VERBAL ORIENTATION SYSTEMS FOR BLIND VISITORS IN PUBLIC SPACES

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1. Introduction

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How can persons with limitations of vision, hearing, language, or thought achieve ease of orientation in transportation settings comparable to those who travel but are without such limitations? Are there verbal orientation systems (VOS) which can help?

For some years, authorities at the Transportation Development Centre, Transport Canada's R&D centre in Montreal, have been investigating systems which assist sensory impaired travelers find their way in transportation terminals. Recently, the Transportation Development Centre asked Behavioural Team to examine the *Verbal Landmark System* and similar approaches to the provision of spoken orientation information.

A high-technology solution

What is the system developed by Verbal Landmark systems (VLS)? In the VLS system, low power transmitters are installed at key intersections and route decision points in a public building. When a user with the proprietary Verbal Landmark receiver approaches within a few meters of the transmitter, a message is transmitted to the person's receiver. It should be noted that applications of VLS include the conversion to speech of any computer signal, such as might be found at automated teller machines; therefore ownership of the system can have a utility beyond orientation applications.

Verbal Landmarks has been committed to the following design elements.

- The transmitter-receiver pair work only when in close proximity; messages can therefore be specific to a limited floor area defined by the radius of reception.

- Messages are specific to the type of receiver being carried or channel-specific to a receiver.

- The traveler hears messages start from the beginning of their text (as contrasted to starting at random points in the message, a potentially confusing condition which one finds with endless loop or repeating systems).

- The messages are downloaded to the transmitter in digital form using conventional ASCII format and converted to speech at the local transmitter using synthesized speech.

Additional information on the Verbal Landmark system is presented below.

Verbal Landmarks is one approach to providing orientation information and it originated in an effort to assist visually impaired travelers. Without too many modifications, a Verbal Landmarks installation can incorporate a channel with spoken information targeted for travelers with impairments of cognition and another channel for those with no disabilities but who can not speak the language of the speaker. With slight modification, it can also assist travelers who may not hear public address announcements clearly, such as those who use hearing aids.

Verbal Landmark is a new system, with the first practical tests underway since the Spring of 1994. The current vicissitudes of the firm are noted in Appendix B.

Can verbal orientation systems (VOS) — Verbal Landmark or another — be useful in enlarging accessibility to transportation in Canada? The search for the answer to that question is initiated in this project.

2. Definition of VOS

Behavioural Team's task is to develop a framework for the evaluation of Verbal Orientation Systems and to recommend a design for a demonstration project of such devices.

A broad definition of verbal orientation systems (VOS) was configured as a guide or target of research. This model was shared with those who served as informants in this study.

At the most general, VOS provide a spoken information source, targeted or personalized in some way to specific users or user groups and applicable, in the present instance, to transportation settings. These settings are principally terminals and stations but can also include or be adaptable to pedways and public transit venues, to vehicles and to any other synergetic application.

Typical users are persons with (a) limitations of vision and with blindness, (b) hearing limitations which may put them at a loss with regard to public address loudspeakers or in conversation with information providers, and (c) language limitations, from cognitive weakness in reading signs, poor understanding of complex messages, memory insufficient for the situation, etc. The system could also be adapted to serve people not speaking the local languages.

Typically, such a device can be located at a doorway or some decision point in a building and it "broadcasts" or otherwise configures the contents of the message to be appropriate within a small radius such as 3 m. Each such locale can bear a few different languages or special messages according to the needs of users.

Typically, the system is unobtrusive except to the related user group and, ideally, activation is passive. Therefore, users are hailed or paged in some way in order to reveal to them that information for their use is available and/or to initiate the flow of that information.

Messages can be changed either by having a service person go to the device to change the tape or, more rapidly, especially as applicable in an emergency, by direct connection to a computer which "downloads" the new message or sends a message that is immediately re-transmitted. In the direct computer format, the speech is likely to be computer synthesized.

3. User perceptions of VOS

3.1. User reactions to potential applications

What issues affect VOS? How do the various families of sensory and cognitive limitations relate to spoken information in transportation terminals? In addition to our own information resources, the viewpoints of persons associated with various sensory and intellectual limitations were solicited on these questions. These respondents are named in Appendix A.

This section provides an indication of sites and markets for VOS.

3.2. Applications for persons who are visually impaired

What information and where?

VOS have a great variety of applications for people who are visually impaired. After all, the “holy grail” assistive device for wayfinding for blind persons is the “talking sign” or the ability of written signs to “speak” to passersby.

The settings where the greatest need has been expressed for these types of devices are airports and transit sites to start with, with train stations, taxi platforms, and bus stations considered later. Within a terminal, travelers want to access washrooms, ticket counters, and routes to transfer *to* and *from* local transit services.

Installation at intersections and crosswalks for mobility orientation would be welcome too. Eventually these devices could be part of the advertising presentation for business along the streets who currently use only visual communications. These devices would “speak” commercial signs of all sorts.

Features

Some thoughts concerning features from the perspective of users who are blind are as follows.

