INTERNATIONAL INNOVATION

Case study

WAY-FINDING IN THE BUILT ENVIRONMENT

Dennis Hogan
Building Commission, Melbourne, Victoria
dhogan@buildingcommission.com.au

ABSTRACT

Purpose
There is an urgent need to address the problem of unaided access to (and egress from) buildings and facilities for the vision impaired.

Design/methodology/approach
The project aims 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.

Findings
This paper will examine existing technologies being used in major venues and new electronic technologies that may be incorporated into a building's management systems considering economics and end user requirements.

Research limitations/implications
The Commonwealth's Disability Discrimination Act ("DDA") makes it unlawful to discriminate against a person because of their disability. Current and draft building law (DDA, BCA, Premises Standard, Australian Standards, common law) do not address access for the vision impaired and little or no research exists on way-finding systems to permit unaided access for the blind.

Practical implications
There are potential benefits to the Australian community of such research both in social and economic terms. An opportunity exists to apply and integrate technologies and systems which will assist the construction industry to make premises comply with current legislation and to be accessible to people with a vision, sensory or print disability.

EXECUTIVE SUMMARY

Project objective

The project sought to identify alternative systems and/or technologies that may assist people with sensory impairment to integrate further with society as a whole. This involved a comprehensive review of research developments internationally in the area of way-finding technology and systems. The project was primarily aimed at people who are blind or vision impaired, but with consideration of other groups of people.

The challenge

People who are blind or vision impaired often have difficulty negotiating public spaces, such as university campuses, public squares or sporting venues, especially when the area is crowded or noisy. Consequently there is a significant impact on their capacity to independently and confidently use public resources in a refusable, unaided and discreet manner. Building legislation in Australia has not addressed an holistic approach to Way-finding systems and/or technologies in the built environment.

The process

Phase 1 of the research was the identification of way finding technology and systems. Future phase 2 is the evaluation of the findings of phase 1 and recommendation of a preferred system to be trialed. Future phase 3 is the opportunity to install, trial and evaluate technologies and/or systems as part of the 2006 Commonwealth Games.

Outcomes

The research found that way-finding systems and/or technologies could be grouped into three areas:

- **passive systems** - provide feedback to vision impaired users without using power sources or involving power or communications infrastructure requirements.

- **dynamic systems** - provide audio and/or tactile feedback to vision impaired users but require (battery) power sources to operate although no additional fixed or network infrastructure is required to be provided by the broader community.

- **infrastructure based systems** - 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 vision impaired users - providing them with additional audio and/or tactile feedback.

Building legislation

The research found no international or Australian examples of specific way-finding legislation, which requires building owners and/or public bodies to build in systems or technology to assist people with a sensory impairment to navigate around buildings and other spaces or to exit to a safe place in the event of a fire or other emergency.

