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Why Hearing Loops

By Steve Thunder, BSE

We all have a connection to hearing loss. Since 14% of adults aged 20 to 69 have a hearing loss, if you don't have a loss, it's likely you know someone who does. As a society, we are living longer than earlier generations; and over the age of 80, 89% of people have a hearing loss. The importance of hearing was succinctly addressed by Hellen Keller who put it best when she said, *"blindness separates us from things, but deafness separates us from people"*. This is because hearing loss is an impairment that affects a person's ability to communicate and interact with other people.

The solution for hearing loss is not as simple as it is often is for eyesight by wearing a pair of prescription glasses. The issues for hearing loss are usually a combination of several factors. First, the "loss" is typically in the higher frequencies. This means a person might hear the bathtub running (low frequency), but cannot hear a bird chirping (high frequency). For speech reception, this type of hearing loss means a person can hear the vowel sounds, which are composed of high energy, low frequency sound. But the same person cannot hear the consonant sounds, which are composed of low energy, high frequency sounds. The example in figure 1 illustrates this using a visual analogy. Figure 1 shows the vowels sounds in a sentence. Seeing only the vowels makes it difficult to read. Figure 2, however, shows the consonant sounds, as if you had a hearing aid prescribed to amplify these weak sounds. Seeing both vowel and consonant sounds, makes it possible to understand the sentence. This is why people with hearing loss often complain that they can "hear" you, but they cannot "understand" you. Hearing aids that have been prescribed and fit properly can really help improve understanding and communication because they "bring into focus" the soft or inaudible consonant sounds.

Figure 1 – High Frequency Hearing Loss

Figure 2 – High Freq. Loss w/ Amplification

If this type of loss was the only issue with hearing loss, hearing aids would work much like eye glasses. However, many people have some additional auditory function issues. Research has found that part of the damage associated with hearing loss often affects the nerve function in the ear as well. This damage leads to distortion in certain frequencies and difficulty understanding consonants in words. The visual analogy to this is shown in the figure 3. In this illustration, amplification improved the audibility of the consonants, but these sounds are blurry. Simply turning up the volume does not usually help because louder distortion is not any clearer.

Figure 3 – Hearing Distortion w/ Amplification

Despite these issues, hearing aids can still be very effective in quiet environments when the others are close by, say within 6-12 feet. But in many spaces this is not the case. Take for example a noisy restaurant. In this environment the background noise masks the speech sounds we want to hear,

Figure 4 – Background Noise

making understanding difficult – even for those without hearing loss. The visual analogy to this is shown in figure 4, where other printed words on the same page make it difficult to read the sentence.

Reverberation in rooms also causes difficulty. Reverberation occurs when sound bounces off the walls, ceiling, and floor to arrive at a person's ear with different amounts of delay. This lingering sound in the room causes the same spoken words to overlap with one another making it difficult to understand. The visual analysis to this is shown in figure 5. In essence, reverberation "smears" the sentence, much as if you dropped coffee on the morning paper. Reverberation exists in every space, but it is worse in large spaces and worse when the surfaces of that space are constructed with hard, smooth surfaces like wood, stone, glass, and concrete floors. Making a sound system more powerful and louder does not help in this case because it also amplifies the reverberation. Similarly, the amplification provided by a hearing aid can't solve the issue either. It is the physics of the room acoustics and becomes a quandary in churches and auditorium halls. In these spaces, the reverberation enhances the music in the room. But the same reverberation will seriously degrade a person's ability to understand. At best, a normal hearing person may be able to understand the message, but with a bit of a struggle and mental effort. At worst, a hearing impaired person will only hear a garbled speech. As a result, that person loses interest and their enjoyment is compromised.

Figure 5 – Reverberation

Hearing aids have improved remarkably in the last decade. Most are essentially digital computers that reside in the ear. But hearing aids have a limited effective range in the real world. While it depends on the room acoustics, this range is typically only 6 to 12 feet. This means that in a room where people are seated further than this distance from the talker or loudspeaker, they will have a great difficulty understanding. This is true regardless of how well a sound system performs. For a person struggling with hearing loss, it becomes very difficult to go to shows, presentations, church services, or musical performances. At some point, they just stop going and/or blame the awful experience on the venue hall.

Many people with hearing loss don't complain about it to facility managers. To start, normally they do not want to self-identify and flag the issue that they have a hearing problem. Similarly, one study showed that only 1 out of 26 unhappy customers complain. In another study, 96% of unhappy customers don't complain, and of those, 91% just stop coming. Plus, it is very difficult to describe this type of issue to facility managers who are generally unfamiliar with hearing loss, especially when it seems like other (normal hearing) people don't appear to have a problem. This all adds up to a limited number of voiced complaints, but a high number of people who stop attending. This situation of hearing loss in combination with poor acoustics contributes to social isolation for these individuals because their communication with other people is so impaired and their life enjoyment/enrichment is substantially reduced. Studies have even linked hearing loss and social isolation as high-risk factors for dementia. So this is a situation that needs to be addressed.

For most venues, there is a solution. A well-designed and installed hearing loop can send clear sound directly to the hearing aid. This allows a hearing aid user to sit anywhere they want, flip a switch on their hearing aid to activate their t-coil, and pick up a direct & clear feed from the sound system. This system bypasses the room acoustics, noise, and loudspeaker distance issue and allows the hearing aid to process the sound as prescribed for that individual. In short, this hearing assistance system removes all the acoustic factors of the room to allow a hearing aid to give maximum benefit. In our own studies, we have found there to be virtually 100% speech

understanding when a hearing loop signal is combined with a hearing aid, no matter how poor the room acoustics. This is something that's just not possible for the hearing aid to achieve on its own, in medium to large rooms.