The design should be one that is already acceptable in society today, and as unobtrusive as possible. It should conform in operation as far as possible to other devices used by blind persons such as Kurzweil readers and the like. Many blind persons experience grave problems related to the inability of mortals to remember complex chains of directions. A VOS installation suitable for travelers who are blind would need to recognize this limitation by providing bite-sized information, enough sites of information transmission so that the burden of information between sites was not excessive, and/or the means to repeat or recapture messages previously heard.

The messages might incorporate a “clock-face compass” or other verbal compass approach for cardinal directions. This nomenclature, which is often used among blind pedestrians today, can be used in addition to the programmed, more literary “feed-out” message.

Finesse in human-computer interaction design is important to people who are visually impaired. Special function buttons for calling up emergency information, schedules, and fares, for example, are helpful for persons with poor vision, especially if the buttons are discriminable by touch. But the use of too many buttons defeats the goal of simplicity.

The ability of the VOS to confirm that a person has arrived at the requested destination is another asset. While this feature implies a level of interaction which no existing VOS possesses, it bears a generic resemblance to State Of The Art transit fare payment methods which keep track of a passenger’s progress through the system, albeit by virtue of a record carried by the passenger on their “smart” fare card; it also bears a resemblance to capabilities of the rapidly appearing global positioning technologies such as the Canadian Visuaide gear.

Headphones should be an available option for use with these systems, for privacy.

It should be a device which blends into the environment, not something that draws other people‘s attention to the person using it. It should be compact enough to put into a pocket or purse.

For distribution, it would be better for those who are blind to have their own devices, supplied through the CNIB’s retail operations.

Even if today’s elderly blind travelers might be hesitant around computerized machinery, the next generation of seniors will not necessarily be as reserved, in as much as they grew up in a higher technology era.

VOS *as systems* should start off as simple devices and have elements developed that people can add on later, as need and ability to afford to satisfy these needs grow. This allows the basic device to be sold cheaply and the burden of the expense could be carried gradually as new parts are added to the basic device. A first-time price of $100 dollars is conceivable — if there has to be a charge involved. The individual user should be able to initialize service themselves and use the device “off the shelf” rather than having to rely on specialized service personnel.

3.3. Applications for persons who are hard of hearing

What information and where?

For persons who are hard of hearing, VOS should be able to provide emergency information, schedules and fares, departures and arrivals times, directions to shops and an explanation of available services at airports. These devices would be really useful at inter-city bus stations as well as on-board inter-city buses. Inter-city train stations, transit vehicles, and stops are also good candidates.

Hard of hearing travelers can be helped in three ways. First, spoken information presented on PA systems can be made more intelligible through acoustic improvements to the room, the source, the gear, etc. Second, the message content can be presented visually. Third, users of hearing aids with a "T" setting (roughly half of all users), can be helped by provision of information in an inductively induced field near the traveler.

For a variety of reasons, the installed base of assistive devices for the hard of hearing is progressing in sophistication and enlarging in implementation. For example, many auditoriums and churches are able to re-transmit microphone, TV and other audio feeds through infra-red or FM assistive systems such as the Phonic Ear. Thus for persons who have already invested in such equipment, it makes sense to coordinate transportation-related systems to other systems already found in place in public spaces such as hotels, museums, art galleries, tourist attractions, and houses of worship.

For those who have not yet invested in a system, it also makes sense to standardize on a system with a large installed base in order to realize economies of scale and other benefits of standardization.

As a general class of information, changes (including emergencies) are communicated to travelers by means of public address systems. Such systems are often unintelligible to many people, and in many areas within a terminal. It is not because managers or engineers are hostile to intelligibility, but because large public spaces such as terminals present difficult acoustic challenges in designing comprehensively effective public address systems — especially if comprehensive budgets are not available! Aural systems which are marginal for persons of ordinary hearing are sub-marginal for persons with poor hearing.

Features

Because these devices would give persons who are hard of hearing more independence and help to break down communication barriers,they should receive the broadest use possible to make it more acceptable to all those who might possibly benefit from clearer spoken information.

An installation could be put around ticket counters, for example. The device should have headphone jacks built in to allow other devices and hearing aids to access it.

One variant of the devices could have a little screen for reading messages as well as hearing them. This would, of course, make it possible for use by deaf passengers. Another concept, along the same lines, is to have a paper print-out like a print-output calculator.

Devices should be designed to work with the “T” circuit of hearing aids which allows the hearing aid to respond to inductively coupled signals from telephones or loops installed in buildings. The sound quality is important, as is some control of the speed of the verbal message. Also control of the speed of the written message would be important to those who have to read any changeable visual message.

These devices should be auto-starting and should be as unobtrusive as possible. They should be shaped for ease of use like a phone or calculator, and be compact enough for purse or pocket. A strap or lanyard option at time of purchase would also be an asset.

There are many advantages to using an existing FM or infra-red system. But there are many sources of interference with auditory broadcast systems; they would have to be tested comprehensively before a standard were put in place. Transportation terminals are far more likely to contain sources of transmission interference than, say, a rural church.