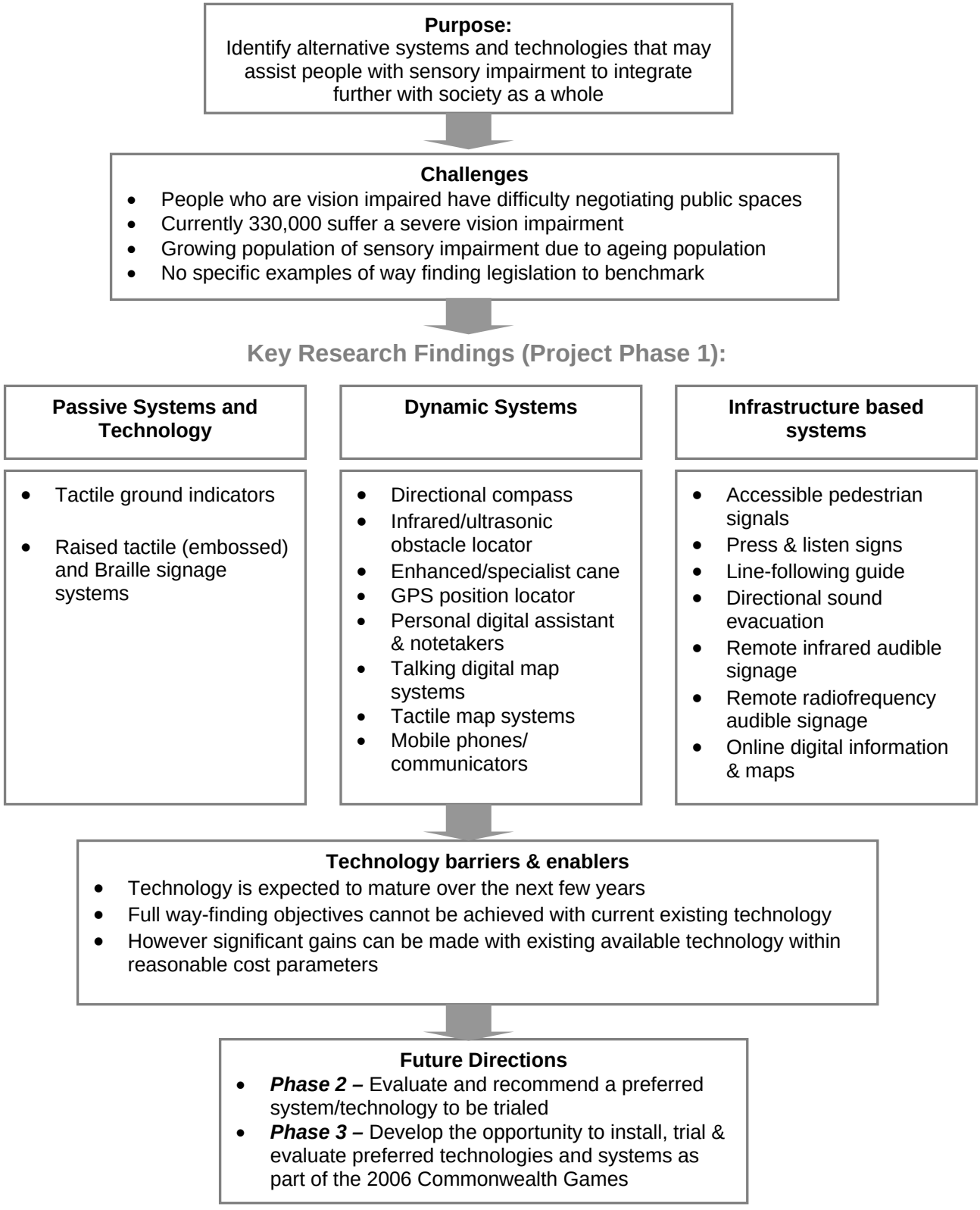
The future

Many systems and technologies which have potential application in the area of way-finding or mobility and location assistance for vision impaired persons are expected to mature over the next few years. The research findings will provide valuable

information in the future development of building legislation in the area of way-finding.

The project map below outlines the key highlights of this paper.

Way-Finding Project Map



1. INTRODUCTION

The objective of way-finding is to ensure that people with a sensory 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.

"Way-finding" is a term used to describe a system, the object of which is to give unaided access to the services offered in buildings to people who are blind or who's vision is impaired. The provision of tactile indicators, which are well developed and available on the market, is insufficient. Further it is not only a system of egress in the event of an emergency (as historically has been the focus of building control) which is required, but also a system of ingress to give unaided access to buildings and services is required. Presently, the complete achievement of this goal may be difficult because the technology needed may not be economically viable.

Mobile portable devices or electronic travel aids (ETA), electronic mobility devices, mobility aids, obstacle detectors, navigational aids as well as tactile signage and other inbuilt physical features may be employed as to achieve the way-finding objective. The project therefore involves consideration of systems that may be employed in both buildings and other external public places. Systems that are considered include physical electronic or tactile items that interact to perform a task, such as interactive hand-held electronic devices and administrative procedures, such as building management procedures.

2. RESEARCH METHODOLOGY

The research was carried out by a project team, which included three industry partners and two research partners. Representatives from the Building Commission (Vic), Queensland Department of Public Works (Qld), Australian Building Codes Board (ACT), Queensland University of Technology (Qld), and CSIRO (Vic) made up the membership of the project team.

