Talking Signs for the Blind
FINAL REPORT
IQP #1212

By

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Date: October 18, 2001

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ACKNOWLEDGEMENTS

ABSTRACT

The goal of this project was the application of technology to a social issue, in this case the inability of the blind community to locate stores or other pertinent information. The original plans called for a talking sign that could be sold as least expensive as possible, but any further details of the operation of this sign were to be determined by the project group. We determined a need for this audible sign for the location of stores in a mall, routes of buses, aisle contents of libraries and supermarkets, and many other possible uses, through market research. We then developed our specifications for our design and implemented our design in the form of a working prototype.

EXECUTIVE SUMMARY

The goal of this project was the application of technology to a social issue, in this case the inability of the blind community to locate stores or other pertinent information, in less than twenty-one weeks. The device was to operate over a RF channel and be capable of audibly informing the person of any pertinent information. The individual operating the device should have some sort of transmitter that would send out a signal, triggering the sign to play back any information this sign contained. As to where the sound would emanate was to be decided by the market research we would perform. There are many other questions that needed to be answered through market research, because we wanted this device to meet the requirements of the customers.

To complete this project, we followed the basic engineering design method. This method is a five-step process that includes a needs assessment, problem formulation, abstraction and synthesis, analysis, and implementation. In the needs assessment stage we determined a need for an audible sign through extensive market research, and then in the problem formulation stage we set our product specifications. In the abstraction and synthesis stage we brainstormed for possible design solutions, and then after analysis determined to use an FM transmitter and receiver in our device. The implementation stage is when we developed our prototype.

The prototype we are working on meets most of our specifications. The device can easily be sold for under the one hundred dollar price tag the consumers said they would pay, this would also allow for great profit. Our device does however have some minor areas that could be improved upon.

The main area of improvement is that the packaging of the device needs some improvement before going to market. The clarity of the recording could be improved upon, and with a larger budget we may be able to improve the battery life of the device.

GENERAL OUTLINE OF TALKING SIGNS FOR THE BLIND

LIST OF ILLUSTRATIONS

1 INTRODUCTION

1.1 PROJECT GOALS

The purpose of this project was the application of technology to a social issue, in this case the inability of the blind community to locate stores or other pertinent information. The device must operate over a RF channel and be capable of audibly informing the person of any pertinent information, such as a store name or items located in an aisle. The individual operating this device would have some sort of transmitter that would send out a signal to a receiver at the sign itself, triggering the sign to play back any information this sign contained. We have concluded that the sign will transmit this information back to a receiver the individual is holding and will be played via a speaker. This process has been determined through our research of existing devices similar to this and extensive market research of what the consumer's requirements are.

The goal of this project is to construct an item that will be ready for the consumer market, and will aid the blind community in a common everyday occurrence, such as store location. This project will demonstrate the knowledge we have acquired here at WPI over the past four years. In order to accomplish this goal we will need to find equilibrium between time, cost, and quality. All of these factors can be exchanged for one another in order to better another area of a product. The perfect trade off of one area for another will come from the engineering design method.

1.2 PLANNED APPROACH TO THE PROBLEM

The methodology we used to complete this project followed the basic engineering design method outlined in the textbook *Engineering by Design* by Voland (pp. 5-7). In order to complete this project we will need to follow this basic engineering design method. This method consists of:

1. Needs assessment

2. Problem formulation

3. Abstraction and synthesis

4. Analysis

5. Implementation

Needs Assessment:

Our needs assessment was determined by extensive surveying of the consumer market, and an extensive look into the market of similar aids to the blind. We determined the needs of the consumer and began to brainstorm over possible problems.

Problem Formulation:

We determined exactly what the problem was that we were trying to solve. We also set design goals and specifications for our project during this stage.

Abstraction:

The third step to the design process is to develop general concepts or approaches to solving the problem. We brainstormed for possible design solutions and came up with

the best possible solutions to our project goal. These possible solutions were further

tested in the following step.

Synthesis & Analysis:

After much analysis of the possibilities from the previous step we determined

which components and approaches best suited the needs and requirements of the

consumer market. We compared and contrasted many design ideas in this stage. From

here determined the best approach to our problem

Implementation:

This is the final stage in the developmental process. Here we developed our

prototype and through extensive testing ensured that our product worked as closely to the

costumer requirements as possible. See Section 3, the Product Specifications, for further

information on market research, consumer requirements, product requirements, and final

specifications.

Our prototype was developed to meet the product specifications. Another

obstacle that we faced was the cost, time, and quality of the final product. The cost was

determined from the market research to be roughly one hundred dollars and needed to be

met as closely as possible. The quality was a variable that was dependent directly on the

cost and time that was put in. The time was the only factor that was a constant in this

process. Our time restraint was limited to twenty-one weeks.

1.3 A NEED FOR TALKING SIGNS

The concept of talking signs to aid the visually impaired is not a new concept by

any means. Ever since the advent of the car with its busy intersections, and the creation

of large shopping centers such as malls and super markets, there has been some need to aid disabled people in navigating these places. We take it for granted when we cross a busy intersection, or go to a mall and look at a sign to see what store we are in front of, or read the label of a product on the shelf of a super market. We take this for granted because we have relied on our eyes to tell us just about everything we need to know about our surrounding environment. If we suddenly had our vision taken away from us then we would find ourselves in a very confusing world that is designed for people with vision. One way to make this world a little friendlier would be to have it talk to us, using talking signs.

A talking sign is not a technically challenging issue at all. With transmitters placed in certain locations, a blind person with a receiver could avoid asking a nearby stranger and find out where he/she was by simply listening to the sign. There are many reasons why such a system is beneficial. One of the biggest benefits of a talking sign system would be that it would give a visually impaired person the confidence to go places on their own. Since a visually impaired person cannot see where they are going they will familiarize themselves with one route and stick to it. But with a talking sign system helping them travel it would give them the confidence to go to new places.

Another benefit to a talking sign system is that it would help reduce the depression associated with blindness. Depression can be caused when a visually impaired person is unable to go to places because they are unable to navigate their way around. If the individual is partially blind and cannot read the surrounding signs or totally blind then they will most likely feel uncomfortable in traveling to new places in

the fear of getting lost. A talking sign would most likely increase their confidence to travel and decrease the depression.

Not only would a talking sign system help the blind, but it would also be helpful to people who have low vision. According to the World Health Organization (WHO) there are approximately 8.9 million Americans with low vision, world wide there are approximately 110 million individuals with low vision[1]. These signs would be helpful to those individuals who are unable to read signs.

Not only would the signs help the visually impaired but also they could be of assistance to travelers. Anyone who travels a lot could benefit from such a system. At the touch of a button you could be given directions to your destination or information about where you are. No matter if you are totally blind or if you have one hundred percent of your vision, this system serves to benefit everyone.

2. LITERATURE REVIEW

2.1 COMPONENTS OF THE EYE

The entire eye, often called the eyeball, is a spherical structure approximately 2.5 cm (about 1 in) in diameter with a pronounced bulge on its forward surface. The outer part of the eye is composed of three concentric layers of tissue. The strong outer layer is the sclera, which is the visible white of the eye and acts as a protective coating. This covers most of the eye, but at the front of the eye there is an exposed surface with a transparent covering, the conjunctiva.

"The layer underneath the sclera is the choroid, a layer rich in blood vessels and nutrients. Toward the front of the eye, this layer thickens to form the ciliary body."[1] "The choroid is continuous with the ciliary body and with the iris, which lies at the front of the eye."[2] The Iris is a circular curtain of muscle fibers, which will vary in color from person to person, thus the difference in people's eye color. The pupil lies in the center of this. Light is allowed to enter the eye through the pupil, the exact amount is controlled by the dilation of the pupil.

"The cornea is a tough, five-layered membrane through which light is admitted to the interior of the eye."[3] Behind the pupil is the crystalline lens, which is a flattened sphere of transparent fibers. The lens is connected to the ciliary muscle through a series of ligaments. The focusing of the eye is made possible by the contraction of the ciliary muscle, which flattens or thickens the crystalline lens. Separating the cornea from the crystalline lens is a chamber filled with a clear, watery fluid, the aqueous humor.

"Behind the lens the main body of the eye is filled with a transparent, jellylike substance, the vitreous humor, enclosed in a thin sac, the hyaloid membrane. The pressure of the vitreous humor keeps the eyeball distended."[4]

Lining nearly three quarters of the body of the eye is the innermost layer, the Retina. The retina is a complex layer, composed of nerve cells called the rods and cones for their shapes. The passing of light through the lens and pupil distorts the image in such a way that it is inverted onto the retina. The rods are very sensitive to

[1] "The American Medical Association Family Medical Guide", © 1987 by Random House, Inc. Page 314
[2] "Eye," *Microsoft® Encarta® 98 Encyclopedia.* © 1993-1997 Microsoft Corporation.
[3] "Eye," *Microsoft® Encarta® 98 Encyclopedia.* © 1993-1997 Microsoft Corporation.
[4] "Eye," *Microsoft® Encarta® 98 Encyclopedia.* © 1993-1997 Microsoft Corporation.

light and enable you to see in dim lighting. The cones, on the other hand, detect color and fine detail. There are 125 million rods and 7 million cones in each eye. These light-sensitive receptor cells lie on the outer surface of the retina in front of a pigmented tissue layer. "Between them, the rods and cones transform the sensations of color, from and light intensity that they see into nerve impulses."[5] These impulses are then transmitted along retinal nerve fibers to the optic nerve and finally to the brain. "The brain interprets the impulses received from each eye, reverses the images, and integrates them into one three-dimensional image."[6]

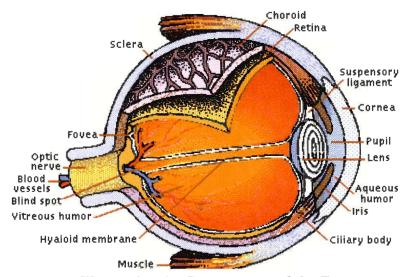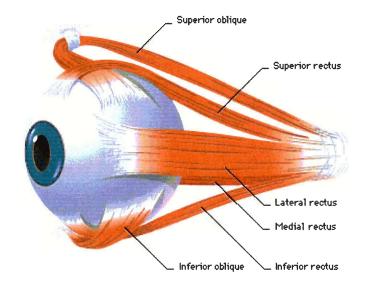

Illustration 1: Components of the Eye

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[5] "The American Medical Association Family Medical Guide", © 1987 by Random House, Inc. Page 314
[6] "The American Medical Association Family Medical Guide", © 1987 by Random House, Inc. Page 314

Superior oblique
Superior rectus
Lateral rectus
Medial rectus
Inferior oblique
Inferior rectus

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Illustration 2: Muscles Controlling the Eye

2.2 FUNCTIONING OF THE EYE

In general the eyes of all animals resemble simple cameras in that the lens of the eye forms an inverted image of objects in front of it on the sensitive retina, which corresponds to the film in a camera.

