We like to think that our patients receive good service and have a good experience when they obtain hearing aids in our offices. At the same time, I’m sure that most of us feel that there can always be room for improvement, no matter how successful we believe our efforts are. Where do we look for opportunities to improve?

Sometimes the rearview mirror is worth checking out. Jim Curran, with more than four decades of dispensing and manufacturing experience, reminds us that techniques our predecessors refined still have a place in a contemporary practice. Don’t miss his excellent article on mold modification and reduction of occlusion.

Our patients may be happy enough with their current products, but they may not know that they could be better served with upgraded or newer technology. The world of wireless communication opens doors for convenience and performance that patients may not be aware of. The addition of custom products to the Starkey Hearing Technologies wireless lineup gives us the opportunity to inform patients of what will be in store for them when they decide to upgrade their hearing aids. This issue of Innovations will bring you up to speed with the latest wireless offerings.

Just like us, patients like to know what is on the horizon. Most of us have thought about the convenience of virtual impression taking — no powder and liquid, no silicone — just electronically scan and send an order for an earmold or hearing aid. The technology hasn’t been available until now. Check out the description of the optical scanner by Lantos Technologies using technology developed at MIT. That news promises to improve the experience for patients, as well as clinicians!

What do a lotus leaf and a Starkey Hearing Technologies hearing aid have in common? Reliability in the performance of the hearing aids we provide is critical if we expect our patients to be satisfied, or even better, delighted with their hearing aids. There is no substitute for the common sense maintenance of hearing aids. We know, however, that for some of our patients even changing batteries can be a challenge, so keeping wax and moisture out of the small openings in hearing aids may be out of reach for them. Innovative approaches to design can help. Find out how we learned from nature in this issue’s feature on the omniphobic coatings and design enhancements of hearing aids.

Once again, we have an issue of Innovations that is packed with solid content useful for your practice today and tomorrow. Whether you are interested in improving fitting skills, business practices or simply being better informed about the offerings available for patients, Innovations has something for you.

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Starkey Hearing Technologies
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Moisture HAS MET ITS MATCH

Kevin Marshall, MBA

Background

One of the most common problems with hearing aids is their ongoing exposure to moisture, wax and other foreign materials. Even brief exposure to these harsh environments can degrade and eventually interfere with proper hearing aid functionality. These issues may be accelerated for patients with more active lifestyles. As a result, almost all hearing aids now contain some kind of water-resistant design to repel water, delaying or avoiding the detrimental effects of moisture. Starkey Hearing Technologies has developed a new protective hearing aid technology called HydraShield®, which not only improves upon existing water-resistant properties, but also adds resistance to waxes, oils and other liquids.

Modeled after Nature

HydraShield® is based on nanotechnology that significantly modifies a surface’s interaction with moisture, sweat, earwax, oils and other fluids. The technology is invisible and biocompatible. Interestingly, the scientific basis for HydraShield® technology is derived from nature. On a lotus plant, water droplets form spheres and completely roll off the leaves, carrying dirt with them. This self-cleaning, or Lotus Effect, is achieved through a combination of microscopic hairs (which provide surface roughness) and the intrinsic non-wetting nature of the surface layer covering these hairs.

Hydrophobic and Superhydrophobic

The degree of water repellency of a surface, or hydrophobicity, can be characterized by measuring the contact angle of a small water droplet on a level surface (see Figure 1). Water with a low contact angle will spread across a surface, seeping into small gaps (see Figure 2). A surface is deemed hydrophobic if the water contact angle is greater than 90 degrees. On a hydrophobic surface, water beads up and easily rolls off the surface. As hydrophobicity increases, the contact angle between the surface and liquid increases. A surface is superhydrophobic if the water contact angle is above 150 degrees. A surface with a contact angle of 180 degrees would mean that water sits on it as a perfect sphere. Currently, most industry hearing aids are only hydrophobic.

With the introduction of nano-sized textures onto hearing aid surfaces, HydraShield® technology improves the hearing aid surface behavior to superhydrophobic. Water drops form an almost perfect sphere and roll off with almost no surface friction.

Oleophobic

In addition to an enhanced superhydrophobic surface, HydraShield® also provides a unique oleophobic (from the Greek “oleo,” meaning “oil”) surface, which effectively mitigates ingress of sweat/moisture, earwax and other oily substances. Patients benefit through less frequent hearing aid repairs and longer times between changing microphone covers and receiver wax guards.

Most hearing aid hydrophobic coatings only offer about a 70-degree contact angle for oily substances.
Where is HydraShield® used on a hearing aid?
The most common failure mode for hearing aids is damage due to foreign materials, such as earwax. Due to its oleophobic properties, HydraShield® significantly increases the lifetime of the receiver, as well as the entire hearing aid.

Receivers: With their position in the ear canal, custom devices, receiver-in-canal (RIC) and custom earmold receivers are heavily exposed to foreign materials. To protect receivers, a newly designed Hear Clear® wax guard can be inserted in front of the receiver. This new wax guard design switches out the acoustic mesh for a wax guard made of plastic. With its HydraShield® oleophobic properties, the Hear Clear wax guard is less prone to getting clogged with oily/waxy residue. In addition, it repels waxes and other foreign material, keeping them away from the receiver electronics. Patients report improvement by a factor of two to three times in the time between replacing wax guards. Hear Clear wax guards are readily identifiable by their red application stick, as compared to the original blue Hear Clear application stick (see Figure 5).

Cases and battery doors: HydraShield® is currently used on all new behind-the-ear (BTE) and RIC cases, as well as the battery doors, to provide protection against liquid seeping into small holes, seams and crevices. HydraShield® reduces damage to mechanical components, zinc-air battery corrosion and electrical circuit malfunctions.

Microphone covers: HydraShield® is used on all BTE, RIC and custom microphone covers to protect the internal microphone from damage due to body oils and sweat. As seen in Figure 4, HydraShield® repels moisture and oily or waxy fluids to protect the microphone and prevent degradation of performance.

Enhanced Mechanical Designs
Starkey Hearing Technologies uses many design techniques to protect batteries and electronic components from foreign material ingress. The most straightforward way would be to completely seal the hearing aids. However, this is not practical as microphones would not be able to receive acoustic signals, and the battery would be starved of air and unable to provide power. The key is to find ways to keep foreign materials out but let air in. Typical forms of ingress management include mechanical barriers, gaskets and water-repellent meshes. These designs are primarily implemented within battery compartments, case seams, microphone modules and receiver areas. Given the small sizes involved, many good design techniques are constrained by physical size or assembly/repair considerations.

Additionally, a small tear in a seal or a degraded mating part surface may negate any protection offered. Acoustically transparent meshes reduce the amount of unwanted substances that reach receivers and microphones; however, their performance is best optimized when used in conjunction with HydraShield® technology. Designing seams, gaps or holes less than 0.004 inch [0.1 mm] in diameter provides excellent resistance to water and oil ingress when combined with HydraShield® technology. Supplementing the limitations of traditional design techniques, HydraShield® technology increases patient satisfaction through extended product reliability and reduced ingress of wax and other foreign materials.

Salt Fog
A salt fog test simulates how a hearing aid may perform long term in a humid and sweaty environment. This testing represents the real-world operating conditions that BTE and RIC devices may experience every day. Starkey Hearing Technologies has adopted the MIL-STD-810G (Method 509.5) standard, as it is widely used in the consumer electronic industry. Hearing aids are placed in the salt fog environment for 48 hours at a temperature of 95 degrees F (35 degrees C) followed by 48 hours of drying time under typical ambient conditions. HydraShield® has been proven to retain its superhydrophobic properties even when exposed to aggressive environments (Figure 6). Figure 7 highlights the corrosion protection provided by HydraShield® in the battery compartment and DAI contacts. These results portend fewer moisture-related problems and better reliability for hearing aids.

Ingress Protection Rating
The hearing aid industry has adopted the ANSI/IEC60529 standard to demonstrate how “resistant to penetration” hearing aids are.
About the Author:
Kevin Marshall joined Starkey Hearing Technologies in 2010 and currently works in Product Management with a focus on wireless hearing aids and accessories. Prior to joining the company, he was a Product Manager with 3D Systems and RTP Company. His experience in plastic material technologies spans 20 years, with the last 10 being focused in the medical device industry. He received his MBA degree from the Amos Tuck School at Dartmouth College.

Based on this standard, hearing aids are given an Ingress Protection (IP) rating. This rating begins with the letters “IP” and is followed by two digits: the first digit of the IP certification indicates the level of protection against foreign objects, such as dust or dirt; the second digit indicates the level of protection against water and moisture. If only one criterion is being tested, then an “X” replaces the other digit. For example, the IP rating scale for water goes from “IPX0” (not protected against moisture) to “IPX8” (protected against continuous water immersion). An IPX7 or IPX8 rating allows a hearing aid to be labeled water-resistant.

An independent lab recently tested each of Starkey’s X Series™ and Wi Series® RIC hearing aids in the formal Water Intrusion Test. After being immersed in three feet (one meter) of water for 30 minutes, they showed no evidence of moisture intrusion, satisfying the IPX7 requirements. IP testing is considerably more rigorous than what would be expected in daily hearing aid use, giving patients added moisture protection with HydraShield™.