A one time price of $200.00 could be charged to those who buy the device. Or it could be rented for a charge of, say, $5.00. If these devices become widely used and there is a great need for them then it would be possible to support a rental kiosk within a large terminal.

The Canadian Hearing Society would be a likely source for purchasers; it could be included as one of their technical devices. The CHS service the systems they sell.

3.4. Applications for persons who have limited cognition or language use

Limitations in language use arise from developmental delays or from unfamiliarity with local languages. People with these two originating sources of need differ a bit in their requirements. Information *content* needs to be presented differently but the technology — providing it is kept simple — can be similar.

Persons with cognitive limitations need to be presented with instructions and wayfinding information in a simplified form and with a reduced temporal density of information flow. Service to these travelers may also require simplification and/or verbal or visual pictorialization of information. Help in the manner of using the device is important too.

When unfamiliarity with the local language is the limitation, information as well as operating instructions need to be linguistically accessible to the traveler.

What features would be useful?

Some suggestions for the design of these devices are:

- big buttons and a way to attach the device to the person,
- pictures or Blissymbolics on a screen on the device,
- very durable construction, resistant to inadvertent rough handling, and
- unobtrusive shape, like a small radio or cassette player.

Other suggestions include: a dedicated channel so that the messages for citizens with developmental disabilities would be extremely simple to understand; the capacity for repeating messages when requested; and controls to allow the user to slow the speech down to a speed that suits the individual's capacity for listening and understanding.

The design should be simple, small, light weight, easy to use with big buttons and contrasting colours for low vision. A textural or raised symbol for the on and off controls would help too. These could also use pictorials.

The amount people have to pay for this device should be based on their income. A renting or borrowing system should be established for accessing these devices.

Whether a person has a sensory or a cognitive limitation, or for that matter, has potential for victimization by dint of being marked as a tourist, designs which do not make the user more conspicuous are favoured.

3.5. VOS for everybody?

Should VOS devices be targeted only for those with disabilities? Or can VOS devices be a convenience for the general public? This latter approach normalizes the orientation system with advantages such as:

- economies of scale and improvements to the availability of maintenance depots, greater likelihood of ensuring future technological evolution, enlargement of installations, greater range of options, and other benefits of being part of larger process,

- main-streaming of users, and

- reduced fears of victimization because users are not uniquely identifiable as persons with functional limitations.

A disadvantage is that needs of special users would assume a relatively smaller share in a larger program and so would not influence the program as decisively.

But the purpose of such systems is *assistance* in those instances where persons in possession of conventional abilities *may* need no such augmentation. To fully explore how useful VOS would be to persons without disabilities we need to address the question, *are* there roles which VOS can serve for the general run of members of the public?

3.6. Summary of worthwhile features

Essential features

- Actual operation is easy to learn.

- Multiple simultaneous messages can be targeted to specific user needs.

- Messages are keyed to circumscribed locations because orientation or wayfinding guidance is tied to pedestrian decision points.

- Messages are updatable and hence they are current. In practice this depends on the site and currency may vary from 2 seconds for life-threatening emergencies to 24 hours for changes in transcontinental train schedules. Emergencies aside, a three-hour horizon is probably a good compromise.

Desirable features

- Unobtrusive or otherwise devised to limit calling attention to the disabilities of the user.

- A screen (to display words, pictures, or Blissymbolics) or another changeable message display which could reveal the messages in writing or help march the user through device operating instructions. This would serve to overcome cognitive limitations and it would allow the device to serve for those who are deaf.

• The VOS can speak messages directly from a computer feed, eliminating the need for human intervention when such feeds are available within a site. Likewise the capability of speaking a human-entered word-processed text or a computer-generated message would eliminate the onerous effort of recording spoken messages in a quiet room with a microphone.

• Messages or instructions can be repeated, recaptured, or slowed down to improve learning or retention.

• The system can serve customers who are in the middle of a large concourse, that is, the user does not need to be within a few metres of a transmitter yet the message is specific to a small circumscribed area.

Useful possible features

In addition to orientation information, messages for individuals or simply news as carried by a radio station could be available.

In relation to the technology

It may be important for the system to already have achieved a large "critical mass" installed base if users are required to own their personal receivers. Or alternatively, the device can be site-specific when it makes sense for receivers to be rented or to be available for free at the site.

The device should be affordable, durable, easy to find, buy, clean, and service. Light, small, and easy to carry. Feasible by virtue of technology and price to install where ever needed. The speech or screen messages must achieve a reasonable level of legibility and intelligibility.

4. Descriptions of available generic systems

4.1. Introduction to available systems

The purpose of this section is to outline the characteristics of three generic technologies, using systems currently in production as examples.

4.2. Localized voice presentation: Secret Sound Directional Speaker and loop

While three technologically sophisticated systems are discussed below, plainer systems can also provide reasonable service — or, at the least, they can represent a baseline of comparison when evaluating higher technology approaches.

