Project ACTION

Transit Accessibility Improvement Through Talking Signs® Remote Infrared Signage:

A Demonstration and Evaluation

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A Demonstration and Evaluation

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Significant technical assistance was provided by Smith-Kettlewell engineers, Mr. William Gerrey and Mr. Albert Alden. Smith-Kettlewell illustrator, Mr. Jim Brodale produced the figures for this document. The staff of Talking Signs, Inc. and Microcomputer Systems (both of Baton Rouge, LA.) provided hardware to the project at a reduced cost.

The project's Steering Committee, composed of a number of blind persons who regularly use public transit, administrators of agencies providing services to blind persons, and accessibility officials from Muni and BART, assisted in guiding the project at key points in its evolution and decided important policy issues.

We appreciate the valuable information provided by and the cooperation received from the 36 persons who participated as research subjects in the study.

Foreword

This technical report is one of three documents that resulted from the project entitled "*Transit Accessibility Improvement through Talking Signs® Infrared Remote Signage: A Demonstration and Evaluation*" (W. Crandall, Smith-Kettlewell RERC) funded by Project ACTION. The main activity of the project was installing Talking Signs® in a tri-level transit station in San Francisco and testing their effectiveness in providing wayfinding information to people who are visually impaired.

This Technical Report sets out the need for accessible signage for people who have print reading disabilities, and discusses why Talking Signs® remote infrared signage is the technology of choice (within the context of previous human factors studies). Finally, it provides the rationale for and the results of studying the impact of training on the use of the technology in a complex transit facility. The project's two companion documents are: Bentzen, B., Myers, L., and Crandall, W. " Talking Signs® System: Guide for Trainers." *Project ACTION*, 1995 and Crandall, W. "Talking Signs® Remote Infrared Signage: A Guide for Transit System Managers." *Project ACTION*, 1995.

The activities of this project were guided, in part, by a Steering Committee comprised of administrators of agencies providing services to blind persons, blind persons who regularly use public transit, and the accessibility officials from the San Francisco Municipal Railway (Muni), and the Bay Area Rapid Transit (BART). At the conclusion of the project, the Steering Committee unanimously approved the following final recommendation to be presented to Project ACTION.

> **"Having noted that the Talking Signs system enables users who are print handicapped to travel independently throughout a complex transit station, that even users who receive minimal training benefit from this system, and that transit operators experienced no operational hardships as a result of this system, we recommend that remote infrared audible signage (specifically Talking Signs®) is the preferred technology enabling print handicapped persons to travel independently in transit facilities."**

Transit Accessibility Improvement through Talking Signs® Infrared Remote Signage
A Demonstration and Evaluation

1. Introduction

Rationale:
Effective mobility depends upon proper orientation; for mainstream society this is accomplished by printed signs. People who are print disabled, are blind, or have other visual impairments are at a disadvantage for the lack of labels and signs. For sighted travelers, signs provide identification and directions. In the broadest sense, signs comprise a menu of choices for travelers; they confront them with the options available at any given point in their travels. In a sense, signs act as a form of memory for travelers; signs "remind" travelers about important characteristics of the environment.

Currently, persons with severe visual impairments most often require extensive assistance from strangers in order to travel in unfamiliar areas. In the best case, the information they receive is accurate, concise, and in the appropriate language. Such an ideal source of information is seldom available. In urban areas, persons who are blind may have safety concerns about approaching strangers for assistance. Finally, blind people just do not like to be dependent upon others for information -- especially if there are suitable alternatives.

The National Center for Health Statistics estimated that 4.3 million people in the US have difficulty reading the newspaper with their corrected vision -- a *functional* definition of perceived limitations termed Severe Visual Impairment as defined by Nelson and Dimitrova in the American Foundation for the Blind's Journal of Visual Impairment and Blindness of March, 1993. Importantly, an additional 2.3 million people have a disability that involves the loss of intermediate or distant vision only. From these statistics, we may conclude that a total of 6.6 million people are unable to read printed signs at normal viewing distance. Data from the Bureau of the Census put the figure for this same level of impairment at 9.7 million people (McNeil, 1993). There is another important way of looking at the demographics of blindness. Estimates of *tested acuity* classify 1.1 million people as Legally Blind which is defined as corrected acuity of *20/200* or less and a visual field of $< 20^0$ (Chiang, *et al*, The Milbank Quarterly, Vol. 70, No. 2, 1992).

Many other disabilities prevent persons from reading print. In addition to people who are blind or have low vision and may not be able to see the print, there are many stroke, head-injured, autistic and dyslexic (or even just educationally impaired) persons who may not be able to assimilate printed language even though they can see the page. Many people can accept this information through speech -- having print read aloud to them.

Remote Infrared Signage:
Remote infrared signs allow people who are print disabled to directly know not only *what*, but *where*. Just as non-disabled people visually scan the environment to acquire both label and

direction information, remote infrared signs *directly* orient disabled people to the labeled goal and constantly update them as to their progress to that goal. That is, unlike Braille, raised letters, or voice signs which passively label some location or give instructions to some goal, the remote signage technology developed at The Smith-Kettlewell Eye Research Institute (Talking Signs®) provides a repeating, directionally selective voice message which originates at the sign and is transmitted by infrared light to a hand-held receiver some distance away. The directional selectivity is a characteristic of the infrared message beam; the intensity and clarity of the message increases as the sign is "pointed at" or approached. This ensures that the people using the Talking Signs® system can choose to get feedback about their relative location to the goal as they move towards it. Talking Signs® are light and small, easy to install, consume very low power, and are easy to program with human voice or synthesized voice messages. Talking Signs® conform to the ADA guidelines which stipulate that an accommodation must also be "refusable" [Title V, sec. 501(d) ADA] Talking Signs® has been subjected to rigorous human factors testing in several settings as reviewed below (see "Background").

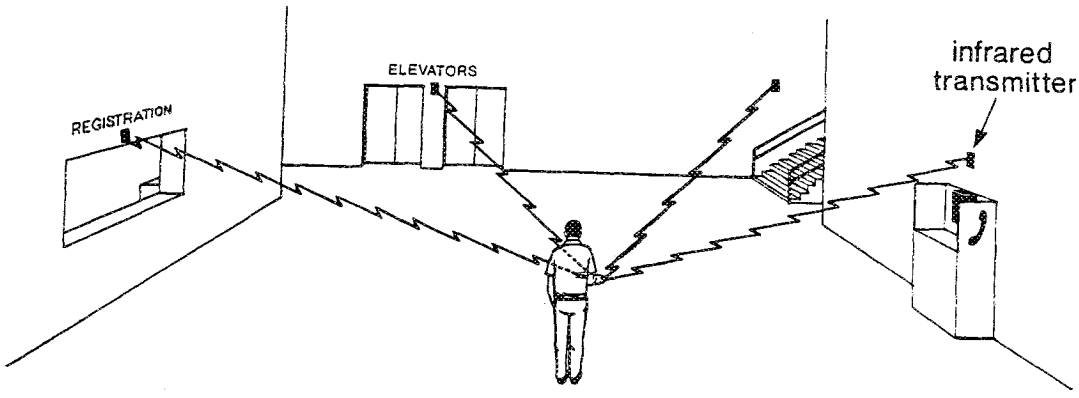

Figure 1. The infrared message beam is directional. By scanning the receiver around the environment, the user is able to determine the precise direction of each of the signs.

Purpose of the Present Study:

Transit stations present unique challenges to people who are print disabled; they must visit specific points along potentially crowded and complex paths of travel having no signs which are legible to them, in order to successfully navigate from street entrances to the proper train. Such a course involves the challenge of identifying the correct entrance, change and ticket machines, station agent kiosks, entry gates, escalators, steps and elevators onto the platform, a specific platform area and specific train or coach.

This project details a transit station installation in which we developed, tested, and determined acceptable performance levels for the Talking Signs® wayfinding technology. In addition, we sought to determine the appropriate level of training for users of this wayfinding system.