In a hearing loop system, the microphone used for the sound system picks up clear sound from the performer. Then, the same signal that is feed to the venue's amplifiers and loudspeakers is also sent to a specialized hearing loop amplifier. This signal is processes and then transmitted into the wires installed throughout the room. These wires create a specialized electromagnetic signal that the t-coil in a hearing aid is designed to pick up. Once the signal is in the hearing aid, it is processed by the hearing aid and turned back into audio that the impaired ear can benefit from.

It's important to note that a hearing loop relies on good quality microphones and placement. For example, if the microphone is simply placed in the audience area, then the hearing loop signal will contain the reverberation, noise, and distortion heard in the audience. However, if a good microphone is close to the speaker's mouth the signal is clear and undistorted - even in the worst of acoustic environments. The good news is that most venues already have quality, well placed microphones. And for ones that don't, they can generally be added.

Of course, hearing loops aren't the only type of hearing assistance. For many years in the United States, RF (radio frequency) and IR (infrared) systems have been used unsuccessfully as the low-cost way of reaching legal compliance in public spaces. Part of the Americans with Disability Act requires the availably of assistive listening in public spaces with sound systems. For these systems a pocket-sized RF or IR receiver picks up the sound system signal from an antenna or light emitter and brings the audio to a person's ears with headphones or an earbud. These devices are normally acquired, distributed, and maintained by the facility. As such, it is common for these systems to be broken, not maintained, and not cleaned. In addition, the staff is usually unfamiliar with them and their operation. They also are not directly compatible with hearing aids, requiring the use of an accessory called a neckloop. However, actual hearing aid users comment that neckloops are typically a poor quality and do not work at all with some hearing aids. Thus, they do not take advantage of the processing provided by a hearing aid. Additionally, most users do not wish to self-identify and do not want to take the time to find, checkout, and return a receiver that may or may not work for them. It is no wonder that facilities that have this type of hearing assistance program find that utilization is very poor. In contrast, studies show that hearing loops are preferred by over 80% of users and have a 3x higher usage rate.

Figure 6 – FM Receiver

There is also a new technology that that has gained some interest. Specifically, it uses a Wi-Fi connection to a smartphone to stream audio. However, this technology has issues, even in the best systems the complete transmission speed to a hearing aid is too slow and causes an audible delay between the sound in the room and the audio from the Wi-Fi system, making understanding more difficult, not less. And if there is crowded Wi-Fi interference, which is common in today's venues, the situation gets worse. Although there are good applications for this technology - like listening to multiple TV's - despite what the advertising suggests, the technology is simply not suitable for live audio.

However, there is also new technology designed to pick up the loop signal. One is the Bean with T-coil, as developed by Etymotic Research. It is a small, non-prescriptive device for only a few hundred dollars that fits in the ear and picks up the signal from the hearing loop. This is a great device for those who do not feel they have much of a hearing loss but want to clearly hear the talk or performance. Another device is LoopBuds by Otojoy. These are designed to replace the listening buds for your iPhone except that they also contain a t-coil that picks up the loop signal. With a free app on your iPhone, you can control the signal and make listening a comfortable and easy experience. They sell for about $75.

In summary, hearing loops are the technology that gets closest to universal hearing. *Universal hearing* is the concept of offering barrier-free, clear sound and enjoyment to all people, regardless of their impairment, for all situations. Hearing loops accomplish this by eliminating the requirement of a bodypack receiver and instead allowing people to conveniently use the receiver (t-coil) built into their device while at the same time offering the best quality via prescribed sound. Hearing loops can also be utilized in places that receiver-based systems are impractical, like in a taxi cab or pharmacy counter, so that universal hearing can be offered in more places.

To successfully implement a hearing loop, there are a number of design factors that need to be considered. “Metal loss” alters the loop signal field in significant ways, if it is not controlled for with proper design. Among other things, we must also consider over-spill to adjacent rooms so that two hearing loops can work side by side without interference. Hence, it is critical to work with a firm that is experienced in hearing loop design and installation. An experienced firm knows the ins and outs of the different types of metal loss testing and how to change the design based on test results. Inexperienced firms conduct a simple, one-size fits all test or no test at all! Which often leads to designs all over the place, just hoping to be lucky and work to standard. Experienced firms are also able to complete a customized design approach to address the specific needs of each space with their in-house design team. Inexperienced firms tend to outsource this work to the equipment manufacturer based on simple forms that lack the depth and understanding to tune a design for a specific space.

No matter what the venue, there is an optimum approach of hearing assistance to every facility. Most often this should be a hearing loop, but on occasion experts with experience working with hearing aid users may recommend FM, infrared, or even Wi-Fi audio. When applied correctly those with hearing loss will hear much better since the adverse effects of noise, reverberation and distance will be eliminated. Even those with normal hearing who struggle because of impaired auditory processing will greatly benefit from assistive hearing. This ease of listening will enhance their connection to others and to the venue. If you have trouble hearing in a space, don’t sit idle about it. Instead, voice your concern and inquire about hearing assistance and especially of the possibility of a hearing loop installation. Just as Universal Design applies to the design and architecture of a building, *Universal Hearing* should apply to the acoustics and audio design of a building. Every person deserves to have barrier-free access to clear sound.