For example, the *Secret Sound Directional Speaker* (SSDS) is being used successfully in many different places, including the Smithsonian Institution. It is a carefully engineered highly directional loudspeaker which can be set to a very low level of loudness. Because it is a parabolic reflector, it looks a bit like a small umbrella, about 75 cm in diameter, mounted as low as two metres above the floor. The cone of sound projection is sufficiently tight that units have been mounted within two metres of one another and at a range of heights.

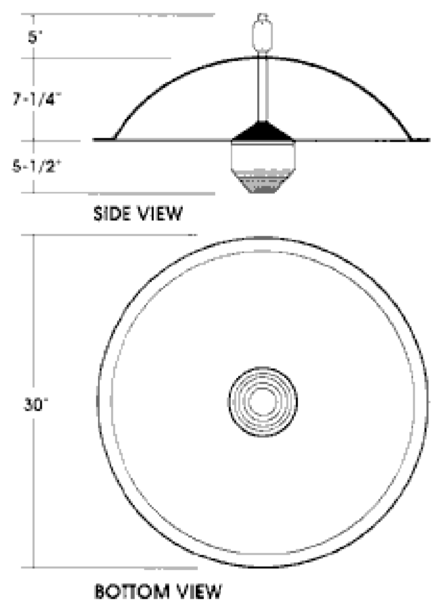
Because its appearance is distinctive, the loudspeaker serves as its own marker. Because it can be set to play continuous messages (without the risk of annoying people at any distance over a few feet), blind travelers can locate it pretty easily.

The SSDS works by reflecting and focusing sound waves into a “beam” of sound that can be pointed in any direction. It is made up of a specially designed quality speaker installed under a clear plastic sound reflector with the wire connections in a small junction box at the top of the reflector. This box can be connected to any ordinary 1/2” male threaded electrical conduit or box. It can be used with any sound source, including computers with an audio output card. It has a frequency response of 65Hz to 18kHz, a power capacity of 30 W per speaker, and a conventional impedance of four ohms. It comes with everything needed to install it and weighs about 5 kg.

Because the Secret Sound provides high quality audio, it may be satisfactory for persons who require a hearing aid. But, it may be possible to offer such travelers a better method. A base-band induction loop could be mounted on or in relation to the loudspeaker; this would work with the “T” setting on hearing aids.

Such a double-use device, when connected to a speaking computer or other source of speech, does in fact satisfy many of the *essential* and *desirable* orientation functions outlined above.

The Secret Sound loudspeakers need to be driven by a source of messages. The Digital Message Recorder manufactured by Stop and Listen of Calgary provides one commonly used and effective system. The messages are held in digital solid-state memories with between 1 and 8 channels of memory per unit (at decreasing cost per channel). These units include a single channel of amplification.



Secret Sound...
a highly directional loudspeaker

A panel of control buttons for choosing the desired channel, durable enough for similar public settings, can be mounted near the unit.

The induction loop would also need a source of messages — which could be different from the messages supplied to the loudspeaker — and its own amplifier.

The unit costs of the main propagation elements in limited quantities are roughly as follows.

Secret Sound loudspeaker $850

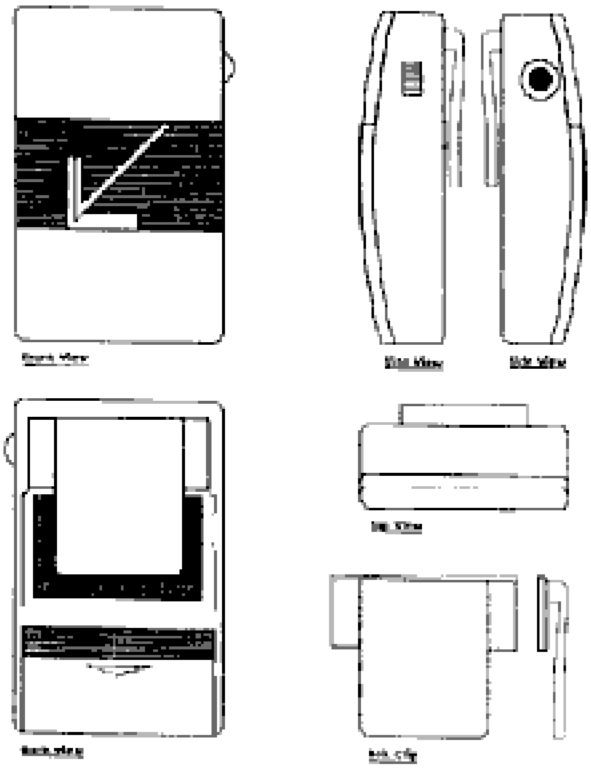
"Compact DMR II," 15 second single channel
$350
DMR-II, 8 minutes divided into two channel
$1350
MMR, 8 channels with up to 2 minutes each channel
$2200
Newtech LS-11 amplifier and induction loop
$300

The Calgary manufacturer offers to modify the DMR units to meet the requirements of the demo as outlined below for an additional $150 per unit. In addition, the cost of installation needs to be considered. Wiring for elements of this system is low-impedance and in the audio band and therefore represents minimum cable and installation costs.