Previous research indicates that Talking Signs users independently learned many characteristics of the system which we did not specifically teach them in the short training preceding test trials. Ease of use, learning to scan, ease of picking up messages, and following the sign to the destination are thought to be related to the level of training and indicate a need to evaluate training requirements for effective and safe use of Talking Signs. The present study, therefore focused on the question: "What is the minimum amount of training required for a person to effectively and safely use the Talking Signs system?" To answer this question, we evaluated the travel characteristics of 36 visually impaired people who used the Talking Signs® system as an aid to navigation through a complex subway station in downtown San Francisco (Powell Station) for the Bay Area Rapid Transit (BART) and the San Francisco Municipal Railway (Muni). The broad cross section of subjects was divided into three groups, each group being matched for varying levels of mobility skills, degree of residual vision, and method of travel (guide dog or cane), presence of hearing impairment, and level of spatial thinking. Each group received a different level of training on the proper use of the system.

Collaboration:
The collaboration between Smith-Kettlewell Eye Research Institute, the Living Skills Center (for orientation and mobility training) and Dr. B. L. Bentzen of Accessible Design for the Blind (for the human factors evaluation), BART and Muni presents a unique opportunity for rehabilitation engineering, human factors research, Orientation and Mobility (O&M) specialists and transit providers to make a significant and timely contribution to moving accessibility technology into the public sector.

2. Background

Audible Signage: Available Technologies:
The disability community has had significant experience with audible technologies in the form of Assistive Listening Devices for the hearing impaired. The Architectural and Transportation Barriers Compliance Board (ATBCB) pamphlet entitled *Assistive Listening Systems* lists four technologies currently in use and the advantages and disadvantages of each technology for this application. These include amplitude modulation (AM) and frequency modulation (FM) radio, inductive loops (magnetic) and infrared (light). Additional experience has been gained in using some of these technologies to serve the general public as tour information systems in museums.

A number of specific applications of audible signage for persons with visual deficits have either been proposed or fabricated. Two examples of proposed systems have been put forward by the College of Communications at California State University at Chico and NYNEX Science and Technology, Inc.

The proposed Chico system would label strategic places of interest with radio frequency transmitter/receiver devices. The user carries a personal receiver/transmitter device which would both "trigger" and receive a code from the remote label. Internal to the personal

receiver is a decoder and voice synthesizer to convert the label information into speech output (Main, R., 1991). A disadvantage of this system is that it is non-directional. A directional audible signage technology has proven superior to a non-directional system in human performance testing with people who are visually impaired (Bentzen and Mitchell, 1995).

The proposed NYNEX system would employ three phases of development. The first would be a "grid" of 20 radio frequency transmitters located on tall structures (each approximately 600 feet in height). The transmitter would broadcast the name of the structure at short intervals. The user would wear headphones to which a directionally selective receiver would be attached and rotate his/her head to locate one or more of these "beacons." If several beacons could be located, the user would "be able to triangulate and ascertain with fair accuracy his/her location and orientation. The second phase involves extremely high frequency, short-range labels (for enhanced directionality) on each street corner. The third phase involves using the global positioning satellite (GPS) system to index geographic information stored in the personal receiver. If speech recognition were added, "the system could respond to user inquiries regarding directions, schedules, and path planning ..." (Urband, E., 1992).

Four audible signage systems which have been tested or produced include designs from the British Open University Interfaculty Electronics Facility, Fanmark Technology Corporation of Auckland, New Zealand, Verbal Landmarks, Inc. of St. Louis and Talking Signs, Inc. of Baton Rouge.

The Open University submitted its talking label-type device for on-campus trials. In this system, the speech emanated directly from an enclosure attached to the location to be labeled. The speech message was "triggered" by the presence of a person in the nearby environment (proximity detector). The researcher considered the advantages of a system that would require a special triggering circuit on the person of the user so that the speaking label would not be constantly activated as members of the (non-disabled) public pass by (Jones, D., 1991). A disadvantage of this system is that all messages such as "Ladies Room" are audible to all passers-by. Audible signage which is audible to the general public has not been favored by blind consumers.

The Fanmark "Locator" employs an FM system that repeatedly transmits digitally recorded human voice messages and uses ordinary, consumer radios tuned to an unused band for the receivers. The technology has the disadvantage of being non-directional.

Verbal Landmark^{R} has an inductive loop system which uses a portable receiver to pick up messages transmitted from an electromagnetic loop. Messages are picked up when the receiver enters the transmission field. The messages are produced by DECTalk^{R} synthesized speech. This technology has the disadvantage of being non-directional.

The Talking Signs^{R} development began at Smith-Kettlewell's Rehabilitation Engineering Research Center in 1978. The infrared system uses light emitting diodes to transmit digitally encoded human speech messages which are picked up and spoken by a speaker in

the hand held receiver. The hand-held receiver contains a photodetector at its front end so that the message is detected when the receiver is pointed in the direction of the sign transmitter. Thus, Talking Signs are a directional system whose messages are received only by users and only when users activate their receivers; unwanted information is not heard. Because different signs have different functions, the range and dispersion angle of each sign are adjustable.

Infrared Communication:

The transmission of voice information over light beams was originally demonstrated by Alexander Graham Bell in 1880. The invention, named the Photophone, preceded voice communications by radio by 19 years. It achieved a range of 230 yards within the first year of development. Variations of this invention were employed in both World Wars for use by the militaries of America, Germany, Britain, Italy, and Japan. The German device achieved a range of over eight miles (Hutt, D., et al., 1993.)

Worldwide demand to move steadily increasing amounts of information has led to the reappearance of light, in the form of fiber optic transmission, as the fastest growing communications medium.

In 1978 William Loughborough, an engineer at Smith-Kettlewell's Rehabilitation Engineering Research Center (RERC), experimented with beacons, the idea being to create target-practice and running games for visually impaired athletes. An infrared beacon and accompanying stereo headset was made with which a blind person could precisely align his head position to within several degrees of the beacon.

At this same time, one of the RERC's blind staff members, diverted by sidewalk construction which involved adjacent streets, discovered himself to be lost at a time of night when no one was available to identify the street for him. Even though he is a good traveler with practiced techniques of regaining his orientation, he went through considerable trouble identifying his location.

Experience with the infrared beacons led Smith-Kettlewell's engineers to the conclusion that infrared beams, coded with signage information, could be accessed from a distance, and could be localized using clarity of signal as the criterion. The device was prototyped in 1979 and had its first installation at the Community College in San Diego, California in 1984.

This interest led to psychophysical evaluations of what came to be known as Talking Signs Infrared Remote Signage. Eight research articles and papers have appeared in journals or been presented at meetings important to the field of rehabilitation engineering (Loughborough, W., 1979; Loughborough, W., 1986; Loughborough, W., 1990; Crandall, W., Gerrey, W., and Alden, A., 1993; Crandall, W., 1993) Among these are human factors studies dealing with issues such as the intelligibility of Talking Signs speech output , light emitting diode beamwidth on Talking Signs detection time, and a comparison of two wayfinding technologies (Brabyn, John A. and Brabyn, Lesley A., 1982; Brabyn, Lesley A. and Brabyn, John A., 1983; Schenkman, Bo N., 1986; Bentzen, B. and Mitchell, P., 1995).

The system is currently installed in the Center for the Visually Impaired in Atlanta, New York Lighthouse for the Blind, and is currently being installed in San Francisco at the New Main Library, Yerba Buena Park, the City's Public Works Department and numerous street intersections.

Most Recent Research in Audible Signage:

1. The Environmental Access Committee of the American Council of the Blind (ACB) determined that there was enough interest and promise in audible signage as a supplement to tactile signage to warrant a formal, functional evaluation of the two most discussed contemporary technologies (Talking Signs® and Verbal Landmark®). The ACB sponsored a trial of the two systems at its July, 1993 Annual Convention hotel in San Francisco (Bentzen, B. and Mitchell, P. "Audible Signage as a Wayfinding Aid: Comparison of "Verbal Landmarks® and Talking Signs®." 1995). The ACB Environmental Access Committee invited Dr. B. L. Bentzen, a human factors researcher and orientation and mobility (O&M) specialist from Boston College and *Accessible Design for the Blind*, to design an experiment which would capture the relative strengths and weakness' of each technology in a "real world" situation. ACB Convention participants were considered to be an ideal population to act as subjects for the evaluation because they are generally aware of O&M issues, are from a broad demographic cross-section and, on the whole, are part of the national leadership in their local communities.