Flattening or thickening the lens accomplishes the act of focusing the eye. This process is also known as accommodation. For the normal eye, accommodation is not necessary to see distant objects, because a normal eye is focused for distant vision. The eyeball is flattened, specifically by the suspensory ligament, when viewing distant objects. This flattening brings the objects into focus on the retina. "To enable the eye to focus on closer objects, the ciliary muscles of the eye thicken and contract the lens, a process known as accommodation"[7]. At a young age the lens is pliable and enables

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[7] "The American Medical Association Family Medical Guide", © 1987 by Random House, Inc. Page 317

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children to see objects close by without any visual aids (approximately 6 cm), but as you age the lens begins to harden and your ability to see objects close by is greatly reduced (about 40 cm at age 50). This condition is known as presbyopia and can be corrected as painlessly with the use of special convex lenses in their glasses.

"The cone-shaped cells of the retina are individually connected to other nerve fibers, as a result fine details can be distinguished. Rod shaped cells, are connected in groups so that they respond to stimuli over a general area. The rods, therefore, respond to small total light stimuli, but do not have the ability to separate small details of the visual image."[8] This results in the ability for the human eye to have a field of vision with great sharpness near the central portion of the eye. An area of lesser sharpness then surrounds this central area. One interesting fact about the outer area of the eye is that it responds better to light, thus objects can be seen in dim light in this outer area of the eye but not in the central area.

"Subjectively, a person is not conscious that the visual field consists of a central zone of sharpness surrounded by an area of increasing fuzziness. The reason is that the eyes are constantly moving, bringing first one part of the visual field and then another to the foveal region as the attention is shifted from one object to another."[9] "The eye is 'directional' in that six separate muscles swivel it to look at objects in various locations, and this directional information is passed to the brain."[10] "The motions of the eye muscles are extremely precise; the estimation has been made that the

[8] "Eye," *Microsoft® Encarta® 98 Encyclopedia.* © 1993-1997 Microsoft Corporation.
[9] "Eye," *Microsoft® Encarta® 98 Encyclopedia.* © 1993-1997 Microsoft Corporation
[10] "The American Medical Association Family Medical Guide", © 1987 by Random House, Inc. Page 64.

eyes can be moved to focus on no less than 100,000 distinct points in the visual field."[11] One of the most important tasks of the muscles surrounding the eye is to converge them on one distinct point. When this convergence does not function properly double vision results.

2.3 DISEASES OF THE EYE

Classification of eye diseases usually correspond to the region of the eye the in which it occurs. Some of the more commonly known are myopia, hypermetropia, astigmatism, glaucoma, cataracts, presbyopia (described previously), macular degeneration, and retinal detachment.

Myopia is the medical term for nearsightedness. In nearsightedness the eye is often too long or the focusing power of the cornea and lens is too great. The result of this is a blurred image of an object at a distance. This disease can be remedied by wearing concave lenses in your glasses.

Hypermetropia, or more commonly known as farsightedness, is often cause by the eye being too short or the focusing ability of the lens and cornea is too weak. The result is a blurred image when attempting to focus on objects close up. This disease can often be overcome by a younger eye by a process previously described, accommodation. However, if the problem cannot be overcome a pair of convex lenses will enable you to read objects close up.

Astigmatism is caused by the curvature of the cornea being uneven. Either vertical or horizontal lines will be in focus, while the other remains blurry. This disease can also be corrected by the use of a corrected lens.

[11] "Eye," *Microsoft® Encarta® 98 Encyclopedia.* © 1993-1997 Microsoft Corporation

Glaucoma is one of the most serious eye disorders for people over 60 years of age. "The ciliary body in the eye constantly produces a fluid called aqueous humor, which circulates from behind the iris, through the pupil, and into a chamber between the iris and the cornea."[12] This drains quickly in a healthy eye through the use of the drainage angle, a complex network of tissue between the iris and cornea. In some eyes the drainage angle does not work properly, either flowing away slower than it is being produced or not flowing away at all. This increase of fluid causes pressure to build up in the eye. "Part of the extra pressure is exerted, via the lens, onto the vitreous humor, the jelly like fluid that fills the eyeball behind the lens. This pressure causes the collapse of tiny blood vessels that nourish the light sensitive cells of the retina and the fibers of the optic nerve. Since these are deprived of the nutrients and oxygen they need to live, they begin to die and vision fades."[13]

"A cataract is an opaque area that occurs in the normally clear lens of the eye. Over a period of years, the cataract blocks or distorts light entering the eye and progressively reduces vision."[14] This is most commonly caused by the deterioration of the lens through old age. Cataract surgery is becoming a common practice to remove the damaged lens and replace it with a fresh lens.

Macular degeneration is caused when the small blood vessels of the eye become narrowed and hardened. This hardening causes the macula, the central portion of the eye responsible for fine detail at the center of the field of vision, to not receive enough blood. This lack of blood causes the macula to degenerate and soon after blurring of the central vision.

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[12] "The American Medical Association Family Medical Guide", © 1987 by Random House, Inc. Page 326
[13] "The American Medical Association Family Medical Guide", © 1987 by Random House, Inc. Page 326
[14] "The American Medical Association Family Medical Guide", © 1987 by Random House, Inc. Page 325

"Retinal detachment occurs when the retina lifts away from the choroids. A hole in the retina causes the detachment in most cases. The hole forms either because of degeneration of the retina or because the vitreous humor has shrunk away from the retina and torn it."[15] Eventually the retina is only attached by the ciliary body, at the front of the eye, and the optic nerve at the end.

2.4 AID TO THE BLIND COMMUNITY

It was not until the end of the 18th century that any organized effort was made to provide blind people with education, books, rehabilitation, or training in appropriate occupational fields. French educator Valentin Haüy founded the first school for blind people in Paris in 1785. Known as the Institution Nationale, it still operates today. During the 1790s schools for indigent blind people were opened in several cities throughout England and Scotland. Their original purpose was to offer instruction in manual labor, but within a few years a system of general education was adopted. In 1806 Haüy established a school for the blind in Russia and aided in the establishment of a similar school in Berlin. These schools proved so successful that by 1811 similar institutions were established throughout Europe.

In the United States, American physician John Dix Fisher founded the first institution for blind people in Boston. This institution was incorporated in 1829 and is now known as the Perkins School for the Blind; since 1913 it has been located in Watertown, Massachusetts. The New York Institute for the Education of the Blind (1831), the Pennsylvania Institution (1833), the Ohio School for the Blind (1837), the Virginia School (1838), and the Kentucky School (1842) are among the earlier private

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[15] "The American Medical Association Family Medical Guide", © 1987 by Random House, Inc. Page 330

institutions for blind people established in the United States. These schools are privately managed but have received state aid almost since they were founded. Many other boarding schools for blind people have been established since then.

In 1900 the city of Chicago, Illinois, organized classes for blind children in public schools. The city thereby initiated the policy under which blind students attend regular classes with sighted children and are segregated only for special classes. Nearly all larger cities in the United States have adopted this policy and all of the states have established schools or made arrangements with schools in other states for free education of blind students from kindergarten through college.

Writing and Publications

Haüy introduced the first printing in raised letters on paper in 1784. He used the italic style of type, embossing the paper with large and small letters set in movable type by his pupils; other styles of type were attempted later. Because of the large type size required, however, the books produced were bulky and expensive. The only system of line type (type characters consisting of embossed lines) in current use is based on outlines of the roman letters; William Moon of England invented it in 1847.

In 1821 a French army captain, Charles Barbier, invented a system of *point type,* a code based on groups of dots. Louis Braille adapted Barbier's system for blind people, using groups of one to six dots. A conference of workers for sight-impaired people held in London in 1932 to standardize point systems adopted an alphabet known as Standard English Braille, which is the original Braille alphabet with a few modifications. This system is now used throughout the English-speaking world and has

been adapted to most other languages, including Chinese. Braille also devised a system of point characters for musical notation.

The American Printing House for the Blind in Louisville, Kentucky, is the principal U.S. producer of books for blind people. In 1882 the Perkins School for the Blind started the first circulating library for blind people. The Library of Congress, many state and municipal libraries, and private associations in most large cities now provide circulating library services. They also circulate so-called talking books, recordings of readings from classical and popular literature. Many commercial publishers produce books and periodicals in large print, using 18-point type, for the benefit of two groups of people. One group, although classified as legally blind, has sufficient residual vision to comprehend large print. The other group includes people who are considered functionally blind because they are unable to read ordinary print.

Among the early appliances developed to aid blind people in writing was the grooved tablet, a sheet of metal or board grooved in small squares. The paper was placed on the tablet, and the pencil, guided by the grooves, indented the paper, forming a large, square handwriting that could be distinguished by both sight and touch. Modern methods employed in American institutions include the use of the typewriter for correspondence with people who can see and the use of tablets for guiding a blind writer in the formation of Braille characters. In addition, the Hall Braille writer, a modification of the typewriter, embosses Braille characters on the paper instead of printing standard visible letters.

Rehabilitation

Pensions or similar forms of financial relief for impoverished blind people were first provided by New York City in 1866. The state of Illinois enacted relief measures in 1903 and by 1947 all states had made similar provisions. With the passage of the Social Security Act in 1935, the federal government supplemented state aid through several agencies. The Social Security Administration provides monetary benefits to blind people; the Rehabilitation Services Administration of the Office of Human Development Services cooperates with state, municipal, and private agencies in formulating plans for treatment and reeducation of sight-impaired people; and Special Education and Rehabilitative Services, a division of the Department of Education, conducts surveys of industry and trains personnel executives to help blind people secure suitable employment. All such federal aid is distributed through state and municipal agencies and local organizations supported by voluntary contributions.

Physical Aids

Specially trained guide dogs have proven successful in aiding some blind people. The Seeing Eye, a nonprofit organization in Morristown, New Jersey, began in 1929 to supply at least 100 dogs a year for nominal charges. Inasmuch as only about five percent of blind people can use dog guides successfully, recipients are selected with great care, and are required to complete a rigorous training period with the dog chosen for them.

During World War II (1939-1945), the U.S. Army Signal Corps developed an electronic eye that enabled a blind person to perceive obstacles in a path. Since then,

more refined electronic devices have been developed. In practice, the majority of blind people today achieve relative mobility and independence simply by the use of canes.