Conclusion
Hearing care professionals and patients want hearing aids that are resistant to water, sweat, earwax and other foreign materials. They desire hearing aids that work reliably in challenging environments and peace of mind in knowing that the sensitive electronics in their hearing aids are well protected throughout years of ownership. In recent years, hearing aids have integrated water resistance to reduce corrosion and improve reliability. Unfortunately, water resistance did little to address the most common failure mode — the ingress of foreign materials, such as oils and earwax. Through successful laboratory testing and actual patient experiences, HydraShield™ technology offers an effective and comprehensive solution that is unrivaled in the industry. Not only does HydraShield™ optimize moisture protection through superhydrophobicity, but it also adds oleophobic surface properties. Together, these features increase the longevity and durability of today’s hearing aids, as well as enhance patient satisfaction.

Hearing Innovation Expo
A RESOUNDING SUCCESS

Kendra Klemme, MBC

The Hearing Innovation Expo 2012 was held at the Cosmopolitan™ of Las Vegas Jan. 4–7, 2012. The response from attendees, staff and speakers was overwhelming! A host of remarkable presenters, a wide array of breakout options, a Concept Office, Solutions Hall and a performance by Rascal Flatts and Chuck Wicks all melded to create an unforgettable experience for attendees.

“We were energized and inspired by the engagement, interest and excitement at the Hearing Innovation Expo,” said Starkey Hearing Technologies Senior Vice President Brandon Savalich. “This event was designed to provide content and innovative ideas that hearing care professionals could use immediately, and it achieved that goal. The comments we received were overwhelmingly positive throughout the event regarding the content, the layout and the production.”

Outstanding Speakers and Entertainment
Starkey Hearing Technologies hosted a number of world-renowned speakers at the Hearing Innovations Expo. Highlights included keynote speakers Sir Richard Branson; President Bill Clinton; author of The Steve Jobs Way: iLeadership for
a New Generation, Jay Elliot; entrepreneur and Apprentice star, Bill Rancic; body language expert and regular FOX News contributor, Tonya Reiman; baby boomer expert and author, Mary Furlong; and a number of leadership figures from Starkey Hearing Technologies. Entertainment was provided by country music singer Chucks Wicks and Grammy award-winning musical group Rascal Flatts, who asked Starkey Hearing Technologies President Jerry Ruzicka to join them on stage for a song.

Course Topics
The Expo offered more than 45 courses with topics ranging from innovation, technology and trends powering the baby boomers to entrepreneurship and philanthropy. Participants chose among 13 courses each afternoon. Each day had a different focus and the breakout classes in the afternoon provided more content about those topics. Thursday’s theme was Research and Hearing Science. Friday covered Patient Engagement 2.0: The New Consumer, and Saturday’s keynotes focused on Best Practices for Entrepreneurial Success.

BY THE NUMBERS:

3,000: The number of hearing care professionals who attended Hearing Innovation Expo

45: The number of courses offered at the Expo

17: The number of booths in Solutions Hall

1,500: The number of people who visited the Concept Office

There were a large number of comments on Twitter, posts on Facebook and conversations at the Expo about the courses and the event as a whole. Here are some example Tweets:

Thank you so much @StarkeyLabs for an amazing #Expo2012! Can’t wait until next year!

Blown away by the Hearing Innovation Expo in Vegas. No wonder Starkey is the leader in the hearing industry!

Very proud to be part of the 3,000 international people attending #Expo2012. Many thanks @StarkeyLabs.

@AudibelBMT: Can’t wait to get home to my patients to show them everything I have learned @starkeylabs #expo2012 in Vegas!

Concept Office
Another event highlight was the Concept Office, which showcased a full-scale model of a hearing care office showing professionals how they can differentiate themselves by providing an extraordinary experience for patients. The office included the world premiere of direct ear scanning technology in partnership with Lantos Technologies, a Reality Room for fitting and demonstrating new technology, a Connect Hear Room for real-world applications of telehealth, an Aural Rehab Room for post-fitting, and, finally, a Testimonial Room to facilitate digital marketing.

The Concept Office will travel to AudiologyNOW! in Boston, Mass., at the end of March as part of the Starkey booth. Following the trade show, the Office will be available for tours at Starkey Hearing Technologies headquarters in late spring 2012.

Solutions Hall
Finally, Solutions Hall was set up like a trade show floor. Featuring 17 booths and a variety of refreshments, Solutions Hall provided participants with a wealth of knowledge about many different service areas within Starkey Hearing Technologies, as well as the Starkey Hearing Foundation, where Marlee Matlin provided some star power on Saturday.

Starkey Hearing Technologies is proud to have had the opportunity to host so many hearing care professionals at the Hearing Innovation Expo and looks forward to providing exciting experiences in the future. For pictures from the event, visit the Starkey for Hearing Care Professionals Facebook fan page and watch video highlights from the Expo by subscribing to Starkey Hearing Technologies’ YouTube channel.

About the Author:
Kendra Klemme, MBC, is the Communications Manager for Starkey Hearing Technologies. She is responsible for public relations and social media, as well as internal and external communication activities. Klemme has nearly 13 years of experience in public relations, and communications strategy and execution both in corporate and agency settings. She holds a bachelor’s degree from the University of South Dakota and a Master of Business Communication from the University of St. Thomas.
Robyn Cox, Ph.D., is a Professor at the School of Communication Sciences and Disorders at the University of Memphis, where she directs the Hearing Aid Research Lab. The Lab focuses on the measurement and prediction of hearing aid outcomes and the development of hearing aid fitting tests and protocols. She has been on the faculty at the University of Memphis since 1977. She and her colleagues have been instrumental in the development of several frequently used outcome measures for clinical and research applications. Cox has agreed to bring us up-to-date with self-report outcome measures in this issue of Innovations.

Let’s start with a very basic question. What are self-report measures, and why have they gained popularity in use with hearing aid outcomes?

Robyn Cox: Self-report measures are just questionnaires. We generate questions or items, and the patient supplies the answers. We use two kinds of self-report measures. The most common ones have a fixed set of questions which all respondents answer by choosing one of a predetermined list of responses. These are called standardized questionnaires. The other, less common type of questionnaire is one where the patient actually provides the questions/items as well as the answers. These are called non-standardized, or patient-centered, questionnaires. The International Outcome Inventory for Hearing Aids (IOI-HA) is an example of a standardized questionnaire. The Client Oriented Scale of Improvement (COSI) is the most popular example of a non-standardized questionnaire. Both types have pros and cons.

Self-report measures have become increasingly popular over the past 20 years as another way of assessing the outcomes (advantages and disadvantages) of hearing aid fittings. Why has this happened?

Probably several reasons. For one, the entire healthcare enterprise has moved substantially away from the paternalistic model where the professional decides what treatment to give and how well it worked. We are now very much in a collaborative and patient-centered mode where the best treatment is decided jointly by the patient and the professional, and the result of the treatment is decided largely by the patient. In other words, we admit that we have not really helped our patients unless they feel that at least some of their daily life problems have
It would be great if we could settle on just one questionnaire that everyone would be happy to use, but it isn’t going to happen. There are many reasons for this, and I will briefly mention three.

First, hearing aid outcomes are multidimensional. Consider, for example, that we might want to know how much help the patient receives (benefit), how satisfied she is with everything about the hearing aids (comfort, help, sound quality, appearance, etc.), how long or often she wears them, whether her husband has noticed any improvement, and so on. The situation is complicated because a good result on one of these questions does not necessarily mean there will be an equally good result on the other questions. And yet, all of these issues and more are important to the overall outcome. Different questionnaires tend to focus more on some outcome dimensions (domains) than others. A questionnaire that fully explores all of the important outcomes would be much too long to be clinically feasible.

Second, people use self-report data for different purposes. For example, we might want to get the patient’s opinions about how much his hearing problems have been improved, or we might need to obtain data to demonstrate to the boss that our clinic is providing services that compare well to population norms, or we might need to obtain some specific information that is required by a third-party payer. Each of these purposes could call for a different questionnaire.

Third, there are some very practical reasons. Some settings can only devote 10 minutes, whereas others have plenty of time. Some questionnaires are best administered using the old approach, while others must be in an interview format, and yet others are completed at a keyboard. In some settings, literacy or language concerns limit the available choices.

How do we choose an appropriate outcome measure for our own clinics? This is tricky because what works for someone else might not be the best for you. This decision calls for some careful consideration.
It would be handy to have a questionnaire that is more independent of personality to use in research where we compare hearing aids or features.

It is important to realize that the patient’s personality is a valid part of the self-report outcome, not a contaminating influence. This is the outcome from the patient’s point of view. Most of the time, the patient’s point of view is exactly the issue you want to explore. For example, if you want to find out how much the patient feels helped by amplification or how satisfied he is with the technology you recommended, his personality plays a front-and-center role in this outcome. There are other times when you might like personality issues to take more of a back seat in the responses to the questionnaire. This might be possible to achieve, at least to some extent.

Reports using an outcome measure called the Device Oriented Subjective Outcome Scale (DOSO). What is that, and will we see that published on your website soon?

The DO SO is a questionnaire that I developed with colleagues Genevieve Alexander and Jingjing Xu. It is a follow-on from our research into the impact of personality on self-report hearing aid outcome questionnaires. We noticed that personality seemed to be rather strongly associated with responses on some questionnaires but not others. After looking closely at this for a while, it seemed that when the item included the word “you,” there was more personality influence than if the word “you” was not used. We called this characteristic “pointing to the wearer” versus “pointing to the hearing aid or device.” According to this theory, an item such as, “How well do you understand speech in a noisy place?” (pointing to the wearer) would be more influenced by personality than “How well does the hearing aid separate speech from noise?” (pointing to the device).