Briefly, the results of the ACB study show that Talking Signs has clear performance advantages in both travel time and travel distance over Verbal Landmark. Human performance data showed the "participants who used Talking Signs were significantly less likely to become frustrated and unable to independently complete the route than participants who used Verbal Landmarks." In subjective ratings from the questions and survey, Talking Signs showed significantly better scores than Verbal Landmarks® for such items as 1) ease of use, 2) ease of comprehension of message, and 3) desirability in both familiar and unfamiliar areas. In terms of preference of each technology in comparison to no technology, "TS (Talking Signs®) was generally considered to increase ease and speed of travel, while the use of VL (Verbal Landmark®) was generally considered to decrease ease and speed of travel relative to travel without audible signage."

2. An evaluation of Talking Signs on a campus environment (indoor and outdoor) has recently been completed. An analysis of our results testing the ability of sixteen blind subjects to navigate six routes (six on each of two visits or a total of twelve trials) on the campus of San Francisco State University (Crandall, 1994), indicates that, in addition to other positive outcomes, significantly more routes were successfully completed with the use of Talking Signs (with minimal verbal travel instructions) than without Talking Signs (but with longer verbal travel instructions).

We believe that the results affirmatively answer the question of the efficacy of Talking Signs in wayfinding when compared to verbal travel instructions alone. The subjects' strong desire to carry a receiver with them in both familiar and unfamiliar signed environments (94%) is, perhaps, the best indicator of the perceived benefit of the system as a wayfinding

aid. In addition to gaining answers to the specific research questions in that protocol, we gained other insights into issues of "sign" (transmitter) placement, "sign" message content, salience of verbal instructions, subject variability (in terms of individuals' ability to adapt to the new technology) and training requirements.

Other subjective responses to the system included the following:

- Sixty-eight percent strongly agreed that the Talking Signs system "... was easy to use."
- Fifty-six percent strongly agreed that "... it was easy to learn to scan" with the receiver.
- Sixty-two percent strongly agreed that the "... messages were easy to pick up."
- Sixty-two percent strongly agreed that once a Talking Sign had been found with the receiver, "... it was easy to follow it to a destination."
- Sixty-eight percent strongly agreed that "... the speech was easy to understand."
- Thirty-one percent strongly agreed that "... the receiver was easy to hold and operate."

3. Methodology

The present project was designed to implement the Talking Signs system in a complex transit station and to determine the amount of training necessary for users of the technology to travel unfamiliar routes within the station given no information other than that available through Talking Signs messages.

Materials:
Ninety-three (93) transmitter "signs" were located throughout the three levels of the transit station. Signs were placed at an elevation of approximately ten feet, either on a wall or suspended from the ceiling. Transmitters were strategically placed and messages optimized to enhance travel efficiency regardless of the direction from which users might be moving through the station. In general, it was appropriate to place Talking Signs in the vicinity of printed signs. The transmitters were adjusted to have a range of transmission from 10 feet (3.1 m) to 60 feet (18 m), depending upon the function of each sign. Messages enabled users to determine which trains stopped on each side of the platform, and which part of the platform was the main boarding area where trains would stop in off-peak hours.

The Talking Signs transmitter sends out a spoken message on a beam of infrared light. The beam starts out at a point in the infrared diode and spreads out in a cone-like fashion, becoming wider as it moves away from the source. Adjustment of the transmitters and the LED arrays ("tuning" of the system) allowed control of the maximum distance at which the Talking Sign message was received, the direction a message was transmitted, and the area the message covered.

Each infrared transmitter consists of a rectangular plastic box [(4"x2"x1") (10.1 mm x 5.1 mm x 2.5 mm)] containing the message unit, transmitter driver electronics and three light-emitting diodes (LEDs). The prerecorded human speech frequency modulates (FM) a 25 kilohertz carrier.

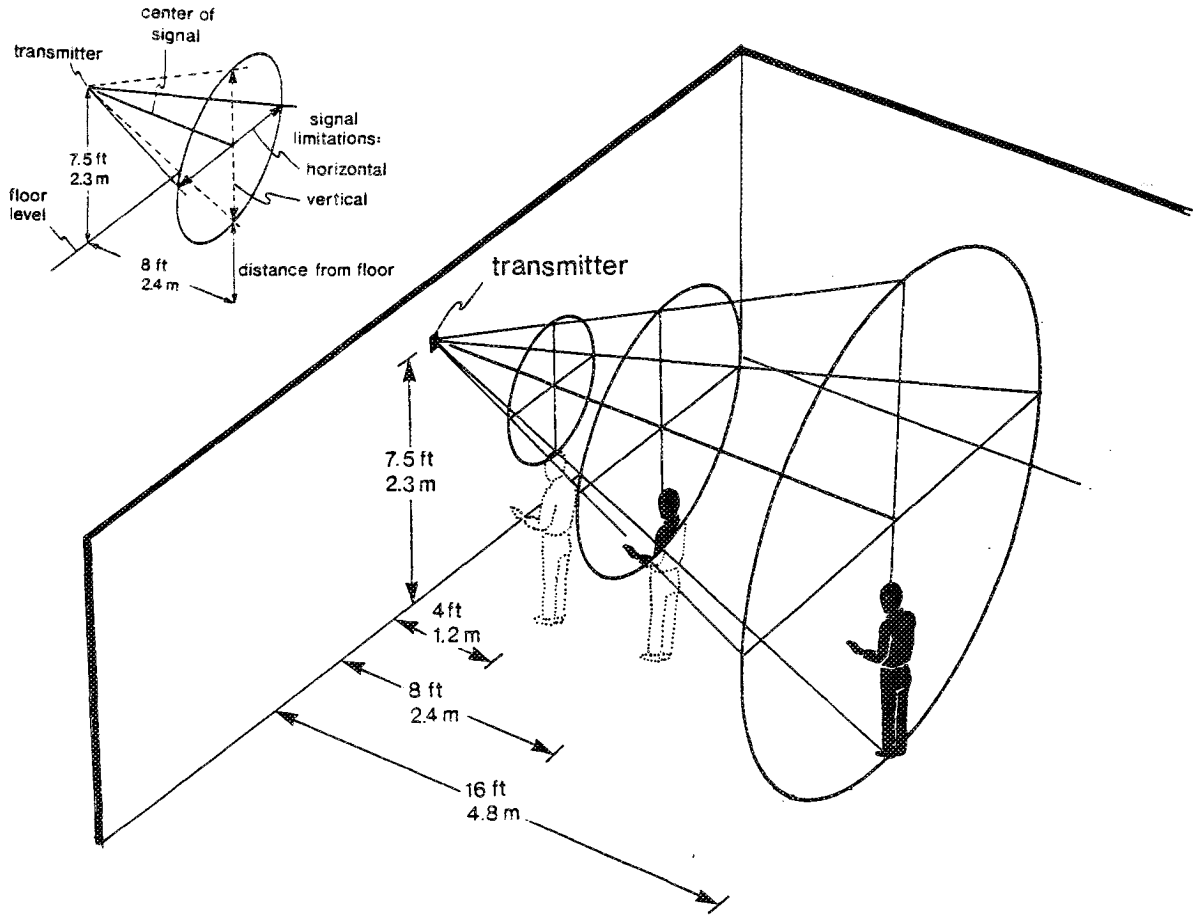

Figure 2. A user standing in the cone-shaped transmission field of the LED array. Shading indicates how much of the user's body is illuminated by the message at each of three distances from the Talking Signs transmitter.

