CRC Construction Innovation

BUILDING OUR FUTURE

Final Report
Wayfinding in the Built Environment – Stage 2 & 3

Research Project No: 2004-028-C

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EXECUTIVE SUMMARY

Stage 2 of the Wayfinding project involved a trial to investigate and examine an innovative broadcast/receive system making use of recently-installed city infrastructure, while Stage 3 of the project focussed on researching and compiling Guidance documents to provide a reasonable, practical and comprehensive design approach to wayfinding for designers as well as developers, property owners and property managers in identifying ways of improving access to, into and through their new or existing property, particularly buildings.

In Stage 2, new infrastructure was put in place around the city business area in Melbourne just prior to the Commonwealth Games in March 2006 and was known as information hubs (or iHubs). A proof-of-concept trial based upon such a system - aimed at delivering "tailored" or location-specific information about key basic facilities and services for users having a vision impairment - was conceived and successfully undertaken. Prior to decisions being made about exactly where a trial might be undertaken, meetings were held with a number of community representatives for the vision impaired to help ascertain the general types of functionality and some specific information that they would like to see available from an electronic system to assist them in wayfinding around a somewhat typical Central Business District (CBD) built-up area.

The Melbourne-based technology trial for Wayfinding in the Built Environment involved temporarily adding suitable (Bluetooth) transmission ability at selected central city information hubs; upgrading the software for each hub server and the receiver to handle suitable messages specific to each particular location; and monitoring feedback of the use of the system by project affiliates. The short-range Bluetooth transmission protocol (widely used to link mobile phones, headsets, MP3 players, and similar devices in quite close proximity) allowed a link from the hub infrastructure to a device worn or held by a traveller with a vision impairment. As they came into range of the information hub it could (discreetly) deliver them a selection of relevant audio messages (pre-recorded, but specific to the particular nearby location).

Following the initial trial, feedback from users with and without a vision impairment was extremely positive and encouraging, and the system – with further development and refinement - was recognised as having real potential for delivering location-specific information about nearby facilities and services on request – discreetly and unaided - as preferred by most users with a vision impairment. Issues relating to the receiver device in particular still remain to be addressed, and the software menu system must be further developed, but the potential for genuinely assisting pedestrians who have a vision impairment in finding their way around the built environment seems enormous once those issues are addressed successfully.

With respect to a future wayfinding technology trial, in the medium term (but beyond the term of this current project), it is recommended that a similar type of experiment (ie initial proof-of-concept) to the Melbourne trial should be undertaken but in an indoor building context rather than open-air. A building owned or managed by one of the industry partners in Brisbane or something similar would be an excellent venue to study by installing limited infrastructure within selected parts of the building to enable the transmission of suitable location-based audio messages to passing personnel and visitors who have a vision impairment but who are equipped with suitable receiving devices. Alternatively, if further follow-up trials in an exterior context are recommended and accepted, then the option of adding wayfinding opportunities for the community to a suggested series of information kiosks based around Brisbane city could be investigated. Approaches should be made to the manufacturers and/or distributors of any handheld devices which might be suitable for use in

such an infrastructure-based system with a view to obtaining additional financial and technical assistance to support any such trial.

Stage 3 of the Wayfinding project focussed on researching and compiling several additional working documents for use by building designers, owners, and operators to provide guidance in their search for techniques and practical approaches to help improve their facilities' accessibility and in particular, access for visitors and staff with a vision impairment. These include Guidance documents for assisting designers with wayfinding concepts, viz. "Wayfinding Audit: Design Principles and Guidance" - CRC-CI (2007a); "Wayfinding Design Guidelines to assist People who are Blind or Vision Impaired" - CRC-CI (2007b); and a Wayfinding Systems Matrix (see Appendix 2 of this document), and the former two Reports will be published separately from this Report as complementary but stand-alone documents.

In particular, the "Audit: Design Principles and Guidance" document was produced to assist with the undertaking of an on-the-ground wayfinding audit of current facilities, and includes some basic design principles for explanatory purposes. The purpose of the Design Principles and Guidance document is to provide a reasonable, practical and comprehensive design approach to wayfinding using the methodology of a 'design audit and checklist' that would assist designers as well as developers, property owners and property managers in identifying ways of improving access to, into and through their new or existing property, particularly buildings. With a concentration upon vision impairment, the Audit Document was developed to prompt and continually remind building owners, architects and interior designers of the many factors they control that contribute to successful wayfinding in the urban environment.

Following the audit or checklist's development, a major multistorey office complex in central Brisbane was then used to refine and improve the audit document so that it might be applied more widely in the future by project partners and other users. The document's further refinement following its future application to an even wider range of different building situations and configurations will further increase it's effectiveness to the industry. The audit document highlights and explains many factors that should be (from an equity viewpoint) considered, as well as many that must be considered (from a legislative viewpoint) when undertaking a building design project.

An additional document entitled "Design Guidelines to assist people …" (including the Wayfinding Systems Matrix) was also compiled. The Systems Matrix complements the other guidance documents and by briefly summarising various Wayfinding Systems and technologies, it was developed to highlight to building owners, architects and interior designers some approaches that are available to assist with wayfinding at the various scales of the built environment – from the "drop-off point" of the transport system where a visitor may arrive, right through to individual floors of a building. In all of these discussions concerned with improving accessibility by assisting community members that have a vision, cognitive or a hearing impairment in finding their way around the built environment however, the continuing importance of major programmes like Orientation and Mobility training, and the critical role that tactile information can play must also not be overlooked.

Being aimed at designers, the "Design Guidelines to assist people" document draws together a number of elements from the principles of so-called 'universal design' or design of the built environment with a range of potential users in mind, and not simply design which caters only for travellers with full vision, who are mobile, and who read English. Briefly, Universal or inclusive design aims to build into the design, or the refurbishment project, basic

considerations for the traveller with vision impairment, the less-mobile and the elderly as well as for those with a low level of understanding of written English.

It is important to note that the checklist and guidance notes are not a substitute code for the Building Code of Australia (BCA), Australian Standard AS 1428, or the pending Draft Disability Standards for Access to Premises (Premises Standard) document. The reference to the BCA and AS 1428 and other Australian Standards within the checklist and guidance notes provide the decision maker with the relevant technical information to assist them in developing a successful wayfinding system for their new or existing property and/or building. It is also important to note that currently the BCA, AS 1428 and other Australian Standards are relevant code and standard requirements for all new building work.

1. WAYFINDING

The initial overall project objective was "to identify technologies and systems that will make it easier and safer for people who have a sensory impairment to find their way around large public areas".

Locally, Queensland Health in their "Building Guidelines for Mental Health Facilities 1996 (Section 1 Background)" has noted wayfinding as :

> *"The ease with which one proceeds and is facilitated through an environment from one point of interest to another. Wayfinding systems include such components as basic layout of building and site, interior and exterior landmarks, views to outside, signs, floor and room numbering, spoken directions, maps, directories, logical progression of spaces, colour coding. "*

For the purposes of this project the term "Way Finding" or "Wayfinding" (either spelling appears acceptable in the literature) has been adopted to describe the process of using spatial and environmental information to find our way in the built environment, or Wayfinding can be defined as spatial problem solving. The objective of Wayfinding is to ensure that people with a sensory impairment - and in particular a vision impairment - know where they are in a building or an environment, know where their desired location is, and know how to get there from their present location. The project therefore involves consideration of systems that may be employed in both buildings and other external public places.

Vision impairment is a term used widely in Australia to describe vision loss that constitutes a significant limitation of visual capability (including terms such as partially sighted, low vision, legally blind, and totally blind), while in the US and UK the term visual impairment is often used as well.

1.1 Summary of Stage 1 Report

The report of Stage 1 identified systems and technologies that could be used to make it easier and safer for people with a sensory impairment to find their way around buildings and large public areas. Those systems and technologies should be suitable for people who have a sensory impairment including people with both a vision and a hearing impairment. That report also made recommendations on how these technologies and systems may be incorporated, by law or otherwise, into Australia's building and construction practice.

The "passive" systems identified in that report, such as tactile ground surface indicators consisting of square tiles with a raised surface which warn of a hazard ahead or indicate safe path of travel, are extensively used in Australia in public spaces to guide people with a vision impairment. In addition, embossed and Braille signs are readily available to supplement vision-based direction and other signs.

There are many systems identified in the Stage 1 report which are of a mobile portable nature but require a power source to operate to provide audio and/or tactile feedback to users who have a vision impairment. These "dynamic" devices are typically designed to be used by such persons in conjunction with a traditional long cane or guide dog. Examples are tactile compasses, talking compasses, infrared or ultrasonic obstacle locators and other handheld devices which are available to assist (in particular) users with a vision impairment to navigate around buildings and other spaces. These systems are essentially of a proprietary nature and

are thus effectively independent of one another. However there is movement to develop communication protocols which would allow new generation devices to communicate with each other to provide multifunctional use.

In addition to the portable devices, there are a range of stand-alone inbuilt systems (that rely upon infrastructure being installed and maintained in buildings and other venues) which can assist users with a vision impairment by providing them with additional audio and/or other feedback, and which have proved to be cost effective and reliable. These include audio and tactile signs - often found in lifts and in the general circulation areas of facilities such as exhibitions, conference halls, museums and other public buildings.

These stand-alone inbuilt systems do not demand the user carry interactive handheld devices but instead rely upon audio, vibration or tactile indicators. Typically these systems adapt existing systems, such as street crossing lights, exit signs and lift controls and thus do not require an additional system for the benefit of sensory impaired users only. Generally they are aimed at improving health and safety rather than improving general accessibility and have proved to be a relatively simple and cost effective adaptation to existing systems. More recently, directional sound evacuation systems (which generate sound patterns which people perceive to be different in different directions) have also been developed to provide a dual function of assisting users with vision impairment to find exits in an event of emergency as well as to assist sighted users in the event of smoke obstructing the illuminated sign.

The final group of systems which are currently in general use are inbuilt electronic systems which communicate with the user via a personal handheld receiver. Typically these systems consist of inbuilt beacons located at key locations to transmit information relevant to that location to the user. For example information describing the location of an entrance to a complex, opening hours, and the location of key services within the facility may be transmitted by infrared or radio transmissions.

For broader-scale location and orientation, there are also specialised geographic information systems (GIS) available to provide access to map-based information and other systems that are in more limited use. In addition, devices utilising information from satellite-based Global Positioning Systems (GPS) will also become more accurate for individual location tasks.

It is expected that the power requirements, physical size and costs of interactive handheld devices will be reduced so as to see greater reliance on such devices in the future, although at this time these systems are seen as offering great future potential rather than being available for immediate use. Even further into the future it is likely that personal virtual reality devices will be available which may or may not rely on inbuilt infrastructure to guide a user who has vision impairment.

The Report of Stage 1 is readily available, however in summary, the authors are of the opinion that while individual users, as well as individual venues, may benefit from the installation and use of the more advanced systems identified in this report, including the satellite-based GPS, computer-based and wireless tracking systems, they are currently not sufficiently developed to justify general application to all buildings and public venues.

Further, systems and technologies that require handheld devices which are useful only within particular buildings and venues, and which must be provided and maintained by the building or venue manager, would also not be suitable for use in all buildings and other spaces. However the authors believe that such systems may be practicable if a suitable communication protocol or standard was developed and implemented to enable the universal

use of devices in different buildings and venues. The authors believe that such a protocol should be given high priority.

The authors are of the opinion that some of the passive systems and technologies, including tactile ground surface indicators, embossed and Braille signage systems, as well as some active systems including audio/verbal information signs and digital sound evacuation systems, are currently sufficiently well developed to be introduced generally as a minimum requirement for all buildings which presently are required to have systems installed for people with no sensory impairment, and for some other venues. The authors acknowledge that these systems will only go part of the way to eliminating access barriers to people with a sensory impairment.

The extent to which these systems could or should be required to be incorporated into buildings and other venues and how the Building Code of Australia and other related legislation should be amended to take these established systems into account needs further investigation.

1.2 Wayfinding Systems and Technologies

Summarising the Report of Stage 1, in the following sub-sections we illustrate the types of systems and technologies that are available, without attempting to be comprehensive in the sense of mentioning every individual product or service available. Any product brands mentioned are for illustrative purposes only and do not imply any endorsement.

1.2.1 Passive Systems and Technologies

We grouped the following systems and/or technologies under a heading of "passive" in the sense that they provide feedback to vision impaired users without using power sources or involving similar infrastructure requirements. These types of systems are widely used in Australia at traffic intersections, and within and around major buildings. For design guide issues, the reader is referred to an information summary produced by the Royal Blind Society of NSW (2003) which sets out a range of accessible design recommendations for designers and decorators so that people with vision (and other) impairments are considered. As well, specific recommendations regarding lettering sizes, use of Braille, use of colour contrast, and other factors are made to try and ensure clear signage is installed. At the request of project partners, in addition the project developed its own Guide and Audit Checklist which again reinforces the importance of building owners, architects and interior designers considering layout; lighting; floor surfaces; Tactile Ground Surface Indicators (commonly known as "TGSIs"); handrails; and other inclusive aids when designing or planning refurbishment of existing facilities.

Not documented in the Stage 1 Report was a more recently developed Australian system known as the "Helping Hand-Rail" system - designed to assist users with a vision impairment within built facilities (see http://www.helpinghandrail.com/). As the name indicates, it is a fixed (metal) handrail system particularly aimed at assisting with emergency egress of vision impaired users from buildings. It does so by adding rail-ends of differing shapes to the fixed handrails - where a different end-shape can indicate whether a user has reached i) a normal doorway; ii) an intersection where they are required to change direction to the other side of the corridor; or iii) whether they have reached a fire-door. In addition, the incorporation of small latch barriers into the handrail means the latch can indicate by touch to the vision impaired user the direction to travel towards a fire-door in an emergency.

- Tactile Ground Surface Indicators (TGSIs)
- Raised Tactile (Embossed) and Braille Signage Systems
- Helping Hand-Rail System™

1.2.2 Dynamic Systems and Technologies

We have grouped the following systems and/or technologies under a heading of "dynamic systems and technologies" in the sense that they provide audio and/or tactile feedback to users with a vision impairment but require (battery) power sources to operate — although no additional fixed or network infrastructure is required to be provided by the broader community.

- Directional Compass
- Infrared / Ultrasonic Obstacle Locator
- Enhanced / Specialist Cane
- GPS Position Locator
- Personal Digital Assistant (PDA) & Notetakers
- Talking Digital Map Systems
- Tactile Map Systems
- Mobile Phones / Communicators

1.2.3 Infrastructure-based Systems and Technologies

The following systems and/or technologies have been grouped under the heading "infrastructure-based systems and technologies" in the sense that they require the broader community (via public and/or private facilities) to install and maintain permanent or fixed communications and/or network infrastructure which can then interact with users with a vision impairment - providing them with additional audio and/or tactile feedback. The supporting infrastructure may be installed around a built-up precinct or within a building, and may consist of a series of 'independent' pieces of equipment, or a network of linked appliances, which can provide feedback of some form to users with a vision impairment should they require it.

- Accessible Pedestrian Signals (APS)
- Press and Listen Signs
- Line-Following Guidance
- Directional Sound Evacuation
- Remote (Infrared) Audible Signage
- Remote Radiofrequency Audible Signage
- On-line Digital Information and Maps

1.2.4 The Future

- Satellite Positioning
- Lower Power Requirements, and Electronics Miniaturisation
- Communications Protocols, and Mobile Bandwidth
- Tactual / Tactile Feedback; Smart Clothing; Wearable PCs
- Virtual Reality
- Broad Integration of Computer Science and Robotics
- Robotic Wayfinding

1.3 Introduction to Stages 2 and 3

Given the budgetary constraints in this CRC-CI project whereby systems and technologies selected for trialling would need to have equipment supplied and installed by sponsors, project committee decisions were made for Stages 2 & 3 to concentrate on a) undertaking a wayfinding trial of an outdoor nature related to the Commonwealth Games in Melbourne, and b) the development, compilation and publication of a set of design principles and guidelines (Audit Checklist, Design Guide and Wayfinding Matrix) which could potentially be applied to a variety of buildings such as the large Brisbane office building complex.