We used this idea to develop an outcome questionnaire that would (in theory) be less influenced by personality, and that’s where the DOSO came from. It would be handy to have a questionnaire that is more independent of personality to use in research where we compare hearing aids or features. Although we do make the DOSO available, it has not found its way onto our website yet because scoring software has not been completed. However, this job is about 90 percent done, so I should be able to put the DOSO out there pretty soon.

You have published updated aided norms for the Abbreviated Profile of Hearing Aid Benefit (APHAB). What has changed that required new norms?

The first set of APHAB norms (published in 1995) reflected use of hearing aids that were new in the early 1990s. It was a time when many hearing aids were linear processors and technology was generally less advanced. Over the decade from 1995 to 2005, hearing aid technology improved in numerous ways, which resulted in more flexible programming, widespread use of WDRC processing, increased use of bilateral fittings, more sophisticated directional microphones and digital noise management, and so on. It seemed intuitive that these changes would produce improved outcomes. Consequently, there were questions about whether the original norms were still relevant. This was the motivation for determining the new norms.
Hearing aid design is challenging. Components must withstand constant exposure to humidity and oils, as well as daily mechanical stress, while complementing other design features and providing a smooth transition to new designs as they evolve. In addition, the hearing aids have to be comfortable, cosmetically appealing and perform to the highest standard. Creating hearing aids that fit all of these criteria is no easy task, but using “forward engineering” principles, Starkey Hearing Technologies’ engineers have succeeded, creating a new design for a receiver-in-canal (RIC) case and cable assembly that will be available in early May 2012 and a new mini behind-the-ear (BTE) that will be available this summer.

New RIC and mini BTE Case Design

The new RIC and mini BTE cases build on the aesthetically appealing design language first introduced in Starkey’s Zn™ RIC. The new cases feature:

- **Comfort:** Since the top of the pinna is the most common point of discomfort for patients, the new cases have a narrow profile in the nose. The design leverages Starkey Hearing Technologies’ understanding of the fit and comfort of products behind the ear to feature more generous radiuses and transition points, ensuring a secure fit while eliminating hot spots and pressure points that cause irritation.

- **Cosmetic appeal:** The microphone and switch cover wrap around the top corners of the hearing aid instead of bluntly capping it. This both reduces the opportunity for moisture to pool and provides sight lines that reduce the visual impact of the case. The RIC case paired with the new cable design reduces visibility over the ear by 60 percent and reduces the size of the hearing aid while still providing a fully featured device.
new RIC cable assembly incorporates an oval shape that resists twisting and conforms to a forward placement on the hearing aid case, allowing a more forward microphone placement, which is important for optimal performance. Six pin connectors allow for future design compatibility and a very stable platform that resists wiggle. A flexible O-ring (Figure 1) around the connector not only provides an additional dust, moisture and oil barrier working with the HydraShield®2, but also adds mechanical stability by adding a physical constraint to dampen movement. A dual-sided snap ring centers the load on the connector and firmly holds it in position yet maintains a very small overall size.

The redesigned receiver housing is smaller, and the two-conductor cable tube diameter is 25 percent smaller than the current cable. When more wires are required for future designs, the cable diameter will be the same as the current design. Cosmetically, the smaller, oval layout (Figure 2) provides a robust connection and allows the tubing to disappear into the case rather than having a large nose cone transition (Figure 3).

**Conclusion**

Two new hearing aid styles, along with a new receiver cable assembly will provide new options for hearing care professionals to help find the best personalized solution for every individual patient.

**Ease-of-use:** Two thin switches offer combined memory and volume control functionality. The user control — a rocker switch — was designed for easy finger or thumb registration. It is also fully programmable, giving professionals flexibility to personalize each hearing aid for their patients. In addition, the new styles offer DAI and complete telephone functionality including programmable Autocoil, Telecoil and Automatic Telephone Response.

**Durability:** An improved battery door design includes firm on/off detent, the right amount of force needed to open and close the battery door, a new fingernail latch to make it easier to open, discreet but easy-to-use battery door lock and the ability to keep the DAI boot on the door when changing the battery.

**RIC Cable Assembly**

RIC cable assemblies encounter twisting and pulling stress as a routine consequence of daily use. Part of the appeal of a RIC hearing aid is that the thin wire cable is discreet and offers good cosmetic appeal, so the design must maintain the contemporary look. Starkey Hearing Technologies’ RIC cable assembly...
A forgotten technique for RESOLVING THE OCCLUSION EFFECT

Jim Curran, M.S.

It is not uncommon for patients fit with an occluding earmold or custom shell hearing aid to complain that their own voices sound hollow, boomy or as if they are “speaking in a barrel.” When listening to others talking, the voices sound OK and do not have this annoying characteristic. The patient is likely experiencing the well-known occlusion effect.

Soft, instant-fit eartips coupled with thin-tube or open earmolds have made fitting most high-frequency hearing losses simple. Receiver-in-canal (RIC) hearing aids have made the occlusion effect usually is not a problem.

As a result, some of the techniques and procedures used in past years to deal with the occlusion effect are less emphasized today. Yet there are a substantial number of cases where knowing and using modification techniques can be extremely useful, especially when fitting custom products and aids using standard tube (#13) earmolds. This article is intended to reacquaint us with useful, especially when fitting custom products and using modification techniques can be extremely effective, especially when fitting custom products and aids using standard tube (#13) earmolds. This article is intended to reacquaint us with useful, especially when fitting custom products and aids using standard tube (#13) earmolds.

How does the occlusion effect sensation arise and what is its cause?

When a patient is fit with an occluding earmold/shell and has pure tone thresholds better than 30dB (or even in some instances, 35–40dB) in the low frequencies, between 125Hz and about 1,000Hz, they will usually become aware of this annoying low-frequency sensation when talking (Dillon, 2001; Killion, Wilber, & Gudmundson, 1988; Kuk, Keenan, & Lau, 2005; Kuk, Peters, Keenan, & Lau, 2005). The hearing loss may have any audiometric configuration (e.g., high-frequency, gently or abruptly sloping, flat, or rising). The patient may be a man or a woman (Mueller, Bright, & Northern, 1996), but personal experience suggests that men with deep voices may experience these negative effects more often. Moreover, patients may not adapt to or become accustomed to the occlusion effect percept, it will not simply disappear over time (Kiessling et al., 2005).

When an individual produces a voiced sound, the vibrations within the vocal tract (larynx, nasopharyngeal column, etc.) are transmitted by bone conduction through the skull to the ear canal (Bekesy, 1960; Goldstein & Hayes, 1965; Khanna, Tonndorf, & Queller, 1976; Tonndorf, 1972). When talking, the movement of the articulators (i.e., the mandibular condyle) causes minute displacements of the cartilaginous portions of the ear canal (Dillon, 2001; Franke, Gierke, Grossman & Wittern, 1952; Zemlin, 1996). Together, these sources of vibration set into motion air particles within the ear canal across the frequency spectrum. These self-generated acoustic effects are always present when a person vocalizes or talks, regardless of whether the ear canal is open or occluded. In the case of the open canal, this transmission of a patient’s own voice is not perceived negatively because the sound is leaked into the environment outside the ear. However, when the ear canal is occluded with an earmold/shell that terminates in the cartilaginous portion, the sound is unable to escape and is trapped. The occluded ear canal becomes a resonant cavity, and the low frequencies, which have been boosted, pass into the cochlea because the impedance at the tympanic membrane has become favorable to the passage of the low-frequency portion of the spectrum (Tonndorf, 1972).

The inside story

This discussion assumes that:

1. A hearing aid functions to amplify only the natural, environmental sounds that come from outside the listener, across the frequency spectrum, lows to highs.

2. When the aid involves an occluding earmold/shell, another source of low-frequency sounds arises from inside the listener’s ear canal, and these sounds are reinforced and enhanced independently of the amplification provided by the hearing aid.

This acoustic effect of self-generated low-frequency sound is why applying a low cut to the hearing aid’s frequency response to eliminate the occlusion effect will ordinarily not make the “speaking in a barrel” sensation disappear; the occlusion effect is not a function of the amplification provided by the hearing aid (Kuk et al., 2005; Mueller, 2003). It is the simple presence of an occluding earmold or shell that gives rise to the unnatural, hollow sensation when talking, and this is the circumstance that must be dealt with.

In our purposes, and in agreement with others (Kuk et al., 2005) we’ve concluded that most of the hollow voice complaints are earmold/shell related, and specifically dealing with them is by far the most important issue.

You can determine for yourself if the patient is experiencing the true occlusion effect as opposed to a new, unfamiliar or degraded sound of amplification. With the aid in place, turn it off and ask the patient to speak or phonate a vowel, such as [æ] or [a]. (In lateral fittings, remove the contralateral aid) If the occluded sensation is still present, gently break the seal of the aid, or pull it slightly out of the ear. If the sensation disappears or lessens as the aid is loosened, you’ve identified the culprit.

