component at intersections. Many of the respondents, with and without a visual impairment, commented that audible crosswalk signals served both as a beacon, or landmark, as well as a way to ensure safe crossing of streets. Participants also agreed that these signals should be standardized throughout the city. Understanding the costs involved, several of the participants suggested that the installation of such signals be done within reason. Primary streets such as Portage Avenue, Main Street, and other busy intersections in the city should be prioritized for the installation of these devices.

Sidewalk maintenance was another issue brought forward by 38% of the sample. A number of participants pointed out the need for regular sidewalk repair and clearance to reduce accidents and increase wayfinding efficiency.

Thirty-five percent of the participants described the need for consistency in curb ramp design and their location along the path of travel. A suggestion made by 23% of the sample was to apply a tactile warning surface on curb ramps to increase detection by people with a visual impairment. Such a device can create a good definition between the curb ramp and street.

Approximately 29% of the sample agreed with improving and standardizing the placement of signs on city streets. Participants, particularly those with low vision, made comments regarding the lack of contrast and clarity of most street signs.

The use of more colour contrast in the street environment would be useful according to 25% of the sample. Participants with low vision, in particular, considered white markings on crosswalks and yellow parking curbs as useful guides when travelling. They pointed out that colour contrast could be used to define bus stops and curb ramps as well.

4.8 How Participants Felt About the Study

The last open-ended question asked participants to comment on what they thought of the study. The majority of the respondents were pleased to have contributed in the research and appreciated the fact that their opinions were being considered. Many had enjoyed the journey and discovered parts of the city that they had never known before. Others liked the fact that the study focused on the exterior environment, since it is the space often neglected with respect to wayfinding. Many of the participants thought that the study had touched on very important issues and hoped that the findings will be used for future applications. Overall, participants appreciated the study's relevance because it dealt with improving the quality of life.

4.9 Summary of Results

Throughout the data analysis, the results point to some of the differences and commonalties among the four groups regarding the particular cues they relied on for wayfinding. In terms of their common needs, many of the participants commented on the relevance of architectural cues, landmarks and sounds as vital sources of information when travelling on city sidewalks.

Landmarks were defined as buildings and large signs which can be seen far away, or they can be street corners and sidewalk patterns which are more integrated in the path of travel. Ground textures were found to be important to most of the participants with a visual impairment because they help to define the sidewalk and mark the transitions along it.

Clearly marked street signs that are easily seen, legible and with colour contrast were found to be significant to people with low vision and people with full vision. Participants with white canes and with guide dogs commented that tactile signs and Braille/tactile maps can be more useful to them if they were available and easy to find along the path of travel.

People with a visual impairment also rely on both pedestrian and traffic sounds for crossing streets and locating destinations, such as street corners and building entrances. Too much surrounding noise, however, can cancel out informative sound cues people with visual impairments use.

A clearly defined sidewalk that is straight and free of obstructions enhances the movement and wayfinding activity of people with or without a visual impairment. The regular maintenance of sidewalks and consistency in the layout of street elements were also of great importance to most of the participants in the study since they help make the sidewalk predictable and safe to use.

Some of the limitations to wayfinding by people with and without a visual impairment throughout the pre-selected route related to the manner in which street elements (moveable and fixed objects) impeded the path of travel. This problem was found particularly in the large traffic island. Other limitations relate to the way paths and crosswalks were positioned, or angled, away from a 'straight line orientation,' a key element to sustaining efficient wayfinding. The lack of well defined curb ramps and audible signals also presented other limitations to the wayfinding activities of respondents in the study.

The field study (journey and interview) was designed to enable participants to discuss key issues concerning the way our street setting limits or aids the wayfinding process. Overall, the respondents in the study provided much insight to the street elements they rely on for wayfinding. Many of the participants were pleased to be a part of the research and hoped that their concerns about the street environment can be applied to real design in the future. The design recommendations participants had made to improve wayfinding in the pedestrian environment will be highlighted in the Discussion Chapter.

5. DISCUSSION

5.0 General Observations and Research Findings

The findings of this research revealed much about the way people interacted with the street environment and how its elements can influence the way they navigate on them. Although different methods of wayfinding were shown by the four different groups, the study showed that most participants shared similar needs and preferences from the pedestrian environment in terms of wayfinding. The results point to some common themes as they relate to both the research site and city streets in general.

Similar to Finkel's study (1994), the results of this research also showed that the majority of participants, whether they had use of full vision or had a visual impairment, relied on architectural cues to wayfind on city sidewalks. Among the architectural cues mentioned by participants were street corners, curb ramps, and edge conditions such as hedges, building walls, boulevards, ground texture, and parking lot curbs. These street components were considered important to participants because they provided definition to the pedestrian route, enabling them to stay on course and reach their desired destinations.

Landmarks were highly rated by respondents with or without a visual impairment, who claimed their reliability when wayfinding on city sidewalks. These elements can help the wayfinder formulate a mental image of a space and recognize where they are and where they must go next within that setting. Participants with a visual impairment identified local elements such as ground surfaces, sounds, and street corners as landmarks, while people with use of full vision regarded distant buildings and large signs as their definition of landmarks.

Landmarks, as described by people with a visual impairment, were ones closer to the path of travel.

As in Finkel's study, different ground or tactile surfaces were revealed to be of great significance to people with a visual impairment. Surfaces which distinguish sidewalks and curb ramps, for instance, are important in determining where the paths and crosswalks exist. Tactual surfaces can be felt and heard by a person using a white cane and aid in giving important information about where they are. The contrast of colours and textures that different materials offer can also serve as landmarks along the pathway. Participants with a visual impairment indicated that different materials could be used more to convey transitions in the sidewalk environment such as crosswalks and building entrances.

Research findings prove that sound is the primary sensory cue used by participants with a visual impairment, particularly those with a guide dog and with white canes. The high rating these two groups gave to sound, as an important sensory cue was consistent with Finkel's research findings. Street sounds are a valuable source of information and can help the wayfinder gauge pedestrian and vehicular traffic in the surrounding area. By listening to specific sounds the wayfinder with a visual impairment can find crosswalk locations or building entrances. Several of the participants, with a guide dog and white cane, indicated that they can isolate reflected sounds (by echo location) to pin-point certain objects and openings along the sidewalk. The sound of vehicles, as they stop and go, at intersections was found to be helpful in determining when to cross streets. As well, the auditory cues that different ground surfaces provide are helpful in establishing a straight path of travel or detecting crosswalk locations, which may have a different tactile surface.

Respondents were asked to comment on the elements which often presented limitations to their wayfinding activities on city sidewalks. The main issues which most participants felt needed more attention were sidewalk maintenance, the standardization of streetscape elements, the use of more proper curb ramps, and the use of more audible crosswalk signals. Participants in the research gave both the study route and city streets only an average rating in terms of their ability to facilitate wayfinding. This may indicate that more focus is needed on the current methods of planning and design to make sidewalks more wayfinding friendly.

Overall, participants from all four groups described the lack of city sidewalk maintenance as a major factor which made wayfinding on pedestrian routes more difficult. Uneven paths and the lack of snow clearance created a walking environment which was unsafe and harder to negotiate. Participants generally felt that there should be regular maintenance of all pathways in the city.

Another area frequently mentioned by participants was the need to have a consistent layout of all the associated elements of the street, such as light standards, trees, trash receptacles, and benches, so that they do not obstruct one's wayfinding activity on sidewalks. This finding was compatible with Finkel's research of indoor wayfinding by people with a visual impairment, which pointed out that obstacles in the path of travel can increase stress and create hazards to wayfinding. The preference by most participants with and without a visual impairment was to have a simple layout of sidewalks which can lessen the hazards of travelling and provide more space for pedestrian traffic. Respondents from all four groups indicated that there should be consistency in the design and placement of all streetscape elements along sidewalks to increase both safety and predictability when wayfinding.

The placement of proper curb ramps along pedestrian routes was discovered to influence wayfinding by people with a visual impairment. Participants with a visual impairment pointed out that a straight alignment of curb ramp with both sidewalk and crosswalk is essential for effective wayfinding. Participants appreciated the continuity that this straight line orientation provides as it alleviates the extra work of finding the ramp as the pedestrian approaches a crosswalk.

Audible crosswalk signals can greatly improve safety and wayfinding for people with a visual impairment when crossing streets. Participants with and without a visual impairment emphasized the importance of these units because they can enhance the wayfinding activity, especially when crossing loud and busy intersections.

In addition to these issues, the other areas concerning the research site were the design of the two traffic islands, the uncontrolled yield turn, and the loud noise from vehicular traffic. The results showed that the clutter of moveable and fixed objects on the large island (on Osborne Street and River Avenue) at times confused and limited the wayfinding activity of participants with and without a visual impairment. The uncontrolled yield turn into River Avenue also increased the danger element, as pedestrians had no control of when to cross safely.

The study showed that among the other limiting factors associated with sidewalk travel, glare was found to be a common problem for most of the participants with low vision and with no aids. A 'white-out' effect can disrupt depth perception and the ability to see objects along the sidewalk, particularly street signs and crosswalk lights. In Finkel's study, participants with low vision and with no aids described glare as a detriment and a reason for avoiding certain areas. The major cause of glare are intense sunlight, reflection from windows and strong head beams from vehicles. Surrounding noise was ranked second as a limiting factor to wayfinding, however, participants with white canes and with low vision with no aids preferred surrounding noise since it enabled them to assess the street environment on a constant basis. Other participants with a visual impairment noted that the sound of heavy machinery, construction sites, and lawn mowers can often cancel out important sound cues.

Participants with a visual impairment indicated that memory and a method of counting streets, houses, and even the number of paces one takes was an effective way of wayfinding by people with a visual impairment. The counting method was reinforced by memorizing certain buildings, houses and other objects as landmarks that serve as guides in their wayfinding journey.

Study findings also indicate that information systems such as tactile signs and Braille and tactile maps can be useful tools that provide important information to people. However, many argued that these systems can only be useful if they were more widely distributed and easy to locate along sidewalks and transit routes. Although not always reliable, participants in the study revealed that they sometimes ask for assistance from other pedestrians to provide them with quick information regarding directions or guidance. This finding is also similar to that indicated in Finkel's study of indoor wayfinding by people with a visual impairment.

5.1 Participants' Methods of Wayfinding on Sidewalks

The study also revealed the various methods participants used to wayfind on city sidewalks. Information on these methods was important since they provided the key to understanding the way participants negotiate the exterior environment.

Participants with guide dogs relied on their dogs to help them maintain a straight path of travel, as well as steer clear of any obstacles on the sidewalk. The role of the guide dog is to assist the person and not conduct the wayfinding activity itself. People with guide dogs wayfind around city streets primarily by using traffic sounds as cues, and even as landmarks, to denote approaches to intersections or openings for buildings. They also rely on edge conditions (grass boulevards, fences, and building walls), and ground textures to detect curbs and curb ramps to maintain a straight course on sidewalks. The 'corridor effect,' which is created by vehicular traffic on one side and buildings on the other for instance, also helps sustain a straight path of travel for several of the participants with guide dogs. In some instances the participants with guide dogs in the study commented that they often used a system of counting, whereby the number of curbs or steps taken are memorized.

People with low vision, with no aids, were found to rely largely on their vision and hearing to find their way around the city. Visual elements such as buildings, signs and contrasting colours become important cues for people with low vision. Because of decreased depth perception, contrasting colours play a significant role in providing people with low vision the necessary information to negotiate exterior spaces. Yellow and white colours, such as those used for crosswalks and parking curbs, stand out best and provide an adequate edge condition to follow when walking on city sidewalks. Different ground textures and edge conditions are also helpful for wayfinding. Informative noises such as the sound of vehicular traffic and pedestrians also help facilitate wayfinding for people with low vision. Participants in the study mentioned that following other peoples' footsteps or voices often become useful guides to finding an intersection or knowing when to cross a street.

People with white canes rely on their hearing to recognize useful cues while wayfinding on city streets. They also rely on the defined edge conditions of buildings, boulevards, hedges and the textures of sidewalks to maintain a straight line of travel. Echo location is another method by which participants who use white canes can find their way around city streets. By hearing sounds that bounce off building walls and bus shelters they are able to gauge where they are in relation to their surrounding environment. This method proved to be effective in locating openings to buildings, as well as maintaining a fair distance away from building walls they walked alongside.