4.3. **Smart Local Broadcast: Verbal Landmark**

The Verbal Landmark System (VLS) can provide spoken information for orientation to people who are blind or who have otherwise impaired vision. Future development of VLS calls for the inclusion of features for citizens with language disabilities and for those who are hard of hearing or deaf.

The VLS works by broadcasting computer synthesized speech to persons with dedicated receivers within a floor area whose size is constrained by the amplitude of the radio signal used. The size can be some dozens of square metres; it is not limited just to line-of-sight transmission. A beeper built into the receiver alerts any person who is within the catchment area to the presence of a VLS signal. The message, which is customized to that receiver's channel(s), plays once from start to finish, but can be repeated. Messages in the form of ASCII (the *lingua franca* of computers) are readily downloaded to the local transmitters, whenever a new message is needed.



Verbal Landmark's receiver unit

The message is exclusively verbal. That is, it contains no inherently directional information unlike a flashing light or directional antenna and, therefore, is limited to communicating to the user whatever message is possible through well-chosen words and in coordination with other available informational and directional cues.

Although currently functioning in base-band mode, the system is intended to transmit in the band 76 MHz of frequencies which the US FCC (and other international bodies) have set aside for assistive devices for the hearing impaired. This band of frequencies has been dedicated to such uses around the world for some time now. The problem is that the *pattern* of modulation used by VLS has not achieved any widespread acceptance; and this means that different systems, albeit sharing that band, do not now work together.

Transmitters in equipment to be sold in 1994 will be capable of broadcasting two channels and, in future production, as many as 10 channels.

Receivers process only the channel or channels for which they are set. These channels can be specific to the language or disability of the user. These receivers may cost between US$50 and US$125, depending on features — on-board battery recharging circuits, carrying cases, etc. The stationary transmitters that can be mounted in hung ceilings and in equipment closets cost more, and costs vary depending on features, method of downloading messages, number of channels, the size of VLS's production run, market factors, etc.

The messages can be synthesized on a computer with a DEC Talk card. These messages are then downloaded by wire for local storage into the individual transmitters, which have digital to analog converters, whenever a new or changed message is needed. The transmitters can be hard-wired to electronic sources of messages, such as automated teller machines or airport flight announcement systems, and serve as the voice for that computer system.

There can be differences in intelligibility and acceptability among specific implementations of analog recorded speech, digitized speech, and synthetic speech, although at their best, any of these systems can be acceptable.

Downloading *analog recorded speech* merely requires a means of "playing" the message. *Digitized speech recording* is a high-tech variant of analog recording. *Synthesizers* can speak messages which were downloaded from an ASCII source, such as the signboard computers in air terminals.

Because no models are in production yet, no prices are available. To provide orientation information at a given location, a multi-channel broadcast unit is needed. These include several technologies such as those needed for local networking, computer control, digital memory, speech synthesis, and the bits and pieces needed to broadcast to a receiver.

4.4. "Tour Guide" systems: AudioMate

Systems developed to serve as non-human tour guides at tourist sites and displays of all sorts may be adaptable to the need for orientation information in transportation settings.

Audioguide Inc. supplies several different systems to exhibits and museums in Canada. The SYCOMORE Infrared Audio Tour System, for example, was used in the Observation Gallery at the CN Tower in Toronto. Other models include the DS-119 Digital Audio Player, the Secret Sound Directional Speaker, the Easy Listener FM Auditorium System for the hard-of-hearing (by Phonic Ear), and the AudioMate Digital Hand-Held Audio Player.

Any of these might be considered, but the AudioMate appears to be the most applicable. The AudioMate Digital Hand Held Audio Player is a handsome black wand, a lightweight device that can be either held in a person's hand or worn around the neck on a strap. It is water resistant and is made of a heavy-duty plastic of the sort that is used in aircraft industries. At the top is a built-in speaker that can be disabled or removed when earphones are called for and at the bottom of the device is a charging and message loading plug, and a place for single or dual headphone jacks. The detachable neck and hand strap allows the hands-free use of this device.

It is a smart audio unit which allows access to recorded voice information and has in the middle a display area that shows the keyed-in entries. These entries have several alpha-numeric codes, such as END for end of message, PAU for PAUSE, DB for the volume control settings and ERR for non-valid message number; a numeric keypad, a previous/next button, a volume control and a play/pause button round out the control series.

There are also diagnostic messages for the maintainer of the unit, such as a LOW BAT indicator which shows the need for recharging the unit or BAD which indicates a malfunction in the unit.

Programming this device is very simple; just record on an audio cassette any information you want and connect the cassette player to a PC-based system which digitizes and compresses the audio data. An automatic editor compresses the data and adds IDs or tag numbers to it. The user can access their needed messages by keying in codes. The audio program is copied onto a programmable memory card which will distribute the audio information to the handset using the proprietary AudioMate Loading Rack.

The memory card is the secret to these devices. It is inserted into the Rack and the audio information is quickly downloaded to all the 25 hand-held sets simultaneously. It then has up to 4 hours of audio and lasts 15 hours before needing to be recharged. A maximum of 995 messages can be used with a total audio capacity of 240 minutes divided into the separate messages. These messages can be made in different languages and two languages can be put onto the same memory flash card which means having two different numbers displayed. It operates on a bandwidth of 4 kHz. The AudioMate Loading Rack offers one way of loading the handset, but you can also use self recordings, personal memory modules or wireless loading.