Investigators have attempted to quantify the frequencies and the magnitude of the SPLs at which the occlusion effect occurs in the canal (Goldstein & Hayes, 1965; Kampe & Wynne, 1996; Killion et al., 1983; Revit, 1992). Occlusion effect SPLs vary in amplitude between patients from as little as 5–9dB to 25–32dB, with peaks at different frequencies (Fulton & Martin, 2006; Killion et al., 1988; Mueller et al., 1996). Instrumentation and techniques are available for measurement of the occlusion effect in the office, but we might ask ourselves whether the time spent performing measurements is worthwhile. The reality as Dillon...
the initial FDA research protocols for represented the industry in developing Audiology and to the Executive Committee to the board of the American Academy of speaking and writing on industry topics. He has authored many articles and textbook hearing aid manufacturer. Over the years he opened his office in 1967 and then in 1970, joined a dispensing audiologists. James Curran, M.S., was one of the first chapters and has had extensive experience during voicing of /i/ as the vent was shortened approximately of SPL in the ear canal. The probe tube depth was held constant results in a reduction of acoustic mass; therefore, length while holding the diameter constant also discussed, these investigators did not measure the effect of shortening the vents. Shortening vent length while holding the diameter constant also results in a reduction of acoustic mass; therefore, vent shortening will also reduce the occlusion effect (Dillon, 2001). Figure 1 is an example of the reduction in gain afforded by shortening a two-millimeter vent in one patient. Note a reduction of approximately 20 dB in the low frequencies. Ordinarily, one can expect slit leak (the escape of sound around the circumference of the mold/shell) to also increase as the vent is shortened. Each time slit leak increases, a little more of the low frequencies are leaked (Macrae & McAlister, 1989; Studebaker, Cox, & Wark, 1978). The end result of a shortened vent is the reduction of acoustic mass combined with slit leak that together produce a substantive decrease in low-frequency SPLs. It would be nice to be able to choose a priori the exact vent diameter and length that would resolve the occlusion effect in a given patient, but vent dimensions have not been found to be systematically related to the perceived amount of occlusion effect (Kampe & Wynne, 1996; Kiesling et al., 2003; Kuk & Keenan, 2006; Kuk et al., 2003). For this reason, it’s impossible to predict the level of perceived occlusion effect reduction that a patient may experience with a given vent diameter/length. We do know that a very small, long vent will invariably elicit a judgment of a significant occlusion effect (Dillon, 2001; Fulton & Martin, 2006; Kiesling et al., 2005), while shortened vents and those with diameters of three millimeters or larger invariably elicit a judgment of a significant occlusion effect in patients (Dillon 2001; Kuk & Keenan, 2006; Kuk et al., 2005). The Solution: Shortening the Vent. Contemporary hearing care professionals more familiar with open-fit standard products using non-custom tips may question the value of learning or utilizing the practical bench skills that are required for earmold/shell modification. What follows is an example of how useful and powerful a simple modification can be in dealing with this frustrating fitting issue. Shortening the vent is possibly the easiest and safest technique, although others have been suggested (Chung, 2004; Curran, 1991; Sweetow & Pizazzari, 2003). This modification is effective for all types of custom aids and for earmolds fabricated from acrylic or made of any material with reduced flexibility. It provides a reliable means to achieve step-by-step, orderly, incremental reduction of the occlusion effect (Curran, 1990). The basic tool to use is a motor tool, with appropriate burs. Smoothing and polishing is done by means of a larger buffing wheel.

The proper way to shorten the vent is to start from the tip of the earmold/shell, the part that terminates in the ear canal, and remove by grinding away, in small steps, a little at a time, the material that surrounds the vent (see Figure 2). The approach is the same no matter what size the vent is. The path of the vent is followed as it becomes exposed, and small amounts of material are removed by the grinding. A kind of “trench” may be formed by the sides of the vent; the sides should be removed and flattened. All surfaces are smoothed and buffed to eliminate roughness each time before reinserting the aid to determine if the occlusion effect has been sufficiently reduced. It may require a few “cut and try” repetitions before a final resolution is reached. It goes without saying, of course, only the vent itself is shortened; the sound bore or receiver tube is left alone.

When the vent has been shortened substantially, you might opt to enlarge the diameter of the remaining shortened vent by also drilling from the outside

Figure 1: Shortening the vent from the tip results in a reduction of SPLs in the ear canal. The probe tube depth was held constant during voicing of /i/ as the vent was shortened approximately 9 mm from the tip in a custom in-the-ear (ITE) hearing aid.

Figure 2a: An example of a vent that has been shortened by grinding approximately 6.4 mm from the tip.

Figure 2b: An example of a vent that has been shortened by grinding approximately 16 mm from the tip.

The author provided a linear relationship between the acoustic mass of vents and the objective, measured level of SPLs in the ear canal. They found that as the vent diameters were increased, the SPLs in the occluded canal decreased in an orderly, predictable manner. Although modeled data are discussed, these investigators did not measure the effect of shortening the vents. Shortening vent length while holding the diameter constant also results in a reduction of acoustic mass; therefore, vent shortening will also reduce the occlusion effect. The reduction of low-frequency SPLs.

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longer vent. We also expect that as the SPL inside
less acoustic mass it contains when compared to a
ear canal (Dillon, 2001). The shorter a vent is, the
we established earlier that a change in the acoustic
You’ll know when you’ve shortened or opened the
Hearing Technologies’ effective adaptive feedback
from an essentially closed, occluding mold/shell
the vent diameter. In effect, you will have proceeded
A slightly larger drill (burr) can be used to increase
Figure 3: The acoustic effect of shortening and enlarging a
-20
20
40
60
200 500 1K 2K 4K
Vent shortened to 14mm L x 3mm ID
Frequency in Hz
Figure 3. The acoustic effect of shortening and enlarging a
parallel vent on a custom in-the-ear (ITE) instrument. A probe tube was
inserted four millimeters beyond the tip of the aid through a second
probe vent and glued in place throughout the shortening.

exterior surface (or faceplate side) toward the inside.
A slightly larger drill [burr] can be used to increase
to turn the diameter. In effect, you will have proceeded
from an essentially closed, occluding mold/shell
the vent diameter. In effect, you will have proceeded
A slightly larger drill (burr) can be used to increase

Planning Ahead
In adults with small ear canals and especially
children, the earmold/shell may accommodate
only the smallest of vents. When inspection of the
audiogram shows thresholds better than 30-35dB
in the low frequencies where the occlusion effect
can be expected to occur, earmold/shell configurations
with pre-shortened vents can be ordered. Further
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fitting, if needed.

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fitting, if needed.

It might be assumed that Select-A-Vents would provide
an easy method for reducing the occlusion effect,
on the assumption that a simple change of the insert
plug to a larger diameter would be all that is needed.
Generally, Select-A-Vent inserts will have little effect
on reducing the occlusion effect. Patients fitted
with custom ITE and completely-in-canal (CIC)
products or with behind-the-ear (BTE) instruments
having thin tube or #13 tubing earmolds often present
the need for occlusion effect reduction.

**Conclusion**

There are numerous occasions where a software-driven
response adjustment alone is inadequate for resolving
the occlusion effect. Patients fitted with custom ITE and completely-in-canal (CIC)
products or with behind-the-ear (BTE) instruments
having thin tube or #13 tubing earmolds often present
the need for occlusion effect reduction.

Effective and reliable, this simple, in-office, on-the-
spot modification of the coupling apparatus can be
counted on to provide immediate relief. The
vent shortening technique is recommended for use
when occlusion effect problems intrude. Over
the years, earmold/shell modification has been
considered an invaluable fine-tuning adjunct to the
modern fitting process.

**References**


Omer, M. (2002). There’s less talking in barrels, but the occlusion effect is still with us. Hearing Journal, 10(8), 10-11.


Personally, to be honest, my day-to-day functions take a backseat to seeing my co-workers — from senior leadership on down — coming together to solve problems and make Starkey Hearing Technologies the best company possible. I tell anyone who will listen, whether here at Starkey Hearing Technologies or outside the company, that this is a great place to work!

What is the most interesting and/or exciting part of your job?
I am most excited when a business owner, dispenser or audiologist calls and is looking for an office management solution for their practice. They have no idea where to begin. They have been so entrenched in archaic methods of running their businesses that it takes some psychology on my part to first convince them they can move forward. I then provide them with a plan to begin that forward movement. In many cases, our sales reps have identified these accounts and have passed them to me. Working with the varying personalities of sales representatives at Starkey Hearing Technologies is interesting, exciting and, at times, challenging.

What are some of the challenges you face?
Staples, an office supply company, has ads that promote the Easy Button; accounts needing help in managing their businesses are looking for that Easy Button. I have to convince them there is not an Easy Button; rather, it’s a Hard Button that becomes easier once they gain an understanding of the data-in/data-out principle of office management software. Another challenge can be working with outside entities such as the Sycle.net corporation that provides us with the software for our clients. Every single opportunity to work with a customer has its own set of risks and challenges. I try to look at the challenge first from 50,000 feet, then, through a process of deduction, arrive at a conclusion that best suits the customer.

What are some of the most exciting trends you see on the horizon for hearing technology?
I see marketing taking an ever-evolving role within the hearing industry. When I started at Starkey Hearing Technologies, we had six people working in marketing. I can’t begin to guess how many we now have working to further enhance our image as a corporation. In addition, marketing managers and marketing associates are in the trenches every day building more business for our customers.

The office management software I provide to our customers goes hand-in-hand with their efforts. What do you do for fun outside of work?
Now that my wife of 33 years and I have pushed two fine young sons “out of the nest,” we don’t have the challenges of raising them, helping with homework or shuffling them off to soccer. I am proud to say that I give a lot of my free time back to the fine city of Eden Prairie as a reserve police officer.

Do you have any advice for people who are interested in getting into the hearing industry?
Yes; get a good education. I’ve looked at the models regarding the need for highly trained professionals in the hearing industry for the next 20–30 years, and the opportunities abound. However, if you are looking for a quiet, sedate job, I would suggest looking at a different career. If you are looking for a fast-paced, ever-changing challenge, look no farther than 6700 Washington Ave. S., Eden Prairie, Minn.

EMPLOYEE PROFILE

Phil Gjervold
Business Consulting Executive

What is your background?
I have an A.A. degree from Lakewood Jr. College in liberal arts and a B.S. degree in education from Moorhead State University. During college I worked at Sears, Roebuck and Co., and after graduating worked for Target Corporation, Northwest Airlines, and now Starkey Hearing Technologies.