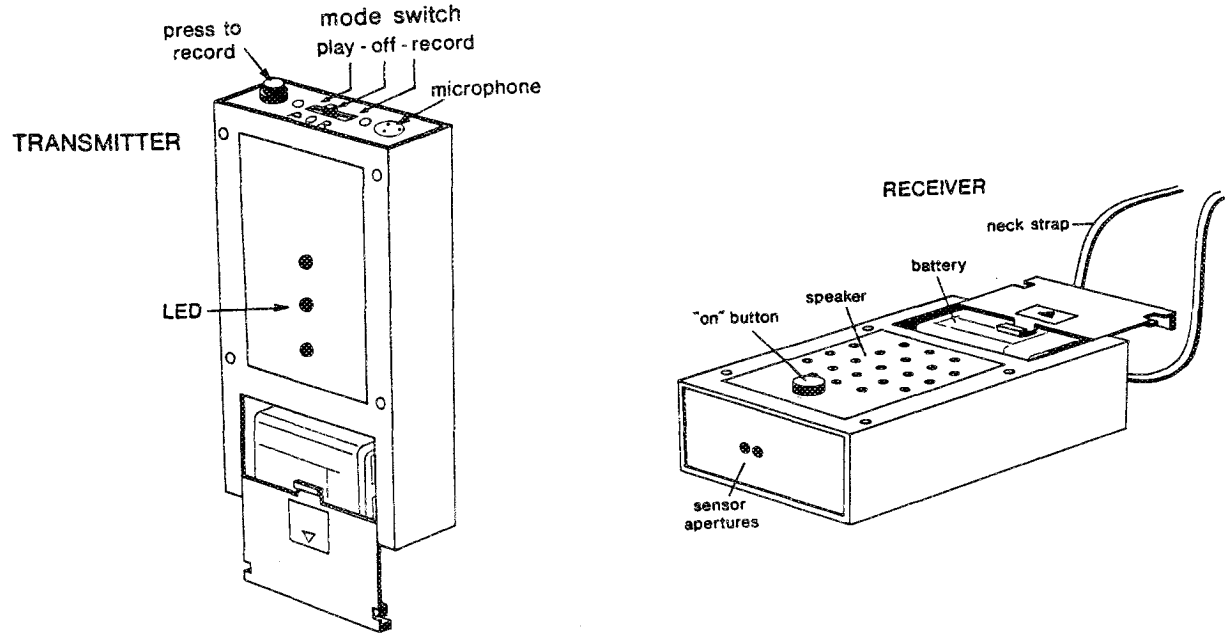

Figure 3. Transmitter and receiver of the type used in the evaluation.

Participants used receivers consisting of a hand-held box [(4"x2"x1") or (10.1 mm x 5.1 mm x 2.5 mm)] containing photodetector, FM discriminator, amplifier, and internal speaker. Participants heard the digitally recorded message whenever the sensor aperture on the front of the receiver was pointed in the direction of the infrared transmitter while the receiver was activated.

Station Configuration:

The demonstration and evaluation project was carried out at the Powell Street transit station. The top level of this underground, tri-level, multi-modal San Francisco station is a concourse serving the San Francisco Municipal Railway Metro (Muni, light rail) and Bay Area Rapid Transit (BART, rapid rail) as well as retail establishments. Trains for Muni and BART are boarded from the two lower levels, which are center-loading platforms. Along the main concourse are station agent booths, faregates, stairs, escalators and elevators up to the street level and down to the platforms, entrances to shops and department stores, restrooms, change machines, telephones, and corridors to other parts of the station.

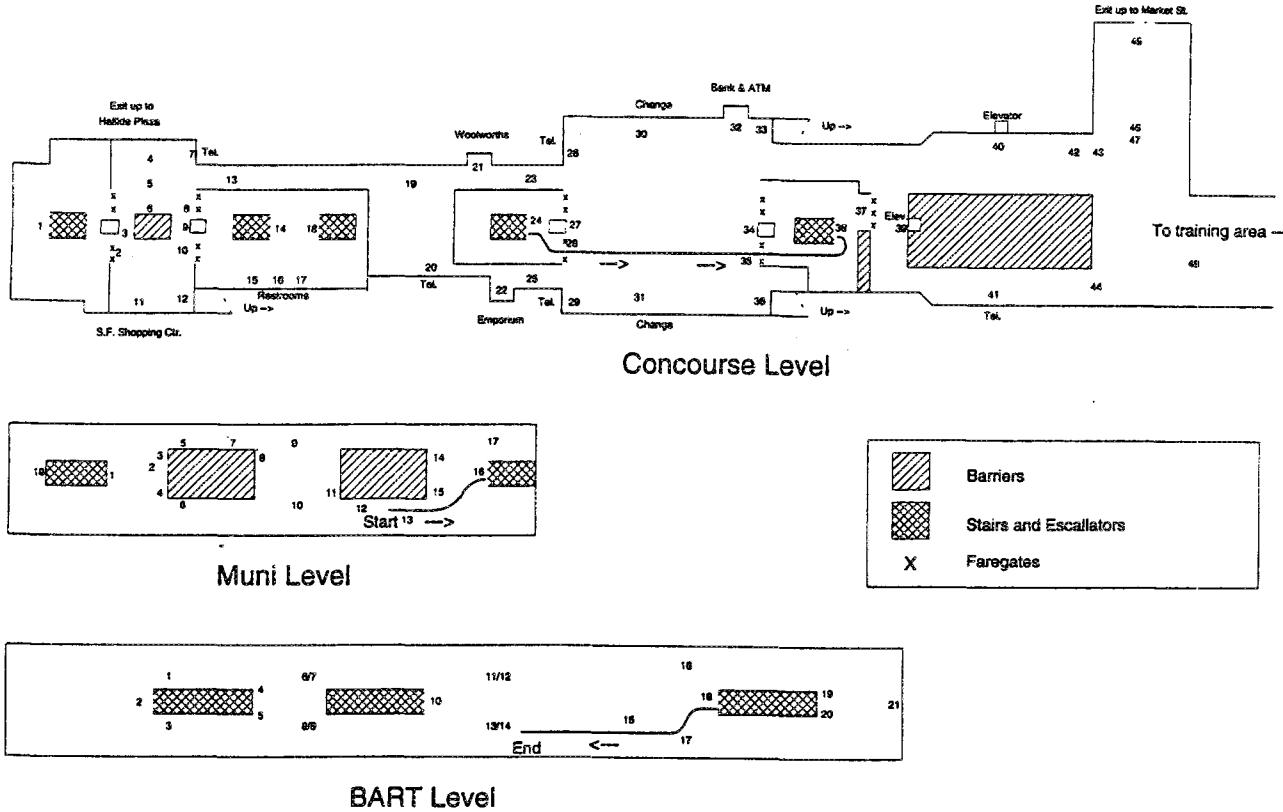

Figure 4. Floor plan of tri-level transit station site of the demonstration project. Numbers on map designate the location of each Talking Signs transmitter.

The Talking Signs installation at Powell Station is a *distributed* system where each transmitter contains its own recording circuit and light emitting diode (LED) array. These stand-alone transmitters are connected to remote, modular power supplies located throughout the station at places convenient to the 110 volt mains.

Subjects:
During an intake interview, prospective subjects were asked questions about their vision history and current level of vision, age, educational background, orientation and mobility training, usual method of travel, knowledge and use of the local transit system, health status or other handicapping conditions, and prior experience using any type of electronic navigational aid. They were also asked to answer situational questions and to solve verbally posed problems indicative of their level of spatial problem solving, and to provide an assessment of their own mobility skills. Ages ranged from 18 to 62 years. The intake survey data on prospective subjects was then put into a matrix in order to assign subjects to three balanced experimental groups of twelve subjects each (total of thirty-six).

Training:
Subjects were divided into three groups, each group composed of 12 subjects. Each group received a different level of training in the use of Talking Signs.

The most highly trained group (Group I) received one to two hours of training, until they reached a predetermined criterion of successful independent travel on 6 practice routes in one end of the station. The next group training level (Group II) was 15 to 30 minutes, or until two practice routes were completed with verbal assistance only. The duration of the training within each group was based upon a criterion level of performance in traveling 6 sample routes using Talking Signs within the training area. Group I completed six sample routes with no assistance. Group II completed at least two of the six routes with verbal assistance only as needed. Prior to coming to Powell Station for testing, participants in the minimally trained group (Group III) received verbal instructions regarding the use of Talking Signs in their preferred reading medium, a receiver, and a pseudo-transmitter which provided a beeping signal for practice.