Respondents with use of full vision relied on clearly readable signs and landmarks. Architectural features and prominent objects, such as signage and church steeples, are useful elements for guidance. Colour contrast and proper lighting are also important factors in wayfinding for participants with full vision.

5.2 Design Implications from Results of this Research

It was evident from the comments made during the journey in Phase I that the prevalent theme centered on the architectural cues found along the route (as indicated in Figure 7). The majority of the participants with or without a visual impairment primarily relied on such cues for wayfinding. The problems with negotiating parts of the street can be attributed to the design and the maintenance of sidewalks and all its components. Although there were many examples of problem areas made explicit by participants in the study, many responded positively and recommended some simple solutions to such problems.

Sensory cues were secondary to the architectural cues and were used primarily by people with visual impairments. The use of sound, illumination, echo location, and smell complemented the surrounding architectural cues.

Similar to Finkel's study (1994), the participants' opinions regarding wayfinding cues in the street environment varied in terms of their usefulness. While some recommended changes to street elements because they were perceived as obstacles, others found these same items to be of benefit to them when navigating city streets. A good example of this discrepancy surrounds the issue of fixed and moveable objects along sidewalks such as benches and bus shelters. Many participants claimed such elements made sidewalks harder to negotiate because they are, at times, 'haphazardly' placed along the route of travel. A few, however, find these same items reliable as sources of landmarks, enabling them to gauge where they are in relation to their surroundings.

It was evident throughout the study that many of the problems pointed out by participants in the study have a particular bearing on the actual design and, to a greater extent, the standardization of sidewalks and its components. However, in some cases, participants had indicated that some of the problems associated with pedestrian travel stems from the lack of regular maintenance of pedestrian routes. In light of this, the issue of wayfinding problems cannot be rectified in terms of pure design. Some solutions are as simple as dealing with the clearance of ice, snow, and debris from sidewalks, which pose hazards to anyone's travel.

Through observations and discussions, participants from the all groups have identified the common issues regarding the deficient state of current city sidewalks and have offered some recommendations which can greatly improve these settings for wayfinding. Knowledge of these needs can be used effectively to manage and create pedestrian environments that may accommodate a wider range of user needs.

5.2.0 Sidewalks

In most street settings, sidewalks function as the primary walking surface and is an important source of cues used for wayfinding. In terms of their design and maintenance, sidewalks were considered by many participants to be the most problematic. The preference for people with and without a visual impairment is a well defined sidewalk with an unobstructed, leveled hard surface. They should have adequate space for two way pedestrian traffic, including use of assistive devices and personal assistance, and have curb ramps. Tactile and colour change are required where the sidewalk and roadway meet. Grass boulevards, hedges, walls, and concrete parking edges create a well defined edge, which many of the participants with a visual impairment relied on for maintaining straight line orientation. Participants with a white cane and with guide dogs also preferred sidewalks to be aligned with other important features in the street such as curb ramps and crosswalks. The alignment of these key elements provide a sense of continuity which helps facilitate wayfinding.

The pattern of materials designed on sidewalks add to the aesthetic qualities of the street, but also become important tools in navigation for many people with visual impairments. Changes to ground surface provide a valuable source of information because of their visual, tactile, and audible characteristics. Uniformity and redundant cueing can be established by using coloured and textured materials to define the sidewalk. The use of such materials can increase the legibility of the path and define the configuration of the circulation system for most pedestrians. Texture and colour contrast are useful, for instance, in denoting entrances to buildings or an approach to an intersection. This is particularly noticeable to people who use white canes and people with low vision. Materials such as paving stones and, in some cases, the changes to elevation created by slopes along the sidewalks are also helpful indicators when approaching back lanes and roadways perpendicular to the path of travel.

Sidewalks should be safe, functional, and convenient for everyone. Paths which are unobstructed, coherent with other street elements and obvious through vision, touch or sound (with use of defined edges, textures and colour) become more perceptible to most pedestrians. The articulation of the path in this manner is key to wayfinding communication.

5.2.1 Sidewalk clearance

Regular maintenance of sidewalks is essential to avoid disruptions to anyone' s wayfinding activity. To enhance safety, the materials must be durable and slip resistant. Sidewalks should be free of any debris and clutter as well as snow and ice throughout the route and crosswalks. Participants from all groups pointed out that lack of sidewalk maintenance can often interrupt wayfinding and rhythm of travel.

There should be no obstructions within width and height of the pedestrian route. People with a visual impairment or limited peripheral vision often concentrate on the surface below and are not aware of the overhanging objects such as overhead signs and tree branches. Often, these hazards can inflict injury to the unsuspecting pedestrian. Several of the participants with a visual impairment stated that they chose to wear protective glasses at all times precisely for this reason. A maintenance program must be followed to ensure that sidewalks are cleared of such obstacles to avoid injury to the pedestrian. In planting schemes, designers should consider the different varieties of plant species used and their placements along sidewalks so that they will create the least amount of hazards to pedestrians.

5.2.2 Building entrances

The location of building entrances was another issue raised by several of the participants with white canes and guide dogs. Entrances provide the transition into another destination zone and communicate to people where to enter that destination. They are sometimes regarded as landmarks or reference points. Participants with a visual impairment mentioned that they have had difficulties locating building entrances, at times, because they were hard to distinguish along the path of travel. To increase their legibility, methods can used to accentuate building entrances. Entrances should be well marked with a different texture and contrasting colour from the surrounding area so that they can be easily noticed by people. Entrances can be recessed, or have a canopy for increased audition cues. Respondents with low vision and no aids suggested that doors and door frames should be colour contrasted from their surroundings to enhance detection.

Participants with a visual impairment also noted that entrances should be supplemented with appropriate signage and information systems such as maps.

These elements should be situated so that they can be easily noticed and used by most people. When building entrances are designed and clearly marked with contrasted materials and colours they can increase visual, auditory, tactual access for the user. Building entrances should be highly legible and communicate to the wayfinder that it denotes an opening along the circulation route.

5.2.3 Moveable and fixed objects on the sidewalk

A number of participants with and without a visual impairment expressed their concerns over the placement of street furniture along pedestrian routes. The main problem participants had with the location of moveable and fixed objects on the sidewalk is that they are not consistent throughout the city. Participants often complained of accidentally running into light posts placed into the path of travel or having to weave through a maze of benches and trees to maintain straight line orientation. Similar to Finkel's (1994) findings, participants of this study stated the fear of running into objects along the sidewalk, which can often lead to increased frustration and limited independent travel. Light posts, trees, newspaper boxes, benches, and trash bins are all essential to the street environment, but they can also create a hazard to anyone's travel. It is imperative to have a consistent method of placing these elements along city sidewalks. It is important to clear the path of travel of any of these objects and locate them to one side on all city sidewalks. The preference by participants with white canes and guide dogs is to have them line up along the curbside. This method is helpful in two ways; first, it helps people with visual impairments who utilize building walls to navigate more effectively with minimal hindrance; and second, the objects placed along the curbside creates a safety buffer between vehicular and pedestrian traffic.

One idea is to keep street furniture grouped together so that they become more noticeable than when they are scattered. The grouping should be located in an area where it does not impede flow of pedestrian traffic or the line of vision. The sidewalk should provide adequate space to accommodate both the grouped objects and two way pedestrian traffic, including use of assistive devices or personal assistance. Placing the grouped objects on a tactile surface with contrasting colours can warn people of the obstacles and assist them in avoiding them.

Large traffic islands, which serve as locations for bus stops, street furniture, and street signs should be well planned where such objects do not interfere with the normal course of pedestrian traffic. In a few instances, several guide dogs in the study were confused once they got on the large island along the research route, largely because of the clutter and human traffic. The preference of people in the study was for a simple design which keep items on the island to a bare minimum. Bus shelters and newspaper boxes on traffic islands should be grouped together away from the path of travel and surrounded with contrasting colours and tactile material.

5.2.4 Sidewalks on traffic islands

The path of travel in traffic islands should be free of barriers that may obstruct access and clear lines of visibility. They should be designed to have adequate space for two way pedestrian traffic, including personal assistance or assistive devices. Paths should have curb ramps that have contrasting colours and tactile cues that can be noticed by people, particularly by people with a visual impairment. Several of the participants with white canes and guide dogs mentioned that they had difficulty distinguishing the smaller island along the research route from the roadway. There should be a clear distinction between the roadway and the walking surface on islands to emphasize a sense of arrival. Some participants preferred a slight lip on the island curb ramp to distinguish it from the road.

The curb ramps on traffic islands should line up with the path of travel and to opposite corners of the street. Participants with a visual impairment were observed to have difficulty with locating decision point 6 on the large island along the route because it was not situated at a right angle from the path of travel. Where vehicular yield turns exist next to traffic islands, pedestrian crosswalks and audible signals should be implemented to control car traffic and ensure safe crossing for all people. Sidewalks on traffic islands should be well defined and distinct from the road surface so that they are safer and more perceptible to wayfinders.

5.2.5 Driveways and parking lots

Several participants noted that they had not felt a difference between the roadway and sidewalk surface when crossing driveways. Pedestrian routes in these areas should be clearly marked with cues at the beginning and end of the driveways.

Navigation in parking lots is generally hazardous to pedestrians mainly because of its large open spaces and the constant flow of vehicular traffic. Participants with white canes and guide dogs commented that since these areas function primarily for cars they often fail to provide safe pedestrian routes. A few had suggested that there be a separate path inside the parking lot. In order to provide safe navigation in parking lots, pedestrian routes should be clearly designated by utilizing materials different from the road surface. All obstacles, such as speed bumps and concrete bumpers, should have textural and contrast markings. The creation of a well defined path within parking lots can help provide a navigable route for wayfinders as well as separate pedestrian and vehicular traffic.

5.2.6 Curb ramps

There are apparent inconsistencies with the design and placement of curb ramps in various intersections in the downtown area of the city. The preference by many people in the study is to have the curb ramp line up with the path of travel for easier location and arrival at both ends of the crosswalk. Participants suggested that all curb ramps comply with current standards and placed at a 90-degree angle along street corners and not be angled into the intersection. A right angle location of curb ramps will help the wayfinder predict where they will exist along the path of travel. Ramps should also have a gentle slope ranging between 1:8 and 1:12 to ensure ease of access and safety for pedestrian use, including assistive devices. All these measures can help improve the legibility and functionality of curb ramps for all pedestrians.

Other methods are currently being used in other cities to increase the safety and effectiveness of curb ramps in wayfinding. Warning strips comprised of bright colours and different textures are utilized as cues to identify these areas from the surrounding sidewalk surfaces. These materials are made of slip resistant materials and placed before the slope to the point where the ramp ends and the crosswalk begins. A yellow detectable surface material with a truncated dome design has been approved by ADA standards (Americans with Disabilities Act) and is currently being marketed in the United States (see Figure 20). The tactile material is 15 mm thick, is skid resistant, and can adhere easily to the contours of the ground surface. It can be applied along curb ramps to serve as warning cues or provide wayfinders directional guidance. This material is meant to be detected easily by audition, by foot, white cane, or vision by a high contrast value colour. It gives a distinct sound quality once the pedestrian steps on it.

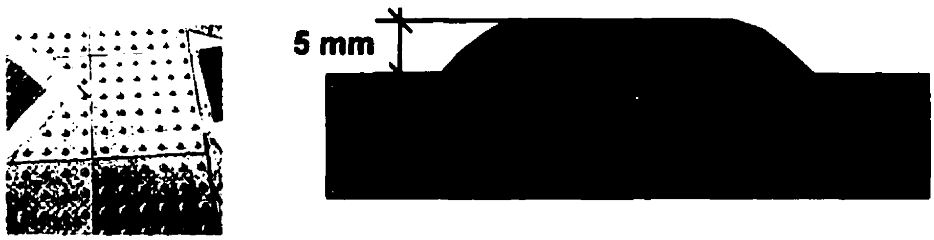


Figure 20. Truncated dome design

5.2.7 Crosswalks

Crosswalks in general were perceived as stressful areas by participants in the study. Similar to sidewalk surfaces, the start of crosswalks should be cleared of obstacles such as poles and fire hydrants which may prevent a person from aligning themselves with the crosswalk. The crosswalk area should also be free of manhole covers and catch basins which can pose a safety hazard. Participants with low vision and with full vision pointed out that crosswalks should be clearly marked with texture and colour contrast it from surrounding surfaces. This is a good way to increase the definition of the crosswalk and, thereby, its recognition along the pedestrian route. People with white canes and with guide dogs suggested that crosswalks line up properly with curb ramps and the path of travel for continuity. They also suggested that there be a standardized manner of placing all crosswalk buttons throughout the city to ensure easier detection. Participants with white canes and guide dogs recommended that all buttons should point parallel to the crosswalk it serves, to clarify orientation, and that it be located at an adequate distance from the area where one needs to cross. During winter months, snow and ice should be cleared around the manual buttons and crosswalk area to provide proper access for all pedestrians.