How did you start in the hearing aid industry?
I started in the ProHear division of Starkey Hearing Technologies in 1997 as the StarBase Product Manager.

What are your main job duties?
I am a Business Consulting Executive, and my main focus is to provide the best practice management solutions (office management software) for dispensers and audiologists to help them manage day-to-day office operations. I also work as the operations manager for our Ascent Audiology and Hearing clinics.

What is one memorable experience or achievement in your career at Starkey Hearing Technologies?
There is not an individual experience that stands out, but rather a collection of experiences that has helped me grow both professionally and personally. To be honest, my day-to-day functions take a backseat to seeing my co-workers — from senior leadership on down — coming together to solve problems and make Starkey Hearing Technologies the best company possible. I tell anyone who will listen, whether here at Starkey Hearing Technologies or outside the company, that this is a great place to work!
Asking the question “What if…?” can be a game changer. That provocative question can provide a venue for good ideas and foster forward thinking. Starkey Hearing Technologies took that idea to a new level at the Hearing Innovation Expo in January with the Concept Office. The full-scale model office demonstrated some new ideas to help hearing care professionals differentiate their practices in their markets, while providing extraordinary service that will increase patient satisfaction and loyalty. Similar to concept cars at an auto show, some of the ideas shared within the Concept Office are right around the corner, while others will spark new thoughts and technologies that may be implemented in the future.

Starkey Hearing Technologies conducted a number of research activities as the Concept Office came to life including:

• Visiting several successful hearing care practices in the U.S.
• Visiting multiple successful, cutting-edge practices in Europe
• Visiting healthcare offices in categories similar to hearing healthcare, such as lasik surgery offices
• Conducting an innovation campaign for Starkey Hearing Technologies employees to provide new ideas
• Conducting consumer and baby boomer market research

According to Hearing Industry Association and MarkeTrak studies, the market for hearing aids, while dynamic in some aspects, has been remarkably static in two critical dimensions:

1. The average age of new hearing aid users has not changed appreciably in decades.
2. The number of potential hearing aid users who obtain hearing aids has hovered around 20 percent for many years.

As hearing care professionals, we need to encourage people who are currently simply surviving with hearing loss to learn more about the loss and what treatments are available. We also want those potential patients to be open and receptive to our treatment recommendations. To do that, we need to change our outreach efforts — and likely the way we present ourselves to the public. The Concept Office is a potential game-changer.

What if … you walk into a hearing products and services office and you sense a comfortable and welcoming environment?

One of the barriers to care may be how consumers feel when they walk in the door and form their first impressions. Do they identify with the office and feel like they belong, or do they feel uncomfortable or out of place? Do they feel they are going to be “sold” a product they aren’t sure they even need?

Market research with baby boomers tells us that they feel at least 15 years younger than their actual age. They want to feel that the office environment they enter is a place that is safe and consistent with their age, values and needs. This might be different from one location to another. An office in West Hollywood, Calif., might be very different than one in Salt Lake City, Utah. Or, if you remember Kirsty Gerlach’s story in the January 2012 issue of Innovations, she found a way to weave in the culture of her native New Zealand to create a beautiful and inviting environment for her patients.

What if as you enter, you are greeted by name, and your needs for that day’s appointment are anticipated and verified? Our target demographic wants good service and expects it to be personalized and specific to their individual needs.

The Concept Office demonstrated how the front office can be high-tech and high-touch. It felt like somewhere you wouldn’t mind spending time while building credibility and trust in the practice. The reception area wasn’t clinical or sales-focused; rather, it incorporated refreshments, photographs from the Starkey Hearing Foundation, a space for wireless TV streaming demonstrations, and an iPad® to facilitate the intake process through the Patient Journey app. The iPad app, currently in development from Starkey Hearing Technologies, will allow patients to provide their intake information including name, address, email and hearing health overview. When the information is entered, the app will prompt patients to watch a short video explaining the hearing evaluation process and what will happen during the visit. The video also reinforces that the patient has made the right decision to do something and that he or she is in the right place to have all hearing needs met. After the video, the Patient Journey app asks the patient to answer some lifestyle questions about typical environments he or she is in and what

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IMPRESSION ROOM

What if … optical imaging technology is used to create an impression of the ear, without silicone?

In the Concept Office, attendees were shown the future of ear scanning — a virtual 3D digital image of the ear canal taken in 60 seconds or less. The system relies on a small, portable, handheld device that can plug into a laptop. The imaging uses a visible light technique paired with a disposable conforming membrane that is inserted into the ear canal to create an accurate and dynamic 3D map of the ear. The conforming membrane has a feature that allows it to act as a video otoscope and, when placed in the ear canal, is expanded with a solution of water and biocompatible dye to conform to the canal. The scans can then be transmitted electronically to create custom hearing aids.

For patients who remember ear impressions taken with plaster of Paris and even those who have experienced current methods with two part silicone, the new virtual impressions will be a truly revolutionary idea.

For more information about the Lantos Technologies ear scanning system, see the “Sneak Peek” section in this issue of Innovations.

REALITY ROOM

What if … hearing aid performance is demonstrated in reality situations to fully represent what the user will experience in a variety of environments?

Presently, some hearing aid patients report frustration at not being able to “experience” the benefits provided by new technologies until they are actually fit with the devices. In addition, many patients report frustration with the artificial nature of hearing aid fitting environments that bear little resemblance to their “real world.” In the Reality Room, hearing aid performance was demonstrated in a wide array of situations to fully represent what the user will experience in four distinct acoustic “scenes”: restaurant, music event, car and watching television. The idea was to create a room where patients can truly hear and appreciate what the various features in the hearing aids can do to enhance their listening experiences in the real world.

DIAGNOSTIC ROOM

What if … testing is completed with stimuli and within environments that represent the situations people experience in the real world, not in a sterile chamber?

When we assess with pure tones and speech in a quiet environment, we may gather good diagnostic information for medical management of hearing loss, but only about five percent of the hearing aid patients we see will need medical management. What is instead needed is information that will help fit hearing aids and allow those fittings to perform well in a variety of situations. Speech understanding, as well as appreciation for music and spatialization within the acoustic scene, are important outcomes that we cannot prepare for with medically based assessment.

What does the future look like? The Concept Office shared a future with no booth, no pure tones; rather, the focus was four simple applications that provided a measure of:

1. Residual auditory area
2. Auditory tuning
3. Cognitive function
4. Auditory localization

The Audio Test Pod could provide a relaxing, less claustrophobic, experience for patients. They simply follow along with the tests on an iPad.

“ The Concept Office shared a future with no booth, no pure tones; rather, the focus was four simple applications …”

The Audio Test Pod could provide a relaxing, less claustrophobic, experience for patients. They simply follow along with the tests on an iPad.
AURAL REHAB ROOM

What if … there was a place in the office that promoted relaxation to prepare for an assessment, tinnitus therapy or rehabilitation?

We all need to be in the proper frame of mine to receive and process information. Some processes require that patients be in a relaxed state; for example, electrophysiological testing, processing and understanding counseling; being receptive to tinnitus therapy; or a variety of other reasons. The Concept Office demonstrated how a space with an Audio Test Pod, a relaxing scent and soothing music could benefit a patient starting aural rehab.

What if … rehabilitation training wasn’t in lecture or counseling format but in entertaining and motivating formats?

Satisfaction with hearing aids is directly related to a patient’s experience with a hearing care professional and the process before, during and after purchase. Aural rehab is a great idea, but many professionals find it difficult to find the time to do it regularly. Additionally, products that are good in theory are often less successful in reality because of the lack of patient engagement and acceptance. The information is factual and practical, just not very compelling or interesting.

Fortunately, there are ways of presenting the basic concepts that are entertaining, compelling and interesting. The energy and creativity that has gone into the development of computer gaming has been repurposed for serious learning. Sometimes called Serious Gaming, the products are being developed for academic, military, medical, and training and development applications. The upshot is that people really want to go back again and again to play the activities because they are entertaining, all the while improving skills and enhancing knowledge.

Starkey Hearing Technologies is in the process of releasing a suite of aural rehab tools as games that will be available to hearing care professionals. One of these apps, released in January 2012, is called Hear Coach. The app has two games designed to challenge a patient’s cognitive and auditory skills. See the Apps Corner in this issue of Innovations for more information about it.

THE CONCEPT OFFICE

The Concept Office demonstrated how a space with an Audio Test Pod, a relaxing scent and soothing music could benefit a patient starting aural rehab.

CONNECT HEAR ROOM

What if … some of a hearing care professional’s office hours were not in the office at all but managed through telehealth, or connected healthcare?

The hearing aid user could be at home, or visiting their children in a different state, while the clinician counsels, adjusts hearing aids and performs an office visit — all at a distance.

There is a lot of talk today about Internet sales and direct-to-consumer sales of hearing aids. What these models cannot provide is the very real need for professional guidance in selecting, fitting and adjusting hearing aids. These critical services may be provided at great convenience to the provider and consumer with a combination of face-to-face visits and connect hear visits. Baby boomers are online and are comfortable using computers to conduct business and enhance their lives. Connected hearing is simply an extension of a very familiar technology.

Providing hearing care professionals with the ability to follow up with patients anywhere at the most convenient time for them. It’s all about the connection.

The Connect Hear area of the Concept Office featured two rooms: one where the patient might visit, and the other where the hearing care professional would be. Demonstrations were conducted to show the possibilities available when the professional and patient are in different locations. The technology, including the video connection, is possible with today’s technology.