2. TRIAL DURING COMMONWEALTH GAMES 2006

2.1 Background

Melbourne hosted the Commonwealth Games in March 2006 and the demands for wayfinding and navigation around and within the Central Business District (CBD) in particular were strong. With visitors to the city as well locals with vision impairment wishing to attend various venues, it was decided to look in more detail at options for wayfinding in the built environment in an open-space context. The lead organisation for the Games was the Office of Commonwealth Games Coordination (OCGC) – a part of the Victorian Department of Communities, whereas the local government responsible for transport and accessibility information around the city remains the Melbourne City Council (MCC). The OCGC had an 'inclusiveness and diversity initiative' under their charter known as "Equal First" - rather than having a separate group focussing on 'disability' assistance - so that they had a brief to assist inclusiveness across all areas of organising for the Games.

2.2 Precincts

Many of the Commonwealth Games 2006 venues were centrally located (see Figure 2.1 noting roofed Docklands Stadium to the west of rectangular street grid, and open MCG to the south-east), and a signage assessment study had been commissioned in early 2005 by the MCC and the OCGC. This resulted in a decision to upgrade the signage around the Central Business District, as well as for the various adjoining special interest precincts.

Figure 2.1 Aerial view of Melbourne Central Business District and adjoining precincts

Image from Google Earth (2006)

Precincts included the Sports precinct to the south-east of the CBD — encompassing the Melbourne Cricket Ground (MCG), Rod Laver and multifunction Arena(s); the Arts and Entertainment precinct — from the Arts Centre in St.Kilda Rd. along Southbank on the southern side of the Yarra river; the Docklands precinct under development to the west of the CBD, and the upgraded transport interchange in Spencer Street — now known as Southern Cross station. Understandably, the OCGC was primarily concerned with visitors and direction-finding during the period of the Games themselves, while the City Council was keen to take advantage of any upgraded signage or wayfinding options — which would remain as a legacy of the Games for the longer term.

Numerous events for the Commonwealth Games were held at the MCG, the nearby Rod Laver Arena and the adjacent Multifunction (Vodaphone) Arena. As anticipated by the OCGC, many visitors attended these venues on foot – often travelling from train stations at Southern Cross (Spencer St.), Parliament or Flinders Street – in the latter case via the side of the Yarra river (through Birrarung Marr park behind Federation Square) and across to the pedestrian footbridges which in turn offer access to these large Games venues.

2.3 Options for Open-Space Wayfinding

2.3.1 Location characteristics and trial factors

Characteristics of many of the potential sites (or at least accessibility around those sites) for trialling around the Melbourne area included:

- Central city street system based on rectangular street grid – bordered by mixture of high and low-rise retail and commercial buildings and some public open space
- Large open spaces leading to sports venues – often featuring some steps, inclines, mixture of grassed/treed and paved areas, …
- Many alternate walkways for pedestrians – some much less well-defined than others
- Many pathways through the city will be shaded from the sun by surrounding tall buildings which may also adversely affect telecommunications signal strength.
- Hand-rails not widely available along many routes
- Outdoors environment and weather factors (summer/autumn heat; rain; …)
- Sunlight brightness and reflection from horizontal and vertical surfaces

When considering the selection of alternate wayfinding systems or technologies for a trial, additional factors taken into account must include :

- The availability or otherwise and proximity of power source / electricity if required
- Areas will be used by many more travellers with full vision than with vision impairment
- The support offered by regulatory and bylaws authorities such as OCGC, transport bodies, MCC, Major Projects Victoria, … and the differing timeframes for their individual construction and refurbishment projects
- Local suppliers / distributors of selected wayfinding system / technology
- Level of support from potential sponsors to provide wayfinding ‘equipment’ (at minimum or no cost) to the project
- Possibility of graffiti or other vandalism of signage / wayfinding installation

Personal directional and mobility aids such as the Tactile Compass, or Talking Compass; personal Infrared / Ultrasonic Obstacle Locators (such as the Miniguide or Hand Guide™) and

Enhanced / Specialist Canes such as the GuideCane or UltraCane may certainly assist the vision impaired traveller's confidence and mobility and ability to navigate obstacles, however it is felt that on their own they would be insufficient to allow users to independently "wayfind" in the city environment discussed above.

Several of the options covered in Section 1 and the earlier Report into Wayfinding Systems and Technologies are either already in wide use around the city (such as Tactile Ground Surface Indicators, and Accessible Pedestrian Signals) or are not considered suitable (Helping Hand-Rail) given the outdoors environment and added constraints detailed above.

2.3.2 Raised tactile (embossed) signage and maps

There is however a strong case for the far more widespread introduction of Raised Tactile (Embossed) and Braille signage systems, which are now being widely produced by a number of both local and overseas suppliers.

Figure 2.2 Example of Braille tactile signage used indoors

This signage is now produced in a large assortment of shapes and sizes, and on a variety of materials such as metal or plastic substrates at quite moderate costs, ranging from A$50 to upwards of A$800 for one-off business signage. With raised or embossed writing, as well as optional Braille equivalents and simplified graphical representations, the signage caters well for both vision impaired and full vision users. Importantly, these types of signs can also be treated to be graffiti-resistant as well as weather and UV-resistant for outdoors applications.

Figure 2.3 Samples of individual tactile signs including graphics and Braille

Images courtesy of Braille Tactile Signs (Aust.)
http://www.brailletactilesigns.com.au/

A further exciting development over and above raised tactile (embossed) signage is the concept of fixed Tactile Map Systems which constitute (usually) a map of a particular area such as a University campus or business park.

The locations of key buildings are often highlighted in Braille and the building outlines and pathways between them are raised from the surface of the "map" allowing users with a vision impairment to locate facilities and pathways by tactile means.

However, it must be recognised that not all people are comfortable with "map-reading" as a form of spatial orientation and thus a *blend* of such tactile maps and directional signage would provide much assistance to wayfinding for the vision impaired traveller in a central city environment.

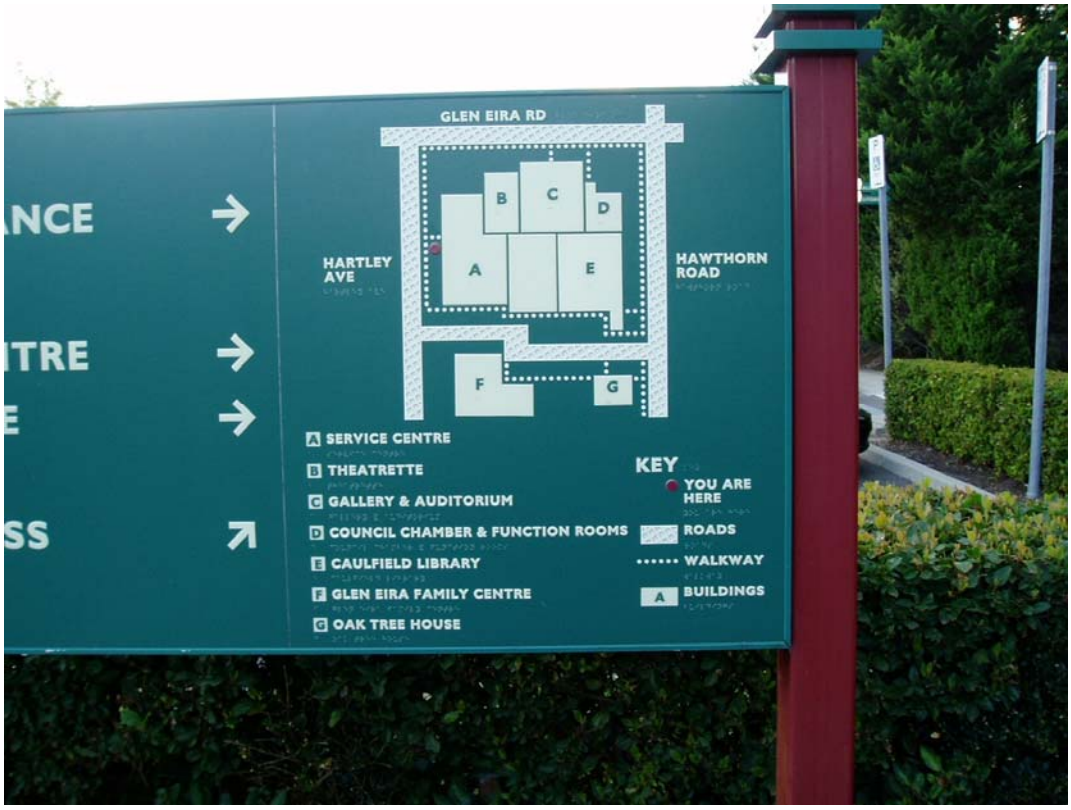

Figure 2.4 Example of tactile map signage used in outdoors setting

GPS technology is certainly suitable for broad scale guidance and orientation in relatively open spaces, and has been integrated into a number of location and orientation devices – both for sighted users and users with vision impairment. However GPS is not well suited for use nearby tall city buildings (or for indoor navigation) since it relies on direct access to at least three of the satellites to calculate correct location and orientation. The recent European project (Galileo) to launch alternative or next-generation GPS satellites to give metre accuracy may improve the precision of GPS systems - but not in the short-term. The level of accuracy for positioning (metres rather than centimetres) which is currently available for these GPS-based systems thus makes them unsuitable for the current application environment.

Of the infrastructure-based systems and technologies identified previously, line-following techniques and directional sound evacuation systems (where a user follows a systematic directional sound pattern) — being primarily aimed at assisting entry and egress from an indoor building type of environment — were not considered suitable to trial in the outdoors situation for Melbourne.

2.3.3 Audio signage

On the other hand, suitably weatherproofed audio signs (either push-button/press-and-listen, or sensor-based motion-activated infrared) designed for external environments have much to offer in outdoors settings such as those described above for Melbourne. Apart from their mutual requirement for electricity supply at each location for each audio sign, the disadvantage of the press-and-listen audio sign would be the potential inability of travellers with a vision impairment to actually locate the press-button in order to trigger the playback of the pre-recorded message. Hence, these audio signs would need to be installed in concert with appropriate signage (Braille, tactile or both) to attract the vision impaired user's attention to the availability of (pre-recorded) messages at particular locations.

In contrast, the disadvantage with the motion-activated infrared audio signage is that it would be triggered by anyone passing the location – whether the recorded information playback was needed or not – and restarting of the message and constant repetitious playback would undoubtedly be annoying to anyone located nearby.

Similar to the infrared signage described above - in the sense that it electronically provides information to persons with vision impairment - radiofrequency signage is designed for outdoors applications. When the user walks within range of the sign, a radio signal triggers the sign and it speaks the message through a loudspeaker. Importantly, the sign only speaks the message when a user carrying the specialised trigger unit is nearby – this alleviates the repetition problem, but imposes its own disadvantages of a user having to acquire and carry the proprietary trigger device.

Multipurpose trigger devices allowing access to a number of different outdoors signage systems do not yet appear to be available to the public, and it may be some time before that is rectified. This situation might be compared to the refinement of mobile phones of some years ago which then broadcast on different frequencies in different countries, but which are now being replaced by tri- and quad-band phones which can automatically transmit on the most appropriate frequency for the user's current location - without user intervention. However such technical innovation is much more rapid for consumer items such as mobile phones for the mass market, so production of multipurpose trigger devices for audio signage for those in the population with a vision impairment could be quite slow in coming.

All these audio signage systems have been designed to be as vandal-proof as possible, but still require electricity at each location to power them, and a computer network to connect them if messages are to be changed/updated from any distant (centralised) location.

2.3.4 On-line maps

As described in the earlier Report, many Geographic Information Systems (GIS) already process street address information by using digital map-bases which contain information about the roads and streets in a particular area or city (for instance Trekker and BrailleNote GPS, and Tactile Map project). The digital map-base often also contains location information about many landmarks such as major parks, public buildings, churches and the like, and although these are currently typically held as 'point data' in the map-base, it is our view that in future more floor-plans, 'footprint' building data or 'virtual models' for public buildings will be available in digital form. One proviso on this is the security considerations - that under the current terrorist situation, many organisations could be reluctant to make detailed layout plans of their facilities widely available, or perhaps not with the level of detail required for it to be useful as a basis for a wayfinding tool ! A simplified or schematic view (similar to that used in a more-traditional tactile map fixed at key physical locations) may be needed to allay security concerns.

Prior to the 2006 Commonwealth Games however it appeared premature and beyond the scope of this immediate project to trial this type of technology, which will likely rely on access to the third-generation mobile phone networks planned for future installation in Australia. The comments from the earlier Report of Stage 1 remain apt, viz. "*whether it is feasible to download street networks and building floor-plans/models across a network to a small device as required - or whether it would be necessary to download the information in advance prior to attending the facility - will likely remain a function of the cost of transmitting the information via the mobile phone network to a speech-enabled WWW browser on the handheld device*", and the security / potential terrorism issues imposed another layer of uncertainty.

2.3.5 Mobile telephones

A technique for establishing and maintaining (wireless) connections between various devices has become more established over the past 12 months or so. Known as the "Bluetooth" communication protocol, it has been driven by the mass consumer market looking for ease of connectivity over relatively short distances. This has resulted in many new mobile phones having an inbuilt Bluetooth capability, as well as in the release of moderate cost devices such as Bluetooth-enabled headsets which can communicate with a mobile phone or another Bluetooth-enabled device through a process known as "pairing".

Disadvantages of this approach are that the protocol currently only has a "reach" of some 5 to 10 metres from one device to another, and the devices must be "paired" in advance to ensure security and privacy of calls and communications are maintained as far as possible.

2.4 Selected Option for Melbourne Trial

2.4.1 Background

Through a timely coincidence of research ideas and commercial and civic interests, the opportunity to trial an innovative wayfinding system arose in Melbourne through the City Council's implementation of information hubs around the central business area. Following suggestions from several of the project team on the significant potential, a wayfinding system based upon transmitting and receiving audio messages for vision impaired travellers via Bluetooth connectivity was proposed and subsequently supported both by the Council and its selected information content partner Digital Spark.

As mentioned in Section 2.2, a signage assessment study was commissioned in early 2005 by the Melbourne City Council (MCC) and the Office of Commonwealth Games Coordination (OCGC). This resulted in recommendations and an accompanying MCC works budget to upgrade the signage around the Central Business District, as well as for the various adjoining special interest precincts.

2.4.2 Information hubs

These upgraded signage initiatives incorporated many of the raised tactile (embossed) signage concepts discussed above – catering to residents and travellers with or without vision impairment. In addition, during 2005/06 Melbourne City Council organised the supply and installation of some 27 electronic information kiosks or "iHubs" around major Melbourne CBD locations and streets (including Birrarung Marr and Spencer Street / Southern Cross station).

Since these kiosks will be "legacy items" of on-going value to the city and Council, these are being organised by MCC rather than OCGC. The kiosks were installed and commissioned by a company called Digital Spark Pty. Ltd. over the period November 2005—February 2006.

While primarily designed to provide an array of on-screen information to users regarding the location (and type) of CBD retail stores, theatres, restaurants, Automatic Teller Machines, and other services, as well as Melbourne travel information and timetables, and details of forthcoming attractions around the city centre, the researchers pointed out that the hubs could also be used to deliver more basic orientation and location information to assist in wayfinding.

2.4.3 Audio message transmission

Each iHub is made up of a cylinder around three metres high - displaying printed map and location information as well as incorporating a large colour touch screen (~ 800mm high & 600mm wide), and containing a networked PC with Internet connectivity; micro-cell transmitters and receivers for Optus or Telstra mobile network, and as a recent addition for this project, some also contained one or more Bluetooth transmitter / receiver modules.

Investigations showed that Bluetooth connectivity could currently be made to a specialised receiver device (and in future to a mobile phone, PDA and/or earpiece with built-in Bluetooth capability) and as an added service to the community, each iHub could be programmed to deliver specific information related to its individual location to vision impaired (and other) persons within a limited radius of ~10 metres. A proof-of-concept trial of such a system aimed at delivering "tailored" or location-specific information about key basic facilities and services (toilets, transport, information booths, venues) for travellers with a vision impairment was organised.