One example of a new crosswalk design uses different materials to convey to the wayfinder that they have arrived at the curb ramp (see Figure 21). The use of another material, such as brick, is then laid out across the full length of the street to serve as the pedestrian crosswalk area. This design allows the wayfinder to make key distinctions between the sidewalk area and the curb ramp as well as the beginning of the crosswalk. The contrasting colours of the crosswalk also help notify motorists that they are approaching a pedestrian crossing zone. This design can help to increase safety and legibility of crosswalks for all pedestrians.

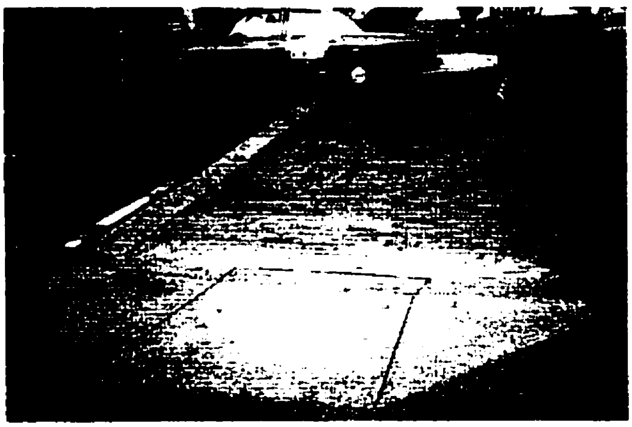


Figure 21. Example of crosswalk design

5.2.8 Audible signals

Almost half of the participants, including people with guide dogs, white canes, low vision, and full vision recommended the use of more audible signals.

Although some had expressed that they still need some refinement, most did agree that they are an effective method of informing people when to cross the street. Audible signals are effective because they reinforce sound cues, thereby alleviating the task of second guessing when to cross an intersection. They also serve as effective landmarks, or sound beacons, which help people pin-point intersections and related destinations along the route. Some of the difficulties encountered with current audible signals are in regards to the generic sound it emits, cueing all directional crossings in a four way intersection. First time users, or people who are not familiar with the intersection, may get confused as to which direction the signal is cueing. Participants in the study suggested using one type of sound for north / south crossing and another distinguishable sound for east / west crossing. Another consideration is to lengthen the time of the actual crossing cycle to ensure a safe arrival at the opposite side of the crosswalk. This was discussed to be particularly important at wide crosswalks such as Portage Avenue and Main Street. Presently, there are only a few of audible units stationed in select areas of the city and participants had commented that they should have a wider application throughout the city. The use of more audible signals has benefits for all pedestrians. When incorporated in the circulation route they help reinforce other cues in the environment and communicate to the wayfinder the appropriate time to cross the street safely.

5.2.9 Spatial configuration and landmarks

The spatial configuration of city sidewalks were a concern to many of the participants. Negotiating unexpected turns and curves can add to confusion and delay the wayfinding process and travel time. Many people with white canes and guide dogs have a preference for grid patterns and 90-degree angles for maintaining straight line orientation. This confirms Finkel's study findings, which indicated that people with a visual impairment continually check right angle reference marks as they move through space. Sidewalks, which are curved and acutely angled, were described by many of the participants as disorienting, especially when approaching a crosswalk. When possible, the configuration of circulation routes should be at right angles to avoid confusion and to increase detection by pedestrians.

The study findings show that participants have defined a variety of landmarks which served as their guides along the path of travel. When travelling, participants with and without a visual impairment are able to signify different landmarks in a sequential manner to mark the points along the path. This process enables the participants to eventually reach their destination point. In complex settings, people will tend to formulate a mental map to understand the spatial organization and objects it contains. Spatial landmarks that are distinct are particularly important in creating an image of a space and are fundamental to the wayfinding process. It is these elements which stand out from its surroundings that enhance the wayfinder's perception of that environment. Creating uniqueness in the exterior setting can be achieved by the form and volume of architectural and decorative elements and by the use of textures, colour, sounds, and graphics. All of these elements can be used to establish landmarks that give a very strong sense of distinctiveness to an urban street and, thereby, contribute to the wayfinding process.

5.2.1.0 Signs and information systems

Street signs which indicate street names, directions, locations of washrooms, and other services are a critical part of the street environment. However, signs should never be considered as a substitute to good street design. Signs can be informative and they can augment the wayfinding information that is being provided to the pedestrian. Many of the participants with and without a visual impairment suggested some basic principles when designing and locating street signs in order to increase their effectiveness for wayfinding. Signs should be colour contrasted and use large readable letters (as well as Braille and pictograms). They should also have proper illumination and be easily found along the pedestrian route to be used effectively. Several of the participants with low vision had commented that they often have difficulty reading the letters of street names. It is critical to place directional signs at decision points, such as intersections and entrances, to help pedestrians identify routes.

All street signage, whether they are overhead or sidewalk level, should be designed and implemented with some level of consistency. Stationary maps should be constructed in a tactile format with colour contrast and tactile lettering. It is important that elements on a tactile map are prominent and simplified in order to avoid confusion to the user. Several of the participants did mention that they would use tactile maps if they were more available.

Tactile maps are more accessible to people than conventional maps, because the information they provide can be seen and touched. Development of tactile maps have become more widespread for both indoor and outdoor applications in public facilities. Independence National Historic Park, in Philadelphia has an example of an outdoor tactile map that describes the major pedestrian routes and buildings in the park. Key elements in the map are designed to be bold and simplified, while messages are raised in tactile form. The entire map itself is made of a weather resistant material (see Figure 22). Signage and maps are vital sources of information in the street environment.

When they are done properly, they help pedestrians maintain independence in gathering information during their journey.

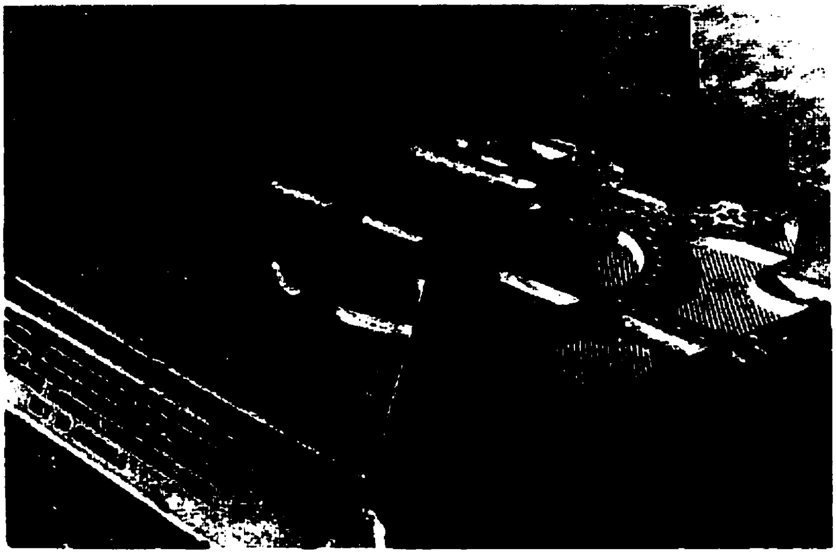


Figure 22. Tactile map design: Independence Hall National Park, PA, USA

A greater understanding of wayfinding issues has lead to the development of new information technologies that can enhance wayfinding for people with visual impairments. One example is Talking Signs, which enables the user to receive verbal information with a hand-held remote control from a number of small transmitters stationed in buildings or along the street. The transmitters are located along key features of the environment and provide the user with information regarding street names, bus stop locations, or directions with the use of the hand-held receiver. Concise messages are repeated continuously and delivered to the user through the transmitter's speakers or through the user's personal headset unit. These audible signals are currently being used in the transportation sector and in public buildings throughout the United States and Europe. (see Figure 23).

Talking Signs have a universal appeal since they can be used to provide many people with vital information. For instance, they can be used to communicate necessary information to people who cannot read conventional signs. The units are also designed to be simple and intuitive so that a wide range of users can access verbal information easily. Although, there should be alternate methods of providing information to users other than using a hand-held receiver. Receivers can be designed to accommodate the different needs and preferences of people. One method is to design the transmitters with sensors which can trigger the verbal information immediately once the user, carrying the receiver, comes within its vicinity without pressing the receiver button. This hands-free method can be useful, for instance, when users are carrying groceries or are with young children.

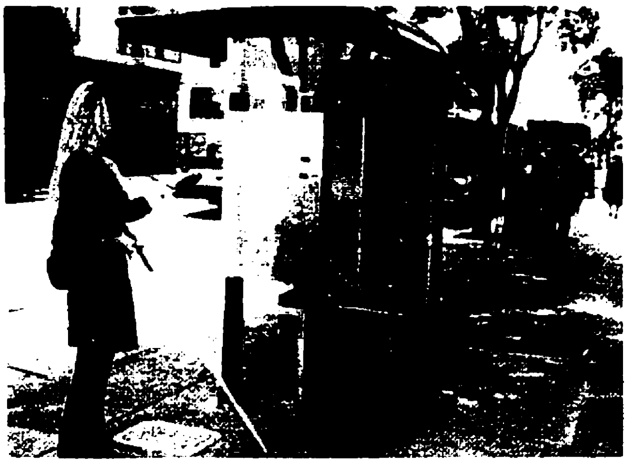


Figure 23. Talking Sign unit used at a bus stop

Other electronic systems being developed are personal units that rely on Global Positioning Systems (GPS), which beam down signals from satellites to give precise information on the user's position to within a metre. The user interacts with the outdoor system by using a small hand-held keypad that provides information with clock-type directional instructions (e.g. "change direction to 3 o'clock and continue 100 metres to Main Street"). The user hears the spoken messages using a special earphone, which does not prevent the user from hearing other important sounds in the environment. This technology enables the wayfinder to get a detailed map of pedestrian routes, but does not give information on other critical features in the environment, such as landmarks and the location of entrances and bus stops. Hand-held units might be cumbersome and less effective if it is being used by a person with a white cane or with a guide dog. These receivers should be designed to accommodate the different methods and preferences people want to receive the information. Similar to suggestions made regarding Talking Signs receivers, people should be able to access information through alternate means other than the hand-held units.

Both devices exemplify new advancements in the development of wayfinding technology, which rely heavily on computer chips and communications hardware. Both provide the wayfinder a level of independence but are expensive and inaccessible to most people at this time. However, further developments may one day lead these technologies to reach critical mass and eventually have a wider application for public consumption.

5.2.1.1 Glare

Visual glare is a common problem among people with low vision and often occurs when excessively bright lights are directed towards the eyes, or when the eyes move from an area of low illumination to an area of higher illumination. Several of the participants with low vision and no aids had expressed glare as a major problem because it prevents them from seeing street signs and crosswalk signals. Intense glare from storefront windows can sometimes prohibit a person with low vision and with no aids from seeing the sidewalk. As a result, people with low vision and no aids can become disoriented and sometimes experience injury by running into other objects along the pathway. By using shading devices, such as awnings on windows, reflected glare can be minimized. Artificial lighting should be positioned in an unintrusive manner, while the utilization of glass, ceramics and metallic materials in the street environment should be kept to a minimum. Such provisions can help diminish the affects of glare and enhance the wayfinding activity of people with low vision without aids.