Sample routes used in training Groups I and II were 50 to 200 feet (15 to 61m) in length and required the use of 2 to 4 Talking Signs messages. The only route instruction given to participants in any group was the destination. Some simple routes for determining the criterion performance for training are shown below:

1. "Go to the turnstiles into BART. Tell me when you're there."
2. "Go to the exit to Union Square. Tell me when you're there."
3. "Exit BART. Go to the exit for the North side of Market St. East of Stockton. Tell me when you're at the bottom of the stairs or escalator."

All sample (training) routes were in a relatively quiet part of the station.

Testing:
Evaluation of the training techniques employed in each of the three groups was based upon subjects' performance on navigating as many *test routes* as possible within a one hour period. All test routes were in highly traveled parts of the station.

Subjects in all three groups had the opportunity to navigate the same test routes, in the same order. Routes were constructed to encompass three levels of complexity and contained different total numbers of relevant signs. For the "Easy" route (requiring use of two key signs) subjects were started from locations facing (and within range of) signs relevant to reaching the destination. Both signs were close together along the path of travel so that as soon as the subject passed one sign, another was within range of the receiver. For both the "Medium" routes (three key signs) and "Hard" routes (five to seven key signs), subjects were started from locations where relevant signs might not be immediately available. The signs were much further apart and sometimes required subjects to travel extended distances before encountering a sign considered key to the task.

Each subject was required to successfully complete two consecutive "Easy" routes in order progress to "Medium" routes (the next, more demanding level). To progress from "Medium" to "Hard", the subjects were required to successfully complete any two trials within the medium level. Successful completion of a route was defined as the completion of that route without intervention. If subjects "gave up" or failed to complete a route, their performance was classified as "Failed to Complete." Subjects were reinforced with the notion that it was not *themselves,* but the system which was being evaluated.

The O&M specialist who accompanied subjects during the experiment was responsible for their safety and verbal interaction, which is a practice 100% compatible with standard instruction in orientation and mobility.

Figure 4 also shows a sample "Hard" route; one which takes the transit patrons at Powell Station from the Muni inbound train (near Talking Sign #13, Muni level) to the BART Richmond-bound train. In order to complete this route, subjects first located the stairs. They then scanned to find a sign which says "Stairs and escalator up to concourse level." At the top of the stairs or escalator they scanned to find a way to exit the Muni system. One of several signs in this vicinity says "Muni faregates." They then scanned to locate a faregate through which they could enter the BART system. One sign in the vicinity, but some distance away, says "BART faregate." After negotiating this faregate, they scanned to find the sign for "Stairs and escalator down to all BART trains." At the bottom of the stairs or escalator, they searched to find a sign saying "Main boarding area for Concord, Fremont and Richmond further down this platform." Continuing down this side of the platform, they eventually come to the destination, a sign saying "Main boarding area for Concord, Fremont and Richmond" (Talking Sign #14, BART level).

The same set of routes was used for all participants, except that not all participants attempted the same number of routes in order to reach criteria for advancing from "Easy" to "Medium" and from "Medium" to "Hard." The test period was exactly one hour.

Measures:

As participants progressed through each route, a trained data collector recorded the following data:

- Routes attempted
- Routes successfully completed
- Routes not successfully completed

Problems along each route:
- Poor grip on receiver
- Failure to understand concept of pointing
- Failure to scan fully, at appropriate angle of elevation
- Failure to monitor progress toward sign
- Misinterpretation of message
- Preservation in ineffective problem solving strategy
- Confused by reflected signal

Potential safety problems along the way:
- Collisions
- Failure to detect drop-offs
- Walking backwards
- Scanning while walking
- Scanning while walking along platform edge
- Use of receiver while negotiating stairs or escalator

Additional training and use of receivers:
Following the formal training and testing of Group I, all 12 subjects agreed to use Talking Signs in Powell Station for four months.

Following the formal training and testing of Groups II, and III, the Rose Resnick Lighthouse for the Blind in San Francisco provided eight members of Group II and six members of Group III with additional training to insure that during the demonstration period their periodic and independent travels through the installation site (requested to be twice monthly for four months) would have efficient and safe use of the installation.

Re-Testing:
An important objective of this project was to obtain information on techniques employed by the most highly trained and experienced users of Talking Signs. This is the first time that users have had an opportunity, over a period of as long as four months, to travel in an environment rich with Talking Signs.

Group I (the most highly trained) was tested again after four months of opportunity to use Talking Signs in Powell Street station. On this occasion, they began with "Medium" routes and progressed to "Hard" routes after successfully completing two "Medium" routes. Differences in performance between the test immediately following training, vs. the second test after four months of informal use was analyzed.

Telephone Survey of Users:
Users were periodically surveyed by telephone to determine the usefulness and functionality of the system. Examples of open-ended questions (15 questions, total) are: "Are there any kinds of signs that seem confusing?", "Have you found any signs that you think would be more helpful if they said something else?", and "Have you found any place you wished for another sign?" Subjects were asked to respond to seven questions based upon a *rating scale* (1=strongly disagree *to* 5=strongly agree). These questions include, for example: "Sometimes I scan while I am walking.", and "As I continue to use Talking Signs, it is easier for me to find and get to signs."

4. Results

Successful route completion:
Subjects attempted as many routes as possible within the one hour test period, progressing from easy to hard routes according to the previously stated criteria. A route was completed successfully if the subject required no assistance in order to reach the destination other than that provided by Talking Signs messages. A route was considered unsuccessful (failed) if subjects became confused, gave up, or needed to be taken back to the starting point to begin again.

If we consider the success rate by subject, we see that 35 of 36 subjects who attempted easy routes were successful in independently reaching their destinations on at least two routes. Of these 35, 30 succeeded on two consecutive easy routes and then progressed to attempt medium routes. Of the 30 who attempted medium routes, 23 were successful on two routes. Those 23 then attempted hard routes, and 17 succeeded in completing two hard routes. (See Table 1.) It should be remembered that the number of medium and hard routes attempted was constrained by the one hour time limit as well as by subjects' ability to use the technology for wayfinding.

	Easy		Medium		Hard	
Group	Attempted[1]	Suceeded[2]	Attempted[1]	Succeeded[2]	Attempted[1]	Succeeded[2]
I	12	12	11	9	10	8
II	12	12	10	7	6	5
III	12	11	9	7	8	4
Total	36	35	30	23	24	17

Table 1. Participants who completed two or more routes at each level of route difficulty within the one hour test period.

[1]Attempted - All subjects attempted easy routes. Subjects who successfully completed two consecutive easy routes progressed to medium routes. Subjects who successfully completed any two medium routes progressed to hard routes.

[2]Succeeded - Subjects succeeded in independently traveling at least two routes.

While it appears that subjects in Group I (most highly trained) were more likely to be successful in traveling medium and hard routes, Chi square tests revealed no significant differences between training groups at any level of route difficulty.

Another way of looking at successful route travel is to consider the proportion of routes traveled successfully to those attempted. Table 2 presents these results in percent. Participants successfully reached their destination on 81% of easy routes, 88% of medium routes, and 92% of hard routes, for a total of 86% (169/196) routes successfully completed.

	Easy						Medium						Hard					
Group	# Ss[1]	# rts [2]	Succeed[3]		Fail[4]		# S's[1]	# rts [2]	Succeed[3]		Fail[4]		# S's[1]	# rts [2]	Succeed[3]		Fail[4]	
I	12	29	24	83%	5	17%	11	22	19	86%	3	14%	10	18	17	94%	1	6%
II	12	33	28	85%	5	15%	10	20	18	90%	2	10%	6	11	11	100%	0	0%
III	12	33	25	76%	8	24%	9	18	16	89%	2	11%	8	12	11	92%	1	8%
Total	**36**	**95**	**77**	**81%**	**18**	**19%**	**30**	**60**	**53**	**88%**	**7**	**13%**	**24**	**41**	**39**	**92%**	**2**	**5%**
Low Vis[5]	10	24	20	83	4	17	9	17	15	88%	2	12%	6	12	12	100%	0	0%

Table 2. Route completion based upon level of training for Easy, Medium and Hard routes.