The Concept Office demonstrated how a space with an Audio Test Pod, a relaxing scent and soothing music could benefit a patient starting aural rehab.

INNOVATIONS VOLUME 2 ISSUE 2 2012
What if … you could capture a patient’s excitement and find new ways to converse with them through social media — all in one simple step?

As digital marketing becomes increasingly important with our patients and their friends and family, it is necessary to be able to generate new content on an ongoing basis. Additionally, for social media marketing to be effective, you need your patients to be your advocates and followers on Facebook and Twitter.

The Testimonial Room was set up with an iMac® that included open windows showing Photo Booth, Facebook, Twitter, and the practice’s website. Photo Booth allows a patient to quickly and easily record his or her experience with the click of a button. That testimonial can then be used on the website, posted on Facebook and linked to Twitter in a matter of minutes. A practice website may benefit from incorporating patient testimonials, since they are a great way to advertise and build credibility for the practice, along with getting extra credit from Google and the other search engines for regularly incorporating new content.

Not every patient will be comfortable giving a video testimonial, but offer the opportunity. Even if they aren’t willing to do a testimonial, ask them to “like” you on Facebook and “follow” you on Twitter.

Conclusion
The Concept Office allowed for a number of “What if …” questions to be asked and addressed. More than 1,500 hearing care professionals explored the Concept Office during the Hearing Innovation Expo, walking away with ideas for what’s next in their own practices. For more information about the Concept Office, contact your Starkey Hearing Technologies representative.

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compliance. This method eliminates many of the risks and inefficiencies associated with the current manual impression process. It enables “end-to-end” digital manufacturing for custom devices, creating workflow efficiencies, improving patient experiences and advancing the science of hearing care by bringing new data to the forefront.

**Lantos Scanner**

The Lantos scanning system consists of a small portable handheld device capable of capturing 3D digital images of the ear canal in 60 seconds or less (Figure 1). The handheld device plugs into a laptop, seamlessly integrating into the current workflow for hearing professionals. The 3D scan files, dynamic information and electronic order forms can then be made available almost instantly.

The 3D imaging technology behind this scanner is a development of the Emission Reabsorption Laser Induced Fluorescence (ERLIF) technique and relies on the selective absorption of emitted fluorescent light. Application of this novel imaging technique uses visible light instead of lasers to generate a highly accurate and dynamic 3D map of the ear involves inserting a disposable conforming membrane (CM) made of an extremely flexible and biocompatible silicone polymer into the ear canal. The CM has a clear viewport at its tip that enables the scanner to act like a high-end video otoscope, while positioning the membrane in the ear canal. Using this video feed, the professional has full control for precise placement of the membrane at the desired depth in the ear canal. Once the CM has been optimally placed, it is expanded to conform to the ear canal geometry using a solution of water and a biocompatible dye. At the press of a button, the scanner switches from video otoscope mode to 3D scanning mode, and the optical tip automatically retracts inside the expanded membrane taking hundreds of images along the length of the canal, concha and helix. The system is able to generate a 3D digital scan from these images in real time using proprietary algorithms, allowing the hearing professional and patient to watch the digital impression “grow” live on the computer screen. When the 3D scanning process is complete, the membrane is automatically deflated and the scanner can be comfortably and safely withdrawn from the patient’s ear.

The CM provides exceptional comfort and safety for the patient because the inflation pressure is low and because it is designed to only inflate radially, and not medially, toward the tympanic membrane, allowing for comfortable and safe deep scans well beyond the second bend. Another key advantage of the CM is that it moves obstructions such as hair or soft cerumen out of the way as it pushes up snugly against the canal walls. Any artifacts caused by hard cerumen or crusting is judged as inadvisable to remove may be noted on the scan and detailed out by the modeler at the lab. Difficult cases such as ear canals that have been surgically altered following mastoidectomy or fenestration, ear canals with osteomas or exostoses, or tympanic membrane perforations, or fenestration, ear canals with osteomas or exostoses, or tympanic membrane perforations, no longer present the risk of injury from impression material when the Lantos scanner is employed.

**New Frontiers**

Not only does the scanner bring digitization to the art of impression taking, but it also allows the hearing professional to capture the exact location and extent of ear canal excursions caused by patient jaw movement. All key stakeholders have long known about ear canal dynamics, but now, for the first time, with the Lantos scanner they can quantitatively measure them and account for them (Oliveira et al., 2005). Assessment of ear canal dynamics will allow the design of an optimally shaped device that will provide an acoustic seal, remain securely in position in the ear and be comfortable for the user over a wide range of physical activity.

Another innovative feature of the Lantos system is that it can slightly vary the pressure inside the CM to show ear canal elasticity. As the CM is slightly expanded, the soft tissues are expanded by an amount proportional to their compliance. Canal elasticity and precise localization of canal wall mobility are important new data sets for the hearing professionals and manufacturers as they personalize the fit. Hearing aid manufacturers will need to collaborate with Lantos to provide the basic research and practical experience to turn the raw dynamic and elasticity data into valuable information that can be integrated into the manufacturing process.

**Hearing Professionals and Patients**

The Lantos scanner presents a promising potential for quickly becoming the default standard of care in the industry. The company plans to make this a platform technology, which will allow all hearing professionals to send the scan data to any hearing aid manufacturer. Given the recent industry trend towards “invisibility” and smaller custom devices, the scanning system provides a state-of-the-art tool for hearing professionals and patients to be engaged in the process of optimizing device fit. A body of research over the past decade has...
Arguably the single most important component of any hearing aid fitting software is its implementation of a “best fit” — an algorithm that automatically adjusts the hearing aid gain to match prescriptive targets based on hearing loss. The prescription, or fitting rationale, will ultimately play a large role in the patient’s acceptance or rejection of amplification. First impressions count! The audiologist may well be able to make slight adjustments if the prescription isn’t just right, but for the patient who rejects amplification after the first fit, the opportunity for fine-tuning is lost. But what defines “just right?” What should be the criterion for determining a good first fit?

- Minimizing initial rejection?
- Maximizing speech intelligibility?
- Maximizing usage of residual dynamic range?
- Maximizing patient comfort?
- Maximizing sound quality?
- Maximizing patient satisfaction?

Most fitting rationales attempt to optimize some combination of the above goals. Optimization is required because often the goals are in opposition to one another. For example, the patient might desire very little gain for maximum comfort, but require a lot of gain for maximum intelligibility. The more factors included in the optimization, the more complex the rationale becomes.

e-STAT®, Starkey Hearing Technologies’ proprietary fitting rationale, started out by leveraging the loudness and intelligibility optimization already done by the NAL (Nonlinear fitting formula), and further customized it to suit the company’s specific needs. This article attempts to explain e-STAT: why it started, how it has evolved, and why it will continue to change as we improve our hearing aids and gather more statistics on user trends and patient preferences.

**History**

Fitting rationales have been in use for many years (see Lybarger, 1978, for a review of early methods). The earliest fitting rationales were developed for linear amplification (since this was the only amplification in use at the time). The start of the modern era of prescriptive fitting could be the introduction of Prescription Of Gain and Output (POGO) (McCandless & Lyregaard, 1983). After POGO, the Australian National Acoustics Laboratories (NAL) method became quite popular for adults, and the Desired Sensation Level method became commonly used with children (Byrne & Dillon, 1986; Seewald,Ross, & Spiro, 1985).
As compressive amplification became increasingly popular in the 1990s, new fitting rationales were developed to specify targets for multiple input levels. FIG6 (Killion, 1994) ushered in the compressive prescription era, but it was quickly followed by DSL6i (Cosnelisse, Seewald, & Jamieson, 1995), the Independent Hearing Aid Fitting Forum (IHAF) protocol (Valente & Van Vliet, 1997), and the Cambridge formulas (Moore, Alcántara, & Marriage, 2001) to name just a few. Currently the most popular nonlinear fitting formula is NAL-NL1 (Byrne et al., 2001).

At the time of this writing, there are second-generation versions of several formulas, such as NAL (NAL-NL2) and DSL (DSL v5.0).

Generic fitting rationales

Initially, fitting rationales were developed by researchers who were independent of manufacturers. These fitting rationales can be said to be “generic” in the sense that they are not designed for a specific hearing aid or compression architecture. Generic rationales have both advantages and disadvantages.

Advantages

One distinct advantage of generic fitting rationales is that they can and have been validated with large populations that would be practically impossible for manufacturers to study. Independent researchers (especially authors of competing rationales) are interested in validating manufacturer-independent rationales to further the body of knowledge about their prescriptions.

Many authors of generic fitting rationales have been very forthright in publishing the workings behind their algorithms (although some like DSL v5.0 and NAL-NL2 have chosen to keep the details of the calculation confidential). All have detailed the goals behind their rationale, but these goals are different for each. This has fueled the discussion about which rationale is “best.”

Disadvantages

Generic fitting rationales are not without their disadvantages. There is very little financial incentive for the development of generic fitting rationales. No one gets rich by publishing fitting rationales or software! In addition, generic fitting rationales need to remain stable so that they can be validated by others and incorporated into fitting software and third-party products such as real-ear measurement systems. For these reasons and others, generic rationales are not frequently updated. For example, NAL-NL2 came more than 10 years after NAL-NL1. The net effect is that generic fitting rationales are always behind in terms of incorporating the latest research.

An additional weakness that arises from the very nature of generic rationales is that they cannot account for proprietary signal processing. As rationales become more sophisticated and deal with second-order effects like dynamics and adaptive feature interactions, the details of the signal processing are likely to be the source of fitting rationale optimizations.