5.2.1.2 Permanent hazards and construction sites

Construction sites can often interrupt the movement of pedestrians by diverting them from their regular routes. A well defined alternative route should be provided along with adequate warning signs to decrease the hazards of pedestrian travel. These temporary pedestrian routes should have the same features as regular routes, such as an even walking surface, no obstacles, and sufficient colour contrast and tactile cues. A secured handrail system should be placed along the temporary sidewalk to ensure safe passage around the barricade. Participants with guide dogs and white canes suggested that the Department of Public Works, and Streets and Transportation notify the public where to expect construction through newspapers, TV, and radio broadcasts. They also suggested that the relocation of bus stops, due to street repair, be treated in the same manner. Broadcasting such information can help pedestrians plan alternate routes to achieve wayfinding in the most efficient manner.

5.3 Significance of Design Implications to Universal Design

The design implications of this study are critical to increasing the legibility and safety of pedestrian routes for wayfinding. But more importantly, they reflect ideas that contribute to the development of universal design - the design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design. In almost all of the suggestions, key elements were found to be consistent with the seven principles of universal design (refer to Appendix A). An evaluation of some of the design improvements may best illustrate how they relate to the seven principles.

Certainly, the notion of principle one - "equitable use," is one principle found to be prevalent in almost all of the design solutions. The need to define sidewalks, curb ramps, and the implementation of more audible crosswalk signals are just a few examples which can adequately improve wayfinding on city sidewalks for most people, with or without a visual impairment, because they help to reinforce other wayfinding cues from the surrounding environment. Such design solutions do not impede travel or wayfinding for others, nor do they stigmatize users in their function. Rather, these changes help to promote useful designs for people with diverse abilities.

Principle two - "flexibility in use," calls for designs which can accommodate a wide range of individual preferences and abilities. The use of audible crosswalk signals is one good example that provides pedestrians with a choice in their preference to cross streets. When these units are partnered with pedestrian lights, wayfinders will be able to rely on both visual and sound cues to cross streets safely.

Principle three - "simple and intuitive use," promotes designs that are easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level. The recommendations to improve signage and information systems, the arrangement of moveable and fixed objects on sidewalks, and treatment of spatial configuration and landmarks are some examples which relate to this third principle.

Signs, which are legible and have colour contrast with tactile elements (including pictograms), can provide wayfinders with clear and understandable information pertaining to the street environment. Tactile maps, for example, can provide necessary information about the built environment to people with or without a visual impairment since the information they render is made available tactually and visually. Tactile maps are universal in this sense because they can be useful to many people.

Recommendations to standardize the placement of moveable and fixed objects along the path of travel helps to eliminate the complexity of having to avoid them on the sidewalks for most pedestrians. Standardizing their placement along the path also increases predictability and user expectations since they will know where such objects will exist along the sidewalk. Similarly, the use of right angles and the grid format reinforces straight line orientation for people with and without a visual impairment. Both recommendations are examples which promote simple and intuitive use of the circulation route.

Designs which include "perceptible information" relates to principle four. This principle encourages designs that communicate necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities. The recommendations, which exemplify this principle, were the ones which dealt with signs and information systems and the use of audible crosswalk signals. The principle is also reflected in the suggestions towards physical changes to the sidewalk environment, such as the use of contrasting materials on sidewalks, curb ramps, and crosswalks, as well as the treatment of spatial configuration and landmarks.

The development of signage, which exhibit detectable contrasting elements as well as tactile and pictorial information, are more perceptible to pedestrians and contribute to the wayfinding process. The placement of signs at decision points can also support other cues being provided from the surrounding environment. Similarly, the use of more audible crosswalk signals can provide perceptible redundant cueing (by way of sound) which strengthens other cues used in the environment. Both recommendations lead to effective means of communicating critical information to wayfinders.

The need to use contrasting colours and textures on sidewalks, curb ramps, and crosswalks are some examples which can greatly define and improve the legibility of the path for most pedestrians. Such materials provide perceptible information which helps wayfinders stay on the course since such materials can be detected visually, tactually, and through audition. Similarly, the treatment of transition points such as intersections and building entrances help distinguish these areas as landmarks along the path of travel. These are some good examples which can be implemented to maximize perceptible information about the sidewalk to the wayfinder.

Principle five, "tolerance for error, " is related to designs which minimizes hazards and the adverse consequences or unintended actions. The participants' recommendations for regular sidewalk maintenance and the placement of moveable and fixed objects along the path of travel are good examples that use ideas that lead to principle five. Responses towards the arrangement of streetscape elements, such as light standards, benches, and newspaper boxes to one side of the sidewalk is one way to increase safety and minimize hazards to the pedestrian travel. Although the need for sidewalk repair and maintenance is not considered a design improvement, the notion of regular management of all sidewalks can also be regarded as an effective way to reduce potential hazards to the wayfinder.

Curb ramps which are clearly designated by contrasting colours and textures provide detectable information about an impending hazard - the crosswalk. Crosswalks, which are defined with similar contrasting materials and aligned with adjacent sidewalks and curb ramps can help guide wayfinders away from hazards, such as oncoming traffic, and maintain the course of the path. Clearly marked alternative routes, designed to channel pedestrians around constructions sites, is another design solution participants have made to minimize hazards and facilitate wayfinding for most pedestrians.

The need to standardize the placement of all pedestrian buttons along crosswalk locations is one suggestion participants have made which is consistent with principle six - "low physical effort." This principle promotes designs which can be used efficiently and comfortably and with minimum fatigue to the user. The recommendation, offered by participants, is to have pedestrian signal buttons run parallel with the direction of the crosswalk and placed where they can be easily found. This suggestion helps to diminish the extra effort of having to search for the button once the wayfinder has reached the crosswalk location.

Principle seven, "size and space for approach and use," considers that appropriate size and space is provided for approach, reach, manipulation, and use regardless of the user's body size, posture, or mobility. This principle is best exemplified in the recommendations regarding the placement of streetscape elements on large traffic islands and along main sidewalks. A simple layout with the reduction of streetscape elements, such as benches, newspaper boxes, and signs can provide adequate space for pedestrian movement on traffic islands. Similarly, sidewalks that are designed to have streetscape elements along one side of the path establishes a clear line of sight and enhances the movement of the wayfinder.

The seven principles of universal design is an effort to address the wide range of user needs. The guidelines serve as reminders to all designers that products and environments should be created so that they facilitate the needs of as many people as possible. It is evident that the design implications of this study can contribute to the development of universal design. The aspects of increasing the "legibility" of paths through use of contrasting materials and colours makes a more recognizable route for all pedestrians. Signs, which are legible and easy to understand, provide perceptible information to all who use them. Efficient wayfinding and safety can be provided to all pedestrians by wisely maintaining and clearing the sidewalk of any elements that may inhibit movement. Safe street crossing can be assured to all pedestrians with the use of more audible crosswalk signals. Perhaps not all of the suggestions made in the study can adequately satisfy the needs of every pedestrian. However, the issues identified above has presented ways of establishing design that is closer to achieving universal design.

6. SUMMARY & CONCLUSION

6.0 Summary of the Study

Contemporary life in a city revolves around constant interaction with the built environment. To sustain life in an urban setting, linkages are created to provide its inhabitants access to essential resources, destinations and other communities. The proficiency to access these critical areas of the city is, therefore, paramount to survival.

Efficient spatial orientation and wayfinding, on a functional level, is achieved though a greater understanding of the surrounding environment. The perception of space and the decisions made to arrive at particular locations will vary according to whoever that wayfinder might be. For many pedestrians with visual impairments, walking from one location to another often involves having a well prepared decision making plan compared with people with full vision. A person's ability to orient and negotiate a circulation route depends largely on what information this environment is communicating. It was apparent, in this study, that architectural elements, such as ground textures, colour contrast, curb ramps, and edge conditions help pedestrians identify the circulation route. At times, these defining elements provide important landmarks, which people use to help find their way along the path of travel. If an element of a street setting is unique, it can be stored in memory and present itself as a helpful tool to one's wayfinding strategy. It is imperative to understand these methods of spatial orientation and that they be adequately facilitated through careful design and planning of city streets and open spaces.

However, there are other factors which can impede the wayfinding process. The lack of consistency, in streetscape design and layout, as well as the lack of regular maintenance, are typically viewed by people as limitations to sidewalk wayfinding. Information systems such as signs, tactile maps, and audible signals are also effective tools to wayfinding, but would be more effective if they were properly designed and widely distributed.

The thesis was structured first with a summation of related literature, which was pertinent to the development of this research. A chapter on methodology reflected the importance of surveying participants and the involvement of a consumer advisory panel which helped to steer the study's direction. The subsequent chapters of this research paper revealed the perspectives of people with full vision and people with visual impairments on wayfinding in the exterior environment. The thesis was modeled after Finkel's research on wayfinding by people with visual impairments in the built environment (1994).

There were three objectives to this study. First it investigated how different elements of the street environment, such as architectural features, moveable and fixed objects, and other variables (illumination, sound), influenced wayfinding by people with full vision and people with visual impairments. Second, it sought to compare the responses and opinions of the participants regarding the route travelled in the study, as well as issues of wayfinding in the general urban environment. Finally, it focused on research findings and recommendations made by participants to develop solutions for design and ideas on future research.

6.1 How Objectives of this Study Were Met

Objective 1: To investigate how the following areas influence wayfinding by people with sight and people with visual impairments in the street environment:

a) architectural elements such as building walls, sidewalk surfaces and edge conditions, open spaces, narrow passages, spatial configuration, curb ramps, and crosswalks

b) fixed and moveable objects such as signs, posts, mail boxes, benches, trees, and newspaper dispensers

c) other variables such as surrounding sound, illumination colour contrast, smell, wind, and echoes which are extracted from the setting

According to the data most respondents typically relied on architectural cues to help them navigate city streets. Contact with the physical environment enabled participants to gauge their surroundings and then execute a plan of action. Wayfinding is achieved by perceiving the different environmental cues the street setting offers. Through complex cognitive processes, respondents obtained critical information that was necessary to establish a wayfinding plan. In this case, participants with visual impairments depended on elements such as edge conditions of sidewalks, the characteristics of street corners, and the different textures of ground surface to determine where they are and where to go next. These key features served as landmarks and guides which, through continuity and memory, helped define a wayfinding strategy. Familiarity with territory and knowledge, acquired through past experience, also helps reinforce the respondents' expectations when they are negotiating city sidewalks.

Participants reacted differently to fixed and moveable cues of the streets and pointed out that only a select few of these elements served as useful landmarks. For instance, bus shelters and traffic boxes were known to be helpful to several of the respondents. Bus shelters were seen as landmarks, where people gathered to wait for buses, as well as guides which aided in the echo location activity of some participants. Traffic boxes emit sounds which cues the wayfinder with a visual impairment to prepare for the next crosswalk cycle. These examples presented the dual functionality of street objects, which go largely unnoticed by most pedestrians with full vision. It was evident in the study that although these objects are assigned a particular function in the street environment, they also serve a secondary purpose in providing the wayfinder with a visual impairment critical information about the street.

Unlike fixed cues, moveable objects, such as newspaper boxes and sandwich board signs, tend to be viewed as potential hazards instead of helpful cues to wayfinding. They are far less reliable and informative as cues, simply because they can be shifted from their positions from day to day. However, there were moveable objects that were considered landmarks even in a temporary sense. The cluster of youth known as the "squeegy kids," which gathered on the corner of Stradbrook St. and Osborne St. and the hot-dog cart near the Safeway parking lot along the studied route, were considered temporary landmarks based on summertime activity within the area.

Data from the study indicated that hearing was a prime mode of perception by many of the respondents with a visual impairment. Traffic sound cues were found to work well as a source of information to the wayfinder. Respondents with visual impairments localized important sounds and optimized them to gain advantage in proceeding safely along a circulation route. It was discovered that too much background noise, such as those projected from construction sites and honking car horns, can inhibit auditory perception and have a disorienting effect.

Other respondents were known to use echo location as well as olfactory and heat perception. However, these methods are rarely used since frequent changes in traffic noise volume and climate can easily render them to be less informative. People with visual impairments also rely on tactual perception. The study pointed out that different ground surfaces can exhibit distinct textural and auditory cues to pedestrians who have a visual impairment. Tactile perception enables the wayfinder to maintain a straight line of travel or detect the difference between sidewalk and street. For respondents with residual vision, contrast was of great importance and is useful when gauging the edge conditions of sidewalks or reading signage. The use of contrasting elements enables the environment to become more legible to its users, and thereby, affecting the outcome of the users' wayfinding strategy.