The project team recognized at the first meeting that there was a need to have a greater understanding of the way-finding needs of users. A community reference group was formed consisting of representatives from Blind Citizens of Australia (Vic), Human Rights and Equal Opportunities Commission (NSW), Office of Commonwealth Games Co-ordination (Vic), Disability Council of Queensland, and Innovative Access Systems P/L.

The initial meeting between the project team and the reference group provided vital information for the research team. It was apparent that way-finding could include a wide range of technology and systems including passive systems and systems that would become part of the built infrastructure of a building. This information highlighted the need for the research to be confined to the scope of work originally developed for the project.

That scope of work for the project included seeking to identify alternative systems and/or technologies to assist people with sensory impairment to integrate further with society as a whole. Phase 1 was a comprehensive review of research developments internationally in the area of way-finding technology and systems. The highlights of this research will be discussed in this paper.

3. LEGISLATIVE ASPECTS

3.1 A SUMMARY OF THE LAW IN AUSTRALIA

In Australia the Disability Discrimination Act 1992 (DDA), Building code of Australia (BCA), and Australian Standard AS1428 (Design for access and mobility), regulate access for people with disabilities. Under the DDA, people with disabilities have the right to make a complaint against a building owner or operator if they believe they have been discriminated against in terms of access to, or use of, any building. The HREOC attempts to conciliate an agreement between the parties, but if that is not possible the complainant may proceed to the Federal Court or Federal Magistrates Service.

3.2 HISTORY OF THE DDA LEGISLATION IN AUSTRALIA

All states and territories introduced anti disability discrimination legislation in the early 1980's. The *Human Rights and Equal Opportunity Commission Act* 1986 (Cth) ("HRC Act") established the National Human Rights and Equal Opportunities Commission (HREOC) with jurisdiction by reference to a number of international instruments, including the Declaration on the Rights of Disabled Persons. Essentially the HREOC Act) established the means by which people with disabilities could be given the same rights as previously enjoyed by people without disabilities.
Throughout the 1980s organisations representing people with disabilities lobbied for their rights to be enforced and subsequently the *Disability Discrimination Act* 1992 (Cth) ("DDA") Act was enacted.

3.3 BUILDING CODE OF AUSTRALIA HISTORY

BCA 96 currently includes energy efficiency and other provisions for access for people with Disabilities, which may be characterised as, not required principally for the health and safety of the occupants of the building. However, recent drafts out for comment go one step further. They include proposals to control emerging contemporary issues of concern to the Australian public and the pressing issues of international community. For example additional environment controls and enhanced provisions for access for people with Disabilities are proposed. The inclusion in building regulations of these additional controls not arising principally from the need to safeguard the health and safety of the occupants of the building is occurring globally throughout developed countries largely through pressure exerted by the United Nations and international conventions.

The ABCB and Standards Australia issued multiple drafts for comment on 1 Feb 2004 including BCA amendments and referenced Australian Standards for Design for access and mobility. AS1428 Parts 1 and 4 propose to include *Disability Discrimination Act* 1992 (DDA) objectives to –

- Eliminate discrimination against people with disabilities
- Promote community acceptance of the principle that people with disabilities have the same fundamental rights as all members of the community, and
- Ensure as far as practicable that people with disabilities have the same rights to equality before the law as other people in the community.

Complaints are the clearest and surest way of illustrating cases of discrimination. Complaints address inconsistencies between building law and anti-discrimination law

and assist regulators, practitioners and property owners in assessing what is required and how to deliver it whilst successfully reducing conflicts with clients over access requirements.

Approximately 330 000 Australians suffer a severe vision impairment and many more have some reduction in effectiveness of their sight (AS1684.4 draft dated 12/1/04) and pressure in mounting for their needs to be recognised.

3.4 AS1428 DESIGN FOR ACCESS AND MOBILITY

Proposed amendments to AS1428, Parts 1 and 4 seeks to enhance access for new building work, interior fitouts and purpose-built buildings, outdoor access, adaptable housing and aged care facilities, communication systems to assist the hearing impaired, and tactile indicators for the vision impaired.
AS1428.4 regulates tactile ground surface indicators (TGSI), raised pavement markers at strategic places within a building. Draft changes include their provision for public areas external to buildings and public transport infrastructure.