About the Authors:

Tom Scheller is a recent member of the Starkey Product Management team, joining in 2010. He has worked for almost 30 years in the hearing aid industry, managing product development for a variety of companies. With his family, he recently returned to the Twin Cities from an extended stay in Switzerland. He has a bachelor’s degree in electrical engineering and mathematics from the University of Minnesota.

Joyce Rosenthal is a Senior Product Manager and has been with Starkey Hearing Technologies for more than ten years. She received a bachelor’s degree in electrical engineering from the University of Rhode, and a master’s in audiology from the University of California, Santa Barbara.

Accounting algorithmically even for weak correlations can help to make the first fit successful for more patients.

e-STAT

e-STAT is a proprietary fitting rationale, but it uses NAL-NL1 and NAL-RP as its foundation, with several modifications that are described in more detail in this section.

Initial Version — The first version of e-STAT was developed in response to customer reports of “too much mid-frequency compression.” Prior to e-STAT, the default fitting rationale was NAL-NL1* (NAL-NL1 with some reduction of high-frequency gain). A combination of NAL-NL1 and NAL-RP fitting rationales was used to reduce compression without significantly changing gain for moderate level speech.

Modifications were made to the targets based on the style of the hearing aid (see Figure 1).

Improved Modeling — The next step in the progression of the e-STAT fitting rationale was to improve modeling of the in situ hearing aid response. Although it might not be intuitively obvious, having an accurate model allows separation of model (hearing aid simulation) and target components. In turn, this allowed improvement of the target, independent of the hearing aid style.

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**Figure 1** Style-specific offsets were used in the e-STAT formula until model accuracy improvements made them unnecessary.
Changes to compression — Simultaneously, Starkey Hearing Technologies developed a new, faster-acting compression scheme. The change in the dynamic behavior of the compressor was significant enough that loudness was affected and the e-STAT targets needed to change to compensate for it. The change was small and straightforward but is an example of how targets and hearing aid-specific processing cannot be treated independently.

Patient Preferences — e-STAT was further modified to incorporate the results of a research study in which subjects’ preferred gain settings were compared to their initial settings. The results were pooled across styles and analyzed for evidence of correlations that might account for variability in preferred gain. By and large, the preferred gain settings showed a fairly large spread, but were evenly distributed around the starting point. There was a weak correlation between preferred gain and the initial gain at some frequencies and some input levels. For example, Figure 2 shows that at 4 kHz for the initial gain at some frequencies and some input levels are evenly distributed around the starting point. There was a weak correlation between preferred gain and the initial gain at some frequencies and some input levels. For example, Figure 2 shows that at 4 kHz for the initial gain at some frequencies and some input levels are evenly distributed around the starting point.

What’s coming

Minimizing the vent-hearing aid interaction — More patient data will be analyzed during an upcoming study in which new Starkey Hearing Technologies’ products are being evaluated. e-STAT targets for the study have been updated; this time to improve sound for vented fittings. In a typical vented hearing aid fitting, the sound follows two parallel paths: the amplified path and the path through the vent (i.e., direct path). These two sounds mix together in the ear canal, but they are out of sync. The amplified path is delayed because of the digital processing (i.e., throughput delay), while the direct path is not. This delay causes a rapidly changing phase response with frequency, which in turn adds constructively or destructively with the direct path. When the signals are of comparable magnitude, the result is a series of peaks and valleys across frequency, also known as a “comb filter” (see Figure 3). Although “comb filter” effects cannot be completely avoided, they can be minimized by modification of the target response.

Conclusion: The Future of e-STAT

To remain competitive, any developer of hearing aid technology must incorporate the very latest in prescriptive research and tailor the prescription for its own brand of signal processing. Proprietary fitting formulas have a clear advantage in this respect. e-STAT, Starkey Hearing Technologies’ proprietary formula, will continue to evolve to keep pace with internal research findings and new, company-specific signal processing strategies. External research will also feed into e-STAT’s evidence base, as more ways in which the hearing aid fitting can be improved are reported. For example, we now know that gender plays a role in preferred listening levels, likely due to different physical characteristics of the ear (Keidser, 2008). We also know that auditory contributions less and less to intelligibility as the hearing loss progresses, especially in the high frequencies (Ching et al., 2001). Effects such as these can be integrated in the formula and released in e-STAT updates as frequently as needed.

Because we are operating at the limits of knowledge of hearing and hearing loss, we can’t rely on theory alone — we must also act on empirical data.

Because we are operating at the limits of knowledge of hearing and hearing loss, we can’t rely on theory alone — we must also act on empirical data.

References


Captain Lee Grant presents some interesting challenges as a patient. He’s now retired, but when he was working he was diagnosed as having a moderate high-frequency hearing loss typical of those exposed to noise. He was trained in the 1960s at the US Merchant Marine Academy and has spent his career at sea, much of it in commercial tugboats.

I first met him after he had been evaluated at his HMO by an audiologist and was told that he was a candidate for hearing aids (Figure 1).

While he had some difficulty in social settings, his primary complaint was hearing and communicating effectively while at work, where he was outside controlling his tug to position barges filled with large boulders so that crane operators could access the rock for precise positioning on the seabed.

The environment often was in excess of 100dBA, requiring ear protection, which made communication even more challenging.

He was successfully fit with in-the-canal (ITC) hearing aids set to limit the output, yet allow effective communication in the noisy environment.

Now that he is retired, his needs are much different. Without hearing aids he has some difficulty understanding speech in social settings. He enjoys live rock concerts and music and he would like to be able to use hearing aids in those settings to optimize the experience. He appreciates the benefit from amplification, but...
About the Author:

Dennis Van Vliet, Au.D., an audiologist with 36 years of experience, has provided clinical services in medical, educational and private practice settings. His professional interests have focused on hearing aids, and his opinions are frequently solicited in U.S. and international publications and lectures. Van Vliet earned a B.S. from the University of California, Irvine, his master’s in speech communication from California State University and an Au.D. from Central Michigan University.

Alexander, & Xu, 2009) to obtain an outcome measure that related to his subjective feeling about the highly featured hearing aids. Figure 2 illustrates that his responses are about at the 50th percentile or above when compared to interim norms for the DOSO. Ease of Listening Effort, the ability of the hearing aids to keep background to a minimum (Quietness) and Convenience were the highest rated subscales.

Captain Grant represents many of the patients we can expect in the coming years. He leads an active life, appreciates technology and is willing to invest some effort in learning to use his hearing aids and optimize their performance. Recognizing the needs of these challenging patients and matching them up with the exciting technology are keys to success.

Reference

HEAR COACH

A different approach to auditory training

Individuals with hearing loss often experience difficulty understanding speech in noise and consequently experience communication breakdowns. Auditory training activities are designed to help these individuals sharpen their hearing and listening skills. However, even the best therapy program can fall short if it doesn’t engage and encourage the individual to spend enough time training to improve his or her performance.

Starkey Hearing Technologies is taking a different approach to auditory training with a new mobile app called Hear Coach. Hear Coach is a suite of interactive listening games designed to challenge a patient’s cognitive and auditory skills. Auditory training activities similar to those in Hear Coach have been shown to improve listening ability in noise which means they don’t have to work as hard and can participate in conversations without as much effort or strain, even in loud or busy environments.

Hear Coach allows patients to track progress over time and challenge themselves as performance improves. Different background noises and levels of difficulty provide players with a variety of entertaining games to help train their auditory system in different environments. This app is designed to be fun and engage people who think they might have a hearing loss, people who have new hearing aids, and even experienced hearing aid users who want to get the most out of their hearing instruments.

Download Hear Coach from the App Store on iTunes.

About the Author:

Chris Howes joined Starkey Hearing Technologies in 1998 after spending eight years working at Bethesda Naval Hospital and Walter Reed Army Medical Center. Howes is currently a Senior Software Product Manager focusing on the design and development of mobile software.
Considering QuickBooks for your office? Here are three QuickBooks products to consider as the bookkeeping system in a hearing care practice:

**QuickBooks Pro** is the most widely used option. Pro is installed locally in an office. It gives the owner the ability to provide access to QuickBooks information to one to three staff members simultaneously. Pro can track receivables, payables, payroll and general ledger/financial statements. It can access online banking and has other features that can be used as needed. The other big selling point is most office management systems like Sycle.Net, ProHear.Net and Blueprint provide the ability to download/interface accounting data to Pro. This product typically retails at about $229 for one user, and up to $495 for a three-user license.

**QuickBooks Premier** is what we like to call Pro on steroids. This version has many of the same features as its Pro cousin, but for larger hearing care practices. If you have a larger staff (say 10+), high transaction volume or need to run a balance sheet by office, you may want to consider the Premier version. Like Pro, Sycle Net, ProHear. Net and Blueprint interface with Premier as well. Premier allows up to five simultaneous users in one company file, and a one-user license starts at approximately $399.

A third product to consider is called **QuickBooks Online Plus**, which is a true web-based product that works with Internet Explorer, Firefox, Safari and Chrome. The advantage: access to your information anytime, anywhere, for up to five users. The disadvantage: it offers fewer features than Pro and Premier including no online bill paying or forms scanning. Additionally, invoice customization options are limited. Also, office management products do not interface with Online Plus. The user pays a monthly fee starting at $39.95 for a five plus user license instead of a one-time fee.

We hope this brief synopsis of these three QuickBooks products gets you pointed in the right direction. Happy bookkeeping!
As long as you have access to the Internet, you have the ability to view your schedule from any Internet-enabled device!