Figure 2.5 MCC "information hub" – outside Parliament station, at corner of Lonsdale & Spring Streets, Melbourne

Figure 2.6 Other views of MCC "information hub" – at corner of Lonsdale & Spring Streets, Melbourne

One disadvantage (at this stage) is that the Bluetooth protocol is only effective over some 2-10 metres so the iHub information would need to be used in conjunction with appropriate tactile signage. However, an off-setting future benefit is that the connectivity is free (unlike wireless Internet where users must connect via an Internet Service Provider - such as Optusnet, BigPond, Primus, and similar). Also, equipment able to be used for Bluetooth connectivity (specialised receiver device and in future, mobile phone and wireless headset) are relatively unobtrusive and expected to be readily available at moderately low cost in future.

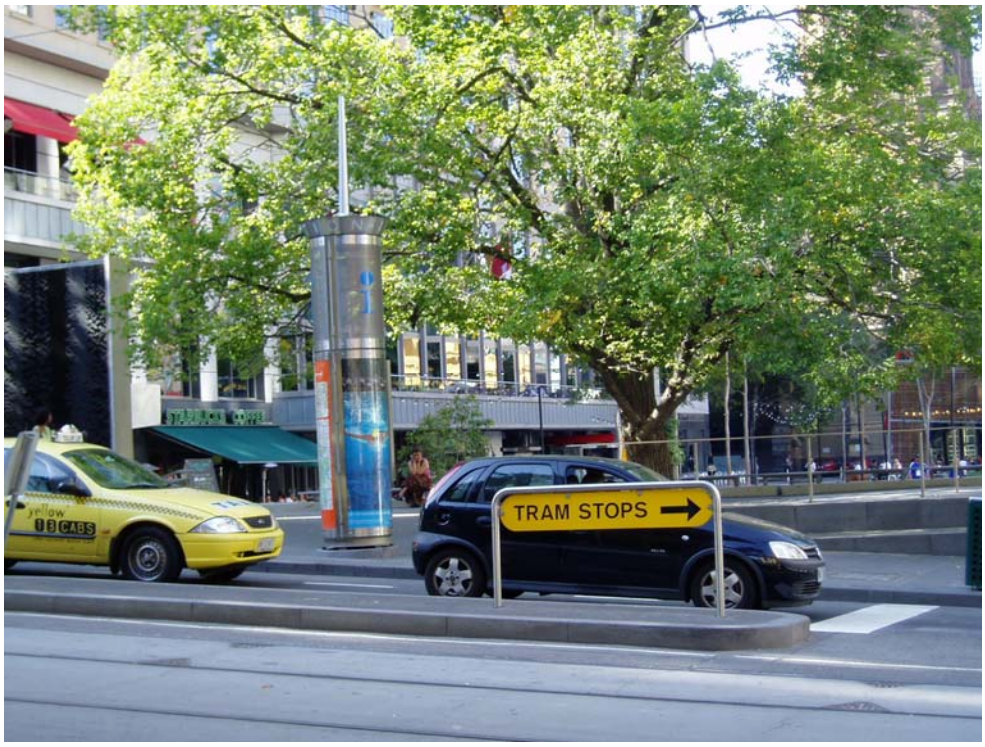

Figure 2.7 Additional MCC "information hub" – in Collins St., at corner of Swanston St., Melbourne

Up to 27 of these iHubs have now been installed around the Melbourne city/CBD area including one outside Flinders St. station; several along Swanston Street; several in Birrarung Marr and near the MCG close to the Yarra Pedestrian Link; as well as in the Arts and Southbank precincts; and later around the Docklands precinct. The Yarra Pedestrian Link was mooted as a possible site or trail for trialling this innovative wayfinding system, but ultimately it was decided to arrange a trial of wayfinding assistance for vision impaired travellers by utilising some key hubs which had been Bluetooth-enabled. To be used in combination with Bluetooth-enabled specialist headsets, the hubs chosen were those located near Flinders Street station and along Swanston Street (one of Melbourne's main thoroughfares) leading from the central city to Flinders St. Station, Federation Square, and Birrarung Marr.

2.5 Initial Inputs from Community Representatives

Prior to decisions being made about exactly where a trial might be undertaken, meetings were held with a number of community representatives for the vision impaired to help ascertain the general types of functionality and some specific information that they would like to see available from an electronic system to assist them in wayfinding around the Melbourne CBD.

Apart from the more expected items such as the location and direction of public transport (buses, trams, trains) and timetables, the location of nearby taxi-ranks, and the location of nearby public conveniences (such as toilets and change-rooms), other issues of interest included the location of (staffed) information kiosks for obtaining further information or assistance; the location of the nearest Automatic Teller Machine for some banks; but also – unexpectedly – information on the location and extent of blockages or disruptions to pedestrian footpaths around the city area.

For instance where a building is being constructed or sometimes refurbished, often the footpath on one side of the street is completely blocked off from pedestrian traffic with hoardings, or the footpath has been narrowed or realigned for purposes of providing building-vehicle access or excavation. Even for travellers with good vision this can present some navigation problems, but for the traveller with a vision impairment it can be a major concern, and the availability of such information would be quite valuable in helping them plan and undertake their trip unassisted.

2.6 Proof-of-Concept Trial around Melbourne CBD

Prior to the 18th Commonwealth Games in March 2006, some preliminary or proof-of-concept trials were carried out using equipment provided by Digital Spark and their technology partner Clarinox Pty Ltd. The hardware consisted of three laptop portable computers - each equipped with a Bluetooth USB connector for transmitting and receiving information, and three Bluetooth-based handheld devices with earpieces to receive audio information, while the software had been tailored to encapsulate, process and buffer the trial wayfinding messages to the transmitter.

These early trials were designed basically to demonstrate the feasibility of automatically transmitting (pre-recorded) audio information – specific to an individual location - to a user wearing a suitable receiving device

2.6.1 Within-building preliminary trial

Three laptop computers were set up on a vacant floor of a building in St Kilda Road, where they were all separated by some 20-25 metres. As the participants moved around the open

floor-space and came within range (5-15m) of a laptop PC, the device they were carrying automatically received a signal from the nearby computer's Bluetooth transmitter and played a series of messages through the ear-pieces attached to the handheld device.

Figure 2.8 Within building laboratory trial

The audio messages provided at each location were indeed different from those at each of the other locations. Despite some audibility concerns with the messages appearing to "break-up" at some stages – apparently caused by issues such as the message size and computer buffering of messages, the trial verified that the concept was indeed feasible, and after some further refinement to ameliorate those buffering issues, a trial in an external city environment at a busy time such as during the Commonwealth Games would indeed be practicable and valuable.

Figure 2.9 Further within building laboratory images (receiver unit, left; and portable computer-based hub, right)

2.6.2 Open-air concept trial

At the time of the Commonwealth Games, for the open-air trials, each of the three laptop computers were set up within a Melbourne City Council iHub situated along the Swanston Street thoroughfare. One test site was at the iHub outside the main central city station on Flinders St. (across the street from Young and Jackson's hotel – see Figure 2.10 below), while the second and third sites were at the iHubs located on the (south-east) corner of Swanston and Collins Streets, and on the (S-E) corner of Swanston and Little Bourke Streets.

Figure 2.10 (Bluetooth-enabled) Information hub outside Flinders St. station (near Swanston St.)

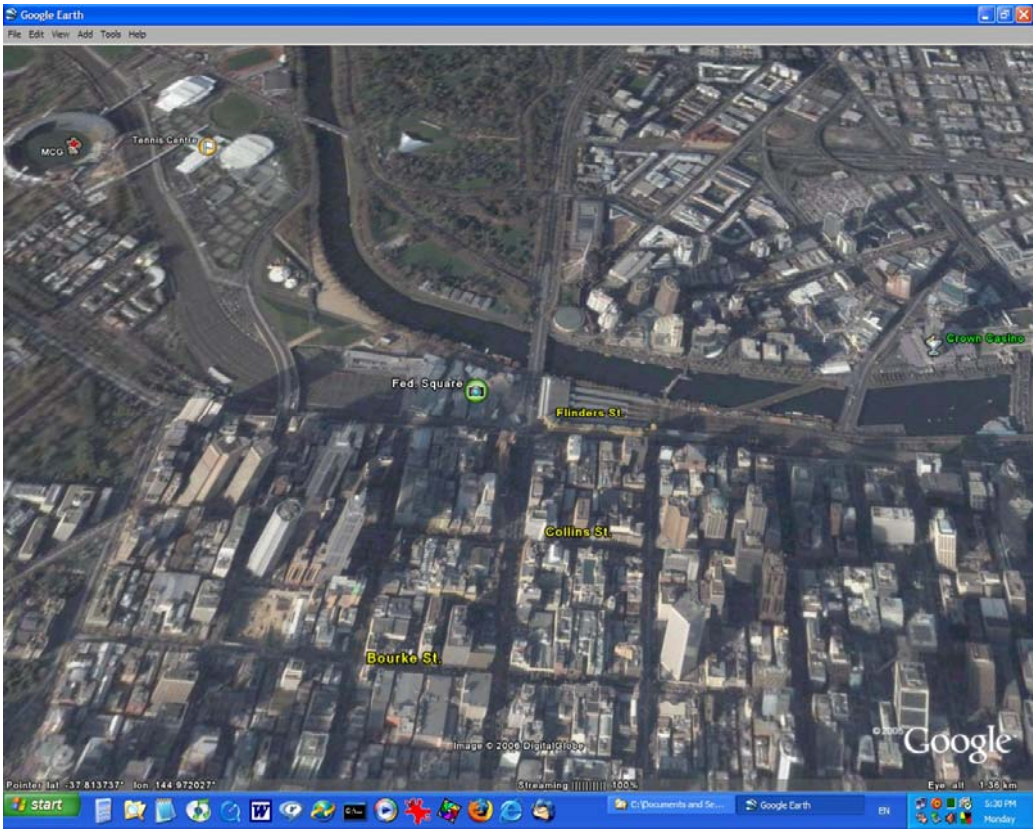

Figure 2.11 Outside trial location (looking south along Swanston St. Melbourne towards Flinders St. station)

Image from Google Earth (2006)

For this outdoor proof-of-concept trial we had the assistance of three volunteers associated with the consumer advocacy group Blind Citizens of Australia, who were very keen to be involved and also willing to travel into the central Melbourne to participate in the trial during March when the 2006 Commonwealth Games were being staged.

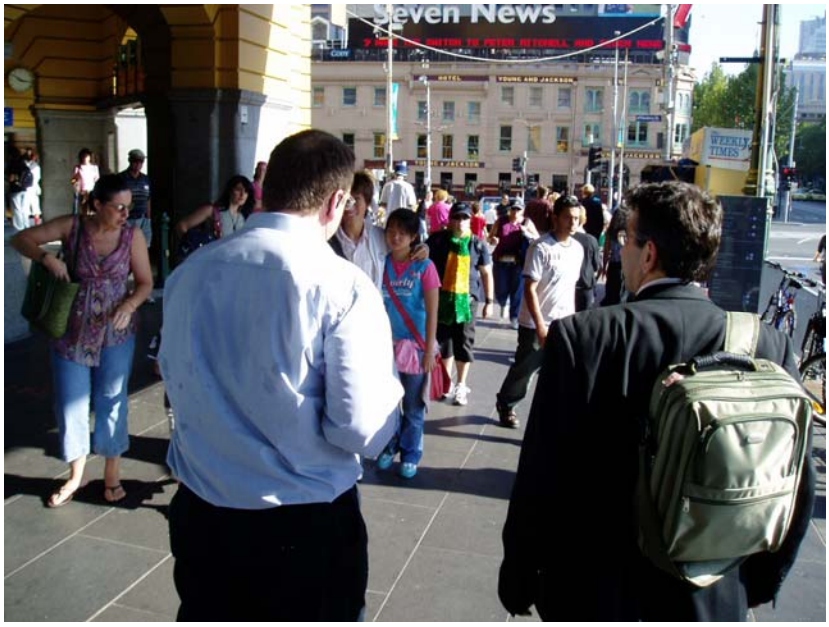

Figure 2.12 One volunteer approaching Bluetooth-enabled "iHub" outside Flinders St. station

One after another, each of the participants (with a companion for safety) moved towards the initial iHub (see Fig. 2.12) and came within range of the Bluetooth-enabled laptop PC enclosed within the iHub. The device which each of the participants were carrying then automatically received a signal from the nearby iHub's Bluetooth transmitter and played a series of messages through the participants ear-pieces - attached to the handheld device. Again, the message at each location was different from those at each of the other locations, and was specific to that location (e.g. "welcome, you are approaching the iHub near the corner of Flinders and Swanston Streets").

Figure 2.13 Another volunteer leaving Flinders St. station "iHub" and moving towards next iHub (to viewers right)

Since the trial was conducted using three adjacent iHubs (typically some 100 metres apart, but "adjacent" in the network sense), it was possible to use messages which referred to the next iHub in the sequence as the user moved northwards along the eastern side of Swanston Street.

Figure 2.14 View of second "enabled iHub" located by moving northwards along Swanston St. from Flinders St.

Figure 2.15 View of second trial "iHub" along Swanston St. - looking south across Collins St.

The trial was conducted using three (Bluetooth-enabled) information hubs - each around 100 metres apart - and as the volunteers moved from Flinders St. northwards along the eastern side of Swanston Street and came within range of the next iHub then a different message was delivered to the volunteer via the audio headpiece. This message indeed confirmed which hub the person was approaching and its street location.

In this concept trial, an extended menu system offering a range of information to the user was not implemented as many of the technical issues must be clarified and refined first, but

indications are that this should indeed be possible with further programming and refinement of the system.

In the brief outdoor trial in the centre of the Melbourne business area, the transmit/receive range between the iHub and the handheld devices appeared somewhat variable across the three different sites/locations, and this was believed due to the possible shielding effects of the metal cladding around the iHub - masking the Bluetooth transmissions.

Figure 2.16 View of the third Bluetooth-enabled iHub near Lt. Bourke St., looking south along Swanston St.

The iHubs are designed to be aesthetically pleasing and yet still retain an ability to stay clean and resist corrosion and graffiti, so the cladding is appropriate for those purposes. The first wayfinding trial perhaps indicates that the precise location of the actual transmitter/receiver should be considered carefully, however further more detailed work would be required to actually assess if the cladding is an explanation or whether any interference comes from other factors such as nearby transport, the surrounding built environment, or nearby people.

Figure 2.17 A volunteer approaching the third Bluetooth-enabled iHub in Swanston St. from the south

At this stage, the device used as the "Wayfinding receiver" remains of the special-purpose type (as opposed to a mobile phone device) because *today's* mobile phones are designed to download files as a complete package, and once having received all the file, then to store it for viewing (in the case of text or an image) or to store then play it (in the case of an audio file).

In the wayfinding context, this would mean that the user would have to wait for the complete file to be transmitted to, and stored on, their mobile phone and then listen to the contents of that file, whereas the current approach of using a specialist device means that the messages can be streamed to the device. This innovative approach results in the message starting to play almost immediately and it is always up-to-date for that location (rather than having multiple messages for different locations remaining on the user's phone with all the management issues that implies). A technical outline of the system is included in the later Appendix 1, while many of the details of the streaming of audio information simultaneously to (multiple) Bluetooth devices (as the outside Wayfinding trials required) are discussed in an explanatory White Paper (TCS/Clarinox Technologies, 2006) but are not detailed here for reasons of technical complexity.

Figure 2.18 Technical personnel adjusting Bluetooth-enabled iHub near Little Bourke St., Melbourne

Feedback from users with a vision impairment and other participants was extremely positive and most encouraging, and the system – once developed and further refined - was generally seen as having real potential for delivering information on request – discreetly and unaided, as would be desired by most anticipated users.

Issues relating to the receiver device in particular (cost; availability; its substitution by a mobile phone) still remain to be addressed, and the software menu system must be further developed, but the potential for assisting vision impaired travellers seems enormous once these issues are addressed successfully. The various parties involved with the innovative wayfinding system are looking to develop it further through approaches to other authorities and relevant bodies to allow further trialling on a larger scale to be undertaken.

3. DESIGN PRINCIPLES AND GUIDELINES

The large State Government office building complex located in George Street, Brisbane was selected as a venue for investigation and audit development since one of the industry partners for the Project maintains and manages the site, and in addition it offers scope for a range of indoor wayfinding environments – as well as elements of an outdoor environment by virtue of the forecourts linking the building's two main entrances onto George Street.