3 PRODUCT SPECIFICATION

3.1 MARKET RESEARCH

Market research played a major role in our development and design of our Talking Sign. The needs of the consumer were the factors that determined exactly what we were going to build. Many questions had to be answered by the consumer that would enable us to build the product the consumer wanted, and hopefully would buy. So, how do we determine what the consumer wants, we ask them. We decided to survey the consumer, but first we had to know what similar products were already out in the market.

3.1.1   Alternatives to Talking Signs

We are attempting to better the lives of all visually impaired individuals by designing a device to alert the individual of relevant information or obstacles ahead. This has been a task for many individuals over the years, but few have succeeded. What problems do the blind face every day? Once these problems are detected we can easily find practical solutions to them.

Blind individuals find traveling difficult and hazardous because they cannot easily determine "where" things are, a process otherwise known as "spatial sensing." The techniques for spatial sensing are well known, radar, sonar, and optical triangulation methods being the most common, and the latter two have been incorporated into a wide variety of past ETA designs.

There are many problems with these current devices. First, the rangefinder technology is unreliable in its detection of step-downs or step-ups, such as curbs. Secondly, many believe blind users find the sounds of various pitches or tactile vibrations being used difficult to understand. This is one area we are trying to find more about in our surveying of the blind community. Thirdly, most blind users do not find the slight improvement in mobility performance to be worth the extra cost (we are trying to improve technology at fairly inexpensive costs), and the additional worry of maintaining and keeping track of a complex system.

One product on the market today emits ultrasound and the returning ultrasonic echoes are translated back down into the audible domain and presented to the blind user. The time-based cues responsible for spatial hearing are encoded upon the sound, thereby creating the illusion of an externalized auditory image located out in space at the detected object's position. While this product has promise, one of the significant drawbacks is that the user must wear earphones, which can interfere with the listening of normal environmental sounds. One product becoming more recognized is the Mowat Sensor.

The Mowat Sensor is a pocket-sized device containing an ultrasonic air sonar system. When it detects an obstacle, the device vibrates, thereby signaling the user. This has the obvious drawbacks listed above. Another product that is becoming better known is the Talking Cane.

This patented invention is a small laser unit to be placed on the white cane for blind and visually impaired. The unit contains a laser transmitter and a receiver that picks up reflections from obstacles like walls and persons. But the receiver also picks up reflections from special retro reflecting signs formed as bar codes at much longer

distances - up to 15 meters. A microprocessor in the unit identifies the bar codes and presents the signs as spoken messages from a small built in loudspeaker. Some individuals are attempting to improve blind peoples' lives by replicating a bat's vision.

This device, known as Sonar Vision Glasses for the Blind, provides information that is not available to the blind by other means. It is a fact that non-sighted persons have a better sense of hearing and feeling by touch than people without this disability. A blind person usually obtains tactile information about his/her immediate environment by using his/her cane or a guide dog. The Sonar Vision glasses were developed to supplement this tactile information. The user can obtain information, from the auditory feedback of the Sonar Vision glasses, about the existence and distances of obstacles within 3-4 meters in front of him/her by the pitch of the warning signal. Higher pitch means a closer obstacle. Lower pitch means an obstacle is further away. No pitch means no obstacle poses an immediate threat.

It is a problem to the sightless or near-blind people to walk trough a simple door or to get on a bus. With this auditory feedback, it is possible to "feel" distances and gaps by moving the head to different directions - this way the user can scan his/her surroundings and get exact information where doors and openings are. Please note that the device can only warn its user of the obstacles within its scanning range, and the stem-implanted mechanism only "looks" in the direction of the user's head, which is mostly straight ahead. Because of this, the device may be unable to indicate small holes or other obstacles just in front of the user's feet. Its range is in a 40-degree cone in front, so things on both sides, and up and down, can only be detected if the user turns his/her head that

way. This also means that, while these devices are efficient supplements to a cane and/or guide dog, they are not made to replace them.

3.1.2 Customer Feedback of Existing Products

The following two essays were emailed to the project members and we felt that they would be relevant to the topic at this point.

Essay 1:

"To public-works officials in Baltimore, it seemed like a good idea:

Install the city's first audible traffic signals, to both aid blind pedestrians and help the U.S. play catch-up on a promising technology. But last October, when officials laid plans to outfit four intersections with beeping devices, they ran into unexpected flak -- from some blind residents themselves. The nonprofit National Federation of the Blind, which maintains that audible signals are usually unnecessary, objected to the proposed locations. The group says the spread of needless audible signals would reinforce stereotypes of the blind as people who need huge amounts of help. So Baltimore tabled the plan -- only to trigger a protest by members of the nonprofit American Council of the Blind, which had sought the signals in the first place. Now Baltimore is going ahead with a slightly altered plan, months behind the original timetable. "It doesn't make it easy, from a public-policy perspective, when two groups of the blind differ drastically on these signals," says Sheila Dixon, president of the city council.

Division within the blind community has slowed adoption of the audible-signal technology in much of the country, says Lois Thibault, research coordinator for the U.S. Architectural and Barriers Compliance Board, which makes rules under federal

disabilities law. The so-called accessible signals beep, chirp or give voice messages to alert the blind when a "Walk/Don't Walk" signal changes. Some devices emit noises automatically, while others require activation by a button.

By some estimates, there are roughly 5,000 communities in the U.S. that have some audible signals. Many are on the West Coast, such as San Francisco and Seattle. Ms. Thibault and others say many blind individuals have requested audible signals near their homes, but the requests often meet opposition from other blind people. Clashes over proposed signals have arisen in recent years not only in Baltimore, but also in Minneapolis, Vancouver, Wash., Portland, Ore., and Hot Springs, Ark, according to advocates for the blind.

Though declaring itself "flexible" since 1992 on the issue of audible signals, the National Federation of the Blind confirms that its chapters -- and sometimes just individual members -- occasionally oppose requests for signals. "If there is a plain four-way stop and no good reason for an audible traffic signal, the mere request of a single individual would not justify it," says James Gashel, director of governmental affairs. Indeed, the wrangling in Baltimore led the city to change one of the four locations slated to get the signals to a more complicated intersection. The federation believes the signals, if used in intersections that aren't especially complex, can stigmatize the blind. The group also believes that money used for signals could be better applied to programs such as job training for the blind. Some members think the devices can even be harmful at times.

Scott Labarre, a 32-year-old Colorado lawyer, says he was once distracted by a beeping signal and thus nearly stepped in front of a moving car. "I was afraid my cane was going to get crunched, if not myself," he says. In Salt Lake City, 52-year-old Ray

Martin says audible signals "are useless to me. I've been taught the proper skills of cane travel." The National Federation viewpoint tends to reflect the opinions of the most mobile and cane-savvy of the blind, sometimes known among themselves as "super blinks." The American Council, which advocates changing facilities to help blind people, tends to speak for the less mobile -- and more numerous -- members of the community. Both groups say they represent all blind people. Marlaina Lieberg, a 51-year-old Seattle resident and member of the American Council, says she was once hit by a car in Boston when a "Walk" light changed sooner than she expected. An audible signal would have helped, she says, calling the issue a "no-brainer." She adds: "Why wouldn't you want any cue you could possibly use to enhance your safety?"

Accessible signals are already widely used in Europe, Japan and Australia. Bob Panich, owner of a company that installs such signals in Australia, says: "We're most surprised at the U.S. being so far behind in this regard, knowing that the U.S. also has antidiscrimination laws and a powerful deaf/blind lobby." The U.S. is moving to catch up. Following intense lobbying by disability coalitions, Congress in 1999 made federal funds available for accessible signals in the same way it was already available for such things as sidewalk wheelchair ramps. Only traffic signals that are along public bus or rail lines are eligible. The devices typically cost $400 to $500 per box, with eight needed for a four-corner intersection. In addition, a key federal manual for highway engineers late last year included standards for accessible signals for the first time. The action removed a huge stumbling block: communities' fear of liability suits if they installed signals without uniform standards. "A lot of communities didn't know what to put in. Now a standard is

available," says Julia Wilkie, a project engineer at MDU Resources Inc.'s Wagner Smith unit, which installs and maintains traffic signals for 140 Ohio communities.

Another boost for accessible signals came in January, when a federal advisory panel endorsed the devices, making a federally mandated phase-in likely within a few years. Such a mandate could require that new intersections or ones being rebuilt include accommodations for the blind. The signals promise to take some hazardous guesswork out of the way the blind cross streets: They listen carefully for traffic sounds, then take their chances. When Mr. Labarre, the Colorado lawyer, needs to cross Denver's Colorado Boulevard where it intersects Mexico Avenue, there is often heavy traffic moving along Colorado. So he listens for that traffic to stop for a red light. When he thinks he hears that, he enters thecrosswalk, sweeping a white cane back and forth in sequence with his steps. Crossing "Is not terribly complicated," he maintains. But the procedure seems terribly intimidating and risky to many other blind people, who are happy when they encounter audible signals. "You know precisely when the walk signal is on," says Christopher Gray, a 46-year-old San Francisco technical writer. When standing at Shattuck Avenue and Center Street in Berkeley, Calif., Mr. Gray says he hears a chirping sound if pedestrians crossing Shattuck have a "Walk" signal; otherwise he hears a cuckoo sound. Several trends in traffic control have been making it harder for the blind to predict when lights will change. Computerized traffic flow, for example, sets traffic lights depending on such things as traffic density instead of at regular timed intervals. Advocates of audible signals say that at least a dozen blind pedestrians have died while crossing streets during the last three years, though whether an audible signal would have changed the outcome isn't always clear. Berl Colley, a 58-year-old computer

programmer in Lacey, Wash., says he was once struck by a car and badly bruised. "Now, every time I cross the street, I wish I had some audible indication that I should go," he says. While the disagreements among the blind have slowed the advance of audible signals, marketers think the industry is poised for a leap forward. "It's going to be another two years before it really takes off, but it is building momentum now," says John McGaffey, president of Polara Engineering Inc. The Fullerton, Calif., firm, has sold audible signals for several hundred intersections, including many in Las Vegas. Meanwhile, Novax Industries Corp., Vancouver, has outfitted about 1,000 intersections in the U.S. and Canada during the last six years. Most accessible signals are heard by all within earshot, but there is another promising technology to help blind pedestrians. In San Francisco, about 100 blind people carry special receivers marketed by Talking Signs Inc., a small company in Baton Rouge, La. The receivers pick up infrared-light signals from transmitters installed inside buildings and, in a few cases, at intersections. Users can hear a computer-generated human voice describe the surroundings and the status of any traffic lights."[16]

Essay 2:

"Ever since the early 1960's inventors have tried to use electronic technology to assist blind and partially sighted people to travel and move successfully. This paper aims to look at electronic orientation and mobility aids that already exist, aids that are likely to be produced in the future and most importantly what the user wants from these aids.