The outdoor pedestrian environment is an inherently complex one. It is a setting comprised of layers of different activities, people, objects (moving and fixed), climate change, and the hazards of vehicular traffic. In general, the biggest obstacles which confront many of the participants when walking city sidewalks are its inconsistent design and lack of regular maintenance.

Objective 2: To compare the responses and opinions of participants regarding the route travelled, as well as general issues of wayfinding in the exterior urban environment.

Much information was gathered from the participants concerning their perception of urban spaces and how they are able to negotiate in them. It was evident from Phase I observations and interviews that all four groups had their particular techniques in navigating city sidewalks. However, there were many similarities among participants' opinions concerning streetscape design and its functionality. Clearly, ground texture, edge conditions and landmarks were of great importance to people with visual impairments. Whether these elements were deliberately placed along the street environment or not, participants with visual impairments are able to read such information from their surroundings and successfully find their way. The objective here was to investigate where these areas existed and then understand how they might be maximized to benefit its users. Wayfinding, as an approach to spatial design, facilitates the successful movement of people through space by respecting their informational needs (Public Works Canada, 1987).

Opinion on the maintenance regimen of city sidewalks was shared by many participants in the study. Respondents pointed out the need to address the lack of regular sidewalk maintenance, particularly along heavily used pedestrian routes. As downtown sidewalks continue to be in disrepair and snow clearing budgets continue to shrink, the lack of regular maintenance on sidewalks will remain a major barrier to providing access to pedestrians. In spatial design, addressing the wayfinding process is as much a design issue as it is a maintenance one.

Based on the study findings, it appears that many of the city's sidewalks lack continuity in design and layout. In spite of design recommendations, cited in guidelines, there is still widespread disparity in the treatment of sidewalks and arrangement of street elements throughout the city. The problem lies in the fact that guidelines are not necessarily followed by street planners. While high profile areas in parts of the downtown are able to comply with at least minimum standards, and at times go beyond them, other places in the city do not. It was evident from the study's inquiry that in order for streetscape design to be successful it must put into place basic components that are easily and universally recognizable by its users. Consistency in street layout and redundant cueing are vital to reinforcing the pedestrian's knowledge of the street environment.

Objective 3: To focus on research findings and recommendations made by participants to develop solutions for design, to evaluate their significance to universal design principles, and gather ideas on future research.

The consultation process proved to be valuable element of the study. In regards to wayfinding, it provided relevant information on the current conditions of the street environment and the necessary changes to improve them through the perspectives of people with full vision and people with a visual impairment. Ideas from respondents brought fresh insight to the way people travel on city sidewalks and, more importantly, on considerations to re-evaluating the current practices in streetscape design.

Recommendations for design varied among respondents, but the underlying focus was a need for more standardization, redundant cueing, clarity of street elements, and careful maintenance of sidewalks. Other suggestions included the application of technological solutions, which some participants described as a viable alternative for enhancing wayfinding and increasing the independence of people with visual impairments. Respondents recognized that such technologies, particularly audible signals, should be more widely used throughout the city. Overall, the suggestions prompted by research participants did not require expensive or complicated improvements to streetscape design. Most recommendations called for sensible planning and design when it comes to spatial organization and the appropriate use of surface materials and signage along pedestrian routes.

There were several aspects of the recommendations that contribute to the development of universal design. Indeed, there were many important points which espoused the guidelines listed under the seven principles of universal design. The suggestions that participants had provided focused on the need to increase the legibility of streetscape elements as well as the need to make them safer for pedestrians. The necessary information provided by the sidewalk environment, whether they be a system of signs or the layout sidewalk itself, should be perceptible and easy to understand by all pedestrians. Spatial configuration and maintenance should also be considered in the development of sidewalks to reflect the movement of pedestrians. By doing so, a well defined circulation route can be established, which will contribute to safe and efficient wayfinding for most pedestrians.

The benefits of including participants in the study can be described in two ways. First, the participants brought forward their personal experiences and perceptions of the urban environment, which was essential to understanding the nature of user behaviour and their relationship with space. Second, the formulation of concepts to improve design of the built environment was achieved by understanding the needs of people who are affected by it the most. Overall, participants helped to identify practical and realistic solutions to the problem. Their participation can help broaden the decision making process regarding future wayfinding research and design.

6.2 Research Limitations

There were limitations to the study concerning the participation of some people with visual impairments in the field study. First, it was discovered that some individuals had more wayfinding skills and greater knowledge of city streets than other participants. Second, several of the participants had some expectations from the study because of their knowledge or experience from similar studies, particularly G. Finkel's work and other related research.

Other variables inherent in the street environment such as sudden change in climate, traffic intensity, noise levels, accidents, and unexpected construction along the site also created an inconsistent setting for the field study. Furthermore, the administration of the field study in two different time slots in the day may have created inconsistencies in site conditions and participant responses. However, due to the short summer season and the number of dry days in Winnipeg, it was necessary to schedule participants accordingly.

In retrospect, there are several comments to be made concerning the limitations of the study surrounding the sample used, site conditions, and the insider perspective of the researcher.

6.2.0 Sample

One major limitation of this study is related to the sample size. The projected number of participants should have been 60 individuals as opposed to the actual total of 48 surveyed in the study. The original sample size was to include four groups of 15 people. The groups with people aided by guide dogs and people with full vision were the only two short of the target number. There were several constraining factors that account for this outcome.

One limitation was that there is a small population of people with guide dogs living in the city of Winnipeg from which to draw a sample group. Another limitation was that potential participants had other obligations (university, work, etc.) and could not partake in the study by the end of August 1997. Since the primary focus of the study surrounded people with visual impairments, the majority of these participants took priority in the scheduling of field work during the summer months. As a consequence, only seven people with full vision could be scheduled before snowfall.

Another major limitation was that the study surveyed only urban dwelling adults who were mobile. Thus, the results of this study reflected only the responses given by this group.

6.2.1 Site conditions

Constraints to conducting research in the outdoor urban environment were encountered and included changing weather conditions, road blocks due to construction work, and the unpredictability of pedestrian and vehicular activity. Such factors resulted in delays in field work observations, increased potential hazards, and affected the journey of several participants during Phase I.

The intent of the study was to chose a route that was least known by participants. Although, there were some participants which had indicated that they had extensive knowledge of the pre-selected route and had created varied responses among the people in the sample, thereby, affecting the research data. The responses given by participants who were familiar with the site may not have had the same objectivity as others who didn't know it so well.

The time of day chosen for field work observations also presented other limitations to the research. Since the research field work took place only during business hours of the work week and in summer conditions, all other environmental variables such as, night time, and rain conditions were left out of the research exploration.

6.2.2 The researcher's perspective

The principal researcher was familiar with several of the participants and had already established a rapport with them in previous studies. It is possible that participants might have discussed issues differently if the study was conducted by a different researcher. Because interviews were administered by the same researcher, there was little opportunity to test the reliability of the interviewer.

6.3 Implications of Findings

6.3.0 Policy implications

The results of this research shed light on some key issues regarding the manner in which people conduct wayfinding in the exterior setting and the particular areas of the built environment we can improve upon to further enhance the wayfinding process. A major area of concern respondents had was that there is a greater need for consistency for streetscape design and layout. Sidewalks need to be unobstructed to ensure that it does not limit access and the free movement of all pedestrians. Uniformity in design and layout of all street elements creates a walking environment that is safe and predictable.

A fundamental weakness in the city's practice surrounding sidewalks is its inability to keep up with basic maintenance. There should be more emphasis in a regular maintenance regime of all city sidewalks. To be useful for all people, sidewalks must be kept safe and well maintained.

Changes can be made regarding the treatment of curb ramps and their location along the circulation route. The use of proper curb ramps and, more importantly, their straight alignment with adjoining sidewalks and crosswalks can help facilitate wayfinding for all pedestrians. In relation to this, the use of more right angles in the design and layout of circulation routes was found to be beneficial for wayfinding, particularly for people with a visual impairment. Such treatment can make street corners and crosswalks easier to locate.

A typical layout of an intersection, which includes pedestrian lights, traffic lights, and street signs, should now include audible crosswalk signals. Audible signals prove to be an effective way of informing all pedestrians when it is safe to cross the street but they also signify important landmarks along the path of travel.

The implementation of more redundant cueing and landmarks along sidewalks is another consideration in streetscape design. The legibility of a circulation route can be greatly improved by repeating certain materials and colours to help define the path of travel. Street corners, building entrances, and crosswalks are just some examples of landmarks which are easily recognized by pedestrians. Emphasis can be placed to accentuate these areas since they are proven to be useful guides for people who desire to reach certain destinations throughout the city.

In regards to site planning, the municipal government needs to widen the decision making process by considering the needs of the broad range of human abilities throughout the life span. To truly promote universal design, people of different functional abilities, ages, backgrounds, and lifestyles should be included in the decision making process. The participation of representatives, who serve different interests, at all levels of decision making can ensure that certain recommendations are followed and that a consensus may be achieved in providing innovative solutions to current or future problems. By working with people who have different needs and interests, municipal governments can direct more informed decisions towards the development of street environments that can best serve the wider population.

6.3.1 Practice implications

The involvement of the consumer advisory committee helped bring direction to portions of the research while research participants helped provide relevant data. The inclusion of people is critical in developing a wayfinding design strategy. They are important as reference from which information, regarding the wayfinding process (decision making, problem solving, spatial perception, and other needs) can be understood and translated into a conceptual plan by spatial planners and landscape architects. By identifying the wide range of user needs, user patterns and destinations, designers can have a better understanding how built environments can facilitate wayfinding.

Designers can gain awareness through research and participation in advocacy groups, which reflect varied functional needs, backgrounds, or lifestyles. Understanding the needs of these consumer groups is an essential way to ensure that a designer does not work in a "vacuum" and that cooperation among designers and consumers are manifested in the final design. The positive working relationship between these parties can efficiently bring together two bodies of knowledge.

Professionals in landscape architecture and city planning play a significant role in facilitating the wayfinding stage by articulating the landscape and communicating the necessary information to the wayfinding person. They have an enormous influence on whether an exterior setting succeeds or fails to help the wayfinding process. It is important that designers and their respective professional associations formally recognize the need for education on the issues of universal design.

Architecture and planning schools can incorporate universal design education as a component of their curriculum. There should be greater emphasis on the promotion and application of universal design in all facets of design education, particularly in the studio program where students are beginning to develop concepts of spatial design. In promoting universal design, it is critical to recognize the broad range of human needs with respect to architecture. The inclusion of people with a variety of needs and backgrounds in lectures and critiques will prove to be an important process in design education. Students and people with varied needs and backgrounds can work together to define realistic design concepts that more accurately meet a wide range of needs.

In theory, the concept of universal design espouses responsible design for all people. Such a diverse population is increasingly demanding better design of the urban environment. Practitioners, educators, and students will need to be knowledgeable of such realities in order to create sustainable and relevant designs.

Professional designers must be sensitive to the needs of the whole of society and move away from designs which continually restrict people who have a variety of needs. Designing an environment that is universally usable does not necessarily have to limit the creative process. As designers, practitioners have to be creative problem-solvers. This may require the ability to be flexible and an understanding that the requirements to provide access need not be prohibitive, but are in fact a means to solving a problem. For example, instead of designating a separate access ramp, why not design one method of access for all people? Not only does this approach cost less, because there is only one method of access instead of two including the ramp, but it prevents separation of people based on their functional needs. This example may not adequately satisfy the needs of every pedestrian, but it does move towards the goal of design which can facilitate the needs of as many people possible. By integrating the universal design philosophy into the language of environmental design at the initial stages, designers do not have to compromise creative integrity.

6.3.2 Future research directions

There were several questions that have arisen from this study that point to further research needs. For example, a wayfinding study conducted throughout the year under different climatic conditions, particularly in the winter, could be explored. Winter travel on sidewalks presents a different set of circumstances to pedestrians who may rely on other methods and cues to navigate.

Further study can focus on evening pedestrian travel. The urban environment, during the evenings, introduces a whole set of different of issues surrounding safety and security, the loss of day light, and decreased pedestrian traffic. How do people with visual impairments, particularly those with low vision, find their way independently under such conditions?