3.1 Background

The extended building is situated in the Central Business District of Brisbane, and has two main entrance points situated along George Street. It is some 5-7 stories high with the site generally sloping back from George Street and down towards William Street and the river, while extending some two city blocks north-west along George Street from the corner of Alice Street, spanning across Margaret Street, and up to Mary Street. The whole complex is very long but relatively low, yet houses a very large number of QDPW staff, their individual offices and open plan areas, as well as many meeting or seminar rooms.

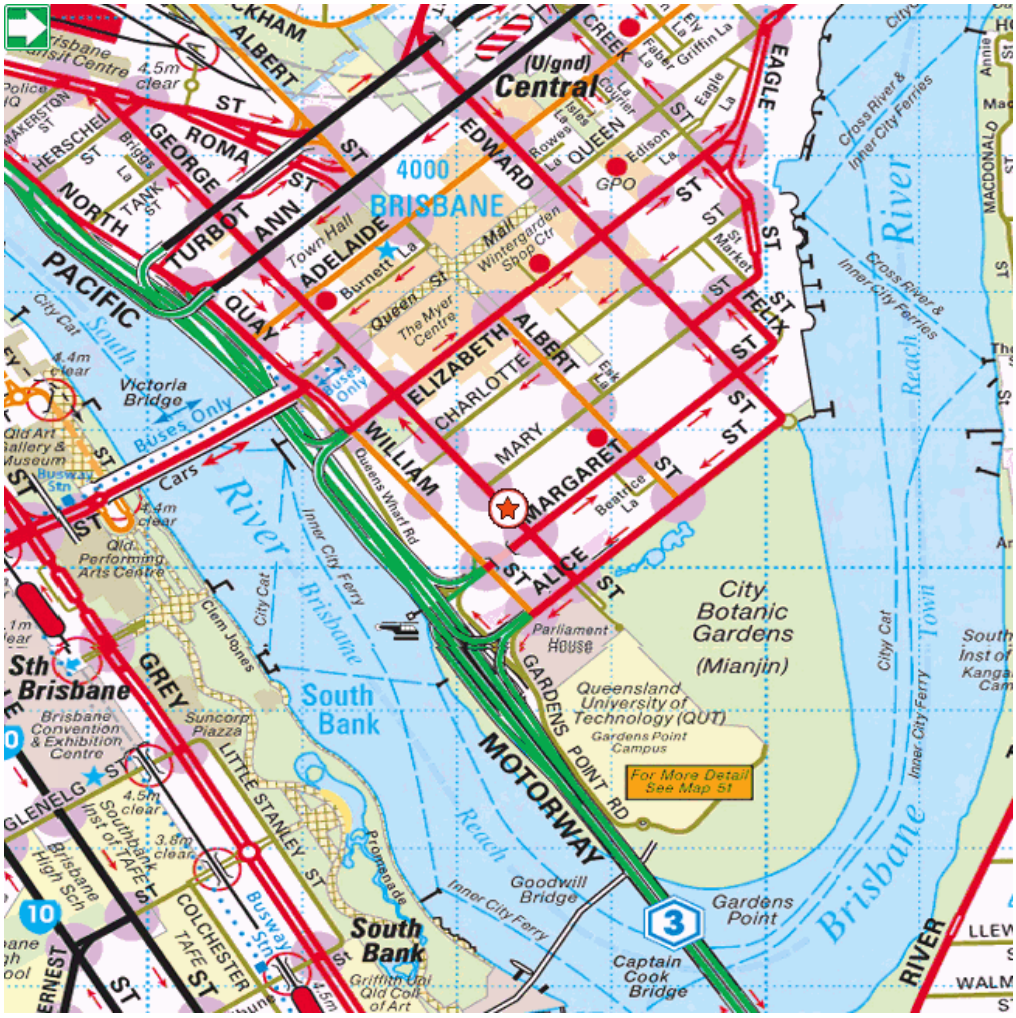

Figure 3.1 Street overview of Brisbane Central Business District - centred on 80 George St. (marked with ✪)

Image from Google Maps (2006)

Figure 3.2 Aerial view of part of Brisbane city focussing on extended building in George Street

Image from Google Earth (2005)

3.2 Characteristics of Example Building

Characteristics of the location in George St., Brisbane with forecourts and surroundings areas linking internal and external environments (and so nominated as a building for a trialling study of the initial wayfinding audit) include:

- Extensive office-type building with 5-7 floor levels, located on a sloping site
- Building extends nearly two city blocks, and actually bridges across one major street
- Multiple entrances along George Street – with differing addresses, but known as Entrance A, Entrance B, or the like.
- Building complex comprises a mixture of government Departmental offices / office suites / work spaces, as well as semi-public meeting rooms
- Very long access corridors of varying widths, and for use by both public and staff, with several unattended reception areas
- Complex accommodates many varied work groups – other parts of whom may be located elsewhere within the building complex
- Indoor environment – security, accessibility and emergency egress are all issues
- Building in need of some refurbishment since designed and built in the early 1980's
- Featuring large lift lobbies necessitated by the large number of staff who work on any one floor level, but lifts without audio options, and non-tactile buttons.

- Future refurbishment may have potential for conflicts between existing architectural design and demands of wayfinding / signage (eg contrasting colour schemes; extended use of TGSI's; brightness of corridor lighting; and like factors)

3.3 Audit: Design Principles and Guidance

As a first step in promoting the more widespread application of Wayfinding in the (indoor) Built Environment, the research team set out to compile an "audit template/checklist" or set of design principles and guidelines which could potentially be applied to a variety of buildings - such as the large Brisbane office building complex located at 80 George Street.

Drawing on a large variety of published sources, an audit template or checklist was subsequently developed and is documented in the companion Report "Wayfinding Audit: Design Principles and Guidance (CRC-CI, 2007a). With the cooperation and support of the building's managers, a draft of the audit template was initially used around and within the building at 80 George Street in order to clarify and refine the checklist, and to highlight some of the issues that must be addressed to help ensure good wayfinding practices are incorporated when a building refurbishment is planned.

The purpose of the Design Principles and Guidance document is to provide a reasonable practical and comprehensive design approach to wayfinding using the methodology of a 'design audit and checklist' that would assist designers as well as developers, property owners and property managers in identifying ways of improving access to, into and through their new or existing property, particularly buildings. It is important to note that the checklist and guidance notes are not a substitute code for the Building Code of Australia (BCA), Australian Standard AS 1428, or the pending Draft Disability Standards for Access to Premises (Premises Standard) document. The reference to the BCA and AS 1428 and other Australian Standards within the checklist and guidance notes provide the decision maker with the relevant technical information to assist them in developing a successful wayfinding system for their new or existing property and/or building. It is also important to note that currently the BCA, AS 1428 and other Australian Standards are relevant code and standard requirements for all new building work.

3.4 Potential Wayfinding Options within Building

Several of the options covered in Section 1 of this current Report as well as the earlier Report into Wayfinding Systems and Technologies (Stage 1) are likely to already be in place within the building (such as Tactile Ground Surface Indicators), but a number of others (Helping Hand-Rail, Raised Tactile (embossed) signage and maps, and Audio signage, …) could be considered suitable for near-future introduction - given the context is primarily indoors, and bearing in mind the inherent constraints within the publicly owned building.

Taking into account the issues that arise within and around large building complexes such as we are dealing with for audit purposes, a number of wayfinding systems or options suitable for deployment in the near future may include :

3.4.1 Handrail systems

A more advanced alternative to the traditional wooden handrail often used along the corridors of some special-purpose buildings (aged care facilities, hospitals, headquarters for vision-related services) is the Helping Hand-Rail™ system (see http://www.helpinghandrail.com/) which is specifically designed to assist low-vision users but in a wide variety of building applications. It is a (metal) handrail system fixed to the corridor walls, and is particularly aimed at assisting with emergency egress from all types of buildings by users with a vision

impairment. It does so by combining different shaped ends with the fixed handrails — where an end-shape indicates to the pedestrian with vision impairment whether they have reached i) a normal doorway to a room; ii) an intersection where they are required to change direction to the other side of the corridor; or iii) whether they have reached a fire-door. In addition, the incorporation of small latch barriers into the handrail means that the latch can indicate - by touch – the direction in which a user with vision impairment should travel towards a fire-door in an emergency.

The Australian-developed system has been investigated overseas and has received some international recognition, but one issue with its limited introduction - as remarked by a associate with impaired vision - may be the training required for people to learn and use the system with confidence. That said though, clearly this issue regarding familiarity and the need for ease of use obviously also applies to many other alternative systems – be they audio signage, or tactile signage, or computer-based guidance – and whether visitors to the building could be at risk through a lack of understanding of the egress system in an emergency situation where panic might arise.

3.4.2 Individual mobility aids

Again, personal directional and mobility aids such as a tactile or talking Compass; personal Infrared / Ultrasonic Obstacle Locators and Enhanced / Specialist Canes may certainly assist the vision impaired traveller's confidence and mobility, however it is considered that on their own they would be insufficient to allow users to independently find their way within the building environment discussed above. In conjunction with Raised Tactile signage or Audio signage, these devices may be of much greater assistance to users in combining mobility with location information and allowing users with a vision impairment to independently navigate within the building complex with increased confidence.

3.4.3 Conventional printed signage

The default option for many existing (and many planned) buildings seems to remain conventional signage in the form of printed location signs, directory boards, etc. However in the interests of equitable access for all visitors, it is expected that such printed signage will be upgraded to incorporate raised tactile lettering, Braille signage and widely understood simple symbols (or pictograms) in future through the wider embrace of the Universal Design principles by building owners, architects and interior designers.

3.4.4 Moving illuminated signage

Based upon Light Emitting Diodes incorporated in a rectangular array, this electronic rolling signage consists of one or more extended lines of text lettering, and is also known as LED moving message signage (single and multi-line). It can be programmed to cycle through the sequence of letters to provide more lengthy information about the current location, and/or provide directions to a nearby building or destination - to those who can see and read the signage – often presented in its simple form of one-colour LEDs with fixed character font.

The signage provides a similar function as a printed location board, but with added flexibility to be more easily updated, and to provide additional information beyond static location signage for those persons with low or some residual vision. If used, the signage must be well-positioned and suitable for pedestrians with some vision impairment (as well as those with other disabilities), using suitable fonts, colour and background contrast. However, as with conventional printed signage, because it has no tactile component the LED moving message signage is not suitable to assist wayfinding by those pedestrians with total vision loss.

3.4.5 Computer directory information system

Building infrastructure based on a computer directory system which provides an unattended or 'faceless' reception desk. System should provide (limited or detailed) listings of building tenants, meeting rooms, or other public facilities and on which floor level and/or rooms they are located, as well as directions to individual building tenants premises, meeting rooms or other public spaces, plus directions to key facilities such as the toilets, stairs and lifts (if any).

As with any computer-based system for likely use by persons with a vision or a mobility impairment, the screen and/or keyboard should have standard accessibility features such as suitable (clear) fonts, suitable sized text, good background colour options and good screen contrasts, as well as being installed in an easily located and accessible position - at a comfortable height.

3.4.6 Talking lifts

In addition to tactile lift buttons useful in assisting persons with vision impairment to easily select their desired floor level, this upgraded building infrastructure incorporates a speaker system into the elevator which can announce pre-recorded messages to lift occupants. The audio in lift-cars is triggered automatically and announces the floor level to travellers as the lift arrives and the doors automatically open at any selected floor level.

The talking lift audio system is also useful in an emergency to broadcast and/or reinforce standard warning messages that building occupants should not use the lifts in the event of fire.

3.4.7 Raised tactile (embossed) signage and maps

Following the opinion expressed earlier (see Section 2.3.2), there is an even stronger case in a indoor built environment for the far more extensive introduction of Raised Tactile (Embossed) and Braille signage systems - which are now being widely produced by a number of both local and overseas suppliers.

Figure 3.3 Examples of individual tactile signs including Braille and graphics

Images courtesy of Braille Tactile Signs (Aust.)
http://www.brailletactilesigns.com.au/

In addition to tactile signage, there are now available tactile maps or floorplan-layouts whereby the locations of key rooms can be embossed in Braille and the corridor walls or room outlines are raised from the surface of the "map" allowing users with a vision impairment to help locate where facilities and pathways are located - by tactile means.

Depending upon complexity, dimensions, range of colours and materials chosen, and the quantity ordered, a complex tactile layout map can cost upwards of several thousand dollars (Aust.) for a single map, so the information depicted must be judiciously selected to ensure the information highlighted in a tactile manner does not quickly become obsolete.

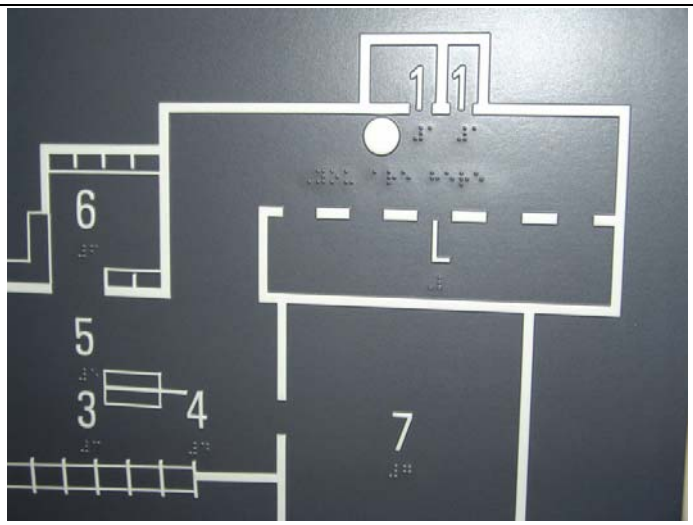

Figure 3.4 Example of locational tactile map including Braille and graphics

As mentioned previously, it must be stressed that not all people are comfortable with using 'maps' / spatial information and thus a *combination* of such 'tactile maps' along with appropriate directional signage should provide invaluable wayfinding assistance for the vision impaired traveller in a large building environment.

Talking Digital Map systems (such as Trekker and BrailleNote GPS) are based upon Global Positioning Systems (GPS) technology which is not well suited for indoor navigation (or use near tall city buildings) since it relies on direct access to at least three of the satellites to calculate correct location and orientation. These types of systems undoubtedly have future applicability as some of the technical issues are overcome, however they are not considered a feasible option for this project timeframe and their use within buildings.

Of the infrastructure-based systems and technologies identified previously, line-following techniques and directional sound evacuation - being primarily aimed at assisting entry and egress from a building environment - would appear to be feasible options to consider when assessing an indoors building environment. The line-following or tracking alternatives discussed in Stage 1 are considered to be still developing, and so like the Talking Map systems, are deemed to have real future potential but are not yet ready.

3.4.8 Egress systems

Unlike the line-following or tracking alternatives and guides, the Directional Sound Evacuation system is a more mature product and one which aims to solve the problem of emergency egress from buildings for travellers with a vision impairment - as well as for building users with full sight but whose vision is affected by smoke. Like the Helping Handrail, this directional sound system is seen as having great potential for assisting users with vision impairment in leaving the building under emergency conditions - however as a method of providing wayfinding assistance to generally navigate from one key place in a building to another, other alternative solutions appear more appropriate.

3.4.9 Audio signage

Some of these more appropriate alternatives that should be considered are audio signs (either push-button/press-and-listen, or sensor-based motion-activated infrared) designed for indoors environments such as those at 80 George St. Apart from their common requirement for power or battery at each location for each audio sign, again the disadvantage of the press-and-listen audio sign would be the difficulty that visitors with a vision impairment may have to actually

find the press-button in order to trigger the playback of the pre-recorded message. Thus these audio signs would need to be installed in precise coordination with appropriate signage (Braille, tactile or both) to draw the vision impaired user's attention to the availability of directional or locational messages at particular positions.

On the other hand, the disadvantage with the motion-activated infrared audio signage is that it would be triggered by anyone passing the location – and the constant repetitious playback could undoubtedly be annoying to anyone working in the vicinity. Effective sound proofing of corridors or lift-lobbies where such signage is installed may ameliorate this, but these effects may need to be considered or trialled prior to any long-term installation.