One of the many different attachments to this device is called the Teleloop Assembly. This device is manufactured by Phonic Ear and when attached to the AudioMate Player provides a magnetic field around the head of a person using a hearing aid. This allows the hearing aid, when set to the “T” position of the switch (typically used with telephones), to act as the receiver and eliminates the need for earphones.

Another aspect of this system is the special data collection memory card. This card allows the collection of data from the loading rack on how often each message was retrieved, and of other statistics, such as the number of times each language was used.

The AudioMate Hand-Held Player uses four ‘C’ batteries that come with the one-year warranty on the system’s components. They are charged by “Trickle Charge” and do not need to be totally discharged to be recharged. They sell for (1700 mA/hour) $15.00 a unit.

The current fees for making a one hour memory card is $1500; to create or update Flash Cards for 30 minutes is $800.00; and for 15 minutes is $400.00. It takes the recording studio 24 to 48 hours from start to finish.

As with the simple directional loudspeaker approach, it might be asked, “How does AudioMate provide the necessary features? How does it differ from carrying about a cassette player with a recorded tour on it?”.

AudioMate, first of all, is an all electronic computerized system with advantages in terms of storage, access, speed of updating, control, and no mechanical parts of the sort which wear out. Because messages can be updated quickly, by wire, from a central control room, users can receive timely updated messages, quickly inputted to their wands when they enter a terminal or at any time throughout their stay in that terminal.

Because AudioMate allows random access to a large body of messages, a traveler who loses his or her way at a certain doorway has merely to locate the nearest wall placard bearing the code numbers for message access.

4.5. **A promising fourth technology: The Phonic Ear**

It is routine for conferences in Canada to supply alternative language and sound enhancement by means of infra-red light transmission to small personal receivers and earphones. FM modulation is an alternative to infra-red.

Infra-red light transmission is limited to one room because it does not pass through opaque barriers. It is also interfered with by sunlight. FM systems *do* pass through walls, a physical property which is sometimes an advantage and sometimes a disadvantage depending on the setting. With FM, you can hear a sermon while standing in the vestibule of the church but it leads to havoc in the case of adjacent meeting rooms. FM is immune to interference by sunlight and most forms of electrical noise.

These systems are inexpensive and easy to use. They provide multiple channels. Many churches and public assembly venues try to serve participants who are hard of hearing through such systems. These systems include the *Easy Listener FM Auditorium System* for the hard of hearing (by Phonic Ear) and the *Conference Mic* for the hearing impaired (by Phonic Ear), also available with the Teleloop Assembly.

Because they are already in wide use and have a special user base among those who are hard of hearing, such systems have a good claim for use in transportation settings. Unfortunately for purposes of orientation and wayfinding in transportation settings, *at the present moment,* there are no systems designed to beam their message to a localized small reception area of, say, 10 metres in diameter.

As an alternative to spatial focus, the Phonic Ear FM system can provide up to 40 messages because it can be tuned to 40 separate channels. So at a given location, the user might be directed to choose "Channel 23" for information for cognitively impaired travelers which is relevant to that location. Unfortunately, while the Phonic Ear can be supplied to broadcast over 40 channels, individual receivers are designed to offer only 6 channels of reception. And that is a confining condition of this technology.

When tight spatial localization or full 40 channel reception becomes possible, a Phonic Ear approach may provide a competitive option for the provision of orientation information.

It is difficult to estimate the cost of a Phonic Ear system because, as matters stand now, it isn't possible to locate a sufficient number of units close enough together to be useful.

5. Evaluation matrix: a recommended trial system

The Evaluation Matrix in Table 1 shows ratings for the three potential systems on a 10-point scale with a "10" indicating that they meet the criterion fully.

On the basis of the analysis shown in the matrix, it is recommended that a combination directional loudspeaker and induction loop system be tried in a demonstration. The Secret Sound loudspeaker is an appropriate component to use.

• The loudspeaker as a distinctive physical object serves to mark certain areas as information sites.

• Several customer groups are served.

• It can be installed right away using available equipment and familiar technology, and it does not require special training of operating personnel.

• It is inexpensive enough to provide coverage of a reasonable number of sites for a major terminal building.

• Most essential and desirable requirements are met.

• It makes no demands on the user either to own, rent, borrow, secure training, or otherwise do anything special to use the system, with the sole exception being that hard of hearing travelers must set their hearing aids to "T" when they seek information and they are near a device. It is functional for blind persons as soon as they are near it.

• The equipment can be supplied by multiple vendors and no aspect of the installation is uniquely limited by proprietary rights.

An important caveat is that a system using close-up personal induction loops has not previously been assessed. Thus is it not clear what amount of cross-site cross-talk (leakage) may occur or, conversely, how close together sites can be placed. Likewise, many transportation terminals are electrically noisy and this may interfere with an induction-based transmission.