To have a better understanding of wayfinding by people with visual impairments in the exterior setting, there is a need to focus on other significant urban centres. Wayfinding research can be conducted in public parks, university campuses, the business district, and suburban areas. A comparison between residential and downtown environments is one good example of assessing the wayfinding needs of pedestrians.

Some of the surprising findings in this study relate to the unusual sources of cues a few of the participants had been accustomed to using, when wayfinding. Traffic boxes, bus shelters, and building walls, for instance, were discovered to facilitate wayfinding for people with visual impairments by way of sounds and echo location techniques. It would be interesting to research the possibilities of enhancing or duplicating such characteristics through design and spatial organization in a prototype study area.

Informative technologies, such as the Talking Sign and audible crosswalk signals, are developed to facilitate the independent travel of people with visual impairments. Indeed in our growing digital age, these devices will become more prevalent, and will soon have wider application. The impact these evolving technologies present to daily pedestrian activity will necessitate further evaluation by both researchers and potential users.

The inclusion of people with diverse needs, cultural backgrounds, and lifestyles is another critical area to explore in wayfinding research. Their perspectives will provide relevant data which will further expand our knowledge of the wayfinding process in the exterior environment.

6.4 Conclusion

This research has presented the experiences and perceptions of 48 individuals pertaining to wayfinding in the exterior urban environment. The main objective of the study was to test the street environment and determine which areas succeeded and which areas failed to facilitate the wayfinding activity of people. Participants discussed various methods of navigating city sidewalks and provided important insight on where public open spaces are helpful, or need improvement in this regard.

A consumer advisory committee helped develop and guide parts of the study, particularly with the review of research objectives, methodology, and all chapters of this study. The advisory committee provided assistance with the recruitment of participants, the study pre-test, and gave valuable advice on issues related to terminology and universal design.

There were common themes in the study which point to some similarities among participants in regards to wayfinding. Participants all rely on architectural cues as the primary source of information to wayfinding. Edge conditions, ground textures and colour contrast are key elements that define the circulation route. Redundant cueing, through constant use of such elements along the path, were found to enhance wayfinding. Prominent landmarks and distinct settings within a given context help form a mental image of space, enabling people to gauge where they are in relation to their immediate surroundings. Participants recognized that spatial organization and other components, such as sensory information and signage systems (including audible signals), are critical elements of the built environment. Such cues often reinforce architectural ones along the route. When these things are considered and properly incorporated into design, they help create outdoor settings that can be clearly understood by the wayfinding pedestrian.

Participants believed that pedestrian routes in the city have many barriers which need to be addressed. The lack of a consistent design and layout of sidewalks and regular maintenance present some of the biggest challenges to walking city sidewalks. Such barriers can be eliminated through careful and thoughtful planning that demonstrates sensitivity towards user needs.

The integration of people with a variety of functional needs, backgrounds, and lifestyles in the design process can help broaden decision making and define built environments more suited to the needs of a larger population. To achieve this designers will need to espouse the principles of universal design. As our diverse population continues to grow, there will be increased demands for products and built environments that are less stigmatizing and provide more choices and opportunities. A universal approach to design engenders values which are inclusive. It acknowledges all people and their diverse needs through effective design.

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8. APPENDICES

Appendix A: The Principles of Universal Design

Appendix B: Description of organizations requested to participate in Consumer Advisory Committee

Appendix C: Letters sent to organizations requesting their participation in Consumer Advisory Committee

- C-1: Letter to the Manitoba League of Persons with Disabilities Inc.
- C-2: Letter to the Inter-organizational Access Committee
- C-3: Letter to the National Federation of the Blind Advocates for Equality

Appendix D: Advertisement, letter of introduction to potential participants, and study information

- D-1: Advertisement for research participants
- D-2: Introductory letter to potential participants
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Appendix E: Screening interview

Appendix F: Participant consent form

Appendix G: Letter to the City of Winnipeg Streets and Transportation Department

Appendix H: Data sheets

- H-1: Data sheet - measuring deviation and time
- H-2: Data sheet - measuring light and noise levels

Appendix I: Instrumentation - electronic equipment used in the study

Appendix J: Interview guide

APPENDIX A: THE PRINCIPLES OF UNIVERSAL DESIGN

Principle One: Equitable Use
The design is useful and marketable to people with diverse abilities.
Guidelines:
1a. Provide the same means of use for all users: identical whenever possible; equivalent when not.
1b. Avoid segregating or stigmatizing users.
1c. Provisions for privacy, security, and safety should be equally available to all users.
1d. Make the design appealing to all users.

Principle Two: Flexibility in Use
The design accommodates a wide range of individual preferences an abilities.
Guidelines:
2a. Provide choice in methods of use.
2b. Accommodate right- or left-hand access and use.
2c. Facilitate the user's accuracy and precision.
2d. Provide adaptability to the user's pace.

Principle Three: Simple and Intuitive Use
Use of design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level.
Guidelines:
3a. Eliminate unnecessary complexity.
3b. Be consistent with user expectations and intuition.
3c. Accommodate a wide range of literacy and language skills.
3d. Arrange information consistent with its importance.
3e. Provide effective prompting and feedback during and after task completion.

Principle Four: Perceptible Information
The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.
Guidelines:
4a. Use different modes (pictorial, verbal, tactile) for redundant presentation of essential information.
4b. Provide adequate contrast between essential information and its surroundings.
4c. Maximize "legibility" of essential information.
4d. Differentiate elements in ways that can be described (i.e., make it easy to give instructions or directions).
4e. Provide compatibility with a variety of techniques or devices used by people with sensory limitations.

Principle Five: Tolerance for Error
The design minimizes hazards and the adverse consequences of accidental or unintended actions.
Guidelines:
5a. Arrange elements to minimize hazards and errors: most used elements, most accessible; hazardous elements eliminated, isolated, or shielded.
5b. Provide warnings of hazards and errors
5c. Provide fail safe features.
5d. Discourage unconscious action in tasks that require vigilance.

Principle Six: Low Physical Effort
The design can be used efficiently and comfortably and with minimum of fatigue.
Guidelines:
6a. Allow user to maintain a neutral body position.
6b. Use reasonable operating forces.
6c. Minimize repetitive actions.
6d. Minimize sustained physical effort.

Principle Seven: Size and Space for Approach and use
Appropriate size and space is provided for approach, reach, manipulation, and use regardless of user's body, size, posture, or mobility.
Guidelines:
7a. Provide a clear line of sight to important elements for any seated or standing user.
7b. Make reach to all components comfortable for any seated or standing user.
7c. Accommodate variations in hand and grip size.
7d. Provide adequate space for the use of assistive devices or personal assistance.

APPENDIX B: DESCRIPTION OF ORGANIZATIONS REQUESTED TO PARTICIPATE IN THE CONSUMER ADVISORY COMMITTEE

(Based on information supplied by these organizations)

The Manitoba League of Persons with Disabilities Inc. (MLPD)

The MLPD is a membership-based organization representing the concerns of people with all types of disabilities in Manitoba. Since its establishment in 1974, the MLPD has developed expertise on numerous issues affecting the lives of people with disabilities. A few such issues are accessibility, education, employment, housing, income security, support services, and transportation. The MLPD supports Manitobans with disabilities with social policy research and consultation, public education programs, information and referral services, and class advocacy.

The Inter-organizational Access Committee (IOAC)

The Inter-organizational Access Committee is a community committee whose mission is to achieve a community that is equally accessible and usable by people with visual impairments. It is composed of visually impaired consumers, designers, governmental representatives, independent living and rehabilitation service providers. It functions through working partnerships in which the consumers direct research and advocacy.

The National Federation of the Blind: Advocates for Equality (NFB:AE)
The mission of NFB:AE is to enable Canadians who are blind or visually impaired to achieve social and economic equality. The five main goals of the NFB:AE are:

1)To serve as a vehicle for self-improvement by the blind and for public education about blindness throughout the Dominion of Canada.
2)To function as a mechanism through which the blind and interested sighted persons can come together in local, provincial and national meetings to plan and carry out programs to improve the quality of life for the blind.
3)To provide a means by which blind adults can share their experience and act as mentors for blind children and support parents in their efforts to improve educational opportunities for blind children.
4)To create a climate through public education to increase opportunities for blind people in employment and social integration.
5)To take any other action which will improve the overall condition and standard of living of the blind.

Appendix C: **Letters sent to organizations requesting their participation in Consumer Advisory Committee**

C-1: **Letter to the Manitoba League of Persons with Disabilities Inc.**

C-2: **Letter to the Inter-organizational Access Committee**

C-3: **Letter to the National Federation of the Blind Advocates for Equality**

APPENDIX C-1: REQUEST FOR MLPD's PARTICIPATION IN THE CONSUMER ADVISORY COMMITTEE

Date:

Mr. David Martin
Provincial Coordinator
Manitoba League of
Persons with Disabilities Inc.
#200-294 Portage Ave.
Winnipeg, MB. R3C 0B9

Dear Mr. Martin

I am a graduate student at the University of Manitoba, in the Department of Landscape Architecture. As part of my program, I will be doing research for my thesis. I am writing to you to describe the study and to invite your organization's participation.

The study is called "Wayfinding By People With Visual Impairments In The Exterior Urban Environment". The aim of this study is to investigate what elements of the street environment limit or aid the wayfinding activities of consumers with visual impairments. The study will also address the concerns and opinions of people with visual impairments regarding the accessibility of city streets. The proposed research location is a route in Winnipeg's downtown area.

I am interested in getting consumers with visual impairments involved with the management and direction of the study. By doing this, consumers will have direct influence in the study's decision making process and the development of recommendations to create more accessible street environments.

I am proposing a Consumer Advisory Committee which will be comprised of people with visual impairments. I would like to find out what your opinion is regarding this idea and if a member of your organization might be interested in joining such a committee.

I will be contacting you shortly to explain more about the study and to answer any questions you might have. If you wish to contact me, my phone number is 284 - 3654. Or e-mail me: rcarreo@cc.umanitoba.ca

Copies of this letter will be sent to members of my thesis committee; Professor Carl Nelson (Department of Landscape Architecture, University of Manitoba), Gail Finkel (The Prairie Partnership Architects), Laurie Ringaert (Canadian Institute for Barrier Free Design), and Dave Wotton (Department of Landscape Architecture, University of Manitoba.

I look forward to speaking with you.

Sincerely,

Ric Carreon

APPENDIX C-2: REQUEST FOR IOAC's PARTICIPATION IN THE CONSUMER ADVISORY COMMITTEE

Date:

Mrs. Ainley Bridgeman
Chairperson
Inter-organizational
Access Committee
#200-294 Portage Ave.
Winnipeg, MB. R3C 0B9

Dear Mrs. Bridgeman

I am a graduate student at the University of Manitoba, in the Department of Landscape Architecture. As part of my program, I will be doing research for my thesis. I am writing to you to describe the study and to invite your organization's participation.

The study is called "Wayfinding By People With Visual Impairments In The Exterior Urban Environment". The aim of this study is to investigate what elements of the street environment limit or aid the wayfinding activities of consumers with visual impairments. The study will also address the concerns and opinions of people with visual impairments regarding the accessibility of city streets. The proposed research location is a route in Winnipeg's downtown area.

I am interested in getting consumers with visual impairments involved with the management and direction of the study. By doing this, consumers will have direct influence in the study's decision making process and the development of recommendations to create more accessible street environments.

I am proposing a Consumer Advisory Committee which will be comprised of people with visual impairments. I would like to find out what your opinion is regarding this idea and if you, or a member of your organization, might be interested in joining such a committee.

I will be contacting you shortly to explain more about the study and to answer any questions you might have. If you wish to contact me, my phone number is 284 - 3654. Or e-mail me: rcarreo@cc.umanitoba.ca

Copies of this letter will be sent to members of my thesis committee; Professor Carl Nelson (Department of Landscape Architecture, University of Manitoba), Gail Finkel (The Prairie Partnership Architects), Laurie Ringaert (Canadian Institute for Barrier Free Design), and Dave Wotton (Department of Landscape Architecture, University of Manitoba.

I look forward to speaking with you.