[1] Total number of subjects who attempted routes at this level

[2] Total number of routes attempted by those subjects who traveled routes at this level

[3] Succeed -- Number and percentage of subjects reached the destination successfully, without need for assistance or restart

[4] Fail -- Number and percentage of subjects unable to reach destination successfully (either gave up or required assistance or restart)

[5] Low vision subject

On the 169 routes successfully completed, subjects picked up, understood, and correctly used the information provided by Talking Signs transmitters on a total of 500 occasions (2.96 transmitters per route). On each of these occasions, had they not had and been able to use the information provided in order to make correct decisions for continuing their travel, subjects would have had to find a fellow traveler to obtain the information needed or would have had to make decisions based on less definitive information.

Subjects attempted as many routes as possible within one hour, progressing from easy to hard routes according to the previously stated criteria. The columns in Table 1 entitled "# S's" and "# rts" show how many subjects in each training group attempted to travel routes at each level. For the easy level, we can see that all 12 subjects in each training group attempted routes. However, for the medium level, we see that 11 of the Group I and 10 of Group II and 9 subjects of Group III attempted this level. For the hard level, 10 Group I subjects attempted routes, 6 Group II subjects attempted routes, and 8 Group III subjects attempted routes. Thus, amount of training appears to be related to the level of route difficulty subjects were able to reach in a given period of time.

Reasons for difficulty or failure to complete routes:
There were eight identifiable reasons that participants had difficulty completing routes independently (See Table 3).

Group	Ineffective scanning	Failure to monitor	No concept of pointing	Mis-intepretation of message	Poor grip	Ineffective exploration	Problem with reflections	Apparent poor spatial reasoning
I	2(2)	3(5)	1(1)	—	—	3(5)	4(4)	1(1)
II	4(6)	3(5)	—	1(1)	—	5(10)	3(5)	3(5)
III	7(19)	5(12)	4(4)	3(3)	2(2)	4(7)	1(1)	1(1)
Total	12(27)	11(22)	5(5)	4(4)	2(2)	12(22)	8(10)	5(7)

Table 3. Reasons for difficulty successfully completing routes. The first number in each cell is the number of participants who were observed to have this difficulty. The second number, in parentheses, represents the total number of times that difficulty was tallied.

Poor use of the Talking Signs receiver, namely failing to scan fully with the receiver held level, and failing to monitor progress toward transmitters at all, account for approximately half (49 of 99) of the difficulties tallied. For these items there is a clear effect of training, with a majority of members of group III showing difficulties in one or both of these areas. Participants who scanned ineffectively typically either failed to scan at all or did not scan a full 180 degrees about the body. Participants who failed to monitor their progress typically found signs and turned toward them, but then attempted to locate relevant landmarks without further systematic use of their receivers. If they veered, or had not accurately faced the center of landmark.

Three other problems appear to be associated with lack of training: understanding the concept of pointing; misinterpreting messages; and a poor way of holding the receiver.

Five participants did not appear to understand that the direction in which they were pointing the receiver when they picked up a message was the direction to travel to reach the landmark indicated by that message. While four of these participants were in Group III, it is interesting that for one participant in Group I, two hours of individual instruction using a controlled curriculum was insufficient to teach this concept. This participant did not reach the criterion of traveling six training routes without physical or verbal intervention within the maximum time allotted for training this group. Thus, it is apparent that training techniques need to be adapted to accommodate individual differences and that some persons will need more than two hours of training in order for them to use the technology effectively.

Four participants misinterpreted messages, either a message which said "Main boarding area further down the platform," or one saying "Stairs down to all Muni trains." These misinterpretations appeared to be associated with general unfamiliarity with use of transit platforms, including the knowledge that trains are boarded at platforms and that trains do not always stop at all locations on a platform.

Two participants, both in Group III, did not know how to hold the receiver. One held it with the sensor apertures pointed toward the ceiling, and another typically held it with the apertures pointed behind her. It is interesting to note that despite this most basic difficulty, these participants nonetheless were able to travel some routes successfully. They tended to use messages to confirm their location rather than to get to a destination. Thus, even the most imperfect use of the Talking Signs system can nonetheless decrease the number of times travelers would need to ask for assistance.

The other problems noted were ineffective exploration (22% of all items), difficulties identifying true signal direction vs. the direction of a reflected signal, and apparently poor spatial reasoning. Observable behaviors which were categorized as ineffective exploration included preservation on finding a transmitter rather than the landmark it labeled, and repeatedly trying to travel in a direction which did not lead to the destination. These behaviors appeared to be more related to general spatial ability than to level of training.

Eight participants appeared to be disoriented as a result of mistaking a reflection for the source of a message. This distinction depends both on discrimination of differences in signal clarity, and on spatial reasoning which would suggest, for example, that the true location of San Francisco Shopping Center was not along a blank, reflective wall, but opposite this wall, where there was a wide opening. Four participants appeared to have difficulty completing routes as a consequence of generally poor spatial reasoning skills.

While the incidence of all difficulties is low enough to preclude meaningful inferential statistical analysis, it appears that participants having the least training were generally the least efficient in using the technology. Overall spatial ability also appears to play a role in the ability to obtain optimum benefit from Talking Signs.

Safety:

At the outset, there was concern that use of the Talking Signs system might adversely impact the protective mobility skills of users. Safety during the experimental procedure was assured by careful, close monitoring of each participant by an orientation and mobility specialist at all times. A few instances of behavior were observed which might be considered unsafe, however it is not possible to draw any conclusion about the effect of the Talking Signs system on the safety of users because of the lack of a true baseline observation of participants' behavior while traveling without the use of the Talking Signs system.

Most participants traveled most test routes with their receivers on. Those behaviors which were observed which were considered potentially unsafe by the orientation and mobility specialist were collisions and failures to detect drops such as stairs, which seemed as likely with the receiver off as on; using the receiver while on the stairs or escalator, scanning while walking on the concourse level, scanning while walking near a platform edge, and walking backwards while using the receiver. None of these behaviors resulted in accidents or near accidents during the testing, however. While any of these behaviors could potentially result in an accident, any could be done at such a time and in such away by an alert and skillful traveler that they would not cause any problem. Instances of walking backwards while

using the receiver appeared to be the result of a particularly ineffective strategy of looking for messages when they became unclear. The training curriculum which resulted from this project (see "Talking Signs® System: Guide for Trainers", Project ACTION, 1995) has revised the strategies taught for looking for messages that become unclear.

Individual differences:

Dog guide users: Of six dog guide users, four completed all routes, one completed easy routes but failed on medium routes, and one failed to complete easy routes. Clearly, there is no reason to think there is incompatibility between Talking Signs and use of a dog guide.

Travel skills: Participants were classified according to their level of spatial problem solving ability as indicated in initial interviews, and participants' levels of spatial problem solving ability were balanced across the training groups. The most proficient participants (survey level travelers) were those who could correctly answer verbal questions requiring abstract spatial thinking. The next most proficient participants (route travelers) were those who could correctly answer simple questions about tasks such as reversing a route. The least proficient travelers (rote travelers) were those who could answer few of the simplest spatial questions. Twenty nine participants were survey level travelers, three were route level travelers, and four were rote travelers. Of three route level travelers, one completed one hard route, and one reached medium routes but was unable to complete any hard routes. Of the four rote travelers, only one reached criterion on easy routes. Thus, it appears likely that persons having poor spatial problem-solving skills will have difficulty learning to take advantage of the additional information provided by the Talking Signs system unless they receive extensive individualized training.

Hearing loss: Of six persons with hearing loss, two completed all routes, one completed two medium routes, one completed one medium route, and two failed to reach criterion on easy routes. There is no evidence that the range of outcomes correlates with severity of hearing loss.