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[16] Audible Crosswalk Signals Divide Blind Community --- *Devices Are Common in Europe, But Opponents Say They Can Stigmatize and Distract*, Jeffrey A. Tannenbaum (Staff Reporter of The Wall Street Journal). 03/13/2001
The Wall Street Journal

The percentage of blind and partially sighted people who are independently mobile has not increased over the last 30 years. This has lead to a large number of technical projects that aim to assist the users when they travel.

Electronic Orientation Aids

Electronic orientation aids have been designed to give orientation and way finding information to blind and partially sighted people. The information they can provide includes location and direction information as well as information on objects in the users environment. Electronic orientation systems aim to give users orientation information, which they can follow so that they can find their destination from their start point, whilst following a safe and sensible route. The signs can be used to give messages such as:

Female changing rooms on your right, straight ahead for male changing
Stairs up straight ahead for upper shopping level

They have all been designed to be used with the users own mobility device - long cane or guide dog. If the system fails for any reason the worst that can happen to the traveler is that they will fail to find what they are looking for or they will get lost.

A number of electronic orientation devices exist or are being developed to assist blind and partially sighted people; these include a wide variety of beacon systems, magnetic strip systems and a number of global positioning systems. Initial work has started which aims to produce standards for the use and installation of electronic orientation systems.

Electronic Mobility Aids

Electronic mobility aids have been designed to either supplement or replace the users primary mobility aid - long cane or guide dog. Although the first electronic

mobility aids were designed over 30 years ago there are very few users of these systems. The only primary electronic mobility aid currently available is based on the long cane. This is a basic long cane with additional electronic equipment designed to detect obstacles above waist height. Secondary mobility devices are designed to act as a supplement to primary non-electronic aid such as a cane or guide dog. They should not be used on their own but provide additional information such as warning the user of head height obstacles. They do not warn the user of the absence of the pavement or floor e.g. steps down or holes in the ground, which would be detected by the primary aid.

The devices generally operate by sending out beams of ultrasound or infrared light. If the beam hits an object it will be reflected back to the device and the presence of the object signaled to the user. Due to the nature of infrared and ultrasound light some objects may be missed. Ultrasonic devices can miss thin poles and infrared devices can miss matt black surfaces.

To make the best use of an electronic mobility device the user should receive training in the aid by suitability trained mobility officer. This will enable the user to use the device safely. If it is secondary mobility device training may also be required in the user's primary aid to refresh their skills and to train the user to use both devices together successfully. For the majority of electronic mobility devices this training is not available in the United Kingdom. Training manuals exist for a number of the devices; for the others a training program will have to be devised.

The mobility and orientation systems are limited in that they are only intended to tell the user which way to go and how to avoid objects on the way there. More complicated systems are currently being developed which give out more information

about the users surroundings. Initial feedback indicates that these systems can be of benefit to some blind and partially sighted people."[17]

3.1 MARKET RESEARCH

In order to find the answers to these questions we developed a survey for the consumers themselves (see Appendices A and B). We feel that meeting the requirements of the consumer is of the greatest importance in this project. Our eventual goal is to market this product and the only way to build a product that the consumer will buy is to ask the consumer exactly what they would like in a product of this nature. After we developed this first survey for the consumer, we emailed it to over fifty newsgroups and email lists specifically designed for the blind community. The response to these surveys was exactly what we had hoped for (see Appendix D). Not only did the individuals answer the questions, but many also included personal stories and situations where a device like this would have helped. These responses further informed us that we were attempting to build a worthy device that would benefit all involved.

The next step was to determine what the storeowners would like to see from a product like this. We decided the storeowners would be a good group to poll because they are going to have to allow the product to be implemented on their property. The single most important reason for determining what the storeowners wanted was that they are the ones that will have to implement these devices and if the product does not meet their needs, then they will not use it. The only way this product will be beneficial is if the device is implemented in as many locations as possible. Otherwise the blind community

[17] Gill Whitney (Principal Researcher), JMU Access Partnership, Royal National Institute for the Blind and the Guide Dogs for the Blind Association, October 2001

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would not have as equal an experience as they could and should have. We again developed a survey for the storeowners (see Appendix C). This survey was dropped off at a variety of stores including major supermarkets, various stores in a shopping mall, and local convenient stores. Again the response was terrific. The storeowners showed great enthusiasm in implementing a device of this nature and believed it would only help both parties involved (see Appendix E).

The data we received proves that an overwhelming ninety-five percent of the stores would implement this device and ninety-eight percent of the consumers would us such a device. These numbers are much higher than first anticipated. There appears to be a market for a Talking Sign in the blind community.

3.2 CONSUMER REQUIREMENTS

Throughout our polling we have incorporated the help of many individuals, including over fifty individuals of the blind community and twenty-one store managers/owners. These individuals included the average middle class man/woman, some members of the upper class (business owners), and representatives from a large chain supermarket, multiple retail stores in a local mall, two large electronics stores, and a local convenience store. We feel this poll represents a great range of individuals and gives us an inclination as to how the product would do on the market due mainly to the diverse group we have interviewed. The following are exactly what the consumers and store personnel would like to see implemented in a market someday soon.

The stores would like to eventually see bar code readers, aisle item indicators, aids in understanding the store layouts, store locators/advertisers, and elevator/escalator

locations. All of these are terrific ideas, but the possibilities for these devices are endless. The store owners/managers would like to see this product widely used.

The consumers themselves would like the product to have the following attributes:

- Device must be small and lightweight, due to importance of free space

- Device must provide store names to user

- Device must use human voice to provide information

- Device must provide other information as needed (i.e. bus stop locations, entrance locations, etc.)

- Device must have audio output with volume control

- Device must have optional earphone jack

- Device must have clip to attach to cane, dog harness, clothing, bags, etc.

- Device must have on/off switch

- Device must not cost more than $100 US dollars

- Device must be incorporated into as many locations as possible

3.3 STORE REQUIREMENTS

In our polling of twenty-one store managers/owners we managed to incorporate a large variety of stores. These stores polled included a large chain supermarket, multiple retail stores in a local mall, two large electronics stores, and a local convenient store. We found that the results followed along with what we had anticipated and believe these results are a good indication of what a larger survey would produce.

All of the store managers/owners seemed to express an eagerness to help the blind community in any way possible, as long as it was going to be cost effective for the store.

All of the stores polled also believed that this device was a great idea and expressed their hope of one day seeing it implemented nationally. They thought that the possibilities for this device were endless and stated that this itself was a very promising indication of the products success.

Some of the areas the store managers/owners would like to see this product implemented are as follows:

- Bar code reader

- Aisle item indicator (especially supermarkets or large retail stores)

- Understanding store layouts

- Store locators or store advertisers, however they use it

- Elevator/escalator locations

3.4 FINAL PRODUCT SPECIFICATIONS

The customer requirements and store requirements lead us to the following product specification:

The device for the customer will be attached to either a cane or dog harness when applicable and will contain a transmitter consisting of an on-off switch. This switch (when on) will emit a signal to all store receivers in a general distance (likely to be 10 feet or so). When the receiver on the store device detects the signal it will trigger a transmitter to send back a signal, consisting of a less than 20 second message that each store will record, to a receiver on the customers device. This message from the store will then be played through a speaker that is part of the customer's device. The optional earphone jack will allow the consumer to listen to the message through headphones rather than being broadcast through a speaker. This could come in handy in the mall when

noise may be a factor but could also hinder the ability to hear other important information and will thus be an option that the individual can chose to implement. The customers' device will also have a volume control that can be easily changed to fit the individuals' needs. These devices should be readily available for best results and should be as cost effective as possible, ideally less than $100.

Hopefully this product will meet the needs of all those who require such a device.

4 PRODUCT PLAN

4.1 TIME LINE

In order to be able to get our product out to market in the allotted time, we needed to set up a schedule of when each task was to be completed. We used a Gantt chart (see Appendix F) to organize our schedule. A Gantt chart is a scheduling matrix that lists the tasks and when the task needs to be completed.

In the first weeks of the project we researched the topic at hand through primary (blind individuals) and secondary (existing articles and research) resources. We spent much of this time determining how the eye functions, just so we could have a better understanding, ad also what diseases can cause blindness, so we know just what many individuals experienced in the past. We also contacted an integral part of this project, Larry Raymond. Larry's knowledge of the blind community and his experiences have helped us throughout this project. Finally, we began brainstorming on possible survey questions and eventual solutions to this project.

In the following couple of weeks, we continued our research for our literature review and the brainstorming. Our main accomplishment was beginning the

development of the first survey for the consumer (see Appendix A). We also met with Larry Raymond at the end of week six, informing him of where we were and what we had planned for this project. Larry recommended that we use the Internet and email for the dispersal of the surveys and gave us many email lists to begin with. This meeting was mostly an attempt to acquire some information from Larry on the daily functioning of the blind community.

Around weeks seven and eight we began to talk with storeowners and mangers in order to begin our development of a survey for the stores. We also began to wrap up our literature review and our research of the eye and it's functioning. We researched and signed up for many email lists and newsgroups focusing on the blind community. We finally began to focus on the surveys that we must send out.

During weeks eight and nine, we developed the surveys for both the consumers and the stores and began to disperse them. The consumer survey was sent out via the Internet to a multitude of email lists and newsgroups. The results began pouring in immediately. The store surveys were handed out at various locations. We attempted to gain a broad spectrum of the store types that the blind community dealt with and hope that we have done a good enough job at obtaining this goal.

The following weeks were spent analyzing the surveys that we had acquired. We received well over fifty emails back about the surveys, and attempted to consolidate these responses. From here we began to brainstorm again on the best solutions to the problem. We also developed our consumer and store requirements, which enabled us to begin the brainstorming process. This brought us up to our summer break, where very little was accomplished.

After our summer break, we got back to work. Progress was slow, as expected after a four-month lay off. We had already determined what the consumer requirements and store requirements were and now had to determine the best possible way to implement these. The product specifications were developed in weeks fifteen through seventeen. Now all that remained was to build the device and wrap up the report.

During weeks eighteen through twenty-one we researched the best components for our circuit and ordered these parts. After the week of waiting, we began to assemble. We used different designs and components to determine which would be the best product for the market. In order to begin the assembly, we purchased a digital recorder from Radio Shack and used this as the recording device for the stores to record their messages. We also purchased a FM transmitter/receiver package and a few resistors and transistors from the ECE shop. Our project was nearly finished. All that was left was to test it and finish up the write up.