The Talking Signs® technology was pioneered and developed at the Smith-Kettlewell Eye Research Institute (SKERI), Rehabilitation Engineering Research Center in San Francisco, California in the 1990's (see http://www.ski.org/), but has since had research and development from a number of commercial sources. Patented in a number of countries and already installed in a large number of sites in the US, Europe and Asia, it is claimed by the US distributors Talking Signs, Inc. (http://www.talkingsigns.com/) to be "*the first infrared system to work effectively in both interior and exterior applications. Talking Signs® may be used wherever landmark identification and wayfinding assistance are needed* ". All these audio signage systems have been designed to be as vandal-proof as possible, but still require electricity at each location to power them, and a computer network to connect them if messages are to be changed/updated from any distant (centralised) location, and the distribution, or purchase or loan to the public of different (proprietary) trigger devices remains an issue to be overcome.

3.5 Companion Report - Design Guidelines

Another comprehensive Report entitled "WayFinding Design Guidelines to assist People who are Blind or Vision Impaired" (CRC-CI, 2007b) was also produced by the project in order to combine together in one place a collection of material which should prove useful to designers.

The "Design Guidelines" Report is aimed at designers and draws together a number of elements from the principles of so-called 'universal design' or design of the built environment with a range of potential users in mind, and not simply design which caters only for travellers with full vision, who are mobile, and who read English.

Universal or inclusive design aims to build into the design, or the refurbishment project, basic considerations for the traveller with vision impairment, the less-mobile and the elderly as well as for those with a low level of understanding of written English.

4. BACKGROUND TO WAYFINDING MATRIX

In order to provide a succinct summary of options for wayfinding (for persons with vision impairment) in and around a building complex (typically commercial or institutional), we have set out the a matrix of scales, spaces, paths and options. In this matrix and its accompanying documents, by 'scale' or 'range' we mean a smaller journey part or a trip from one location to another within the overall wayfinding journey - rather than scale or range being a measure of distance between sequential wayfinding cues. Costs of systems are not canvassed as they will vary enormously depending upon the system employed - as well as the physical extent of the sections of built environment that must be encompassed.

Appropriate planning scales will vary depending on the location, as will issues such as weatherproofing of equipment, availability of power, ability to withstand malicious damage/graffiti, etc. for external applications, while factors such as the ready availability of power or computer networks, perceived disruption to other building users, etc. may also affect the choice of within-building wayfinding options.

The terms "pedestrians" or "travellers" used herein could refer to passing foot-traffic, building occupants, visitors, staff or indeed anyone accessing the building on foot or with limited mobility. The matrix consists of a description of the wayfinding system, how/where it may be applied, and further comments , e.g.

	Wayfinding System	**Description**	**Application**	**Comments**
1.1	**Tactile Ground Surface Indicators (TGSIs) including directional indicators** See #3.1 of Stage 1 Report	System of raised domes and stripes placed in patterns on the ground to provide tactile information. Their colour and luminance contrast provides information to people with vision impairment about hazards & directions	Warning tiles indicate hazards such as platform edges, stairs and overhead obstacles (and also inform people about changes in the direction of the path of travel). Directional tiles assist people to negotiate difficult environments such as open or busy spaces or to find specific locations such as a building entrance or exit	Two types of TGSI tiles (Warning and Directional) are currently used under Standard AS1428.4 TGSIs are provided as local government or venue owners infrastructure - as required by the Building Code of Australia
1.2	**…**	…	…	…

for each of the following 'scales' of the built environment where various parts of an overall wayfinding journey may be undertaken:

Neighbourhood scale	say 30-200m e.g. malls, arcades, urban open space, pocket parks, ..
Building precinct scale	say 30m e.g. forecourts, podiums, plazas, piazzas, ...
Building entrance scale	say 5m e.g. immediate vicinity, building entrance, ...
Inside building scale	say 1-20m e.g. lobby, reception area, lift lobbies, information desk,.
One floor level scale	say 1-20m e.g. corridors, offices, fire exits, classrooms, meeting rooms, sanitary facilities, storage rooms, ..

and is shown in detail in Chapter 9 - Appendix 2 of this Final Report document.

5. CONCLUSIONS

5.1 Wayfinding Outdoors trial - Melbourne

A "proof-of-concept" type trial was undertaken in Melbourne in conjunction with the suppliers of the Melbourne City Council information hubs infrastructure to ascertain whether the broadcast of audio messages from these hubs to selected handheld receivers is a) technically feasible and b) useful to travellers who have a vision impairment.

The trial involved temporarily adding suitable (Bluetooth) transmission ability at selected central city information hubs; upgrading the software for the server and the receiver to accommodate suitable messages which are specific to each particular location; and monitoring feedback of the use of the system by members of the vision impaired community.

Response by the (limited number of) users from the vision impaired community and others was most encouraging, and the system – once developed and further refined - was generally seen as having real potential for delivering information on request – discreetly and unaided, as would be the wishes of most anticipated users. Issues relating to the receiver device in particular (cost; availability; it's replacement by mobile phone) still remain to be addressed, and the software menu system must be further developed, but the potential for assisting travellers who have a vision impairment seems enormous should these issues be addressed successfully.

5.2 Wayfinding Audit Design Principles and Guidelines Documents

A set of design guidelines and an audit template for wayfinding within the built environment were produced, and trialled using the facilities and services available around and within the QDPW building in George Street, Brisbane. The trialling was undertaken by number of travellers – some with a vision impairment and some with full vision - who were asked to find their way from the street kerb outside (which is setback some 50 metres from the entrance) to a particular location within the multi-storey building. The feedback garnered from these experiences was used to refine the audit template, and to clarify some of the questions which were asked of users. The template does not of course substitute for a designer's requisite knowledge of the Building Code of Australia (BCA), Australian Standard AS 1428, or the pending Draft Disability Standards for Access to Premises (Premises Standard) document.

Perhaps in the longer term, and beyond this current project, a similar type of experiment to the Melbourne trial (ie initially proof-of-concept) could be undertaken at the 80 George Street complex or similar by installing limited infrastructure within appropriate parts of the building to enable either a) the transmission of suitable location-based audio messages to passing personnel and visitors who are equipped with suitable receiving devices, or b) the delivery of audio messages in response either to a push-button request or to passing foot-traffic. Approaches should be made to the manufacturers and/or distributors of any handheld devices which might be suitable for use in such an infrastructure-based system with a view to obtaining additional financial and technical assistance to support any trial.

5.3 Wayfinding Matrix

A matrix of options has also been produced to assist architects, designers and building owners in their awareness of suitable systems for wayfinding within and around new and existing buildings. Developed and used in conjunction with the design guidelines and audit template for wayfinding, a range of possible options for systems and technologies to help address wayfinding within the built environment are set out.

6. REFERENCES AND KEY INTERNET SITES

Barker, P., Barrick, J. and Wilson, R. (1995). Building Sight – a handbook of building and interior design solutions to include the needs of visually impaired people. HMSO in association with RNIB, London. ISBN 011 701 993 3

CRC-CI (2007a) "Wayfinding Audit : Design Principles and Guidance"

CRC-CI (2007b) "Wayfinding Design Guidelines to assist People who are Blind or Vision Impaired"

Royal Blind Society of NSW and ACT (2003) Accessible design recommendations for people with vision impairment.
See http://www.rbs.org.au/about/factsheets/Accessible Design.doc, August 2003

TCS/Clarinox (2006): White Paper "MP3 streaming over Bluetooth to multiple users".

Key Internet / World Wide Web sites of interest include :

Australian Building Codes Board (ABCB) see http://www.abcb.gov.au

Australian Human Rights and Equal Opportunity Commission (HREOC)
see http://www.hreoc.gov.au

Blind Citizens Association (BCA)
see http://www.acb.org/washington/imperatives-2004.html

BlindSigns - Detectable Directional Guidance Systems (DDGS)
see http://www.blindsigns.com/

BrailleNote-GPS see http://www.senderogroup.com/shopgps.htm

Braille Tactile Signs (Aust) see http://www.brailletactilesigns.com.au/

HandGuide see http://www.guideline-technologies.com/

Helping Hand-Rail see http://www.helpinghandrail.com/)

Localiser (Directional Sound Evacuation) see http://www.soundalert.com/way-finding.htm

Melbourne City Council see http://www.melbourne.vic.gov.au/

Miniguide see http://www.gdp-research.com.au/ultra.htm

Mobility Agent see http://www.agentsheets.com/

Office of Commonwealth Games Coordination see http://www1.dvc.vic.gov.au/ocgc/

Polaron see http://www.lasercane.com/pola1.htm

Sonic Pathfinder see http://www.sonicpathfinder.org/

Sound Alert Technology. Localiser. see http://www.soundalert.com/dse_buildings.htm

Tactile (Braille) Compass see http://onlineshop.rnib.org.uk/display_product.asp

Talking Compass see http://www.sensorytools.com/c2.htm

Trekker see http://www.visuaide.com/

UltraCane see http://www.soundforesight.co.uk/media_gallery.htm

VoiceNote see http://www.pulsedata.com/Products/

7. GLOSSARY

The following explanations are provided as a guide to acronyms and terms which may not be familiar to or readily understood by some readers.

ABCB - The Australian Building Codes Board is responsible for developing and managing a nationally uniform approach to technical building requirements, embodied in the Building Code of Australia (BCA) and enabling the building industry to adopt new and innovative construction technology and practices.

Accessway - An accessway is a path of travel suitable for use by people with a disability. It is a 'continuous accessible path of travel'. An accessway is required to provide access to, into or within buildings for people with a range of disabilities. It must not incorporate any step, stairway, turnstile, revolving door, escalator, travellator, moving walkway or other impediment which would prevent it from being safely negotiated by people with a disability.

APS - Accessible Pedestrian Signals. Additions to the traffic signal system at crossings to provide signal information in audio, tactile, and/or vibrotactile form to the pedestrian.

AS 1428 – Australian Standards AS1428 Parts 1 to 9 specifies design requirements applicable to new building work in public and commercial buildings, to provide access for people with disabilities. Attention is given to the needs of people who use wheelchairs, people with ambulatory disabilities and sensory disabilities, to permit independent use of buildings. The requirements specified are intended to permit general use of buildings and facilities by people with disabilities acting independently, or where a person's usual method of operation is with an assistant, in the company of that assistant.

Audio – Audible sounds that are recognised as either speech, warnings, coding clues etc

BCA – Building Code of Australia 2006 **is a uniform set of requirements for the design and construction of buildings and other structures throughout Australia.** It includes access for persons with disabilities, services and equipment, and certain aspects of health and amenity.

Bluetooth – a wireless communication standard primarily designed for low power consumption, with a short range (from 2 up to 20 meters) and with a low-cost transceiver microchip in each device. Useful for connecting mobile products such as mobile computers, mobile phones, digital cameras, and other portable devices. Bluetooth should not be confused with Wi-Fi, a faster protocol requiring more expensive hardware that covers greater distances and uses the same frequency range.

DDA - *Disability Discrimination Act 1992* seeks to eliminate, as far as possible, discrimination against persons on the ground of disability in the areas of work, accommodation, education, access to premises, clubs and sport; and the provision of goods, facilities, services and land; and to ensure, as far as practicable, that persons with disabilities have the same rights to equality before the law as the rest of the community; and to promote recognition and acceptance within the community of the principle that persons with disabilities have the same fundamental rights as the rest of the community.

Disability – A condition or state of being which is covered by the broad DDA definition. The term includes physical, sensory, psychiatric, intellectual and neurological disabilities, physical

disfigurement and the presence in the body of organisms causing or capable of causing disease, such as HIV - the virus which causes AIDS.

Discrimination – Treating a person less favourably (on the basis of a disability that that person has, may have, used to have or may have in the future) than you would treat a person without that disability in the same circumstances or circumstances which are not materially different. Discrimination may be either.

Direct discrimination - treating a person less favourably because of their disability, such as a policy that people with infectious diseases may not enrol at a particular institution.

GIS – Geographic Information System - a computer system for capturing, storing, checking, integrating, manipulating, analysing and displaying spatial data (i.e. related to positions on the Earth's surface). Typically, a GIS is used for handling maps of one kind or another which might be represented as several different layers where each layer holds data about a particular kind of feature (e.g. roads).

GPS - Global Positioning System. Satellite system to provide information about any location, such as the latitude, longitude and altitude or elevation.

Indoors – Any space that is protected from weathering; generally within the confines of a building or structure with the aid of weatherproof walls and a roof.

Infrared (IR) – form of light with a wavelength between those of visible light and microwave radiation. A common use of IR is in television remote controls. In this case it is used in preference to radio waves because it does not interfere with other devices in adjoining rooms (IR does not penetrate walls). IR data transmission is also employed in short-range communication among computer peripherals and personal digital assistants.

Outdoors – Any space within the built or natural environment that humans utilize. Generally, outdoors spaces are those not within the confines of a building or structure (Open air courtyards are an exception).

Peak Disability Organisations – Organisations representing groups of disability organisations. Peak organisations often liaise with government in relation to disability issues.

PDA - Personal Digital Assistant. A small handheld computer typically providing calendar, contacts, and note-taking applications but may include other applications, for example a web browser and media player. Small keyboards and pen-based input systems are most commonly used for user input.

Premises standard (PROPOSED) – The Disability Access to Premises (Buildings) Guidelines proposes if adopted to remove discrimination on the basis of disability from access to and use of premises. Clause 4.7 of the Premises standard allows for and encourages innovative solutions to meet the Performance Requirements through the development of new technologies and through the use of Alternative Solutions.

Public Spaces – Any internal or external space where groups of people congregate or pass through for a variety of activities.

Sensor - a device that detects, or senses, a signal. A sensor is a type of transducer, and most sensors are electrical or electronic, although other types exist. Examples are light; sound; heat; pressure; magnetism; motion; orientation sensors. Sensors are either direct indicating (e.g. a mercury thermometer or electrical meter) or are paired with an indicator so that the value sensed becomes readable by a human.

Shoreline - A shoreline (or 'trails') is a detectable outline along or around part or all of a building, and a trail is a linear path of travel or designated corridor.

Standards Australia - Standards Australia is a standards development organization and is Australia's representative on the International Organization for Standardization [ISO]. It develops and maintains more than 7000 Australian Standards® including AS 1428, AS 1735.12-1999 : Lifts, escalators and moving walks - Facilities for persons with disabilities and many other standards.

System - a group of interacting, interrelated, or interdependent elements forming a unified whole. A system typically consists of components (or elements) which are connected together in order to facilitate the flow of information, matter or energy.

Tactile – Information and interpretations derived from the sense of touch or contact with an object as well as sensations that approach the skin, such as pressure, wind, and temperature. The object can be accessed by Braille; vibrations; differences on texture when walked on or rolled across, including hand held devices with aided technology.

Tactual – of or relating to or proceeding from the sense of touch; "haptic data"; "a tactile reflex"

TGSI - Tactile Ground Surface Indicator. A system of raised domes and stripes placed in patterns on the ground to provide tactile information. Either warning or directional, these typically square 'tiles' are laid in various patterns at key points to indicate to persons with a vision impairment where potential hazards are located, or where ground levels or directions change.

Technologies – Any devices incorporating a number of specialised mechanisms incorporating electronics or digitised products that are computerised, automated, or have the ability to transmit and decipher information through air, cabling or electronic systems.

Vision Impairment – term used widely in Australia to describe vision loss that constitutes a significant limitation of visual capability (encompassing terms such as partially sighted, low vision, total vision loss, legally blind, totally blind)

Visual –Indicators recognisable by sight, such as words, lights, signs etc

8. APPENDIX 1 – PROTOTYPE SYSTEM ARCHITECTURE

8.1 Overall System for Melbourne Trials

Courtesy of Digital Spark and Clarinox Technologies, the following figures depict the four-part system (Administration Server; Way Finding Server; Way Finding Station; and Handheld WayFinder) as conceived for potential city-wide application.