Office Management Systems

Hearing care practice management software applications have come a long way since their inception more than 20 years ago. Some of the players include ProHear, Siemens Practice Navigator, Clarity, Beltone Office Pro, HearForm, Blueprint, Swenson and Sycle.net, just to name a few. This article covers 10 things you need for a successful hearing care practice management system:

1. An electronic, centralized database to manage patient information
2. The ability to track all patient information for one or multiple offices, from one centralized web-based application with 24/7/365 access
3. A secure database that meets HIPAA regulations
4. Standardized intake forms for patient data entry
5. The ability to extract valuable marketing information from the database such as lead source, birthdates, warranty expirations, last test date, and tested not sold
6. The ability to track patient appointments
7. Effective tracking of orders and inventory
8. Insurance billing capabilities via paper claim or electronically with a reputable clearing house
9. The ability to track of accounting information and statistical key performance indicators (KPI)
10. The ability to pass financial information to QuickBooks seamlessly daily, weekly, monthly or yearly

One key component of Sycle.net (the office management software sold by Starkey Hearing Technologies) is the Appointment Calendar Module. As you can see at first glance in Figure 1, the calendar is straightforward. Appointments can be viewed by day, week or month, and by office, provider or all providers. Patients are listed conveniently under their assigned specialist. Sycle.net has also given the user the ability to color-code the appointments as well as assign appointment statuses such as Confirmed, Not Confirmed, Checked Out, No Show or Left Message. When an appointment is made, the clinician will also choose referral and sub-referral categories that play nicely into tracking the appointment for sales and marketing. As long as you have access to the Internet, you have the ability to view your schedule from any Internet-enabled device!

If you feel that your current office management software cannot provide you with the tools you need to run your business efficiently, you should take a serious look at implementing a new office management solution like Sycle.net for your business. Starkey Hearing Technologies has more than 20 years of experience helping businesses gravitate to an office management solution that covers all 10 bullet points listed here, and much more! Call the Starkey Business Consulting Group at 800.328.8602 x2591 for more information.

About the Author:

Phil Gjervold joined Starkey Hearing Technologies in 1997 and currently holds the position of Business Consulting Executive. He helps implement proven solutions including key business measures, strategic planning tools, best practices and education that allow objective measurement of business performance to facilitate increased financial stability. Gjervold earned an associate degree from Lakewood Jr. College and a Bachelor of Science degree from Moorhead State University.
You want to work smarter, not harder, right? We hear that often from our hearing aid and audiology practice business owners, and we AGREE!

The issue here is knowing how to manage your business effectively and efficiently. To do this you have to arm yourself with factual information. The natural tendency is to rely on what you thought you knew about your business.

The first step in this quest is track and measure your data. Remember this motto: “what gets measured, gets done.” It sounds like a reasonable motto to embrace, but there is a lot of data to look at, and it can be daunting to track it all!

Remember, just as in other industries, the hearing healthcare industry has identified many measures, generally labeled as Key Performance Indicators (KPIs), that are linked directly to the success of your business. Our goal in this section of “Counting Beans” is to shine a light on these various measures so that you can determine which measures are key to your unique business situation.

KPIs can be categorized as either:

1. Financial indicators that correlate with your income statement, or
2. Productivity indicators relate to dispenser performance.

For example, measuring your marketing cost per hearing aid sold falls into the financial indicator category, while looking at the success rate of patients following treatment recommendations can help measure productivity.

We are often asked to provide benchmark results for various KPIs. Rather than look at a broad range as an answer (for example, 70 percent to 80 percent) we will provide Good, Better, Best approaches.

Over the next few issues of Innovations we will take a closer look at specific KPIs, provide definitions and discuss how they relate to each other. Managing by the numbers gives your business a big advantage! More next time in Let’s Talk Performance!

About the Authors:

As a professional business consultant, Susan Atchison brings more than 25 years of experience in the hearing healthcare industry to her clients. In early 2008, Atchison joined forces with Starkey Hearing Technologies in the development of protocols for business consulting services. Since joining the Starkey Business Consulting Group, Atchison has provided hearing aid business owners with objective assessments information on best business practices and has assisted customers with incorporating positive change for improved business performance. She has experience as a dispensing audiologist, hearing aid business manager, practice administrator and chief operations officer.

Michael Eckert has been in the healthcare industry since 1992 and in the hearing healthcare industry since 1995 when he joined MicroTech Hearing Technologies as a Regional Sales Manager. In 2009, Eckert moved into a role as a Professional Business Consultant with Starkey Hearing Technologies. His responsibilities include complete assessment and implementation of industry retail best practices. He then assists professionals in implementing statistical key measures, industry best practices, new practice start-up, practice expansion and ownership exit strategies. Eckert earned a Bachelor of Arts degree from the University of Minnesota, Duluth.

Let’s Talk Performance: Key Performance Indicators (KPIs)  Susan Atchison & Mike Eckert

Let’s Talk Performance is a regular column that provides information and advice on how to measure your business success and how to improve your business performance. Each issue of the column will provide “Good,” “Better,” and “Best” approaches to key performance indicators (KPIs) of your business. For more information, visit BLOG.STARKEYINNOVATIONS.COM.

BLOG.STARKEYINNOVATIONS.COM

INNOVATION'S CORNER

Innovation is a hot topic these days. In a recent McKinsey survey, 84 percent of CEOs said that innovation was very or extremely important to their companies’ success, yet few of those CEOs knew how to make innovation happen.

Why is innovation so important? In last year’s Booz & Company’s analysis of the Top 1000 companies in the world, the companies with the highest profits were also the most innovative in their industry. By continually innovating, businesses ensure increased profitability and success providing value to their customers.

But Clayton Christensen, the prominent innovation researcher at MIT’s Sloan School of Business, assesses the value of innovation more bluntly: innovation prevents commoditization. Successful companies don’t think that they need to innovate because they appear to be doing everything right, but those companies are in danger of commoditization and failure because they are vulnerable to being out-innovated and out-performed by someone else. For many businesses today, it’s innovate or die.

So what is innovation and how does someone do it? There are many different definitions for innovation, but I like this simple one: innovation is anything new that adds value. People often think of innovation as a new technology — the latest iPhone® or newest kitchen gadget — but innovation can also be a process or service.

Amazon is great at doing this: they are constantly improving their customer experience and improving the process by which they deliver products. Improving a process or service is often the easiest way for a business to innovate.

If you do something new to your reception area while waiting, that is an innovation for your business. If you do anything new that adds value to your business, congratulations — you’ve just innovated!

Brent Edwards, Ph.D.
Starkey Laboratories, Inc. Changes Name to Starkey Hearing Technologies

Starkey Laboratories, Inc. is changing its name to Starkey Hearing Technologies. The company is making the change based on its overall technology focus, global expansion and a changing marketplace that is looking for cutting-edge technology and personalized service. The new name is better aligned with the company’s initiatives and will be more easily recognizable to patients. Starkey Hearing Technologies will also continue to support its philanthropic arm, the Starkey Hearing Foundation.

STARKEY Wi SERIES CUSTOM PRODUCTS NOW AVAILABLE

Three custom wireless styles — Secret Ear® completely-in-canal (CIC), in-the-canal (ITC) and in-the-ear (ITE) were introduced to the Wi Series® family at the Hearing Innovation Expo 2012 in Las Vegas. The addition complements the Wi Series receiver-in-canal (RIC) 13 and RIC 312, providing a personalized experience and one-of-a-kind solution for each patient.

“"If you do anything new that adds value to your business, congratulations — you’ve just innovated!”

So why isn’t everyone innovating all of the time? Most people don’t know how to innovate. They don’t know how to generate ideas or how to turn ideas into a valuable reality. Many people think that innovative ideas must come to you in a eureka moment, like a lightning bolt out of a blue sky, or that only super-geniuses can create innovative ideas. That thinking is wrong. Innovation is a process that can be managed like any other process: inventory tracking, patient scheduling, tracking finances. Unfortunately, few people know what that innovation process is. The purpose of this column is to explain that process.

At Starkey Hearing Technologies, everyone is responsible for innovation. Not just the engineers, not just the researchers — every single employee in every job position. And we have a process to make innovation happen. Come to the Innovator’s Corner in future issues to learn how each of your employees can be responsible for innovation in your business. There are challenges and pitfalls to overcome, but if you understand the process, then innovation will come naturally.

About the Author:
Brent Edwards, Ph.D., joined Starkey Hearing Technologies in 2004 and is responsible for developing and executing the organization’s corporate research strategy worldwide. Edwards founded and developed the Starkey Hearing Research Center, and he leads a team of interdisciplinary scientists and engineers in both Minnesota and California, who are conducting longitudinal research on hearing impairment and hearing aid technology.

Edwards received his Bachelor of Science Degree in Electrical Engineering from Virginia Polytechnic Institute and State University, his M.S. and Ph.D. in electrical engineering and computer science from the University of Michigan, and was a Postdoctoral Fellow in psychology at the University of Minnesota.

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Starkey Hearing Foundation
Breaks Records During India Mission

The Starkey Hearing Foundation began a historic 25-day mission November 4, 2011, in India, where they traveled to New Delhi, Ranchi, Kolkata, Bhubaneswar, Varanasi, Bhopal and Jaipur fitting children with hearing aids. The Foundation hit a new record, fitting 1,225 people with hearing aids on one day in New Delhi. The staff included 25 volunteers including the Starkey India team, who coordinated all ground logistics so that hearing aids could be fit each day. At the end of the mission, the Starkey Hearing Foundation made history, donating 30,010 total hearing aids!