3.5 GOVERNMENT INITIATIVES

On 16 April 2004, Acting Disability Discrimination Commissioner Dr Sev Ozdowski welcomed the announcement by the federal Government to inject $99 million over the next four years into providing quality services and good working conditions to people with a disability working in business services." While we have no statistics on the number of blind and vision impaired workers, it follows that of the 330 000 Australians with such a disability many will be in the workforce and would benefit by improved access to their workplace and facilities within public buildings.

4. RESEARCH FINDINGS

The research set out to identify 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. The systems and technologies needed to be suitable for people who have a sensory impairment including people with both a visual and a hearing impairment.

The findings of the research were grouped in to types of systems and technologies that are available: passive systems, dynamic systems and infrastructure based systems. The following details give a brief outline of the technologies that are available, without attempting to provide a comprehensive product list. Any product brands mentioned are for illustrative purposes only and do not imply any endorsement, and no attempt is made at assessing the benefits of one over another.

Technology Area 1:
PASSIVE SYSTEMS AND TECHNOLOGY

Description:

The following systems and/or technologies are considered "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, within and around major buildings.

Selected Examples of Technology in Action:

Tactile ground indicators
In Australia, Tactile Ground Surface Indicators (TGSIs) are typically square tiles with series of regular raised areas which can be laid in various patterns at key points where surface levels or directions change. They are detectable via the sole of the foot, or with a sweep of a long cane, and they come in two types - warning and directional. Warning TGSIs indicate that there is a hazard ahead, while directional TGSIs assist in way-finding by directing people along a safe and direct path of travel from one point to another.

Raised Tactile (embossed)and Braille Signage Systems
The use of tactile/raised/embossed signage systems is becoming more widespread throughout buildings. Signs are available in aluminium and acrylic with various combinations of flat or tactile/raised lettering – with or without accompanying Braille dots.

Technology in Focus:
A range of specialist signs known as BrailliantTouch® Accessible signage are available locally through BrailliantTouch Australia. Incorporating optional coloured text and embossed Braille dots, these (layered) signs are available in a wide range of finishes; and can include background colours/textures and optional logos, while a variety of metal and plastic substrates for the signs can also be selected.

Technology Area 2:
DYNAMIC SYSTEMS AND TECHNOLOGIES

Description:

The following systems and/or technologies are considered “dynamic” in the sense that they provide audio and/or tactile feedback to vision impaired users but require (battery) power sources to operate although no additional fixed or network infrastructure is required to be provided by the broader community. Such dynamic devices are designed to typically be used by a vision impaired person in conjunction with a traditional long cane or guide dog.

Selected Examples of Technology in Action:

Directional compass

Several brands of directional compasses are available - ranging from larger tactile devices with Braille lettering to ones which speak the direction via a speaker or through an earpiece. These include both tactile and talking compasses.

Infrared / Ultrasonic Obstacle Locator

Often known simply as Electronic Travel Aids (ETAs), such devices are designed to use light or sound wave technologies (invisible to the human eye or ear) to detect an obstacle and provide feedback as to the obstacle’s approximate location and distance from the user. Products on the market include: Sonic Pathfinder, NavBelt, Miniguide, Hand Guide™, Polaron™

Enhanced / specialist cane

The GuideCane is a wheeled device based on an ultrasonic-based obstacle location and avoidance system which leads the user to avoid obstacles by steering around / away from the detected obstacle by providing tactile feedback through a rigid connecting ‘lead’. The UltraCane is based on a traditional white cane, but it uses "echolocation" to emit ultrasonic waves that reflect from objects in its path and echo back to the cane. It feeds that information through to the buttons on the handle, indicating to a user how far away the object is, and whether it is in front or at head height. This gives users more knowledge about their environment, and enables them to make decisions much more quickly than is possible with an ordinary white cane.