Low vision: Ten participants reported at least enough sight to tell what direction light is coming in from. None were able, according to informal screening measures at the time of testing using Talking Signs, to read signs even at relatively close distances. Their results are reported in the Route Completion Table (Table 1) and the table below. Their results conform well to the pattern observed for all participants. Of course, there is quite a range among amounts of vision, therefore it may not be appropriate to treat this group using a homogeneous model. This group of 10 participants varied widely in their amount of vision. Given the small size of this group and the variability of vision, it is inappropriate to conduct inferential tests.

Post-testing:

Eleven participants returned to post-testing following four months unsupervised travel using the Talking Signs system in Powell Station. Ten participants were in Group I, having had 1-2 hours of training prior to their initial testing. (Two of the original 12 members of

Group I were unable to return for post-testing.) One additional participant was in Group II, having received an initial 1/4-1/2 hour training prior to testing, and received additional follow-up training before being given a receiver for her own use.

One primary objective for post-testing was to determine the extent to which participants continued to use Talking Signs messages in an environment and on routes which they had some familiarity. At issue here is whether the Talking Signs system should be conceptualized as a system for learning to travel in an area or a system for continual use in an already familiar area. Another objective was to learn whether participants continued to use the system in the way they had been taught, or whether they might have discovered more effective techniques. If so, this would suggest revisions in the training curriculum. Participants were instructed to travel the routes in the post-test in any way they wished to -- they were not to be constrained to using the Talking Signs system in the way they had been taught to do. They were explicitly told that it was... "OK to skip transmitters if you don't need them."

Route Completion. Participants began by traveling "Medium" routes, and progressed to "Hard" routes after successfully completing two "Medium" routes. Of 11 participants, 8 completed at least two medium and two hard routes. Three participants who had had some difficulty completing routes at pre-test also had difficulty at post-test.

It is important to understand the practical implications of failure to complete experimental routes. Participants may have failed to complete routes if they failed to pick up, understand, or go towards the transmitted message at just one out of as many as seven decision points along a route. In an unsupervised travel situation, however, the traveler would have sought assistance at this one decision point, reaching the destination successfully without needing assistance at the other six decision points -- still a considerable gain in independence.

Use of Messages. During route travel, a participant's use or non-use of each relevant transmitter was noted and subsequently discussed with that participant to determine why particular messages were or were not used. Participants looked for and found 284 of 297 messages at decision points on routes traveled at post-test. On familiar routes, participants looked for and used messages primarily because they were very familiar with the portion of a route they were on, or because they heard or saw available cues such as sounds of faregates, escalators, or persons on stairs.

The continuing use of receivers, even in familiar areas or on familiar routes, indicates that the confirmation and reassurance provided by transmitters is valuable to persons who are blind -- even in familiar areas. Thus, it is most appropriate to consider the Talking Signs system as one which is intended for continuing use in travel.

Techniques for Using the Talking Signs System. All participants but one continued to hold the receiver in the manner in which they were taught -- level, with the thumb on top, to depress the "on" button -- finding this comfortable and efficient. Participants tended to scan in a more limited arc when traveling in familiar areas, and when using messages just to

confirm their location. They would scan just the area in which they expected to find a particular message. If they did not find an anticipated message, they might scan in a wider area. This seems to be an efficient use of the system in familiar areas, but does not suggest any changes in the curriculum for teaching the use of the Talking Signs system.

Some participants scanned for messages while walking, a practice which was discouraged during instruction. At debriefing, participants' opinions were quite divided on whether, for experienced users, it was necessary to scan only while standing still. However, there was general agreement that the greatest safety and least confusion for new users would be achieved through instructing users to stand still while scanning for messages.

Participants were less likely to monitor their progress toward messages at post-test than at pre-test. In initial training, (especially individual training as for Groups I and II) participants were encouraged to monitor their progress toward messages so that they would be immediately aware if they veered away from a message; they fairly consistently did so during initial testing. At post-test participants frequently found a message to confirm their location or heading, and then stopped using the receiver until they wanted more information. If they were actually well oriented at the time, this was an efficient strategy. If they were not as well oriented as they may have thought, however, this appeared to result in loss of messages and great difficulty in recovering those messages because users had traveled some distance before realizing that they were no longer on the correct route. In general, more proficient travelers monitored less than less proficient travelers, the latter continuing both to scan more fully and to monitor progress toward messages they had located. This suggests that it is very appropriate to initially train users to monitor their progress toward messages.

Focus Group:

Two groups of five participants took part in focus groups to provide qualitative information for use in understanding the effects of a Talking Signs system, in fine-tuning instructional procedures, and in recommending improvements in design and implementation of the technology. Eight of these ten persons were in Group I, having received 1-2 hours of training prior to initial testing. The other two persons were in Group II, having received 1/4-1/2 hour of training prior to initial testing, followed by additional individual instruction (provided by T. D. Farrar, orientation and mobility specialist from the Rose Resnick Lighthouse for the Blind).

All ten participants, following conclusion of their training, were given receivers for their own use, having previously agreed to use them in regular (unsupervised) travel in Powell Station at least two times per month for four months. The number of times these participants actually used their receivers in Powell Station, however, varied widely, from 1 time to 47 times during the four months.

The researchers particularly desired to benefit from the knowledge and experience of this group of persons, the first such group ever to have had the opportunity to travel over a

period of time in an environment rich with Talking Signs transmitters. Researchers were interested in three kinds of information.

- ways in which the availability of Talking Signs transmitters in a transit station affected travel in that station.
- user suggestions about specific ways to use the receiver.
- user suggestions about amount, content, and ways of providing training.

Twelve questions were developed to elicit these three kinds of information. These questions guided the structured discussion of the focus groups (see Appendix B). Group I was asked all twelve questions. Group II was asked only four of the questions -- those four which provided the most helpful input to the project. Focus group responses are summarized below, by topic and/or question.

Differences between travel in a station having vs. not having Talking Signs (TS).
Question 1
n = 10

Participants were enthusiastically unanimous in finding that travel in a station with TS was easier and more enjoyable than travel in a station without TS. Many benefits were mentioned.

- "I don't have to stop and ask for help."
- "I don't have to rely on people who point; TS are verbal."
- "When I don't have TS I need reassurance."
- "With TS, I have a better sense of orientation."
- "With TS, I can discover all the facilities such as alternative exits, phones, restrooms, and ATM's in the station. Otherwise they're out of reach."
- "I don't have to remember so much."
- "I can make the correct [wayfinding] choice each time; I don't have to analyze and infer and hope I get it right."
- "I'm less tired. I don't have to suffer to get around."

Three participants who previously avoided Powell Station because of its size and complexity now prefer using it as a transfer station instead of other options they used to prefer.

Specific ways to use the receiver.
Questions 3, 4, 5, 6, & 7
n = 5

These five questions were asked in the first focus group only. They were intended to be a check on the specific techniques taught, and language used to verbalize these techniques. Researchers considered that it was possible that users had discovered more effective ways tc use or to describe use of receivers than those included in the instructions. (Additional input was received from participants who were post-tested.)

- Receivers were held "level" or "flat," with the "thumb on top." (Q 3 & 4)
- Participants were taught to find "signs" by first scanning 180 degrees across the body and locating both "edges" of the signal field. They faced the center of the signal field, and walked straight ahead. The "sign" was in the center of the signal field. Three persons preferred to find "signs" in the way taught. Two persons headed for the "strongest" or "clearest" signal[1]. (Q 5 & 6)
- Participants were unanimous in saying that users should be taught to keep their receivers on, pointing straight ahead, as they travel toward "signs." They also agreed that keeping the receiver on all the time was somewhat tiring, and that in familiar areas intermittent monitoring of progress toward "signs" was sufficient. (Q 7)

([1] Technical note: The signal is strong and clear throughout the cone of transmission, so this method is less precise than finding the center of the signal field. Simply heading toward strong, clear signals works, but may be less efficient, particularly in unfamiliar environments. Persons who use this technique may take zigzag routes, walking into and out of the cone of transmission.)

Importance of understanding the technology.
Questions 9 & 10
n = 5

All participants thought it was either somewhat important or very important for users to learn something about how the technology works. Particular information considered important was:

- TS uses light transmission.
- Light does not travel through objects or around corners.
- Light can reflect off of surfaces.
- The signal field is cone shaped.