Sincerely,

Ric Carreon

APPENDIX C-3: REQUEST FOR NFB:AE's PARTICIPATION IN THE CONSUMER ADVISORY COMMITTEE

Date:

Mr. Neil Graham
Chairperson
National Federation of the
Blind Advocates for Equality
#200-294 Portage Ave.
Winnipeg, MB. R3C 0B9

Dear Mr. Graham

I am a graduate student at the University of Manitoba, in the Department of Landscape Architecture. As part of my program, I will be doing research for my thesis. I am writing to you to describe the study and to invite your organization's participation.

The study is called "Wayfinding By People With Visual Impairments In The Exterior Urban Environment". The aim of this study is to investigate what elements of the street environment limit or aid the wayfinding activities of consumers with visual impairments. The study will also address the concerns and opinions of people with visual impairments regarding the accessibility of city streets. The proposed research location is a route in Winnipeg's downtown area.

I am interested in getting consumers with visual impairments involved with the management and direction of the study. By doing this, consumers will have direct influence in the study's decision making process and the development of recommendations to create more accessible street environments.

I am proposing a Consumer Advisory Committee which will be comprised of people with visual impairments. I would like to find out what your opinion is regarding this idea and if you, or a member of your organization, might be interested in joining such a committee.

I will be contacting you shortly to explain more about the study and to answer any questions you might have. If you wish to contact me, my phone number is 284 - 3654. Or e-mail me: rcarreo@cc.umanitoba.ca

Copies of this letter will be sent to members of my thesis committee; Professor Carl Nelson (Department of Landscape Architecture, University of Manitoba), Gail Finkel (The Prairie Partnership Architects), Laurie Ringaert (Canadian Institute for Barrier Free Design), and Dave Wotton (Department of Landscape Architecture, University of Manitoba.

I look forward to speaking with you.

Sincerely,

Ric Carreon

Appendix D: Advertisement, letter of introduction to potential participants, and study information

D-1: Advertisement for research participants

D-2: Introductory letter to potential participants

D-3: Study information sheet

APPENDIX D-1: ADVERTISEMENT FOR RESEARCH PARTICIPANTS

VOLUNTEERS WANTED FOR WAYFINDING STUDY

Are You:

*** Someone who is mobile without the use of a wheelchair or crutches?**

*** Between the ages of 18 to 65?**

*** Willing to be observed and interviewed for about 1 hour?**

Please contact Ric Carreon
889-6514 for more information
Call before Nov. 20, 1997

APPENDIX D-2: INTRODUCTORY LETTER TO PERSONS INTERESTED IN PARTICIPATING

Date:

Dear

I am writing to invite your participation in a research study on "Wayfinding By People With Visual Impairments In The Exterior Urban Environment". I am a graduate student at the University of Manitoba, in the Department of Landscape Architecture. The research I am about to describe will contribute to my thesis. I also hope it will contribute to the understanding of how the built environment influences wayfinding. By wayfinding I mean the methods or techniques one uses to find their way around the city. During the course of the study, I will be working with both a consumer advisory committee and a thesis committee to ensure relevance to people with visual impairments and appropriate academic standards.

The aim of this study is to investigate what elements of the street environment limit or aid the wayfinding activities of both people with and without a visual impairment. I want to include people with no visual impairments in this study because there will be some important comparisons that can be made between this group and people with visual impairments. I plan to do this by observing the wayfinding experiences of people with visual impairments, as well as sighted people, in one of Winnipeg's downtown streets. I am also interested in hearing the concerns and opinions of both groups regarding the accessibility of city streets. More information about the study accompanies this letter.

If you decide to participate, I will ask you some questions to ensure your eligibility. If you are eligible for the study, I will schedule you in for the field study which will consist of a wayfinding experience and an interview. Both will take approximately one-and-a-half hours to complete. The location of the field study will be in the Osborne Village area.

I will be contacting you shortly to explain more about the study and to answer any questions you might have. If you wish to contact me, my phone number is (home) 889-6514, (bus.) 943-6099. Or e-mail me: rcarreo@cc.umanitoba.ca

Copies of this letter will be sent to members of my thesis committee; Professor Carl Nelson (Department of Landscape Architecture, University of Manitoba), Gail Finkel (The Prairie Partnership Architects), Laurie Ringaert (Canadian Institute for Barrier Free Design), and Dave Wotton (Department of Landscape Architecture, University of Manitoba. A member of my consumer advisory committee, Ainley Bridgeman (Inter-organizational Access Committee) will also receive a copy.

I look forward to speaking with you.

Sincerely,

Ric Carreon

APPENDIX D-3: STUDY INFORMATION SHEET

Project Title: Wayfinding By People With Visual Impairments In The Exterior Urban Environment.

Investigators: Ric Carreon will be doing the research. He is a graduate student in the Department of Landscape Architecture, Faculty of Architecture, University of Manitoba, 201- C J. A. Russell Building, Winnipeg, Manitoba,
R3T 2N2. Ph. 474-9458. The thesis advisors are; Professor Carl Nelson (Department of Landscape Architecture, University of Manitoba. Ph. 474-6418), Gail Finkel (The Prairie Partnership Architects), Laurie Ringaert (Canadian Institute for Barrier Free Design), and Dave Wotton (Department of Landscape Architecture, University of Manitoba. The contact person for the study's consumer advisory committee is Ainley Bridgeman (Inter-organizational Access Committee, Ph. 338-6736) .

Purpose of Study: Through this study, I hope to learn about how both sighted people and people with visual impairments are able to find there way in Winnipeg's existing downtown streets. I believe that learning this can help landscape architects and city planners understand what aspects in these settings impact the movement and wayfinding of these individuals.

How the Study will Work: In the study, I will be interviewing and observing the wayfinding activities of sighted people and people who are visually impaired. People participating in the study are selected because they are 18 years of age and older, visually impaired or not visually impaired, may or may not use mobility aids (i.e., white canes, guide dogs, corrective lenses), do not have a mobility impairment, have mobility and wayfinding experience, and reside in Winnipeg. The reason why I want people without visual impairments people and people with visual impairments to take part in the study is so that I can make comparisons between the two when they are finding their way through a city street. I am interested in knowing what elements in the street environment influences the way a person travels through it. This is a test of the built environment and not of the individual's mobility skills. There are two parts to my study, one is a walk through observation, and the other is an interview.

'Walk Through': If you decide to participate, I will walk through a specific route in the downtown area (will specify exact location later) with you and let you know where you should start and finish. I will then ask you to walk through the same route leading the way. During this time, I will be around to make observations and will only interrupt if you go off the route, or in danger of getting hurt. I will also have a co-researcher measuring street noise and light levels which will be necessary for the study.
Before you begin, I will ask your permission if you can carry a small tape recorder and microphone so that I can record all the comments you may voluntarily make during the walk through. There are two reasons why I'd like to tape record your comments along the route. First, is because I'd like to get your comments on what cues or landmarks you use on the route to help you find your

way. Second, I won't be next to you to accurately record what these comments are which will be important for the study. Walking the route will involve crossing streets and making turns in order to get to the destination point. The route which will be used for the study is located in the Osborne Village area. The walk through should take only 20 to 30 minutes.

Interview: All interviews with participants will be by me and will be held at a location close to the route. I should point out that there are no right or wrong answers during the interview. I am simply interested in your opinions, ideas, and experiences. You are not obligated to answer questions you're not comfortable with. With your permission, I would once again like to tape record your interview. I would like to do this because a tape recording of your own words will best describe what you think, rather than me paraphrasing them. Another reason is that it'll make the interview go faster without me having to record every word you say.

I will ask you if you are visually impaired, how long you have been visually impaired, if you use a mobility aid, and if you have previous mobility training. The reason why I will ask these questions is so that I can better understand you and how you get around. I will then ask you about the route you just travelled and if you found your way around it easily. I will also ask you which parts of city street makes it easier or harder for you to get to where you're going. Then we will talk about what you think needs to be addressed to make city streets more accessible for people. The interview should take about 45 minutes to complete.

Confidentiality: Records of the interview will be coded only with a number and not any names. This way records can only be identified by me, my co-researcher, or my advisor. My co-researcher and myself will be the only ones responsible for analyzing the information you provide us during the field study. No other person will be given any of the 'walk through' and interview records. The consent form will be the only record with your name on it. Any reports written about this project will neither mention your name or mention any description that could potentially identify you. I will treat the tape recording of the interview in the same confidential manner. All information provided by the parties involved in the study (i.e., all project committees and participants) will be edited for the thesis paper.

Participation: Being involved in the study is completely up to you. I hope that you will take part in it, but you are under no obligation to do so. You will be asked to give your consent once you agree to participate and sign a paper that says that you have agreed. I will also sign this paper and answer the questions you may have. You will get a copy of this agreement. If you wish, I can drive you to the research site and then drive you back home once the study is completed .

Risk and Discomfort: In all projects carried out by the University, the person doing the project must point out any risks and discomforts to you as a participant. I do not think that this study will cause any problems for you other than taking your time to walk a specific street route in downtown and to answer questions afterwards. I can assure you that the route would be one that will not pose a problem to your movement, nor would I distract you in any way when you are walking through it. If you think any of the questions are too personal, you may refuse to answer them. Just let me know if you would like to skip any questions.

Consumer Advisory Committee: Portions of this project will be directed by a consumer advisory committee which consists of representatives from the Manitoba League of Persons with Disabilities Inc. (MLPD), the Inter-organizational Access Committee (IOAC), and the National Federation of the Blind: Advocates for Equality (NFB:AE), Winnipeg Chapter. This committee is primarily responsible for ensuring relevance of the study and helping with the site selection, sampling process and the development of recommendations for future design and research.

Report: The result of this research will be a thesis paper outlining the development of the study, background, discussion, and conclusions. Only the organizations (represented in the consumer advisory committee) will receive a copy of the final report. Participants who want to read the final report can access it either through me or through one of the organizations involved in the study. I would be pleased to provide you with a summary of the study findings, at no cost to you, if you are interested. Please specify what media you prefer to receive it in (i.e., Braille, large print, regular print, or computer disk).

Benefits: All University projects must also point out if there are any benefits to you if you participate. There is a possibility of providing you with a stipend for your participation in the study, however, this is pending on the approval by the funding source from which we had applied. When completed, this research should help design professionals and policy makers understand the concerns that both sighted people and people with visual impairments have about getting around city streets. This information may be helpful in urban development as well as to consumer advocates who may use it to influence design.

For More Information: If after the interview you have any questions about the study, please feel free to contact me, Ric Carreon. You can reach me at home: 889-6514 or at work: 943-6099. There is an answering machine at this number, so if I am not there please leave a message and I will call you back as soon as I am able. You can also e-mail me at: rcarreo@cc.umanitoba.ca

APPENDIX E: SCREENING INTERVIEW FOR ALL PARTICIPANTS

When I contact you, I will be asking you the following questions to determine if you are eligible for to participate in the study: " Wayfinding By People with Visual Impairments in the Exterior Urban Environment."

1) Do you have a visual impairment? Yes _____ No _____

2) Are you 18 years of age and older? Yes _____ No _____

3) Do you have a mobility impairment? Yes _____ No _____

4) Do you use any mobility aids? Yes _____ No _____
_____ white cane
_____ guide dog
_____ other, please specify
____

5) What type and amount of mobility training have you had?
____

6) Do you reside in Winnipeg? Yes _____ No _____

7) If you are eligible for the study, when can you be available?

_____ July 14, 1997 to July 31, 1997
_____ Aug. 1, 1997 to Aug. 30, 1997
_____ Sept. 2, 1997 to Sept. 8, 1997
_____ Sept. 16, 1997 to Sept. 30, 1997
_____ Oct. 1, 1997 to Oct. 31, 1997

I will be contacting you soon.

Ric Carreon

APPENDIX F: PARTICIPANT CONSENT FORM

Participant Code:______

This consent form indicates that I, ________________________________
(please print full name) voluntarily agree to participate in the study, " Wayfinding by People with Visual Impairments In the Exterior Urban Environment". I have been given the researcher's name and university address, and an oral and written explanation of the study.