In weeks twenty and twenty-one we finished our write up and tested our prototype for the first time. The product functioned properly, but could use some minor adjustments to make it perfectly marketable. Overall, this IQP followed schedule and hopefully will benefit all that were involved.

5   DESIGN APPROACH

5.1 OPTIONS

Upon receipt of our IQP assignment recommendation by Professor Polizzotto, we considered several possibilities for the implementation of a talking sign. First we considered having the device trigger a message to be played directly from the store sign.

This idea was determined to be unacceptable by the consumers after analyzing the surveys.

Next we considered the many possible ways to emit the signal to the sign. We could use ultrasound, FM, infrared, etc. The major problems with ultrasound and infrared location are that they miss objects relatively easily. Ultra sound location can easily miss these poles or tress, etc, because the sonic wave being sent out is not being interrupted enough to detect the object. Infrared on the other hand would pick these objects up but would miss any object that is matte black in color; the infrared beam is not reflected back off of this color. We chose to use a simple FM transmitter/receiver package because it would be the least expensive alternative and the previous group had used FM. We eventually planned to tie both projects together into one working device.

5.2 MODULE DEFINITION

Handheld module   **Store module**

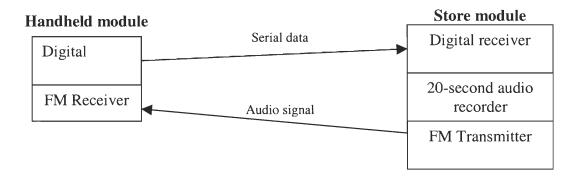| Digital	Serial data →	Digital receiver
FM Receiver	← Audio signal	20-second audio recorder
		FM Transmitter

Illustration 3: Block diagram of completed prototype

The completed prototype consists of two modules. Each module contains a pair of embedded transmitters and receivers capable of transmitting data up to 300ft. Both modules are self-contained and do not requiring any modifications to use, except the

addition of batteries. The cane module has a volume adjustment knob and an optional headphone jack (as specified in the product requirements) and an on/off switch. The store module has a microphone (to record the message) and an LED indicator, to indicate whether the device is recording or transmitting. There is also an on/off switch on this device.
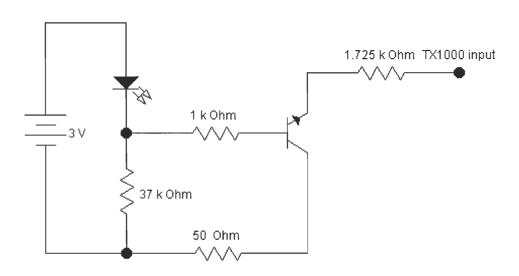
Transmitter schematic

Illustration 4: Cane transmitter schematic

Transmitter

The transmitter that is embedded into the cane is the same transmitter that was used for the audible crosswalk indicator. This is a serial data transmitter that is used to send out a command signal that turns the audio recorder on, a small 3V calculator battery powers this. The blinking LED is used to create the "command" signal. This is simply a square wave of amplitude 3V and frequency of approximately 1Hz. This was the best

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choice for a signal generator since the power consumption of the LED is only 55mA when the signal is high. The square wave is input into the TX1000 transmitter that is then transmitted via an antenna approximately 12cm long.

Transmitting Data

With the addition of an antenna all we need to due is basically plug the output of our transmitter schematic into the input of this transmitter module. We can get away with this because the module works on what is known as carrier-present-carrier-absent modulated transmission, otherwise known as on off keying. This simply means that if a binary "1" is input then the transmission is high and thus is carrier-present. If the input is low or binary "0"then the output is carrier-absent[18].

The Antenna

The antenna is the most difficult part of the assembly for this module, since without it we will not be able to achieve our goal of a "wireless" system. Some of the most common antenna styles are the ½ wave whip or the ¼ wave whip style antenna. For our prototype we will utilize a ¼ wave whip style antenna with an impedance of 50Ω to achieve optimum performance.

In order to design our antenna to the proper length we can use this simple calculation[19]:

$$L = \frac{234}{F_{MHz}}$$

$L = length\ in\ feet$
$F = operating\ frequency$

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[18] Linx Technologies Note #00232
[19] TXM-418-LC data sheet

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$$L = 6.7"$$

To help reduce the size of the antenna we can partially wind the wire about itself. This will help in size reduction but will decrease the total bandwidth of the antenna.

Ill. 5: ¼ Wave whip style antenna with helical coil

Receiver

This receiver is also the same receiver module from the audible crosswalk indicator with one modification. The original receiver only played a piezo buzzer that was mounted on a crosswalk indicator. The only modification to this circuitry that was made was the addition of a switch at the collector and emitter of the NPN transistor. The addition was made at this point so that the audio device would turn on every time a signal was received. Note the buzzer still beeps the same as before. This always us to mount the module in specified locations such as entrances, bus stops, etc. Once this signal is received and activates the recorded message, the recorded message is then sent back to the receiver on the cane. This message is then played via a speaker.
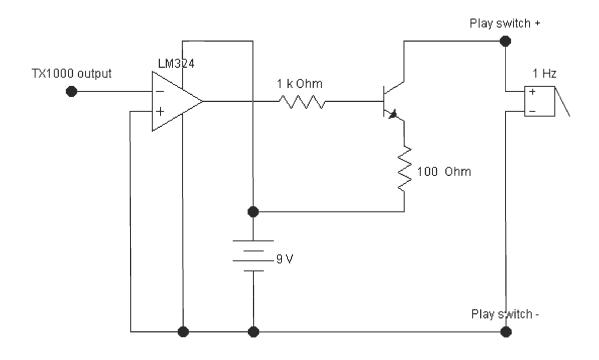
Illustration 6: Receiver schematic (store module)

Audio Recorder

For audio recording purposes the Radio Shack digital voice recorder was used (model #276-1326). This is capable of storing 20 seconds of continuous audio data and comes equipped with a microphone, speaker, play button and record button. The play button was attached to the receiver in the fashion described above (receiver schematic). This device is a good choice since the power consumptions are minimal. The standby current is less than 5μA and the operating current ranges from 24mA to 71mA. The device runs off of 4 AA batteries (4.5V to 6VDC).

FM Transmitter

The transmitter that was used was from a kit that was purchased from Jameco Inc. for only $11.95. The kit, model number K1771, was an easy to assemble 17-piece kit, that runs off of a 9VDC battery and has a transmission range of approximately 300ft. (depending on how good the battery is). The transmission frequency is between 100MHz and 107MHz; we are operating it at 105MHz since there are no local radio stations to interfere with the transmission.

FM Receiver

We utilized a inexpensive ($15) AM/FM radio that was purchased at RadioShack for our cane receiver. This was removed from its original package and was placed into the cane module. This station adjustment knob was set to 105MHz and was then removed so that the user requires no tuning. This runs from the same power supply as the cane transmitter (3VDC).

Final Note

Most of the major components that were used to create these devices were purchased at local electronic stores and for a minimal amount of money. This allowed us to keep the cost down for the prototype and for future products will lower their prices as well.

5.3 MANUFACTURABILITY

This product has been designed for manufacturing. The parts used are mostly standard 5% resistors (with some being 1%), simple transistors, blinking LED's, digital

recorder from Radio Shack, AA batteries, and a 9 V battery. The circuit was designed with minimum cost in mind. Nothing on this device is complicated and thus should be able to be reproduced efficiently and at low cost.

5.4 LEGAL CONSIDERATIONS

The first part of the legal considerations for the talking sign consists of researching what other products, technology, or intellectual property there was that would impede the entire design process. Much of this was done in researching competitors and equipment that was used to design the talking sign.

The other side of the legality issue is to determine what needs to be protected so that others do not try to use our intellectual property without consent. It may be possible to patent this device and should be investigated. One definite legal consideration would be to make the brand name a trademark, although we have not yet determined one. If we can come up with a catchy yet effective brand name and we make it a trademark, we can then gain the stability in the market and provide needed name recognition for the market.

6 RESULTS

6.1 PRODUCT FUNCTIONALITY

When the on/off switch on the cane unit is in the "on" position, the transmitter emits a signal to the store receiver. The store unit receives this signal and activates a switch. This switch turns on another transmitter, which sends a recorded message back to the cane unit. This message is received and played through a speaker. The volume of the speaker can be controlled by the consumer directly on the cane unit or can be bypassed by using an optional earpiece. If the on/off switch is placed in the "off" position the

transmitter does not send out a signal and thus there is no message sent back to the cane unit. This cane unit runs off of a 9-volt battery and can be easily replaced.

The store unit consists of many of the same parts as the cane unit but it has the addition of many other valuables items. The store unit can be adapted for many uses, varying from information of a bus stop to the name of a store that it is in front of. This is accomplished by having a 20 second recorder on the store unit that allows the individual store to record whatever message they choose to record. This unit runs off of 6 AA batteries. The previous group developed a device that would inform the consumer of where the button locator is for a cross walk. Our device includes this option. This is included because we decided it would be valuable for the consumer to know where the store is as well as what the store is. The location is determined via a buzzing noise that is being emitted from the store unit. Now, a consumer can walk down the mall and hear all of the store names that they are passing, and if they decide they want to shop at one of these stores they can then follow the buzzing directly to the store entrance. This could also be placed at the crosswalk button, and inform the consumer of what street they are crossing as well as where the trigger for the cross sign is. The possibilities for this device are endless, which is exactly what the consumers asked for.

6.2 PRODUCT FORM

CANE UNIT

The cane unit is a plastic rectangular box that houses the transmitter, receiver, and speaker. Its dimensions are 4.5"x2.25"x0.75". The top of the cane unit has an on/off power switch for easy access. There are slices carved into the front side of the box, in

front of the speaker, to allow the message to pass thru relatively unobstructed. The color of this cane unit is black, which will allow the unit to blend in on the cane easily.

STORE UNIT

The store unit is also a plastic rectangular box that houses the receiver, message recorder, buzzer, and transmitter. Its dimensions are 6"x4"x2.25". The record button is placed in the top right hand corner of the device for easy recording. The store locator buzzer is in the middle of the device. The color of this unit is also black. This device is small enough that it can be easily mounted just about anywhere.

7 NEXT STEPS

In order for our product to go to market we should make some minor changes first. The first area we could improve this product would be the packaging. First, we should try to package the unit smaller. Second, we could obviously improve the looks of the device, but this would be easily accomplished with professional manufacturing.

The next area is the functioning of the device. First, we could fine-tune some of the areas of the device, including the interference of the message being received in the cane unit. We should also make the store unit run on 120 volts AC power, rather than six AA batteries. This would allow for the store to plug the device in and forget about it after recording their message. As of now they have to monitor the device and change the battery whenever it dies.

The final area of improvement would have to be the battery and its life. First, we should implement a battery meter of some sort. This battery meter would have to audibly alert the consumer when the battery runs low. We could also try to improve the battery life of both devices. This is always a factor in electronics, and could always be improved

upon. Finally, we could use rechargeable batteries for the devices rather than the 9-volt battery and six AA batteries. Overall this product functions to the specifications of the consumer and to the expectations we set forth at the beginning of the project.

APPENDIX A (Survey I – Customer-original)

1. Have you ever used a navigational system before, or something along those lines? (Button locator, talking sign)

2. Do you go shopping on your own? (Y/N)

3. What would facilitate the shopping experience?

4. What is the hardest thing about crossing the street?

5. Would a talking sign or other audible device make it easier? (Y/N)

6. Would such a device make you feel safer when crossing the street? (Y/N)

7. When you walk down a sidewalk would you like to be able to know what stores you are passing, if you do not already know? (Y/N)

8. What type of aid do you use, cane, dog, etc.

9. Would you use a talking sign system? (Y/N)

10. How much would you be willing to pay for such a device?

11. What type of sounds would you prefer such a device make? (A human voice, beeps, chirps, etc.)

12. Do you think this would improve the quality and or safety of a visually impaired persons life? (Y/N)

13. How helpful would this device be to your daily life? (On a scale from one to ten)

14. How important is space and the amount of devices you have to bring with you on a daily basis? (Scale one to ten)

15. Would another piece of equipment be a problem? (Such as an earpiece to avoid confusion from noise pollution) (Y/N)

16. Would you prefer to have an earpiece to hear the device? (Y/N)

17. Would it be better to have an earpiece as an option to plug into this device? (Y/N)

18. What type of places do you think these devices should be incorporated? (Supermarkets, street signs, cross walks, everywhere, etc.)

Suggestions:

APPENDIX B (Survey I – Customer-added one question)

1. Have you ever used a navigational system before, or something along those lines? (Button locator, talking sign)

2. Do you go shopping on your own? (Y/N)

3. What would facilitate the shopping experience?

4. What is the hardest thing about crossing the street?

5. Would a talking sign or other audible device make it easier? (Y/N)

6. Would such a device make you feel safer when crossing the street? (Y/N)

7. When you walk down a sidewalk would you like to be able to know what stores you are passing, if you do not already know? (Y/N)

8. What type of aid do you use, cane, dog, etc.

9. Would you use a talking sign system? (Y/N)

10. How much would you be willing to pay for such a device?

11. What type of sounds would you prefer such a device make? (A human voice, beeps, chirps, etc.)

12. Would you prefer the sounds to be on the sign to help locate it or on a device that you carry?

13. Do you think this would improve the quality and or safety of a visually impaired persons life? (Y/N)

14. How helpful would this device be to your daily life? (On a scale from one to ten)

15. How important is space and the amount of devices you have to bring with you on a daily basis? (Scale one to ten)

16. Would another piece of equipment be a problem? (Such as an earpiece to avoid confusion from noise pollution) (Y/N)

17. Would you prefer to have an earpiece to hear the device? (Y/N)

18. Would it be better to have an earpiece as an option to plug into this device? (Y/N)

19. What type of places do you think these devices should be incorporated? (Supermarkets, street signs, cross walks, everywhere, etc.)

Suggestions:

APPENDIX C (Survey II – Store)

1. How often do blind customers shop at your store?

2. When a blind shopper comes to shop here how are they assisted?
   - They are not assisted
   - They have their own helper
   - They are provided with a helper
   - Other

3. Would you be willing to implement a device for the sensory impaired to assist them shop? (i.e. a device that would let the shopper know what aisle that they are in and what's in it or a device outside the store to let them know where they are) (Y/N)

4. How much would you be willing to pay for such a device?
   - $10-$20
   - $20-$40
   - $40-$70
   - $70-$100
   - Over $100

5. Do you think that such a device would help the shopper? (Y/N)

6. Do you think that such a device would make them feel like shopping here again? (Y/N)

7. Do you think that such a device, if implemented, would benefit the store? (Y/N)

Grocery Stores only
8. Would you be willing to implement such a device for regular shoppers as well? (i.e. incorporating a device into a carriage letting the customer know what is in the aisle as they walk down it) (Y/N)

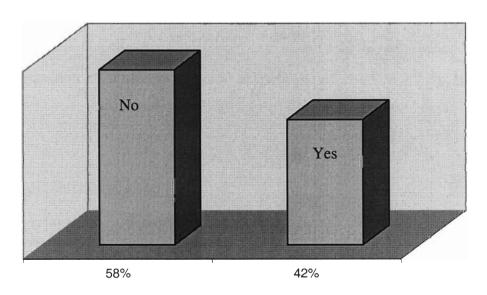9. Do you think that such a device might deter other customers? (Y/N)

Suggestions:

Question 1 Results

Have you ever used a navigational system before, or something along those lines?

(Button locator, talking sign)

Question 1 results

58%   42%

More than half of the people surveyed stated that they have never used any kind of talking sign or any other audible sign system before. The remaining forty-two percent had used a system of audible signs. Table 1.1 lists the types of devices that these people have used and table 1.2 lists places that they have used them.

Table 1.1 - Used Devices

- Talking sign locator
- Talking signs (4)
- Chirping traffic light signals
- Experimental sign reader
- Most every kind
- Audible traffic lights (2)
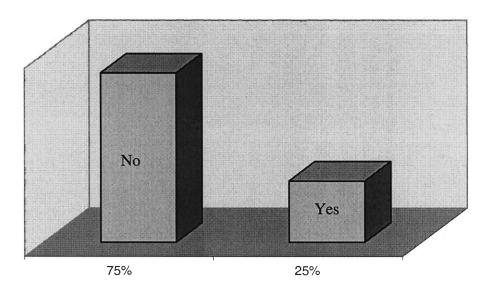- Beeping signs
- Audible signs

- Button locator
- Chirping cross walks

Table 1.2 - Places Used

- San Francisco
- Merced, Ca
- Carroll Center for the Blind

Question 2 Results

Question 2 results

| 75% | 25% |

Do you go shopping on your own? (Y/N)

Comments:

A comment from some of the people surveyed is that shopping malls seem to be a problem since they do not know which stores that they are at, which brings us to question 3.

Question 3 Results

What would facilitate the shopping experience?

The responses that we received back from this question were very interesting. The most common response was that people, or better customer service would make the shopping experience easier. As many stated, good customer service just can't be beat. This is true, since a person can tell the customer exactly what the need to know and it doesn't cost the customer a cent. However, since we are trying to find a technological solution to this problem then we will now look at the other responses that we received.

Some sort of bar code scanner was the second most common response. The visually impaired shoppers not only have a difficult time getting to or finding the stores, but also finding out the prices of the products that they want to buy. Not only would the bar code scanner be able to provide the shopper with a price but it could also provide them with the ingredients and other necessary information.

The third most common response to the third question was tied between three different solutions. Since many of the visually impaired shoppers are not totally blind, they're biggest concern was that the signs for the sales do not have big enough print. Larger print for the sale items is a must.

Also tied for the second most common response was the need for a talking sign system. We received a total of six responses stated that a talking sign system would make their lives easier. Some replied with comments that the signs would be helpful in shopping centers, crosswalks, and other commonly traveled areas.

Another response that we received that is related to the talking signs is that the visually impaired need to know where the stores are. Most of the comments that followed this response were that knowing where the stores are located is almost impossible. One person even replied stating that " I can't imagine how shopping in a mall could be possible."

Some other common responses where knowing where the entrances of the stores where and to know where elevators where. Some even replied that knowing where the buses and the bus stops where would help significantly. One person said that getting back to where the bus dropped them off is nearly impossible.

Table 1.3 – Things that would help

Response	**Percentage**
Better customer service	22%
Bar code reader	20%
Talking signs	12%
Bigger signs	12%
Store location	12%
Finding entrances	6%
Finding buses	4%
Online shopping	2%
Lower shelves	2%
Wider aisles	2%
Knowing store layout	2%
Finding elevators	2%
Better transportation	2%

Question 4 Results

What is the hardest thing about crossing the street?

The most common response that we got for this question is the one that makes the most sense, when to cross. Twenty-three percent of the surveyed responded with this answer. The next most common answer was that the visually impaired have problems when drivers turn right on red. Many of the surveyed felt so strongly about drivers turning right on red that they felt it should be banned! Some other difficulties that the visual impaired have crossing the street are drivers who try to beat a red light, finding and staying within the crosswalks, knowing if the "walk/don't walk" sign is on, and seeing the signs. Table 1.4 shows a list of problems listed in the surveys.
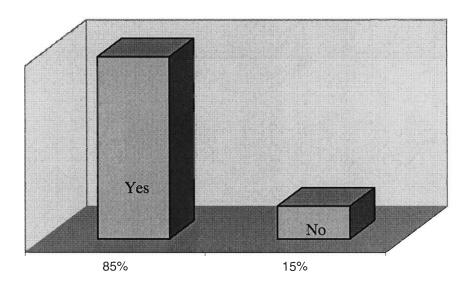
Table 1.4 – Difficulties crossing the street

Response	Percentage
When to cross	23%
Rights on reds	15%
People who run red lights	8%
Traffic	8%
Walk/Don't walk sigh on?	6%
Seeing signs	6%
Where the crosswalk is	6%
Finding light	6%
Waiting for help	4%
Complex intersections	4%
Construction work	4%
Staying in crosswalk	4%
Cars with quiet engines	4%

Where the curb is   2%

Question 5 Results

Would a talking sign or other audible device make it easier? (Y/N)
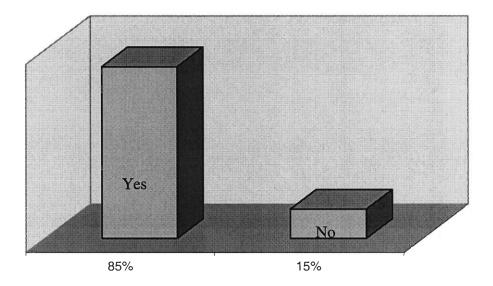

Question 5 results

Although most of the surveyed stated that such a device would be beneficial, there were a few people who strongly opposed to any type of device or system that relied on sound. Their reasoning is that it is unacceptable to add more noise pollution to an already noisy world or that it is difficult to hear the signs when there are cars making so much noise in the background.

Question 6 Results

Would such a device make you feel safer when crossing the street? (Y/N)
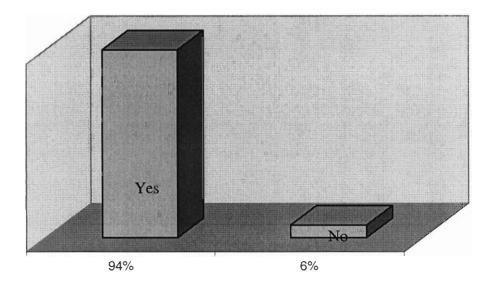
Question 6 results

Question six received the same responses that question five received. A total of eighty-five percent of the surveyed thought that a talking sign or other audible sign system would make them feel safer when they cross the streets. The remaining fifteen percent felt that it would be hard to distinguish the noise from the sounds of car engines or any other noise such as construction work that may be going on in the area. Most of the people that said no didn't want to trust their well being to an electronic system because "even electronics mess up from time to time."

Question 7 Results

When you walk down a sidewalk would you like to be able to know what stores you are passing, if you do not already know? (Y/N)

Question 7 results

This question received the most enthusiastic responses out of any of the other questions that we asked in the survey. With only six percent of the people surveyed saying no, it seems pretty obvious that the visually impaired want to know what stores they are passing by. There were some people who responded with comments like: "such a system would be great!!" or "such a system would be great if it were even humanly possible." Over all if such a system were designed it is highly likely that it would be used by the visually impaired.
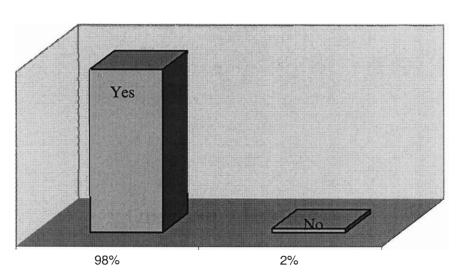
Question 8 Results

Table 1.5 – Aides used

Response	Percentage
Cane	61%
Dog	22%
Telescope	8%

None   8%

As you can imagine the two most commonly used devices that the visually impaired use for travel are the cane and the dog. But not all the visually impaired are totally blind, some of them have limited vision and instead of the dog and cane, they rely on a telescope or other magnification system, and even others have enough vision where they do not rely on any assistance at all.

Question 9 Results

Would you use a talking sign system? (Y/N)

Question 9 results

98%   2%

In order to determine if a talking sign system would be used at all, we had to ask if anyone would use it. As you can see it is very clear that this system would be used by

60

almost all of the visually impaired community. While almost all of the surveyed said that they would use a talking sign system, about fifty percent said that they would only use it if was reliable and if they could understand what the sign was trying to let them know.

There was also a concern whether or not the user would be able to hear the device. Several of the people surveyed not only suffered from vision loss but some from hearing loss as well.

Question 10 Results

How much would you be willing to pay for such a device?

I think that for this question we worded it poorly. Most of the people thought that they were going to have to pay for signs with transmitters that were going to be put up in stores and street corners. These people felt that the State of Federal Government should be responsible for taking up the bill. Many people had no idea what they would pay for such a system, while others needed to know what the capabilities and how reliable he device was before answering the question.

For the people who responded with a number answer, it seems that one hundred dollars ($100) is about the average. There were a few people who would only be willing to pay as few as thirty dollars ($30) or as much as one thousand dollars ($1000.) The price for most of the people was a problem because many of them were either on welfare or social security and would not be able to invest all that much.

Another concern that most all of the people who responded had was whether or not the system would be widely. If the system was not going to be installed everywhere and used by everyone, then they felt that it would not be worth their investment.

Table 1.6 – Price

Response	Percentage
Depends on capabilities	21%
$100	18%
Not much	14%
Didn't know	16%
$300	10%
On social security (minimal)	7%
Should be paid for by Gov.	7%

Question 11 Results

What type of sounds would you prefer such a device make? (A human voice, beeps, chirps, etc.)

Table 1.7 – Desired Sounds

Response	Percentage
Human voice	77%
Beeps	13%
Vibrations	6%
Not important	2%

Don't' know   2%

Our survey results indicated that seventy-seven percent of the people surveyed would prefer to hear a human voice rather than beeps or any other audible signals. Although the seventy-seven percent indicated that they would prefer human voice, they also stated that it would depend on what the information was that was trying to be delivered. Most suggested using a combination of beeps and voices. One person said that they would prefer a system that used a human voice when information like the names of stores was going to be given and beeps when directions are given (i.e. beeps on a sign to help locate it.) Table 1.7 shows the total results for question eleven.

Question 12 Results

Would you prefer the sounds to be on the sign to help locate it or on a device that you carry?

Table 1.8 – Sounds on sign or portable device

Response	Percentage
Portable device	47%
On the sign	32%
Combo	12%
Doesn't matter	9%

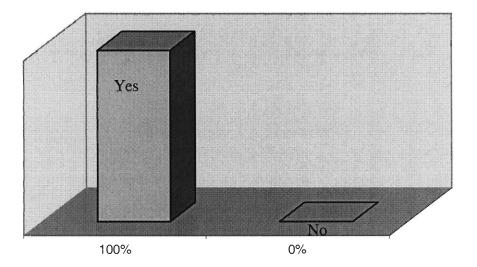It seems that having the sounds coming from a portable device is more desirable. There were several reasons given for why this would be better. Most of the people felt

that it would be better coming from the portable device that way they wouldn't confuse it with other sounds or noise coming from their surrounding environment. Another reason was that it would be less bothersome to those around that did not need to add to the noise pollution. One reason for having the sounds emanating from the sign was that in the case of a entrance locator it would help them know how close to the sign they are and to help find their way to the sign and therefore find their way to the entrance.

Question 13 Results

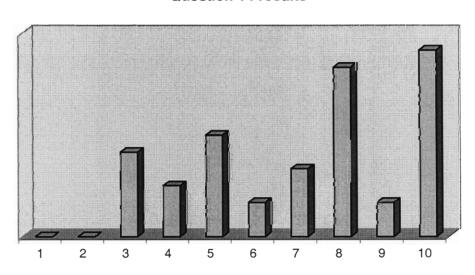Do you think this would improve the quality and or safety of a visually impaired persons life? (Y/N)

Question 13 results

100%   0%

Question thirteen seemed rather obvious, but while every person surveyed had the same answer they all had different opinions. Many people felt that such a system would improve the quality of their life while others felt that it would improve the safety of their lives. Still others felt that it would improve both, the quality and safety of their lives.

Question 14 Results

How helpful would this device be to your daily life? (On a scale from one to ten)
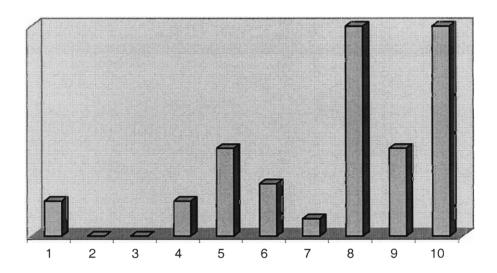
Question 14 results

Mean = 7.44

Some comments that people added to their answers was that a talking sign system would be helpful to their life's if it was incorporated into malls and sidewalks but not so for street corners and intersections.

Question 15 Results

How important is space and the amount of devices you have to bring with you on a daily basis? (Scale one to ten)
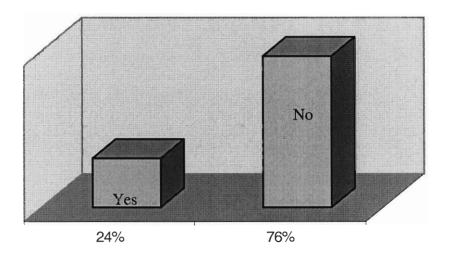
Question 15 results

Mean = 7.64

Although the results indicate that space is important to a visually impaired persons daily life, most said that they would be willing to add to their luggage if it were a device that would help them know what was around them, where they were going, or how to get there. Some of the things that are commonly carried on a daily basis are backpacks, fanny packs, and brief cases. There were several suggestions stating that a clip on device would be preferred.

66

Question 16 Results

Would another piece of equipment be a problem? (Such as an earpiece to avoid confusion from noise pollution)
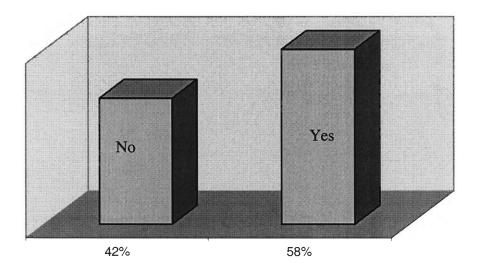
Question 16 results

| 24% | 76% |

Question 17 Results

Would you prefer to have an earpiece to hear the device? (Y/N)
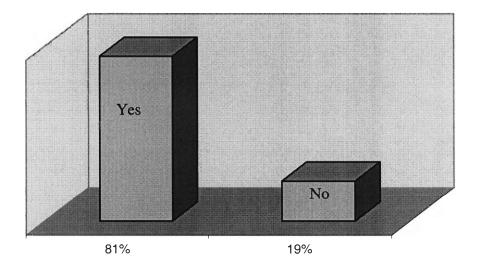
Question 17 results

No	Yes
42%	58%

Question 18 Results

Would it be better to have an earpiece as an option to plug into this device? (Y/N)

Question 18 results

Yes	No
81%	19%

Question 19 Results

What type of places do you think these devices should be incorporated? (Supermarkets, street signs, cross walks, everywhere, etc.)

Everyone who responded to this question were very enthusiastic about wanting these devices to be incorporated everywhere. Some suggestions were that they should be incorporated into malls for store locators, and crosswalks for audible crosswalks.

Survey II Results

In our polling of twenty-one store managers/owners we managed to incorporate a large variety of stores. These stores polled included a large chain supermarket, multiple retail stores in a local mall, two large electronics stores, and a local convenient store. We found that the results followed along with what we had anticipated and believe these results are a good indication of what a larger survey would produce.

All of the store managers/owners seemed to express an eagerness to help the blind community in any way possible, as long as it was going to be cost effective for the store. All of the stores polled also believed that this device was a great idea and expressed their hope of one day seeing it implemented nationally. They thought that the possibilities for this device were endless and stated that this itself was a very promising indication of the products success.
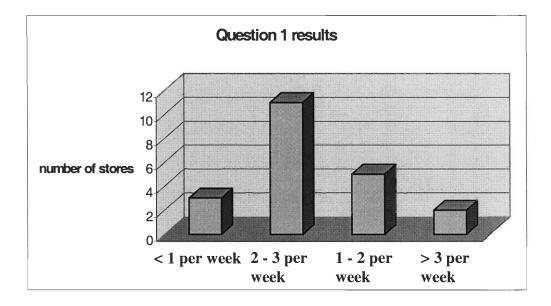
Some of the areas the store managers/owners would like to see this product implemented are as follows:

- Bar code reader
- Aisle item indicator (especially supermarkets or large retail stores)
- Understanding store layouts
- Store locators or store advertisers, however they use it
- Elevator/escalator locations

Question 1 Results

How often do blind customers shop at your store?

Of the twenty-one store managers/owners polled for this survey they all stated that members of the blind community often visit their stores. The results are just estimates of the frequency of the visits, it is not exact. As with most results, the frequency varies from store to store and day to day. These results are meant to be a building block in our understanding of the daily life of the blind community.

Question 1 results

| number of stores | < 1 per week | 2 - 3 per week | 1 - 2 per week | > 3 per week |

From the above results we conclude that 52% (11 of 21) of the storeowners agreed that on average they have between two and three each week. 14% (3 of 21) say they have less than one per week. 24% (5 of 21) of the stores average between one and two members of
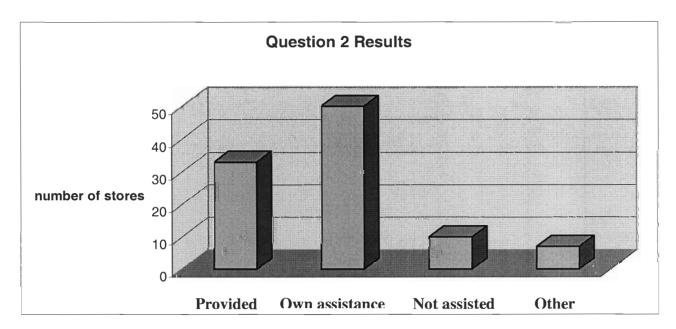
the blind community per week. Finally, 10% (2 of 21) say that there are greater than

three blind patrons each week.

Question 2 Results

When a blind shopper comes to shop here how are they assisted?

- They are not assisted
- They have their own helper
- They are provided with a helper
- Other

Again with this question the store managers had to generalize their answers, as some

people may come with help one day while another may be alone. They do not keep exact

results on hand so the managers had to estimate the percentages of the situations

occurring. From their answers we then found the averages among the situations and

rounded off to make the results more easily understood.

The above chart shows that 33% of the blind patrons are usually unassisted when entering

the store and are then provided assistance, either by asking for it or being asked if they
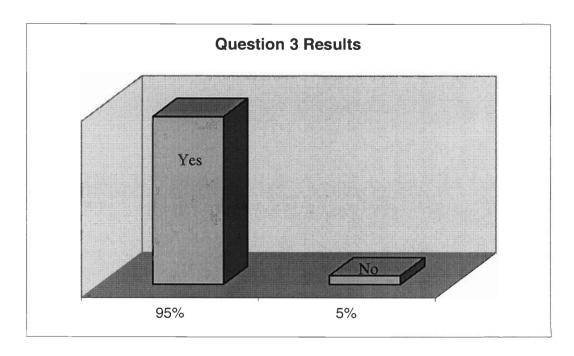
need aid. 50% of the people are accompanied by their own assistance. Approximately 10% of the blind patrons decline assistance and prefer to shop on their own. Some of the store managers filled in the other option, 7% to be precise, specifically commenting that they filled this in because some people prefer to shop on their own and only ask for assistance for a short question (such as if they have selected the correct product they were looking for) or directions (much the same as sighted people do).

Comments:

Many of the store managers commented that they always offer assistance to the blind community, "but sometimes they prefer independence and would like to shop on their own." As states above, some did not know where to place certain situations and just decided to check off 'other'.

Question 3 Results

Would you be willing to implement a device for the sensory impaired to assist them shop? (i.e. a device that would let the shopper know what aisle that they are in and what's in it or a device outside the store to let them know where they are) (Y/N)?

Question 3 Results

Yes

No

95%   5%

The responses we received were just as we expected, the storeowners would like to help the blind community by installing these devices, an overwhelming 95% said yes. The only store that would not like to implement these devices, a local corner store, said that they do not have many members of the blind community shopping there and that implementing this device would not be worth the cost they expected to pay. This did not seem very cost effective to this owner because he owns a small two aisle convenient store, and believes that the only possible way to truly help the blind would be to implement a Bar code reader. This device would be expensive because it would have to be implemented on more than 1000 individual items. It would also have to be added to every time a new item was introduced to the store's inventory. This same store also stated that if the cost were low enough or free, then they would consider it because it would be nice to help out anyone less privileged.
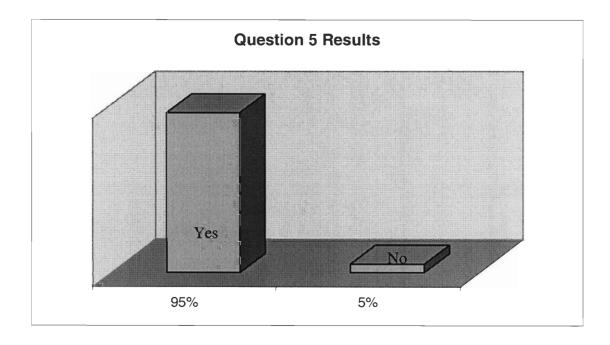
Question 4 Results

How much would you be willing to pay for such a device?

- $10-$20

- $20-$40

- $40-$70

- $70-$100

- Over $100

Most said that they would pay any reasonable price as long as it would help the community and benefit their store in some way, especially if that meant more customers. Most said that a fair price would be anywhere up to $100, but depending on circumstances they would be willing to pay more. Many seemed to be confused with this question, wondering just exactly what they would have to pay for and how many. I explained it to a couple stores and just included these results, others I did not have a chance to talk to. This implementation would be beneficial in many ways, including customer relations.

Question 5 Results

Do you think that such a device would help the shopper? (Y/N)

Question 5 Results
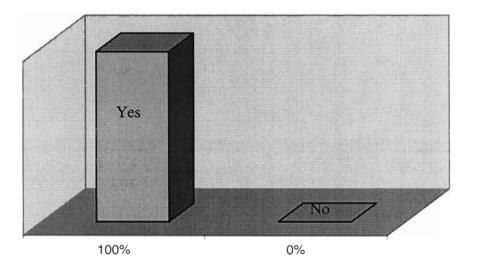
Yes

No

95%   5%

All of the people polled believed such a device would help the blind community but one in particular thought that this device might not be as beneficial in their setting as maybe a helping hand would be. This particular individual owns a local corner store and thinks that it would not be very cost effective to have every item in the store implemented with this device (i.e. a bar code reader). With there only being two aisles and having a large variety of products in each, it does not seem feasible to implement this device in this particular situation.

Question 6 Results

Do you think that such a device would make them feel like shopping here again? (Y/N)

Question 6 results

Yes

No

100%   0%
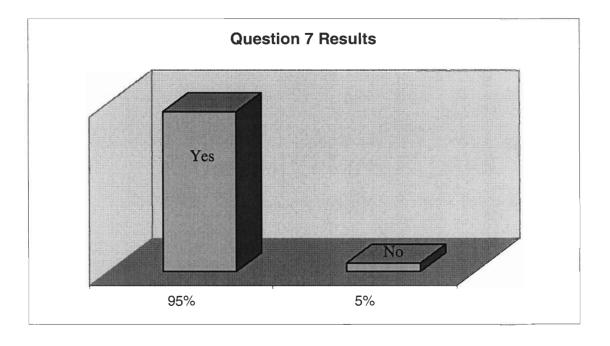
All of the managers polled agreed that this device would benefit the blind community and since this would improve customer relations they feel that these customers would return. Also, they believe that these customers would then pass on their pleasant shopping experience to other potential customers. Overall this device stands to benefit all involved in its implementation.

Question 7 Results

Do you think that such a device, if implemented, would benefit the store? (Y/N)

Again the managers agreed along the same lines as questions 3 and 5. The only

store to think the product would not benefit was the individual corner store. The reasons

behind his decision have been well documented in the earlier questions.

The following question was for supermarkets only:

Question 8 Results
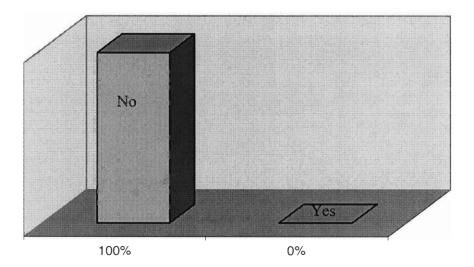
Would you be willing to implement such a device for regular shoppers as well? (i.e. incorporating a device into a carriage letting the customer know what is in the aisle as they walk down it) (Y/N)

We only polled one major supermarket, *Shaws* in White City. They said that they would be interested in implementing this device, but would like more information and further details of what they would be getting involved in, as well as a price.

Question 9 Results

Do you think that such a device might deter other customers? (Y/N)

Question 9 results

All of the individuals agreed that this would be a great device and would not hinder any of the other customers as long as the sound were kept to a minimum. This would be accomplished by having the speaker attached to the receiver of the patron or clipped onto their collar or by using an earpiece. This would be up to the customer because we would have the option of an earpiece on the receiver/transmitter.

APPENDIX F (Timeline)

Gant Chart

Tasks	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12	Week 13	Week 14
Get old IQP and read it	X													
Call Larry Raymond		X	X	X	X	X	X	X	X	X	X	X	X	X
Research Blindness		X	X	X	X	X	X	X	X					
Primary - Blind		X	X	X	X	X	X	X	X					
Secondary - Articles		X	X	X	X	X								
Brainstorming		X	X	X										
General Survey Layout			X	X										
Meet Larry Raymond					X	X								
Talk to Store Managers (i.e. Shaw's)							X	X						
Go to Meetings for the blind								X	X					
How do they shop?								X						
What would make that easier?								X						
Do Survey for the blind									X	X				
Do Survey for the store managers									X	X				
Analyze survey results										X	X	X		
More Brainstorming											X	X	X	X
Come up with prototype designs													X	X
Test Design														
Paper work		X	X	X	X	X	X	X	X	X	X	X	X	X
Work on final design														
Work on final report														
Deadline														

	Week 15	Week 16	Week 17	Week 18	Week 19	Week 21
Finalize customer requirements	■	■				
Start getting parts together	■	■	■			
Begin building			■	■		
Research communications regulations	■	■	■			
Test prototype				■	■	■
Build final model					■	■
Write up design and testing stages	■	■	■	■	■	■
Final IQP Report						■

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