Most important thing to emphasize in training
Question 2
n = 10

Participants stressed that TS must be understood as providing additional information for decision-making, not for safety.

Users must rely on traditional mobility techniques and aids, as well as on good spatial reasoning when using TS.

Searching with the receiver while walking
Question 8
n = 10

During training, participants were told not to search back and forth with the receiver while they were walking. They were asked always to **STOP** and **SEARCH**. Researchers were

concerned that the effort involved in searching with the receiver might take needed attention away from mobility skills, especially for persons who were not skilled in use of the technology nor familiar with the environment in which they were traveling.

- All participants recommended that users be taught to stop and search.
- All agreed that the greatest safety was provided by stopping to search.
- All agreed that at times, particularly when they were in somewhat familiar environments, they might now search back and forth while walking.
- Participants using dog guides or having low vision are more likely to search while walking.

Recommended amount of training
Question 11
n = 10

Participants were in agreement that individual instruction was very helpful but that amount of training needed would vary with the general travel proficiency and spatial ability of users. No participant thought that there should be any minimum amount of training required before an individual could obtain and use a TS receiver independently.

All participants felt that they became more proficient in use of TS as they continued to use the technology in normal travel situations.

Recommended way to provide training
Question 12
n = 10

All participants were in agreement with the following recommendations:

- Training in use of TS should be included in instruction in orientation and mobility.
- It should not be required that training in use of TS be given only by orientation and mobility specialists.
- Training provided by persons who are not orientation and mobility specialists should be given only to users who are already proficient in independent travel and safety.
- Training can be provided by persons who are visually impaired or blind.

One participant summed up his feelings about using the Talking Signs system in Powell Station in this way:

> **"In this station I am truly equal!"**

5. Summary and Conclusions

Remote infrared signs allow people who are print disabled to know directly not only *what*, but *where*. Just as sighted persons visually scan the environment and read signs to acquire both label and direction information, remote signs *directly* orient persons who are print disabled to labeled goals, and constantly update them as to their progress toward these goals. This study evaluated the usefulness of Talking Signs as a wayfinding technology for people who are blind in a complex pedestrian environment where the conventional way of getting wayfinding information is through verbal assistance from other pedestrians. Such information is useful if it is accurate, concise, and in the appropriate language. However, an ideal source for this information is seldom available. Furthermore, it is known that, in general, travelers least prefer getting information from other travelers (Battelle, 1976). Persons having impaired vision may particularly have safety concerns about approaching a stranger for assistance. Finally, independence in travel is an especially high priority for blind people. The current study focused upon Talking Signs as being a suitable substitute for and/or enhancement to their conventional method of wayfinding.

It is clear that persons having visual impairments are readily able to learn to use the Talking Signs system for the wayfinding information necessary for traveling routes in a transit station without assistance. Within the limits of the one hour test period, of 36 participants traveling routes without aid, 35 successfully completed at least two easy routes 23 successfully completed at least two medium routes and 17 successfully completed at least two hard routes. It appears that training enabled participants who were more highly trained to complete more complex routes. This finding was not statistically significant, however. Even the minimal level of training in which participants received written instructions in their preferred medium, enabled many participants to successfully travel routes in a complex transit environment in which they were given no information other than that available from the Talking Signs, themselves.

The Talking Signs system proved to be beneficial to travelers using dog guides as well as those using long canes. It was useful to persons having hearing loss as well as those having some useful vision. Participants whose spatial skills were relatively poor had the greatest difficulty using the Talking Signs system efficiently and to their best advantage, but nearly all were nonetheless successful in traveling one or more easy routes, and some were successful in traveling medium and hard routes. Individual training in use of the Talking Signs system appears to be particularly important for users having poor spatial skills.

Participants who had the opportunity to use Talking Signs receivers independently at Powell Station during a four month period gained increased confidence in using the system. On the whole, despite the fact that at post-test subjects were familiar with some routes and parts of the station, they nonetheless continued to use their receivers to locate almost all of the key messages. They often reported locating messages to confirm that they were headed in the correct direction.

In focus groups it was clear that the opportunity provided by the Talking Signs system to obtain wayfinding information at will, whether to obtain new information or to confirm

information, gave users a greater level of confidence and ease in traveling in this complex environment than they usually had when using complex transit stations. Participants expressed overwhelming pleasure in the opportunity to travel in a complex, relatively unfamiliar environment without the need to frequently ask for information or assistance. This transit station which had previously been avoided by some participants became a preferred station.

It may help the reader to understand the savings in time and energy (as well as reduced personal discomfort and inconvenience) provided by the Talking Signs system, if we return to the data on route completion (Table 2). Subjects successfully reached their destinations on 169 of 196 (86%) routes. Along those routes subjects passed decision points at which they needed information provided by a Talking Signs transmitter a total of 500 times. Had Talking Signs transmitters been unavailable, the travelers would have had to get some form of information or assistance, or to make their travel decisions on less definitive information 500 times.

Steering Committee

The activities of this project were guided, in part, by a Steering Committee comprised of administrators of agencies providing services to blind persons, blind persons who regularly use public transit, and accessibility officials from the San Francisco Municipal Railway (Muni) and the Bay Area Rapid Transit (BART). They assisted in planning the direction the project would take at certain points in its evolution and were often responsible for deciding important policy issues. At the conclusion of the project, the Steering Committee unanimously approved the following final recommendation to be presented to Project ACTION.

> **"Having noted that the Talking Signs system enables users who are print handicapped to travel independently throughout a complex transit station, that even users who receive minimal training benefit from this system, and that transit operators experienced no operational hardships as a result of this system, we recommend that remote infrared audible signage (specifically Talking Signs®) is the preferred technology enabling print handicapped persons to travel independently in transit facilities."**

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Project Steering Committee Membership

- Ms. Annette Williams, Director of Muni Accessible Services.
- Mr. Ron Brooks, BART Access Planning Department.
- Ms. Anita Baldwin, director of the Rose Resnick Lighthouse for the Blind.
- Mr. Mike Cole, director of the Living Skills Center for the Visually Impaired.
- Dr. David Kallinger of the Center for Independent Living.
- Barbara Rhodes of Metropolitan Transportation Commission's Elderly and Disabled Advisory Committee and the Santa Clara County Transit Agency's *ad hoc* Committee for Transporting the Mobility Impaired.
- Mr. Jerry Kuns of Talking Signs, Inc.
- Ms. Jewell McGinnis president of Blind San Franciscans, Inc.
- Mr. Tom Karns of the Muni Accessibility Committee.
- Mr. Ken Moriyama, chairman of the BART Accessibility Task Force and director of Losing Sight Foundation.
- Mr. Jerry Fields of the Muni Advisory Committee and Muni Paratransit Training Committee.
- Mr. Bill Gerrey of The Smith-Kettlewell Eye Research Institute.

APPENDIX B

Project ACTION - FOCUS GROUP

Purpose:

To obtain additional information and insights from persons who are blind who are experienced users of Talking Signs. This information and these insignsts will be used to guide decisions about Talking Signs installations and about training in use of Talking Signs.

Introduce all group members.

Rules:

Each participant will first have an opportunity to respond to each question or topic, without any discussion by other participants. This is to encourage presentation of the full range of ideas that group members have. Then each response will be discussed by the whole group, in light of the total range of responses made by all the members.

Questions:

1. In what way is your travel in a transit station having Talking Signs different from use of a station which does not have Talking Signs?

2. What do you think is the most important thing to emphasize in training?

3. What do you think is the best way to hold the receiver?

4. How would you tell a new user to hold the receiver?

5. What do you think is the best way to look for signs?

6. How would you tell a new user to look for signs?

7. Would you tell a new user to keep the receiver on while walking toward signs? Why?

8. Would you recommend that the receiver be moving while the user is walking? Why?

9. How important is it that users know something about how the technology works, as well as about how to use it?

   Very important Somewhat important Not very important Unimportant

10. What do you think users should be told about how the technology works?

11. How much training do you think users should have?

12. What do you think is the best way to provide training?