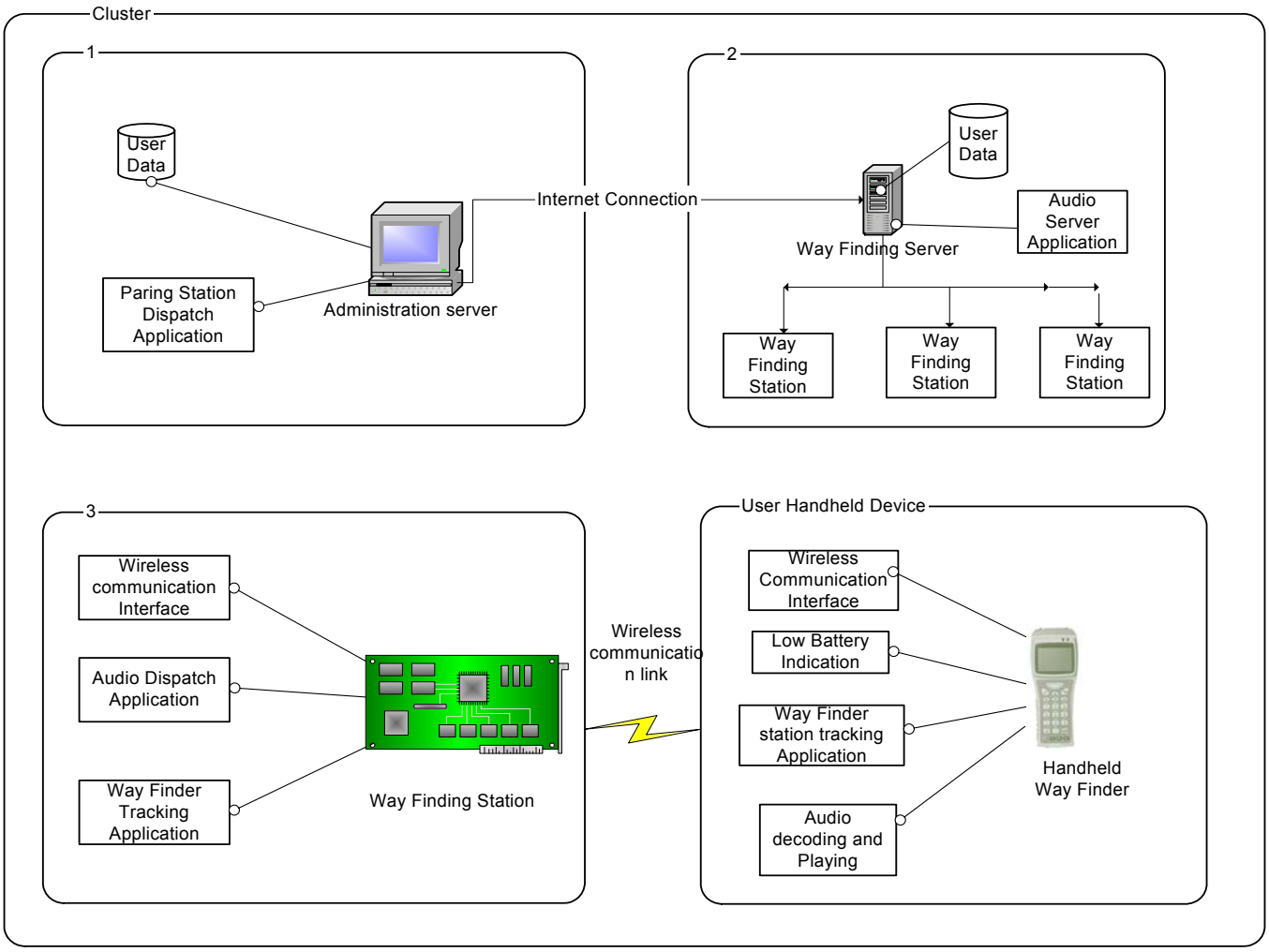

Figure 8.1 Way Finding System Architecture

In the Way Finder System the users' details will be kept in a centralized location called the Administration Server. The Administration Server is a PC based terminal that will be connected to the internet. The user is given a hand held device called the Way Finder device or WayDev. The device must have been registered to the system. Once the user has been successfully registered, the user information is sent via the internet to all the Way Finding Servers.

Each way finding system, i.e. each building or city network, will have a Way Finding Server. The Way Finding Server is a Windows or Linux based device connected to the internet. This keeps all the user data as in the Administration Server. Every time a new user is registered in the Administration Server automatically the database in the Way Finding Server will be

updated. The administrator of the Administration Server will have the accesses to the Way Finding Server.

Within each way finding area, with the system installed there will be a number of Way Finding Stations depending on the number of locations where there is a need to provide location information. Each Way Finding Station has a wireless communications interface to track and exchange information with the Way Finder devices. They are also connected to the Way Finding Server through a LAN. The Way Finding Server administrator can send the necessary location and direction information to the Way Finding Station via the LAN connection from the Way Finding Server. The Way Finding Station sends the information as the Way Finder device comes in the vicinity of the Way Finding Station.

The Way Finder device is a user handheld device. The Way Finder device is a wireless enabled device capable of discovering and communicating with Way Finding Stations.

As the user walks with the Way Finder device it discovers the Way Finding Station. The Way Finding Station starts to send the information. The dispatching of data can be implemented in two different methods.

- Method 1: Way Finding Station broadcasts

As the Way Finder device discovers the Way Finding Station, the information is broadcast from the Way Finding Station through a either a headset or speaker so that user can get audio feedback about the location of the station.

- Method 2: Way Finder device delivers the audio information

As the Way Finder device comes within the vicinity of the Way Finding Station, a wireless link is established between the devices. The information is then transmitted from the Way Finding Station to the Way Finder device. The information is then presented as audio information to the user from the Way Finder device for providing the relevant information.

8.2 Administration Server

This component:

- Registers the New user information
- Keeps the User Device Id
- Has connection to the internet for accessing Way Finder Servers

8.2.1 Software Components

- User interface
- Pairing of user devices with the system
- Transfer user information to the Way Finder Server
- Database interface to store user information
- Database interface to store Way Finder Server information

8.2.2 Hardware Components

- Windows/Linux PC with internet access (user interaction required)
- Wireless Communications interface to pair user devices with the system

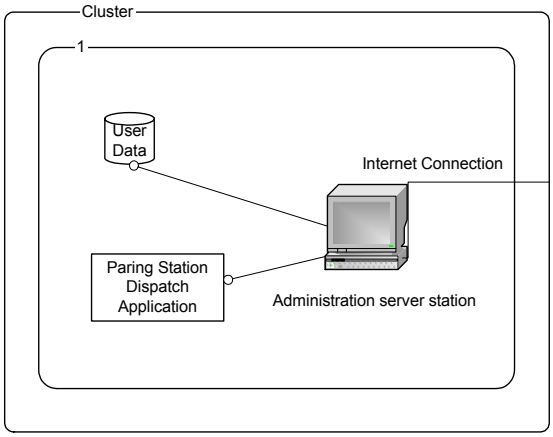

Figure 8.2 Administration Server

8.3 Way Finding Server

This component:

- Store the user information and send it to the Way Finding Stations
- Send location / direction information to the Way Finding Stations
- Provide a GUI for administration

8.3.1 Software Components

- User interface for updating Way Finding Station information
- Administrator Server Station interfacing
- Way Finding Station interfacing
- Database interface to store user information
- Database interface to store location and direction information

8.3.2 Hardware Components

- Windows/Linux PC with internet and LAN access (user interaction required)

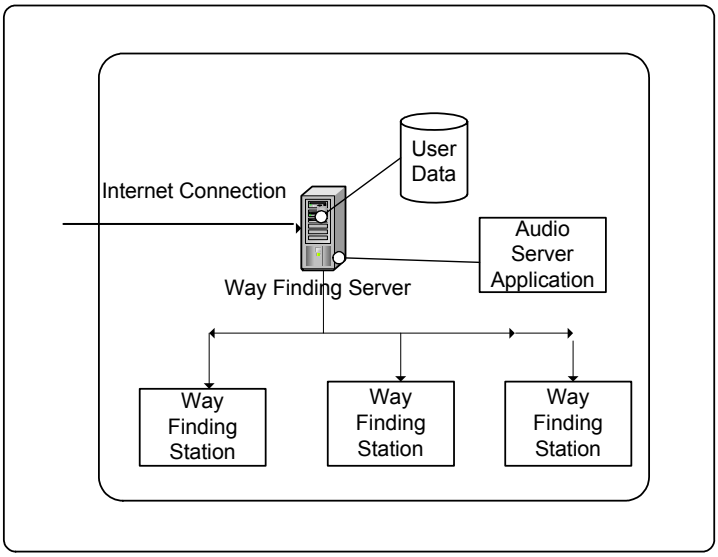

Figure 8.3 Way Finding Server

8.4 Way Finding Station

This component:

- Wireless communications interface
- Detect users being in the vicinity
- Send the location / direction information
- Interface to Way Finding Server for updating the information

8.4.1 Software Components

- User tracking application
- Wireless Communications Interface
- Information transfer with Way Finding Server
- Information transfer to Way Finder

8.4.2 Hardware Components

- Embedded Linux Device with LAN connection
- Wireless Communications interface to track user devices
- Speaker(optional)

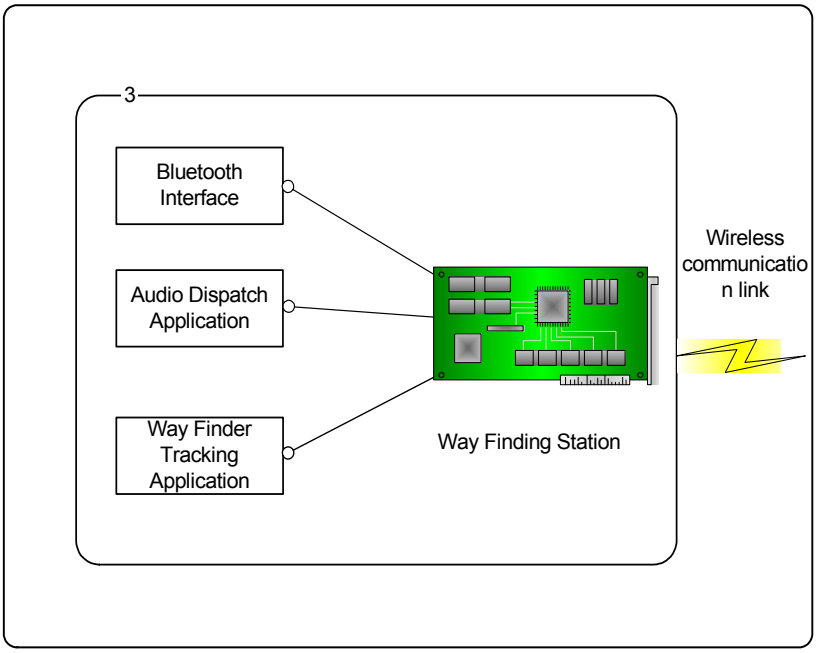

Figure 8.4 Way Finding Station

8.5 Way Finder device

This component:

- Is a handheld device with minimal user interface
- Discovers the Way Finding Station
- Presents the information to the user

8.5.1 Software Components

- Way Finding Station tracking application
- Wireless Communications Interface
- Application to present information
- Present device status information to the user

8.5.2 Hardware Components

- Handheld wireless device

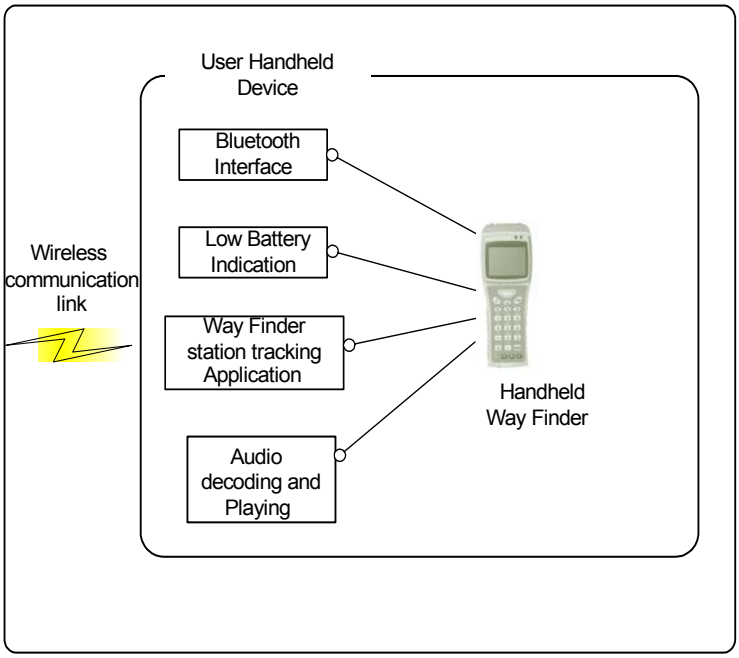

Figure 8.5 Way Finder device

9. APPENDIX 2 – WAYFINDING SYSTEMS MATRIX

In order to provide a succinct summary of options for wayfinding (for persons with vision impairment) in and around a building complex (typically commercial or institutional), we have set out the following matrix of scales, spaces, paths and options. In this matrix and its accompanying documents, by 'scale' or 'range' we mean a smaller journey part or a trip from one location to another within the overall wayfinding journey - rather than the scale or range being a measure of distance between sequential wayfinding cues. Costs of systems are not canvassed as they will vary enormously depending upon the system employed - as well as the physical extent of the sections of built environment that must be encompassed. Appropriate planning scales will vary depending on the location, as will issues such as weatherproofing of equipment, availability of power, ability to withstand malicious damage/graffiti, etc. for external applications, while factors such as power or computer networks availability, perceived disruption to other building users, etc. may also affect the choice of within-building wayfinding options.

The terms "pedestrians" or "travellers" used herein could refer to passing foot-traffic, building occupants, visitors, staff or indeed anyone accessing the building on foot or with limited mobility. The matrix consists of a description of the wayfinding system, how/where it may be applied, and further comments – for each of the following 'scales' of the built environment where various parts of an overall wayfinding journey may be undertaken

Neighbourhood scale	Journeys of say 30 to 200 metres e.g. malls, arcades, pocket parks, urban open space, ...
Building precinct scale	Journeys of say 30m e.g. building forecourts, podiums, plazas, piazzas, ...
Building entrance scale	say 5m e.g. immediate building vicinity, building entrance, ...
Inside building scale	say 1-20m e.g. building lobby, reception area, lift lobbies, corridors, information desk,.
Floor-level scale	say 1-20m e.g. corridors, offices, fire exits, classrooms, meeting rooms, sanitary facilities, storage rooms, ..