GPS Position locator

The global positioning system (GPS) is based upon a series of satellites and was originally developed by the U.S. Department of Defence to provide information about the location, such as the latitude, longitude and altitude or elevation of a military target. 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 and vision impaired users. However GPS is not well suited for indoor navigation or for use nearby tall city buildings since it relies on direct access to at least three of the satellites to calculate correct location and orientation. Products developed include: MoBIC Travel Aid and the Drishti system.

Personal Digital Assistant (PDA) & Notetakers

A range of accessibility features such as on-screen text and video magnifiers, full audio prompts, and more recently speech synthesis and speech recognition have become available on laptop computers and their characteristics have developed substantially. Laptop computers and Personal Digital Assistants can now be used to provide audio capture and playback of notes, documents, and a wide range of information.

Technology Area 2:
DYNAMIC SYSTEMS AND TECHNOLOGIES, continued

Selected Examples of Technology in Action, continued:

Talking Digital Map Systems
The Trekker is a package of a GPS receiver, speaker, and additional battery pack combined with an off-the-shelf PDA (HP iPAQ), and a Braille touch screen. As the vision impaired traveller moves about the urban environment, the Trekker utilises 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 articulate them to the user.

Tactile Map Systems
The Arlene Gordon Research Institute of Lighthouse International is currently undertaking a research project to test the feasibility of commercial development of a computer-controlled, interactive tactile map and way-finding system to enhance the accessibility for vision impaired individuals, of office buildings and other public accommodations. The research is advised as current however little else can be located about the on-going research or results.

Technology in Focus:

Mobile Phones / Communicators
A number of cell/mobile phones may have *potential* as navigation and location aids for vision impaired persons. Two Nokia devices both with added software for speech input/output, and more recently the Audiovox, Toshiba and Samsung have models that included speech systems. Neither of the tested Nokia's had GPS capability, however both Audiovox and Samsung phones have a GPS feature that may be used to help locate users in case of an emergency, but the local emergency system must be equipped to use satellite systems. The GPS feature can also access other location-based services (such as location of restaurants, retail outlets, etc.) that may be offered by network providers in the future

Technology Area 3:
INFRASTRUCTURE-BASED SYSTEMS AND TECHNOLOGIES

Description:

Infrastructure based systems and technologies will 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 vision impaired users, 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 vision impaired users should they require it.

Selected Examples of Technology in Action:

Accessible Pedestrian Signals (APS)

Accessible pedestrian signals (APS) are additions to the traffic signal system at crossings to provide signal information in audio, tactile, and/or vibrotactile form to the pedestrian. APS devices available today are of four general types: pushbutton integrated, pedhead-mounted, vibrotactile only, and receiver-based.

Press and Listen Signs

Most often used in an indoor setting, and necessarily working in tandem with other signage systems since the "signs" themselves must be first found to be "pressed", Press and Listen Signs can be used in various applications, such as giving spoken directional instructions, spoken information about displays in exhibitions, conferences and museums, or as a means of passing on messages.

Line-Following Guide

Recently, improved algorithms have been devised that will allow a Guiding Robot to detect, recognize and follow a series of TGSI tiles in order to lead a vision impaired user towards their destination. In terms of Line-tracking Guidance, a sensor system mounted on a wheelchair, which was able to 'follow' a reflective tapeline marked on the floor of buildings, and variations of such line-following options have now been incorporated in many wheelchairs. The user would get an audible sound feedback when the line was being followed correctly, but if the sensors detected the chair was 'straying' from the line, voice feedback advised the user to steer left or right in varying degrees to correct their course.

Directional Sound Evacuation

An innovative audio-based guidance system for evacuation has now been developed in the UK with a view to incorporating it with traditional Exit signage. Although perhaps not a general way-finding system specifically for the vision impaired, it certainly assists the vision impaired with emergency egress, as well as the sighted population.

Remote (Infrared) Audible Signage

There has been a substantial amount of research and development into this area of Remote Infrared Audible Signage systems over the past 15 years – mainly in the US and in the UK. Based upon broadcast or transmission of pre-recorded messages, key locations and corridor intersections are fitted with one or more specialist audible signs or transmitters so that users are 'guided' to the facility that they require simply by following the series of messages as they move throughout the building.