6. Specification for a demo project

6.1. How many orientation locations are needed?

To gather some empirical evidence on the question of how many orientation locations are needed in representative terminals, parts of blueprints for two large air terminals of contrasting design (Terminals 1 and 2 at Malton) and a recently renovated moderate sized inter-city train terminal (Vancouver) were examined. In addition, a subway station (St. Clair West) with a connected bus and streetcar platform serving six routes was examined first-hand.

In reviewing the locations, some effort at moderation in the placement of devices was the rule. After all, if cost were no object, orientation devices could be put every two meters apart. On the other hand, some parsimony resulting in placements only at major portals and decision points is more typical of likely demonstrations. No orientation devices were placed outside the locations except at the tracks of the train station.

Results of this scrutiny are as follows.

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air terminal, departure level.... 20 to 48 sites
air terminal, arrival level...... 15 to 35 sites
train station.................... 15 to 18 sites
subway/bus station...............  8 to 12 sites
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Some of the sites can broadcast the same message. Possibly, *all* of the induction loops for hearing aid users can broadcast the same message if that message relates only to "late breaking news."

Implementation of major systems often calls for addressing the issue of phased implementation in order to phase the cost of the project. In providing a spoken information system to overlay existing communications, does there exist a phased-in state? In plainer terms, is "half a loaf" any better than none at all? It is believed that the lower figures for each of the locations represents an adequate provision of information, not just a half-a-loaf condition.

6.2. Description of a demo

The recommended approach works as follows. The distinctive umbrella shaped loudspeaker plays a continuously repeating message. The sound is restricted to a narrow area and so it does not leak out to bother others in the vicinity.

The message presented by the loudspeaker would be biased to blind travelers and might have two components. One component would be instructions for using the nearby control panel to select a message suitable for that traveler's needs (including a channel yet more fine-tuned for blind travelers as well as all the other variants which are appropriate). A second component might be a short orientation message component which would suffice for many travelers who would not then need to seek a more detailed or fine-tuned message.

It is likely that an 8-channel (hence, 8-message) digital message recorder would be used.

A message delivered to the induction loop, suitable for persons with hearing aids, would also be running continuously. Because no one but hearing aid users can "hear" the induction loop, it can run continuously. Messages directed to the loop would tend to be related more to changes, personal paging, and emergencies, rather than to orientation, as is appropriate for this customer group.

Corresponding to the professional practice among signage authorities of creating "directional major" and "directional minor" centres, there would be a number of locations which would be single channel continuously repeated messages, particularly fashioned for the needs of blind travelers. Blind travelers need orientation centres closer together. But the messages can be short ones, intended merely to help the traveler navigate onwards to one or two downstream message centres.

6.3. **Where?**

The demonstration installation should take place at a facility that *wants* to improve accessibility and has the human resources to provide updating of messages when needed. Working with two settings, say a transit station near a CNIB office and an inter-city terminal, would cover two divergent types of application.

6.4. **A framework for evaluation, criteria of success, and possible outcomes**

The utility of the VOS should be examined separately for each type of user group as well as potential utility for the able-bodied public at large. It is recommended that alternatives to the expensive Secret Sound loudspeaker be investigated by substituting cheaper, less evolved designs in a few locations.

Because of uncertainties surrounding the use of small induction loops in electrically noisy terminals, it is likewise suggested that some experimentation take place here too.

Phased implementation might be considered: would partial implementations be beneficial or is it necessary to add VOS everywhere in a terminal and/or in many terminals simultaneously?

Appendices

Appendix A. Informants

Interviews were conducted with the following informants.

Alan Beatty
President
Verbal Landmark
Telephone (303) 484-8088

Joanne Bentley
Technical Devices for the Canadian
Hearing Society in Toronto
Telephone (416) 964-9595

Richard Buell
until recently, Director of Marketing
Verbal Landmark

Linda Carmichael
Family Support Worker
Metro Toronto Association for Community Living
Telephone (416) 968-0650

Lesley Crader, M.A.
Project Co-ordinator for Ontario Division, CNIB
specialist in mobility training
Telephone (416) 480-7016

Sherry Dounie
Peer Support Coordinator
Centre for Independent Living
a user of a guide dog
Telephone (416) 599-2458

David Ogilvie
Interim Technical Devices Specialist
CNIB
Telephone (416) 480-7025

Eitan Oren
President of AudioGuide which markets and distributes Secret Sound
Directional Speakers, AudioMate, and the Phonic Ear line of products.
Telephone (416) 787-5159

As well, thanks are also due to many individuals who have provided ideas on a less structured basis.

Appendix B. Current activities at Verbal Landmark

As of June, 1994, the state of corporate health of Verbal Landmark Systems (VLS) is mixed according to Alan Beatty, President of the firm. The company has been forced to reconsider its business plan over the past few months and some threats to their viability loom. Mr. Richard Buell, the main promoter of the system at the start of operations, is no longer working there.