9.1 Neighbourhood scale

Range, say 30-200m; e.g. malls, arcades, 'pocket' parks, urban open space, and similar

	Wayfinding System	Description	Application	Comments
1.1	**Tactile ground surface indicators (TGSIs) including directional indicators** See #3.1 of Stage 1 Report	System of raised domes and stripes placed in patterns on the ground to provide tactile information. Their colour and luminance contrast provides information to people with vision impairment about hazards and directions	Warning tiles indicate hazards such as platform edges, stairs and overhead obstacles (and also inform people about changes in the direction of the path of travel). Directional tiles assist people to negotiate difficult environments such as open or busy spaces or to locate specific objectives such as a building entrance and exit	Two types of TGSI tiles (Warning and Directional) are currently used under Standard AS1428.4 TGSIs are provided as municipal, local government or venue owners infrastructure - as required by the Building Code of Australia
1.2	**Directional Compass** See #4.1 of Stage 1 Report	Handheld aid designed to assist orientation and navigation by persons with a vision impairment	Usually used in conjunction with a traditional long cane or guide dog to navigate about the urban area at a broader scale	Assists with navigation at a broad urban physical scale
1.3	**Obstacle Locator** See #4.2 of Stage 1 Report	Handheld navigation aid for persons with a vision impairment to help detect potential obstacles	To assist navigation around the urban area by providing feedback on potential obstacles such as trees, refuse bins, chairs, tables, pot-plants, A-frame signage, etc.	Assists with independent wayfinding movement and navigation
1.4	**Enhanced / specialist cane** See #4.3 of Stage 1 Report	Relatively new navigation aid /cane to assist persons with a vision impairment in avoiding obstacles	Used as an alternative to a traditional long cane, to navigate about the urban area and provide aural and tactile feedback about the position of nearby obstacles	Assists with independent wayfinding movement and navigation
1.5	**PDA and notetakers** See #4.5 of Stage 1 Report	Generally small PDA (Personal Digital Assistant), handheld PC, or portable electronic note-taker to hold and process spatial and other information that may assist in wayfinding	Can provide easy yet detailed capture and playback of audio (and video) information about locations or paths between facilities which a traveller with vision impairment may wish to record for future reference	Assists with recall and independent wayfinding movement and navigation

	Wayfinding System	Description	Application	Comments
1.6	**GPS (global positioning system) position locator** See #4.4 & 4.6 of Stage 1 Report	Based on data from publicly available Earth satellite systems, a suitable electronic receiver can calculate a position / location to within several metres (similar to locations calculated for in-car navigation systems). Most suitable in open air locations without interference	Wayfinding systems incorporating GPS information can provide pedestrians with audio or visual information about surrounding locations – at a broad scale. Combined with other software, can be used for locating current position and landmarks such as major buildings, concert halls, churches, stadiums, transport interchanges, etc. as well as parks and lakes	Pedestrian must have a suitable GPS receiver unit, and this must be used in conjunction with specialist software plus electronic data depicting local streets and landmarks for that particular area - provided by a commercial data supplier
1.7	**Talking Digital Map Systems** See #4.6 of Stage 1 Report	Blend of a PDA (Personal Digital Assistant) and GPS information to provide audible information - at the broader urban scale - to a traveller with vision impairment	Similar to PDA and note-taker, but can utilise a digital map-base of GPS coordinates to find street names, intersections, addresses and major landmarks or features and then uses the speech applications of the PDA to relay them to the user	Requires a suitable GPS receiver unit - used in conjunction with specialist software plus (electronic) data covering local streets and landmarks for that particular area
1.8	**Tactile Map Systems** See #4.7 of Stage 1 Report	Printed maps can be produced in tactile or embossed form on specialised paper to assist with wayfinding. Tactile maps can be provided by appropriate authorities directly, or perhaps accessed via the Internet and printed at home	These 'Braille or tactile/raised maps' outlining access routes to certain facilities could be made available to those who can interpret such maps, and thus assist them in planning and subsequently undertaking such travel	Any key facilities likely to be accessed by a user would need to be known in advance and those maps then produced prior to the trip - unless they are made available at a venue as a service by the venue's management
1.9	**Mobile phones / Communicator** See #4.8 of Stage 1 Report	Widely available yet sophisticated portable devices which receive and transmit signals to and from each other via commercial mobile telecommuni-cations networks	Because the phone's SIM card is tracked and automatically 'located' by the network, these devices are more and more being used to provide location-specific information to all users - via the 3G or "next-generation" mobile networks	Increasingly, these devices with long-life battery power can provide users with a range of information about facilities in an area, however the user must be a customer of a mobile phone network to receive general data and information
1.10	**Accessible Pedestrian Signals** See #5.1 of Stage 1 Report	Infrastructure provided primarily at pedestrian crossings and street intersections to assist users determine when it is safe to cross the street	Generally linked to traffic signals, they are designed to provide recognisable audio signals to pedestrians in guiding them across intersections	Fixed local government / State authority infrastructure for pedestrian crossings and street intersections
1.11	**Press and Listen Signs / Press-button audible signage** See #5.2 of Stage 1 Report	Fixed infrastructure installed at selected locations to provide spoken information about that location to those persons who press the button	Able to provide specific audio information about a location (eg tourist site) to any persons, and now widely used to provide bus/train departure information to travellers	Pedestrian with a vision impairment may not realise the 'sign' is available unless other means are used to draw their attention to the availability and actual location of the press & listen sign.

	Wayfinding System	Description	Application	Comments
1.12	**Printed signage (location signs) featuring words, or words and symbols** See #2.3.2 of Stage2-3 Report	Conventional fixed signage of a concise nature featuring words, or words and symbols, to help (sighted and literate) pedestrians confirm their location, and/or indicate the general direction of other likely destinations	Usually constitutes a traditional printed location board accompanied by arrows indicating the general directions of specific destinations (e.g. direction of toilets, lifts, taxis and bus stops, Automatic Teller Machines, major facilities, particular shops, etc.)	Not suitable for people with total vision impairment (see Raised Tactile & Braille Signage below), however if designed correctly and well-positioned may be suitable for people with low vision (as well as those with other disabilities), using suitable fonts, colour and background contrast. Increased use of symbols rather than just words can aid illiterate and non-English-speaking pedestrians (e.g. replace EXIT with 'running man' symbol on building exit signs)
1.13	**Raised tactile / Braille signage** See #3.2 of Stage 1 Report	Specialised tactile signage which incorporates raised lettering and/or Braille beneath each line of printed signage	Applications are as for conventional printed signage - with the added benefit of assistance to pedestrians who have a vision impairment to help identify their current location and to indicate the direction of other likely destinations	Must be used for people with total vision impairment, but must be correctly positioned (i.e. easily found by pedestrians) and have optimum accessibility (easily approached, and within comfortable reach) for pedestrians with a vision or mobility impairment
1.14	**Remote (infrared) Audible Signage Motion-activated** See #5.5.1 of Stage 1 Report	Information about a location can be obtained at some distance rather than by touching a sign. Has some similarity to a press-button system, except the recorded information playback is triggered by any person passing by, rather than by a particular pedestrian finding and pressing the button	Again, useful at key travel decision points or to provide additional information about the immediate surrounding area. Time-sensitive messages can also be replayed by a centralised system	Supplement to building locational signage - however everyone nearby may hear the (repeated) brief information since all passing pedestrians will trigger the message. Orientation issues must be considered in the design to ensure the user is located and aligned appropriately for the message being delivered
1.15	**Remote (infrared) Audible Signage Speaking Signs** See #5.5.2 of Stage 1 Report	Information is remotely provided rather than by pressing a sign. Single or multiple transmitters are installed as building infrastructure (usually above head-height) at key travel decision points, while individual portable receivers (purchased or on loan from the venue) must be either worn or carried about the venue by users	Messages are triggered by the user's handheld or worn device, and relayed to him or her via a receiver or speakers. Different information can be provided from different directions, as the trigger device is slowly moved around. Messages can be tailored to the specific location and can be thought of as the audio equivalent of a printed directional sign	Can indicate and confirm which direction a visitor should travel in to find various key facilities. Useful in train and bus stations, airport halls, malls and similar large building complexes, or perhaps at outdoors bus terminals (when transport vehicle have transmitters fitted) but not usually used in a completely open-space outdoors situation where the locations of key facilities are less well-defined

	Wayfinding System	Description	Application	Comments
1.16	**Remote Radiofrequency Audible Signage** See #5.6 of Stage 1 Report	Outdoors system designed to provide varying audible information to travellers. Messages are customized to the individual location and have similar brief content to a printed directional sign	The user's handheld or worn device triggers the sign, and information is then wirelessly relayed via a receiver and earpiece or speakers. Aural information can be provided in different languages	Useful in outdoors settings to confirm which direction to travel in to find various key facilities. Lack of a common trigger device that interoperates between alternative systems is likely to impede progress towards widespread adoption
1.17	**Moving illuminated signage single and multi-line** See #3.4.4 of Stage2-3 Report	Moving (rolling) LED signage consisting of one or several lines of text to provide more lengthy information about the current location, and/or provide directions to a nearby building or destination	Similar function as printed location board, but with flexibility to provide additional information beyond static location signage for those persons with low or some residual vision	Must be well-positioned and suitable for pedestrians with low vision (as well as those with other disabilities), using suitable fonts, colour and background contrast. Not suitable for those who read tactually or those with total vision loss
1.18	**Enhanced location maps (raised tactile, Braille)** See #2.3.2 of Stage2-3 Report	Simplified and scaled location map incorporating raised building outlines, raised lettering and/or Braille beneath or within each area to designate the name or purpose of that area	The small-scale outlines of buildings or corridors can be traced by touch by low-vision pedestrians to help identify their current location within the context of the overall surrounding vicinity, while other travellers may use the map in the traditional viewed manner	Must be well-positioned and accessible (within reach) to assist pedestrians with vision or mobility impairments. However, some travellers can have difficulty interpreting maps and may prefer aural or printed directions. Similarly to signage that uses symbols, enhanced maps can be valuable for illiterate or non-English speaking travellers
1.19	**Trail between one location and another** See Audit Checklist	Series of easily recognisable pathways characterised by directional tiles; handrails; stepping stones; distinctive trail (eg using particular plants, water features); etc	Pedestrians with a vision impairment often use a series of discernible vertical surfaces to 'shoreline' along by using a long cane, but clearly-marked and distinctive pathways or handrails can provide other options for wayfinding across open areas	A 'trail' should be designed to 'lead' a hesitant traveller from one key destination to another one relatively nearby.
1.20	**On-line Digital Information and Maps** See #5.7 of Stage 1 Report	Computer-based systems designed to provide detailed spatial and location information to users	Detailed information generated from user queries on a spatial database would probably have to be undertaken in advance of their travel	This area is changing rapidly with new advances in mobile Internet technology becoming available – see section on mobiles / communicators

	Wayfinding System	Description	Application	Comments
1.21	**Computer directory information system** See #3.4.5 of Stage2-3 Report	Usually located indoors, this type of infrastructure can provide visitors with simple screen-based or audio directions to assist them in finding key facilities nearby. In the absence of a staffed reception area or desk, provides 'do-it-yourself' assistance to any visitors	With large fonts or audio outputs via speakers for those requiring this type of assistance, system should provide (limited or detailed) listings of public facilities such as meeting areas, and conveniences, and instructions on how to locate them. More useful within an individual building complex	Unless networked, each workstation must be individually updated with information specific to that location, and if making use of a keyboard and/or mouse, the system should be robust and sturdy yet must remain simple to use. Since tactile output is not available from these systems, aural directions would assist more people with a severe vision impairment
1.22	**Talking lifts** See #3.4.6 of Stage2-3 Report	Infrastructure in the form of a speaker system that provides pre-recorded messages to lift occupants and is triggered automatically when lift arrives at a lift lobby	Audio in lift-cars announces the floor level to travellers as the lift arrives and doors automatically open at any floor level. Maybe required in multi-storey situations but not appropriate for outdoors open spaces	Audio system is also useful to broadcast / reinforce warning messages that travellers should not use these lifts in the event of fire or other situations as set out in the building's emergency evacuation procedures
1.23	**'Kiosk' (or network) of touch-screen or audio-based computer systems** See #2.4 of Stage2-3 Report	Typically housed in a small kiosk, this computer-based system with large TV-type screen can provide information and directions for specific locations in the vicinity. System may incorporate large screen-fonts that assist users with a vision impairment, or can produce audio that is output through kiosk speakers - or wirelessly to a user's individual receiving device in a discreet manner	An enhancement of the computer directory systems, it allows pedestrians to enquire and receive directions to specific locations for a particular destination or service they are seeking. Should provide appropriate information and directions for specific locations in the vicinity such as bus/train-stops, public toilets, theatres, restaurants, and even timetable and ticket information if possible	Local government infrastructure (eg as commissioned by Melbourne City Council – iHubs), or could be provided by owners of commercial venues. Orientation issues must be considered in the design to ensure the user is located and aligned appropriately for the message being delivered Any screens should be at an appropriate height for use by persons with a vision or a mobility impairment

9.2 Building precinct scale

Range, say 30m; e.g. building forecourts, podiums, plazas, piazzas, and similar

	Wayfinding System	Description	Application	Comments
2.1	**TGSIs including directional indicators** See #3.1 of Stage 1 Report	See 1.1 above		
2.2	**Directional Compass** See #4.1 of Stage 1 Report	See 1.2 above		
2.3	**Obstacle Locator** See #4.2 of Stage 1 Report	See 1.3 above		
2.4	**Enhanced / specialist cane** See #4.3 of Stage 1 Report	See 1.4 above		
2.5	**PDA and notetakers** See #4.5 of Stage 1 Report	See 1.5 above		
2.6	**GPS (global positioning system) position locator** See #4.4 & 4.6 of Stage 1 Report	See 1.6 above Most suitable in open air locations without interference. Combined with other software, can be used for locating current position and other landmarks	Information and locations of key landmarks such as major buildings, concert halls, churches, stadiums, transport interchanges, etc. as well as parks and lakes	Pedestrian must have a suitable GPS receiver unit, and this must be used in conjunction with specialist software plus (electronic) data depicting local streets and landmarks for that area
2.7	**Talking Digital Map Systems** See #4.6 of Stage 1 Report	See 1.7 above		
2.8	**Tactile Map Systems** See #4.7 of Stage 1 Report	See 1.8 above		Tactile maps of specific venues should be made available at that venue by the venue's management

	Wayfinding System	Description	Application	Comments
2.9	**Mobile phones / Communicator** See #4.8 of Stage 1 Report	See 1.9 above	Starting to provide location-specific information to users via the "next-generation" or 3G mobile networks, but service is aimed at the majority of users rather than adapted for niche users with vision impairment	User must be a customer of a mobile phone network to receive information,
2.10	**Accessible Pedestrian Signals** See #5.1 of Stage 1 Report	See 1.10 above		
2.11	**Press and Listen Signs / Press-button audible signage** See #5.2 of Stage 1 Report	See 1.11 above	If signs are networked, then time-specific messages (or "live") information such as timetable details can be replayed when the button is pushed	System acts as a supplement to locational signage - but everyone near the sign hears brief information being constantly repeated about that location
2.12	**Printed signage (location signs) featuring words, or words and symbols** See #2.3.2 of Stage2-3 Report	See 1.12 above		Allows pedestrians to confirm their location, and/or indicates the general direction of other likely destinations. Not suitable for Blind or Vision Impaired users, and Raised Tactile and Braille signage must be used
2.13	**Raised tactile / Braille signage** See #3.2 of Stage 1 Report	See 1.13 above		
2.14	**Remote (infrared) Audible Signage Motion-activated** See #5.5.1 of Stage 1 Report	See 1.14 above		
2.15	**Remote (infrared) Audible Signage Speaking Signs** See #5.5.2 of Stage 1 Report	See 1.15 above		
2.16	**Remote Radiofrequency Audible Signage** See #5.6 of Stage 1 Report	See 1.16 above		

	Wayfinding System	Description	Application	Comments
2.17	**Moving illuminated signage single and multi-line** See #3.4.4 of Stage2-3 Report	See 1.17 above		
2.18	**Enhanced location maps (raised tactile, Braille)** See #2.3.2 of Stage2-3 Report	See 1.18 above		
2.19	**Trail across forecourt or plaza** See Audit Checklist	See 1.19 above	Clearly-marked and distinctive pathways or handrails can provide other options for wayfinding across open areas	A 'trail' should be designed to 'lead' a traveller across the open space from one key destination to another one relatively nearby.
2.20	**On-line Digital Information and Maps** See #5.7 of Stage 1 Report	See 1.20 above		
2.21	**Computer directory information system** See #3.4.5 of Stage2-3 Report	See 1.21 above, and 2.25 below	Can act as a directory board and supplement signage for the vicinity	Acts as an unattended information desk / screen, however cannot be read by touching the board or screen and thus is not suitable for people with vision impairment who read tactually
2.22	**Talking lifts** See #3.4.6 of Stage2-3 Report	See 1.22 above		
2.23	**'Kiosk' (or network) of touch-screen or audio-based computer systems** See #2.4 of Stage2-3 Report	See 1.23 above	Acts as a directory board for the vicinity, but can supply additional information about particular locations upon inquiry from a pedestrian with vision impairment or with full sight	L.G. or commercial infrastructure which acts as an unattended information desk / screen. Orientation issues must be considered in the design to ensure the user is located and aligned appropriately for the message being delivered

9.3 Building entrance scale

Range say 5m; e.g. immediate vicinity, building entrance(s), and the like

	Wayfinding System	Description	Application	Comments
3.1	**TGSIs including directional indicators** See #3.1 of Stage 1 Report	See 1.1 above	Directional indicators can assist a pedestrian with vision impairment to find their way unaided from the street to the building entrance / front door where other shorelines do not exist which can be utilised to locate the building entrance	
3.2	**Obstacle Locator** See #4.2 of Stage 1 Report	See 1.3 above		
3.3	**Enhanced / specialist cane** See #4.3 of Stage 1 Report	See 1.4 above		
3.4	**PDA and notetakers** See #4.5 of Stage 1 Report	See 1.5 above		
3.5	**Tactile Map Systems** See #4.7 of Stage 1 Report	See 1.8 above		
3.6	**Press and Listen Signs / Press-button audible signage** See #5.2 of Stage 1 Report	See 1.11 above	When found and pressed, external audible sign announces address, building name, major tenants, etc.	Other indications or forms of signage are needed to draw the attention of persons with vision impairment to the availability and specific location of the press & listen sign
3.7	**Printed signage (location signs) featuring words, or words and symbols** See #2.3.2 of Stage2-3 Report	See 1.12 above	Directory board providing listings of building tenants, etc., and general direction of many significant amenities and services. Increased use of symbols rather than just words can aid illiterate and non-English-speaking pedestrians (←and → rather than left and right)	Must be well-positioned and suitable for pedestrians with low vision (as well as those with other disabilities), using suitable fonts, colour and background contrast. Not suitable for Blind or Vision Impaired users, and Raised Tactile and Braille signage must be used
3.8	**Raised tactile / Braille signage** See #3.2 of Stage 1 Report	See 1.13 above	As earlier, but enhanced with tactile aids for pedestrians with vision impairment	