Technology Area 3:
INFRASTRUCTURE-BASED SYSTEMS AND TECHNOLOGIES, continued

Selected Examples of Technology in Action, continued:

Remote Radiofrequency Audible Signage
Products such as RNIB React are similar to the Infrared Signage above in the sense that it electronically provides information to vision impaired persons, this radiofrequency signage however 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.

Technology in Focus:

On-line Digital Information and Maps
Most recently, new toolkits allowing software developers to customise World Wide Web pages for vision-impaired users are becoming available, so that users can create machine readable Web pages using the syntax and grammar of extensible mark-up language (XML). This will allow computers (desktop, wearable, handheld,) to 'read' WWW pages automatically and decipher their contents for the vision impaired user. Of particular interest is the potential for 'on-the-fly' spoken interpretations of map-based queries from GIS systems.

6 THE FUTURE

Many systems and technologies which have potential application in the area of way-finding or mobility and location assistance for vision impaired persons are expected to mature over the next few years. One only has to consider the enormous developments made by manufacturers of mobile phone handsets to appreciate the rapid changes in characteristics such as lower power consumption; increased battery life; use of integrated audio for dialing; screen resolution and colour; etc. for handheld devices.

Consider also the introduction of small handheld or palmtop devices like Hewlett Packard's iPAQ or the PalmPilot from Palm Corporation with sufficient computer processing power and on-board storage/memory to undertake many complex tasks such as speech processing and location calculations. On the other hand, improvements in the provision of network infrastructure being installed by the telecommunications companies are much slower in arriving (for instance, actual network upgrades to allow higher bandwidth for delivery of information to handsets; and outright costs of using mobile phones and GPRS to give access to the WWW and Web-based information).

Devices and systems such as data-gloves, smart clothing, and various tactual feedback devices may have been developed for personal Virtual Reality or military and commercial applications, but have enormous potential in providing additional spatial information to vision impaired users who can embrace the technology.

7 CONCLUSIONS

There are no international or Australian examples of specific way-finding legislation, which requires building owners and/or public bodies to build in systems or technology to assist people with a sensory impairment to navigate around buildings and other spaces or to exit to a safe place in the event of a fire or other emergency.

The research has revealed that with current systems and technologies the objective of universal way-finding cannot be achieved immediately. However, there are things that can be done immediately to progress the way-finding objective and to lay the foundation for the future.

Public open spaces within buildings, to which people with a sensory impairment have access, should have inbuilt systems to guide those people along safe paths of travel to and from key entrances and exits. This should also include the paths of travel from the main entrance to the lifts, if any, and to a refuge in the event of fire or other emergency.
The research identified that systems and technologies are presently available to achieve this without building owners incurring unreasonable cost or unjustifiable hardship. Examples of these systems that could be used immediately include:

- Ground surface indicators as well as embossed and Braille signage systems are well developed and available.

- Infrared audible signage (known variously as “speaking signs / audio signs / talking signs” etc.) is advanced sufficiently to assist.

- In the **outdoors** environment, the radio beacon approach based on an external audible signage system would appear the best short-term approach.

Improvements in storage devices, communications protocols, plus integration with specialised sensors and improved location positioning systems, it is expected that in the medium term, information that is ‘tailored to the individual’ could be made available to individual users from inbuilt location-specific transmitters.
Devices such as mobile phones (where small computers, personal digital assistants, and digital cameras are already integrated) but with the potential addition of a digital compass, pitch & roll indicator, accelerometer, as well as GPS-type location features, such mobile tools *could* converge into one (maybe costly) device, or could remain as a series of optional add-on extras - depending on how strong the demand is, and on an impaired individual’s particular needs.

It would still appear quite a long way off before a ‘robotic guide’ of some form or similar of a **sufficiently small, light, powerful yet discreet** nature will be available for the sensory or vision impaired visitor to use with confidence for orientation and navigation within the built environment.

Consequently, way-finding guidance of the preferred *refusable, unaided and discreet* type may well come from feedback supplied individually and directly to the sensory-impaired user. These would include innovative and inconspicuous options such as advanced smart clothing and personal tactile devices – perhaps augmenting or replacing traditional tactual and aural sources like vibrating mechanisms and headsets/earphones.