The study has been explained to me, and I understand that Ric is just interested in my opinions and experiences regarding the city's existing street environment. I have been given the chance to ask questions and understand that I can ask more questions at any time. I understand that in giving my consent to participate in this study, I will be observed and interviewed by Ric. I have been told that the information I share will be identified by code rather by name and that the study will not affect me in any way, except that I have taken the time to participate in it. I also understand that my participation will help add to the knowledge about making streets more accessible for people.

My signature on this page indicates that I understand and agree to take part in the study.

________________ ________________________________
Date Signature of Participant

____
Signature of Witness

I would like a copy of the results. Yes ____ No ____

If yes, send to:

____

____

Please specify format. ___Regular Print ___Large Print
___Braille ___Computer Disk

I have fully explained to ________________________________
the nature and purpose of this research as described on the information sheet given to this participant. I have asked the participant if he or she has any questions about the study and have answered these questions to the best of my ability.

________________ ________________________________
Date Investigator: Ric Carreon

APPENDIX G: LETTER TO THE CITY OF WINNIPEG STREETS AND TRANSPORTATION DEPARTMENT

Date:

Mr. Andy Chimko
Traffic Operations Engineer
City of Winnipeg Streets &
Transportation Department
100 Main St.
Winnipeg, MB. R3C 1A4

Dear Mr. Chimko

I am a graduate student at the University of Manitoba, in the Department of Landscape Architecture. As part of my program, I will be doing research for my thesis. I am writing to you to describe the study and where it will take place.

The study is called "Wayfinding By People With Visual Impairments In The Exterior Urban Environment". By wayfinding I mean the methods or techniques one uses to find their way around the city. The aim of this study is to investigate what elements of the street environment limit or aid the wayfinding activities of people with visual impairments as well as people without visual impairments. I plan to do this by observing the wayfinding experiences of these individuals in one of Winnipeg's downtown streets.

The route selected for the study is within the Osborne Village area. It begins at the corner of Stradbrook and Nassau St. (at the northeast corner of the intersection), and proceeds down Stradbrook heading east. A left-hand turn at the intersection of Osborne St. and Stradbrook will take participants northward along Osborne St. Individuals will then have to cross onto the bus stop island at the intersection of River and Osborne then proceed down River Ave. going west along the Safeway parking area. The route then crosses River at the Nassau St. and River Ave. intersection and then terminates at the starting point at the corner of Nassau and Stradbrook. The route is a complete loop.

The project will not involve the implementation of instruments or materials on the site, nor will it alter the existing condition of the street. The field study on the site will not in any way interrupt the normal flow of vehicular and pedestrian traffic. Consent forms will be signed by all research participants prior to any field testing

I plan to conduct the field study in the summer and the tentative schedule is as follows:

Between: July 14 1997 to September 30, 1997
Monday to Saturday
9:30 am to 12:00 PM and 1:30 PM to 5:30 PM

I have been told by Mr. Pat Carson, of the City of Winnipeg Streets & Transportation Department, that there are no plans for major construction in the selected area other than for emergency repairs. I will be contacting you shortly to explain more about the study and to answer any questions you might have. If you wish to contact me my phone number is (home) 889-6514, (bus.) 943-6099. Or e-mail me: rcarreo@cc.umanitoba.ca

Copies of this letter will be sent to members of my thesis committee; Professor Carl Nelson (Department of Landscape Architecture, University of Manitoba), Gail Finkel (The Prairie Partnership Architects), Laurie Ringaert (Canadian Institute for Barrier Free Design), and Dave Wotton (Department of Landscape Architecture, University of Manitoba. A member of my consumer advisory committee, Ainley Bridgeman (Inter-organizational Access Committee) will also receive a copy.

Sincerely,

Ric Carreon

Appendix H: Data sheets

H-1: Data sheet - measuring deviation and time

H-2: Data sheet - measuring light and noise levels

APPENDIX H-1: DATA SHEET MEASURING DEVIATION AND TIME

Code no: _______
Date: __________
Time: __________
Weather Condition: ______________________________

	Deviation		Time	Notes on Decision Points
	Yes	No		
Decision Point 1	______	______	______	______________
Decision Point 2	______	______	______	______________
Decision Point 3	______	______	______	______________
Decision Point 4	______	______	______	______________
Decision Point 5	______	______	______	______________
Decision Point 6	______	______	______	______________
Decision Point 7	______	______	______	______________
Decision Point 8	______	______	______	______________
Decision Point 9	______	______	______	______________
Decision Point 10	______	______	______	______________
Decision Point 11	______	______	______	______________
Decision Point 12	______	______	______	______________
Decision Point 13	______	______	______	______________
Decision Point 14	______	______	______	______________
Decision Point 15	______	______	______	______________
Decision Point 16	______	______	______	______________
TOTAL:	______	______	______	______________

Notes: ____

APPENDIX H-2: DATA SHEET MEASURING LIGHT AND NOISE LEVELS

Code no: _______
Date: __________
Time: __________
Weather Condition: _________________________________

	Light Levels	Noise Levels
Decision Point 1	______	______
Decision Point 2	______	______
Decision Point 3	______	______
Decision Point 4	______	______
Decision Point 5	______	______
Decision Point 6	______	______
Decision Point 7	______	______
Decision Point 8	______	______
Decision Point 9	______	______
Decision Point 10	______	______
Decision Point 11	______	______
Decision Point 12	______	______
Decision Point 13	______	______
Decision Point 14	______	______
Decision Point 15	______	______
Decision Point 16	______	______

Notes:

APPENDIX I: INSTRUMENTATION: ELECTRONIC EQUIPMENT USED

1) One RCC Electronics Light Meter

Analog Output
- 0.1mV/1 digit, MAX. output: 200mV

Specifications
- Display: 13mm (0.5") LCD
- Measurement: Lux, Ft-candle
- Ranges: Lux - 0 to 50,000 Lux, 3 ranges,
  Ft-candle - 0 to 5,000, 3 ranges
- Zero adjustment: Automatic adjustment
- Over-input: Indication of "1"
- Sample time: Approx. 0.4 second
- Sensor material: Selenium photovoltaic cells
- Power supply: 006P DC 9V battery
- Operating temperature: 0 to 5 degrees C (32 to 122 degrees F)
- Dimension: 163 x 70 x 30 mm (6.4 x 2.8 x 1.2 inch)
- Weight: 220g (0.52 lb)
- Standard accessories: Light sensor - 1 pc.
  Instruction manual - 1 pc.

2) One General Radio Type 1565-B Sound Level Meter

Specifications
- Sound level: 40 to 140 dB re 20 μN/sq.m.
- Weighting: A, B, and C conforms to ANSI S1.4 - 1971 Type 2 and IEC 123, 1961
- Meter: Rms response with fast and slow speeds
- Input: Microphone - lead-zirconate-titanate ceramic. 1560-P96 adapter converts input to 3-pin male A3 connector; for correct weighting source impedance must be 380 pF ± 5%. Input impedance: ˜ 13 M? // 15 pF
- Output: = 1.2 V rms behind 620 ? with meter at full scale will drive 1556 noise impact analyzer, 1558 Octave-band noise analyzer, 1521 or 1523 recorders, oscillscopes, or low-impedance headphones. Harmonic distortion: = 0.5% (0.1 typical) from 32 Hz to 8 kHz, C weighted with meter with full scale.
- Calibration: Can be pressure calibrated at 125, 250,500,1000, and 2000 Hz with 1562 sound level calibrator
- Environment: Temperature - 10 to 50 degrees C operating. Humidity - 90% RH
- Supplied: Carrying pouch, miniature phone plug to connect output, screwdriver, and allen wrench
- Power: Two 9V battery
- Dimension: 92 x 165 x 53 mm (3.63 x 6.5 x 2.09 inch)

- Weight: 13 oz (0.45 kg)

3) One General Electric Model 3-5385 Micro cassette Recorder, with one collar microphone

<u>Specifications</u>
- Power requirements: 2 AA batteries (R6), 3V DC jack for 3V AC power converter
- Accessories: External microphone jack, built-in microphone
- Dimensions: 60 x 100 x 42 mm (2.5 x 4.2 x 1.75 inch)
- Weight: 190 g

4) One Stopwatch

APPENDIX J: INTERVIEW GUIDE

Code no: _______

• To begin, I would like to ask you some questions about the route you had just travelled. I want you to tell me what elements on the route made it easy or hard for you to know where you are going.

I) Questions About the Route Travelled

	Not at all		Neutral		Very accessible
1) In a scale of 1 - 5, rate the accessibility of this route.	1	2	3	4	5

1a) What made it that way for you? ______________________________

1b) What sources of information did you find helpful to navigate the route?

1c) Was there any part of the route you found particularly confusing?

1d) How comfortable did you feel travelling the route?

1e) Were there any other factors which may have limited your proper navigation of the route (i.e. noise, traffic)?

* Now I would like to move on and find out what you think about city streets. I would like to know how accessible or inaccessible streets are for you when you use them.

II) General Questions About the Accessibility of City Streets

	Not at all		Neutral		Very accessible
2) In a scale of 1 - 5, how do you rate the accessibility of downtown streets.	1	2	3	4	5

2a) What problems do you typically run into when you walk down city streets?

____
____
____

2b) What makes it easy for you to navigate downtown streets?

____
____
____

3) In a scale of 1 to 5, how do you rate the value of the following items for wayfinding in the exterior urban environment.

	Not helpful		Neutral		Very helpful
a) Landmarks	1	2	3	4	5

Why?____

b) Signs	1	2	3	4	5

Why?____

c) Tactile signs	1	2	3	4	5

Why?____

d) Braille/tactile map	1	2	3	4	5

Why?____

e) Asking other people	1	2	3	4	5

Why?____

	Not helpful		Neutral		Very helpful
f) Ground surface	1	2	3	4	5

Why?____

g) Changes to ground surface	1	2	3	4	5

Why?____

h) Colour contrasts	1	2	3	4	5

Why?____

i) Building walls	1	2	3	4	5

Why?____

j) Open spaces	1	2	3	4	5

Why?____

k) Narrow passages	1	2	3	4	5

Why?____

l) Sound	1	2	3	4	5

Why?____

m) Temperature	1	2	3	4	5

Why?____

n) Smell	1	2	3	4	5

Why?____

o) Air pressure	1	2	3	4	5

Why?____

p) Illumination	1	2	3	4	5

Why?____

q) Other: __________ 1 2 3 4 5

Why?____

4) Are there any other methods or items you find useful to get around city streets? ____
____
____
____
____

5) In a scale of 1 to 5 , how do rate the following areas when you are wayfinding in the exterior urban environment?

	Usually a problem		Neutral		Not a problem
a) Surrounding noise	1	2	3	4	5

If a problem, why?____

b) Glare	1	2	3	4	5

If a problem, why?____

c) Vehicular traffic	1	2	3	4	5

If a problem, why?____

d) Pedestrian traffic	1	2	3	4	5

If a problem, why?____

e) Other: __________	1	2	3	4	5

If a problem, why?____

6) Are there any other areas which may be a problem to you when you are wayfinding in the street environment? ______________________________
____
____
____
____
____

7) What advice would you offer to landscape architects and city planners to make city streets more accessible?______________________________
____

8) Overall, what comments do you have concerning wayfinding in the exterior urban environment? What else needs to be examined? What comments do you have about this study? ____

* I would now like to ask you some questions about your background. I will be using this information to help me describe all of the participants in my study and to gain a better understanding of how you get around city streets.

III) Background Information

9) Age: _____ 18 - 25
_____ 26 - 35
_____ 36 - 45
_____ 46 - 55
_____ 56 - 65
_____ 66 -75
_____ 76 - 85

10) Gender: Male _____ Female _____

11) Do you have a visual impairment? Yes _____ No _____

11a) Level of impairment? ______________________________

11b) Is it progressive? Yes _____ No _____

11c) For how long? _____ Since birth
_____ less than 1 year
_____ 1 - 2 years
_____ 3 - 5 years
_____ 6 - 10 years
_____ more than 10 years

11d) Do you use any mobility aids? Yes _____ No _____
_____ white cane
_____ guide dog

_____ other, please specify

____

11e) What type and amount of mobility training have you had?

____

____

11f) Did you ever participate in other wayfinding studies similar to this one?

____

____

* Thank you very much for participating in the study. Your input will be very useful for me to have a better understanding of how we use the street environment. If you wish, I can notify you about the results of this study.

Notes: