Stanford Affordable Hearing Project
Product Design Report
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1 Introduction

The electronic digital signal processing technology to help restore hearing to those with hearing loss is well established, and high-quality chips and software that implement this technology are readily available. Yet a far smaller percentage of those with hearing loss take advantage of this technology than, say, those who wear eyeglasses to restore their vision. Part of this project was to explore the opportunities for new products that could reach those with untreated hearing loss. The Social Entrepreneurship Startup (SES) team conducted fieldwork to gain understanding and empathy for various consumer groups, including baby boomers and senior citizens. We sought to understand what consumers would value in a hearing device and what they would consider to be superfluous. Our goal was to lay the foundation for the design of an affordable product that could have a wide consumer appeal.

Below we summarize the findings for each specific consumer group and discuss the conclusions we were able to draw about their preferences. We then discuss the implications of these findings for some possible design innovations.
2 Human Factors: Baby Boomer Men

2.1 Introduction

We investigated the possible use of an assistive listening device (ALD) by baby boomer men. We studied the views of men from a wide variety of backgrounds, professions, and lifestyles, on such features of an ALD as its cost, size (obtrusiveness), and the stigma of wearing such a device.

2.2 Feedback

While the range of boomer males interviewed was wide, ranging from electrical engineers to dentists, the subjects generally maintained active lifestyles and, in fact, shared many common desires and concerns about the device.

One concern shared by the subjects was the device’s obtrusiveness. They wished the device to be as unobtrusive as possible, perhaps analogous to a small MP3 player. Several subjects would not want a device that would bang against their bodies or “swish” against their clothes while moving. Some suggested that a smaller device or perhaps a device that could be attached better to the body would reduce this “swishing,” “bouncing” effect.

The subjects had active lifestyles that included activities such as jogging, sailing, and skydiving. A concern almost every subject had was the size of the device. They wanted the device to be small, out of the way, and more like an MP3 that a younger person might use. However, one subject who wore a prototype shared that observation that a device that looked like a music player could affect one’s day-to-day social interactions; wearing two large earphones with such a device could make it seem as though you are listening to music and not wish to interact.

Finally, most subjects were concerned about whether the device would amplify the right sounds, citing a perceived problem with such devices. They wanted a device that was directional, that is, a device that could amplify desired sounds they were facing and not amplify undesired background noise, such as others talking or environmental noise.

2.3 Conclusion

Our human factors research into boomer males found that these men want an ALD that is small, inconspicuous, with a design analogous to a small MP3 player, with directional sound amplification, and something that does not interfere with day-to-day social interactions. The last concern could possibly be addressed in the design of the earphones, perhaps having only one earbud instead of a large headset.
3 Human Factors: Baby Boomer Women

3.1 Introduction

We went seeking the advice of baby boomer women around Stanford. The people we spoke with were very enthusiastic and willing to help. We began each interview by sharing with the individual pictures of different types of products, hoping to receive insightful feedback. From what we were told, we were able to draw valuable conclusions about the preferences of boomer women towards hearing devices.

3.2 Observations

3.2.1 Microphones

The people we spoke with preferred products that were unobtrusive and relatively unnoticeable. They were concerned about products that would draw the attention of others, as well as those that would interfere with typical social interactions. They were relatively unconcerned, however, with where on the body the microphone would be placed.

3.2.2 Unit

Once again, our interviewees preferred products that would not capture the attention of others. Most were fascinated by the idea of a hearing device placed inside a wristwatch, but felt it would lack the mass appeal that other innovative products, such as the iPod, have generated. They valued sleek, modern-looking gadgets, emphasizing clarity of design and small size as important factors. They commonly rejected the Pocketalker as a clumsy and archaic device.

3.2.3 Headphones

Comfort and usability were prioritized higher than they were in the previous two components. These characteristics, they felt, would be most successfully employed by a product that fit well within the ear and remained secure, regardless of the wearer’s degree or direction of motion. The interviewees seemed to prefer the Microsound Pilot and ReSound AIR BTE hearing aids over the Nokia cell phone earpieces.

3.3 Design Principles

- On the whole, boomer women value comfort, lack of visibility, and unobtrusiveness over all other characteristics.
- Boomer women, because they are at a “pivotal” age, are quite concerned about growing old. They often view a hearing aid as a sign of aging. This likely explains the concerns mentioned about of minimizing product visibility.
- Unlike seniors, most boomer women are still employed and active. Their lifestyles call for a portable and comfortable device, one that will not conflict with their daily routines.
4 Human Factors: Seniors without Physical or Cognitive Impairment

4.1 Observations

We conducted this research at two senior centers, one located in Palo Alto, the other in the Mission District in San Francisco. At each center, we spoke with numerous seniors and gave them the opportunity to test out ALDs and prototypes that we brought. The experiences and discoveries at each center had similarities but also some differences due to the different populations.

4.2 Avenidas Senior Center, Palo Alto

At an intermediate lip reading class, we discussed ALDs and hearing aids with three students and their teacher. We brought actual headphone sets as well as the Pocketalker and Easy Listener. While we explained the purpose of our visit, the students that were hard of hearing tried on different headsets along with the ALDs. We also showed them pictures of different types of hearing aids, including the Microsound Pilot and ReSound AIR, and talked to them briefly about microphones and units. Below are the likes and dislikes from the surveyed seniors:

4.2.1 Popular Models and Features

- The single cell phone earbud with microphone on hanging cord had a very comfortable fit and was convenient to use.
- The hands free set with the behind the ear piece was liked, but there were concerns about the fact that putting it on took too long.
- Over-the-head with earbud style was liked the most by two out of the three seniors we spoke to because it is light yet stable.
- Earbuds were popular because they were not too big and bulky, but the cloth ones provided too much resistance to placing in the ear.
- The Microsound Pilot was aesthetically pleasing. (The seniors wanted to fly out to Denmark to get some.)
- Some seniors preferred having only one earphone in order to avoid being completely cut off from the outside environment.
- The audiologist teacher of the class noted that a boom microphone would be helpful in allowing the user to direct the sound to be amplified.

4.2.2 Dislikes

- The traditional supraural or circumaural headphones that are over the head and have large coverings over the ear were disliked, because the seniors thought they were too big.
- There were no strong preferences for over-the-head versus in-the-ear earbuds.
- Having to hold the microphone out to someone was too intrusive for the seniors. Instead, they would rather turn their heads to direct the microphone to where the sound was
coming from. The teacher felt it important that the microphone not obstruct the user’s line of vision with a speaker’s mouth, because many people rely on lip-reading.

- The Pocketalker was too loud on its lowest volume. Also, it was impossible to determine the direction the sounds were coming from.

### 4.2.3 Areas for Innovation

Although most of the seniors were fine with simply holding the unit in their hand or pocket, we brainstormed ideas for other places to put them:

- The watch idea seemed very high tech to them.
- We also thought of the microphones used by theater actors that are situated near the hair on the forehead.
- The teacher suggested using several microphones across your chest or across your head along the band of your headphones to place where the sounds are coming from.
- They all would much prefer a wireless device to get rid of the wires.

### 4.3 El Centro Latino Senior Center, Mission District, San Francisco

Our second location was El Centro Latino, a hispanic community center in the Mission District in San Francisco. We had the opportunity to shadow an information session led by Laura Clark of the Hearing Society for the Bay Area. Due to the center’s lunch time and activities, we were unable to survey the seniors on the pictures we used in the lip-reading class. Ms. Clark’s presentation was geared towards educating the senior population on the symptoms of hearing loss, the need to seek professional help, and the specifics regarding insurance and hearing devices. With help of an interpreter from the center and a bilingual member of our team, the seniors were very receptive to all the information and also had the opportunity to try Pocketalkers.

The Pocketalkers were very popular but presented a problem for those who only had hearing loss in one ear. It was common to see seniors putting the headphones on but covering only the damaged ear. Several female seniors did not mind using the headphones but commented that their husbands wouldn’t use them because of their cumbersomeness.

A large number of seniors approached the interpreters at the end for handouts, wishing to get one of each. Ms. Clark indicated a higher than usual level of participation and interest from the seniors in the presentation, thanks to the interpreters, particularly our male team member. In addition, the center’s interpreter acted as the voice of command in the room since she was the seniors’ English teacher. Our team member was able to mix and mingle with the seniors, engaging them in the presentation. He was extremely useful to get, specifically, senior males to come up front at the end of the presentation and ask case-specific questions.

### 4.4 Design Principles

- The seniors we spoke to are looking for convenience. They want something they can handle easily, that is not too heavy or big to carry around, but that can still be worn securely.
- The Microsound Pilot appealed to many seniors. Seniors find appearance important.
- Seniors are concerned about the safety of knowing where sounds are coming from when they are walking around with headphones on, so stereo feed would be very useful.
- Seniors do not mind carrying around a unit, though women do not always have pockets to store it.
• Types of microphones preferred might depend on the hearing situation, with a directional microphone or one that can be placed closer to the sound source being helpful in noisy situations or ones with undesired sources.
• The teacher has used ALDs with some of her classes and it seems that seniors are very keen on them at first but then do not want to use them later, so we should look into investigating long-term use.
• With smaller headphones, it is important to explain to seniors how to put them in (which way), so if we were to use intraural headphones, we would need to include some sort of diagram or explanation.
5 Human Factors: Low-Income Seniors

5.1 Observations

As a group we twice visited Stevenson House, a retirement community for low-income seniors in Palo Alto. In our first visit, we spoke about general questions regarding hearing aids and ALDs.

- One of the major uses the seniors brought up for ALD use was in their dining room. We were talking to them about 15 feet from the dining room and they had trouble hearing what was being said. In such a large and loud room, people with hearing aids have a very hard time distinguishing sounds.
- Most seniors said they had had their hearing tested, and often they were told that they had a hearing problem. However, when we asked, “Do you think you have a hearing problem?” many would answer, “No” or would say that it did not affect them very much.

On our second visit, we came armed with a set of ALDs. We had four in total, the Williams Sound Pocketalker, a Radio Shack amplifier with an equalizer, the Sonic Super Ear, and the wireless Phonic Ear Easy Listener. We observed through one-on-one conversations.

5.1.1 Devices

- In general, people saw the ALDs as devices they would use on specific occasions, such as seminars, conventions, movies and TV, with family members.
- One senior said she would not use an ALD, because she did not think it would function as well as a professionally fitted hearing aid.
- Several of the seniors asked for information about the devices, because they were interested in learning more and possibly purchasing one.
- They really liked the $30 price tag for the Radio Shack device. They had mixed reviews on the $150 price of the Pocketalker.

5.1.1.1 Sonic Super Ear

- Some of the seniors did not like that they could hear their own voices amplified while they were using this device.
- One of the males thought the microphone was too phallic and said he would not use it for this reason.
- The volume dial was quite small and hard for the seniors to use.

5.1.1.2 Williams Sound Pocketalker

- Good size – easy to put in pocket or clip on belt (male).
- Where could female carry it?
- Volume dial too small.
- For a few people, it was too loud even on the lowest setting.
- For the hearing aid wearer, preferred using without hearing aid.

5.1.1.3 Phonic Ear Easy Listener

- The microphone was stronger on this device than on the Super Ear and Pocketalker.
- Did not like the idea of asking someone else to wear a microphone – too intrusive.
- Having two devices was perceived as too complicated.
5.1.1.4 Radio Shack Amplifier

- The equalizer gave ability to filter out some of the noise.
- A little complicated at first, but liked being able to adjust equalizer.
- Volume dial too small.

5.1.2 Headsets

5.1.2.1 Earbuds

- People liked that they were lightweight.
- People liked that they were less apparent/obvious to others.
- They fell out of a lot of people’s ears – this might become annoying to the user.
- Were a little less comfortable than the headphones.

5.1.2.2 Headphones

- More comfortable.
- Heavier and bulkier than ear buds.
- More obvious (seen as a negative).

Picture from second visit:

![Image of seniors interacting]

5.2 Design Principles

- The seniors need to have a device that is sturdy and easy to use. Simplicity is very important. One woman spent a lot of time complaining about how complicated her cell phone was.
- The knobs on the device must be large enough for people with poor eyesight or who have arthritis or diminished manual dexterity. When they took them too close to their head to adjust the knob, it was create very discomfiting feedback. Larger dials are also easier to operate.
• There is still a tradeoff between earbuds and over-the-head earphones. A lot of the seniors did not already have a preferred pair of headphones, so one should be included in the package.
• Directional or omni-directional? Most people preferred the directionality, because it took out irrelevant sounds. People seemed to like resting it in their laps while sitting and talking to people.
• Often people confused the directionality of the microphones (especially the Super Ear). They would point them the wrong way.
• One man had a pretty easy time adjusting the equalizer bars on the Radio Shack device. He said that they made the sound quality much better for him.
• The volume dial should not be located next to the microphone. Users turn the device to look at the dial, and bring the microphone towards them, which hinders their ability to adjust the volume to the voice or sound they are trying to amplify.
6 Design Innovation: Hearing Aids

6.1 Recommendations

The Process Report describes the potential of some new technology to greatly streamline the screening, diagnosis, and “first fit” programming of hearing aids through a largely automated process. In addition to this electronic fitting, hearing aids must be fit physically. In the traditional process, the dispenser takes an impression of the patient’s ear, sends it to a lab, and then has the patient return one to two weeks later once the custom earmold is sent back. To explore ways to streamline the physical fitting, we examined non-custom standardized earmolds and instant earmolds. Both of these options allow a hearing aid to be dispensed in one visit.

6.1.1 Non-Custom Earmolds

Non-custom earmolds come in several different types and are particularly suitable for patients with common high frequency hearing loss and for those with mild to moderate hearing loss. Of the different types we studied, of particular promise to this project are flexible plastic/silicone earmolds that come in various stock sizes. The ReSound AIR, a hearing aid designed for high frequency hearing loss, uses this type of non-custom earmold, and it is considered very comfortable. The Microsound Pilot uses silicon eartips, which come in two sizes and both vented and non-vented. The company recommends that the eartips be replaced every month, and a replacement set costs about a dollar. Currently, 90% of Microsound’s customers choose non-custom eartips, even though they have the option of using a custom-made earmold.

6.1.2 Instant Earmolds

Instant earmolds provide the benefit of a custom earmold but do not require the wait for an ear impression to be sent to the lab and the earmold to be made and sent back. The impression is made with a two-part silicone material, cures with 20 minutes or so, and is trimmed for the final earmold. Instant earmolds are suitable to the wide range of hearing loss as custom earmolds. Dreve currently has a new direct fitting product that has been recommend to us for study. It is being distributed in the US by Warner Tech Care Products.
7 Design Innovation: Assistive Listening Devices

7.1 Overview

In the course of our study, we learned that assistive listening devices (ALDs), such as the Williams Sound Pocketalker, are used by those who cannot afford hearing aids to treat their hearing loss. Such devices are also used by those with hearing aids to better hear desired sound sources. ALDs are suitable for correcting a large percentage of hearing loss, especially presbyacousis, the common, high frequency hearing loss that comes with old age. An advantage of ALDs as an affordable hearing solution is that they are consumer products and as such can be distributed in more ways and more economically than hearing aids, which are highly regulated medical devices.

Our research has led us to the conclusion that greatly improved ALDs are possible and could be a desirable and successful product, especially for those with low incomes. Available, off-the-shelf, digital signal processing chip technology and software would enable devices of very high quality – comparable to that of top hearing aids – for a low cost. The challenge will be to come up with a good design that people like. In the last few for weeks of the study, we got feedback from different populations of users on various possible designs. The matrix below summarizes our very preliminary findings.
### 7.2 Matrix of Possible Designs

The following matrix displays the results of our empathy research. It ranks consumer preferences regarding product characteristics and features on a scale of 1 (low) to 5 (high).

<table>
<thead>
<tr>
<th></th>
<th>Simple Amplifier (Like Pocketalker)</th>
<th>Earbud (Like Microsound Pilot)</th>
<th>Simple BTE (Like ReSound AIR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social Intrusion</td>
<td>1 (low) to 5 (high)</td>
<td>1 (low) to 5 (high)</td>
<td>1 (low) to 5 (high)</td>
</tr>
<tr>
<td>Cool factor</td>
<td>1</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Self-image</td>
<td>3</td>
<td>4</td>
<td>2</td>
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<tr>
<td>Size</td>
<td>2</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>“Spy effect”</td>
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<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Visibility</td>
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<td>4</td>
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</tr>
<tr>
<td>Style</td>
<td>3</td>
<td>5</td>
<td>3</td>
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<tr>
<td>Ease of Use</td>
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<tr>
<td>Cordage</td>
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<td>5</td>
<td>5</td>
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<tr>
<td>Simplicity</td>
<td>2</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Controls (Volume)</td>
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<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Storage</td>
<td>3</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Functionality</td>
<td></td>
<td></td>
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<tr>
<td>Programmability</td>
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<tr>
<td>Battery life</td>
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<td>Directionality</td>
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<td>Stereo</td>
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</tr>
<tr>
<td>Cost</td>
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