	Wayfinding System	Description	Application	Comments
3.9	**Handrail System** See #3.4.1 of Stage2-3 Report	Wooden or metal infrastructure provided to allow users to follow the handrail and find their way from one specific location to another one nearby - along paths or across open space	Fixed to building shorelines or standalone beside trails or paths, handrails may be placed around building entrances and forecourts to assist persons with limited mobility or vision impairment to find their way unaided to the entrance	Separate indication of the actual direction of the building entrance or the street may be necessary to confirm the traveller is headed where they expect
3.10	**Remote (infrared) Audible Signage Motion-activated** See #5.5.1 of Stage 1 Report	See 1.14 above	External audible sign announces address, building name, major tenant when triggered	Supplement to building locational signage – but sign may be triggered by passing pedestrians – not just those with a vision impairment
3.11	**Remote (infrared) Audible Signage Speaking Signs** See #5.5.2 of Stage 1 Report	See 1.15 above Audio equivalent of location sign	When any transmitter is 'triggered' by a signal received from a nearby user's device, pre-recorded audio information such as the building name or a welcome message is then "broadcast wirelessly" by the transmitter to that user's receiver	Distinct information can be provided for different locations – but is audible only via an individual receiver worn or held by the user. Unfortunately, currently a user may need alternate types of devices to receive information within different building complexes
3.12	**Remote Radiofrequency Audible Signage** See #5.6 of Stage 1 Report	See 1.16 above		
3.13	**Moving illuminated signage single and multi-line** See #3.4.4 of Stage2-3 Report	See 1.17 above	As earlier, with more detail provided for locations signs, directory boards	Must be well-positioned and suitable for pedestrians with low vision (as well as for other disabilities), using suitable fonts, colour and background contrast. Not suitable for those with total vision loss
3.14	**Enhanced location maps (raised tactile, Braille)** See #2.3.2 of Stage2-3 Report	See 1.18 above	Map of raised outlines of entrance or lobby can be traced by touch by visitors with a vision impairment to aid their orientation and plan their journey	Limited further information in raised lettering and/or Braille may further assist the traveller to locate their intended destination
3.15	**Trail between forecourt / street and building entrance** See Audit Checklist	See 1.19 above		

	Wayfinding System	Description	Application	Comments
3.16	**On-line Digital Information and Maps** See #5.7 of Stage 1 Report	See 1.20 above	Detailed information such as building floorplans or the like would have to be obtained or produced in appropriate form in advance of travel being undertaken	This area is changing rapidly with new advances in mobile Internet technology becoming available – see section on mobiles / communicators
3.17	**Computer directory information system** See #3.4.5 of Stage2-3 Report	See 1.21 above	System should provide (limited or detailed) listings of building tenants, and public facilities	Suitable for unattended or "faceless" reception, accessibility options for software can enhance contrast / colours / size / fonts for on-screen information, and may provide audible prompts for those that require them. Not suitable for those people with vision impairment who rely on tactual reading
3.18	**'Kiosk' (or network) of touch-screen or audio-based computer systems** See #2.4 of Stage2-3 Report	See 1.23 above	Allows pedestrians to obtain appropriate information and directions for specific building, such as listings of building tenants, and public facilities	Could be provided by owners of individual building venues, or as local government infrastructure. Orientation issues must be considered in the design to ensure the user is located and aligned appropriately for the message being delivered

9.4 Inside building scale

Range 1-20m; e.g. lobby, reception area, lift lobbies, corridors, information desk, and similar

	Wayfinding System	Description	Application	Comments
4.1	**TGSIs including directional indicators** See #3.1 of Stage 1 Report	See 1.1 above		
4.2	**Obstacle Locator** See #4.2 of Stage 1 Report	See 1.3 above		
4.3	**Enhanced / specialist cane** See #4.3 of Stage 1 Report	See 1.4 above		
4.4	**PDA and notetakers** See #4.5 of Stage 1 Report	See 1.5 above		
4.5	**Tactile Map Systems** See #4.7 of Stage 1 Report	See 1.8 above	These 'Braille or tactile/raised maps' describing access to certain facilities at particular venues could be made available to those who can interpret such maps, and thus assist in planning and subsequently undertaking such travel	Any key facilities likely to be accessed by a user would need to be known in advance and those maps then produced - unless they are made available at a venue by the venue's management
4.6	**Mobile phones / Communicator** See #4.8 of Stage 1 Report	See 1.9 above	Combining information about layout with a sensor network throughout the building, trial systems based on adapted phones or communicators have been used overseas to assist in wayfinding within buildings	Once the technology is further developed, proved and made accessible at affordable costs, it may become a more widespread option. A development with real potential, but not ready for widespread use as yet
4.7	**Press and Listen Signs / Press-button audible signage** See #5.2 of Stage 1 Report	See 1.11 above	When found and pressed, audible sign announces information specifically about the nearby area such as location of key facilities, lift lobby, staffed reception desk, etc.	Other indications are needed to make sure a person with vision impairment knows of the availability and specific location of the press & listen sign

	Wayfinding System	Description	Application	Comments
4.8	**Printed signage (location signs, directory boards, etc)** See #2.3.2 of Stage2-3 Report	See 1.12 above	Directory board providing broad listings of the services and tenants on each floor level, plus the general direction of many key amenities and services	Must be well-positioned and suitable for pedestrians with low vision (as well as those with other disabilities), using suitable fonts, colour and background contrast. Not suitable for Blind or Vision Impaired users, and Raised Tactile and Braille signage must be used
4.9	**Raised tactile / Braille signage** See #3.2 of Stage 1 Report	See 1.13 above		
4.10	**Line-Following Guides** See #5.3 of Stage 1 Report	Robotic-type devices are being developed which will follow fixed paths within a building	Within suitably 'fitted-out' buildings, such devices may in future assist in guiding users with a vision impairment (or indeed any visitor) to find certain locations within the building	These and other general types of robotic 'guides' are still under development at this stage
4.11	**Directional Sound Evacuation** See #5.4 of Stage 1 Report	Building infrastructure installed to alert building users in an emergency and help guide them (using sound rather than sight) towards an exit in an evacuation	In an emergency, distinctive sound patterns with a directional emphasis are emitted along corridors and the like which assists in guiding both sighted travellers, as well as those with a vision impairment, towards a building exit	Most appropriate (unless persons have a hearing impairment) for assisting egress from a building in an emergency, but not for general wayfinding around and within a building complex under normal conditions
4.12	**Handrail System** See #3.4.1 of Stage2-3 Report	See 3.7 above	Fixed to corridor and lobby walls to assist persons with limited mobility or vision impairment to find their way unaided from one location to other ones relatively close by	Supplementary tactile, audible or Braille signage may be necessary along the way to help confirm that the traveller is headed where they expect
4.13	**Remote (infrared) Audible Signage Motion-activated** See #5.5.1 of Stage 1 Report	See 1.14 above	When triggered by nearby movement, the audible sign used as a directory board plays pre-recorded messages listing tenants and/or key facilities and their approximate location	Supplement to building location and directory board signage designed to assist those persons with adequate hearing but with loss of vision

	Wayfinding System	Description	Application	Comments
4.14	**Remote (infrared) Audible Signage Speaking Signs** See #5.5.2 of Stage 1 Report	See 1.15 above	Pre-recorded audio information such as the location of lifts, toilets, staffed reception desk, etc. is "broadcast wirelessly" by a transmitter to a user's receiver device. Different messages may be received from different directions - allowing the user to discreetly choose in which direction they should proceed	Distinct information can be provided for different locations – but is audible only via an individual receiver worn or held by the user. Unfortunately, currently a user may need alternate types of devices to receive information within different building complexes
4.15	**Remote Radiofrequency Audible Signage** See #5.6 of Stage 1 Report	See 1.16 above	Generally used in outdoors settings	
4.16	**Moving illuminated signage single and multi-line** See #3.4.4 of Stage2-3 Report	See 1.17 above	Type of directory board typically providing broad listings of the services and tenants on each floor level, plus the general direction of many key amenities and services	Not suitable in assisting those persons with total vision loss
4.17	**Enhanced location maps (raised tactile, Braille)** See #2.3.2 of Stage2-3 Report	See 1.18 above	Map using raised outlines to highlight lift locations and other key facilities and the paths between them. Map and text can be traced by touch by visitors with a vision impairment to aid their orientation and plan their journey	Accompanying text in raised lettering and/or Braille on the map may further assist the traveller to locate their intended destination, and help plan their path towards it
4.18	**Trail between building entrance and main tenant directory board** See Audit Checklist	See 1.19 above	Pathways leading to and from key facilities such as Reception, lift lobbies, toilets, etc. can be highlighted through the use of contrasting textures and colours on walls and floors	Designed to help a pedestrian with vision impairment to locate key facilities in an unaided and discreet manner - through the use of architectural features and interior finishes
4.19	**On-line Digital Information and Maps** See #5.7 of Stage 1 Report	See 1.20 above	Detailed information such as building floor-plans or the like would have to be obtained or produced in appropriate form prior to travel being undertaken	The availability of tactile maps at individual venues may eliminate the necessity to download much directional and wayfinding information before attending a venue
4.20	**Computer directory information system** See #3.4.5 of Stage2-3 Report	See 1.21 above	System should provide individual listings of building tenants, public facilities and their locations within the building	Suitable for unattended or "faceless" reception e.g. "take lift to Level 3 then turn left and proceed 20 metres directly along corridor. Offices are on your right"

	Wayfinding System	Description	Application	Comments
4.21	**Talking lifts** See #3.4.6 of Stage2-3 Report	See 1.22 above		Also useful to reinforce warning messages that travellers should not use lifts in the event of fire or in other situations as set out in the building's emergency evacuation procedures
4.22	**'Kiosk' (or network) of touch-screen or audio-based computer systems** See #2.4 of Stage2-3 Report	See 1.23 above	Allows pedestrians to obtain appropriate information and directions for specific building, such as listings of building tenants, and public facilities	Could be provided by owners of individual building venues, or as local government infrastructure. Users spatial orientation must be considered to ensure they are located and aligned appropriately for the message being relayed

9.5 Floor-level scale

Range 1-20m; e.g. corridors, offices, classrooms, meeting rooms, sanitary facilities, fire exits, storage rooms, and the like

	Wayfinding System	Description	Application	Comments
5.1	**TGSIs including directional indicators** See #3.1 of Stage 1 Report	See 1.1 above		
5.2	**Obstacle Locator** See #4.2 of Stage 1 Report	See 1.3 above		
5.3	**Enhanced / specialist cane** See #4.3 of Stage 1 Report	See 1.4 above		
5.4	**PDA and notetakers** See #4.5 of Stage 1 Report	See 1.5 above		
5.5	**Tactile Map Systems** See #4.7 of Stage 1 Report	See 1.8 above	Braille or tactile/raised maps outlining key facilities at an individual floor level may assist, but other options seem more appropriate at this scale	
5.6	**Mobile phones / Communicator** See #4.8 of Stage 1 Report	See 1.9 above	Again, other options appear more appropriate at this scale	
5.7	**Press and Listen Signs / Press-button audible signage** See #5.2 of Stage 1 Report	See 1.11 above	Provided in a lift lobby or similar, when found and pressed audible sign announces specific information about the nearby area such as location of key facilities on that floor level	Other indications are needed to make sure a person with vision impairment knows of the availability and specific location of the press & listen sign
5.8	**Printed signage (location signs, directory boards, etc)** See #2.3.2 of Stage2-3 Report	See 1.12 above	Directory board providing listings of the services and tenants on each floor level, plus the general direction of many key amenities and services	Should be well-positioned, and designed for pedestrians with low vision, but are not suitable for those with total vision loss and Raised Tactile and Braille signage must be used to assist those people

	Wayfinding System	Description	Application	Comments
5.9	**Raised tactile / Braille signage** See #3.2 of Stage 1 Report	See 1.13 above		
5.10	**Line-Following Guides** See #5.3 of Stage 1 Report	See 4.10 above		Still in development at this stage
5.11	**Directional Sound Evacuation** See #5.4 of Stage 1 Report	See 4.11		
5.12	**Handrail System** See #3.4.1 of Stage2-3 Report	See 3.7 above		
5.13	**Remote (infrared) Audible Signage Motion-activated** See #5.5.1 of Stage 1 Report	See 1.14 above	Play pre-recorded messages through speaker listing services and/or key facilities and their location on that specific floor level	Triggered by nearby movement, such signs are designed to assist those persons with some vision loss, but with adequate hearing
5.14	**Remote (infrared) Audible Signage Speaking Signs** See #5.5.2 of Stage 1 Report	See 1.15 above	Normally located at travel decision points (e.g. lobby or corridor intersections), these signs 'wirelessly' transmit pre-recorded audio to devices enabled to receive such messages – for instance, the location of lifts, direction of nearest toilets, staffed reception desk, etc.	Messages are audible only via an individual receiver worn or held by the user. Messages can be transmitted and thus received from different locations - allowing the user to discreetly decide in which direction they should proceed
5.15	**Remote Radiofrequency Audible Signage** See #5.6 of Stage 1 Report	See 1.16 above	Generally used in outdoors settings	
5.16	**Moving illuminated signage single and multi-line** See #3.4.4 of Stage2-3 Report	See 1.17 above	Providing broad listings of the services and tenants on each floor level, plus the general direction of key amenities	Not suitable in assisting those persons with total vision loss
5.17	**Enhanced location maps (raised tactile, Braille)** See #2.3.2 of Stage2-3 Report	See 1.18 above	Map using raised outlines to highlight pathways between key facilities. Map and any text can be traced by touch by visitors with a vision impairment	Added text in raised lettering and/or Braille on the map may further assist the traveller to locate their intended destination, and plan their path

	Wayfinding System	Description	Application	Comments
5.18	**Trail(s) between key locations such as lift lobby, meeting rooms or tenant offices** See Audit Checklist	See 1.19 above	Pathways leading to and from crucial facilities such as Reception, lift lobbies, toilets, etc. can be highlighted through the employment of the Universal Design Principles	Designed to help a pedestrian with vision impairment to locate key amenities in an unaided and discreet manner
5.19	**On-line Digital Information and Maps** See #5.7 of Stage 1 Report	See 1.20 above	Detailed information such as building floorplans or the like would have to be obtained or produced in appropriate form in advance of travel being undertaken	The availability of tactile maps at individual venues may eliminate the necessity to download much directional and wayfinding information before attending a venue
5.20	**Computer directory information system** See #3.4.5 of Stage2-3 Report	See 1.21 above	System should provide individual listings of tenants, public facilities and their locations on this floor level	Suitable for reception area not always attended by staff. Not appropriate for those people with vision impairment who rely on reading by tactual means
5.21	**Talking lifts** See #3.4.6 of Stage2-3 Report	See 1.22 above		
5.22	**'Kiosk' (or network) of touch-screen or audio-based computer systems** See #2.4 of Stage2-3 Report	See 1.23 above	System should allow pedestrians to obtain appropriate information and directions for specific floor-levels, such as listings of tenants as well public facilities and conveniences located on that floor	May be provided by owners of individual building venues. Users spatial orientation must be considered to ensure they are located and aligned appropriately for the message being relayed

10. RESEARCH BIOGRAPHIES

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Prior to establishing Allor Consulting, John Crawford was a senior Scientist with the building and urban planning divisions of CSIRO for 30 years. He has been deeply involved in design research and in working with public and private industry in the innovative usage of ICT in building, construction and engineering for many years. Some years ago, John co-authored the key Technology Review for On-Line Remote Construction Management (ORCM) project report, as well as more recently undertaking research on Wayfinding Systems and Technologies, on Successful e-Tendering Implementation, and on Early-Stage Parametric Building Development.

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