VLS have had two installations underway in past six months, one of which is an automatic teller machine at a local credit union. It has been working successfully, according to the firm, although not many users with VLS receivers use these systems. Verbal Landmark found the content of the messages had to be modified slightly from the ASCII stream, which generates the text on the ATM screen, in order to serve the blind better. For other ASCII streams — perhaps less tied to visual interface screens — the modifications would not be as great. Since screens are becoming more (not less) graphical, the tide seems to be flowing away from the "free" or piggy-back use of ASCII.

Another avenue where there is an apparent need for these devices is menus such as those handed to restaurant patrons. This will enable those who are vision impaired to listen to what is on the menu.

According to Beatty, not much research went into the decision of using a synthetic digitized voice. The mechanism produced by DEC, DEC Talk, is used because it was the most widely accepted system for the blind using reading machines at the time the Verbal Landmark system was under development. Today much better quality devices such as the Sound Blaster are in use.

There are no plans now to use the device for the deaf and hard of hearing or those with cognitive disabilities. Eventually this is likely but it would be a year before a visual type is developed. The messages for each would have to be distinct because of the different modes of presentation and the different information needs.

The transit community has not shown any interest in Beatty, because, in his view, they have their own ideas on what is needed and how to provide it. They would have to come up with money to do tests and carry on. It takes time to undertake this level of intensive development.

Verbal Landmark is quite interested in participation in Transport Canada's projects. However, the ongoing health of the firm raises grave questions of long-term viability. These would have to be assessed before commitments were made to use VLS gear.

Appendix C. Dr. Barkow's idea

Turning the problem of navigation on its head, one might ask, "Can a system be devised which tracks the traveler as they navigate through a terminal?" Two possible implementations come to mind.

First, the person can be tracked just like tracking a light-pen as it navigates a CRT screen. Control by means of an audio feedback signal can be provided analogous to the *Audio Strokes* approach of McQueen and Mantei, reproduced below. Their approach is sort of like the electronic instrument called the "Onde Martineau" — but conceptually in reverse — where the position of the performer's hands *determines* the sound the instrument generates.

Second, a guidance signal could be developed which is specific to the wayfinding requirements of the traveler. This is analogous to the way pilots maintain their course to a runway during instrumented landing runs. The traveler would receive feedback of some sort indicating proximity to a "flight path" or the degree of deviation *from* the "flight path."

AudioStrokes: Using Sound as a Continuous Feedback Mechanism

by Craig McQueen and Marilyn Mantei

A new input feedback mechanism that uses sound to guide continuous motor performance of users is proposed. The mechanism, called Audio Strokes maps continuous sound properties to a 2-dimensional visual coordinate system and plays the sound changes that occur as a user moves a stylus or mouse linearly in the x-y space. A pie marking menu was implemented in this acoustically driven system and users were tested with pitch mapped to the horizontal axis and intensity, timbre or pitch mapped to the vertical axis. Speed and accuracy were collected as measures of performance. The pitch vs. pitch condition was significantly worse than pitch vs. intensity or pitch vs. timbre. The latter two conditions were not significantly different although pitch vs. timbre had shorter times and less errors. The study indicated that applications using stroke input could be guided by acoustic feedback suggesting that this feedback can be a secondary guidance in many user input tasks and a primary guide for the visually impaired.

Appendix D. What information flows within buildings?

Information — verbal or silk-screened — can be static in the sense that a house address sign never changes. Or verbal information can be dynamic, updated regularly or hot-off-the-presses for changes or emergencies. The more readily a system can handle dynamic content, the better it is.

Further, the more easily obtained the information, the more feasible the system. For example, the gates used by airplanes at a major terminal are tightly coupled to computer-borne activities of the air traffic controller who is called, paradoxically, the *Ground Controller.* Thus little organizational effort is needed to post gate locations for incoming flights: the information is already "flowing" within the terminal's computer.

Further yet, the information about gates which is used by the Ground Controller, becomes posted on the flight arrival annunciators; this information can be spoken by VOS. By contrast, if special personnel and special efforts are needed to mount the information in the verbal parallel system, then the verbal system is likely to be sporadically ignored and the first victim of cutbacks.

It is therefore recommended that further study be given to the origination of the messages to be used in VOS. To what extent can existing flows be used?

In so far as VOS can capture "free" or easily generated information in buildings, it can speak this information to its constituent consumers. What information is available now or could be available in the future in buildings?

When heating, ventilation, and integrated lighting systems are considered, the information flows are self-evident. There are thermometers throughout a building and numerous sensors which reflect the parameters of climatic comfort. These sensors inform the building control computer and generally output on a screen which can be viewed by human attendants if they need to keep track of the building's status.

What information flows about relating to passenger-side issues? Would the message

Men's Toilet #3 is being cleaned; estimated completion downtime count: 20 minutes

appear in the system? This message certainly is not in anybody's computer today, except maybe some super high-tech place or a place where space occupation is of great interest such as a prison. But is there any reasonable need for such information? Would it help run an airport terminal better if this level of detail — here concerning washroom maintenance — were routinely kept?

In so far as flows of this sort were kept, the implementation of automatic VOS would be very simple indeed.