



## SoundBites Podcast Transcript

### Episode: Achin Bhowmik

Dave Fabry: Welcome to Starkey Sound Bites. I'm your host, Dave Fabry, Starkey's Chief Innovation Officer. Our guest today is Dr. Achin Bhowmik who serves as Chief Technology Officer and Executive Vice President of Engineering here at Starkey. Of course, he's become a good friend over the last several years and colleague. Thanks for being with us here today, Achin.

Achin Bhowmik: Thank you for having me, Dave. And it's a fun, pleasure to talk to you no matter what the stage is.

Dave Fabry: Indeed. And we've been on more than a few stages together. I was thinking about this earlier, and I think we've been on at least three continents together as we've launched Livio AI when I first rejoined the company and you were here. And it was really the industry's first device that incorporated embedded sensors in combination with artificial intelligence and it's been a rocket ship ride ever since then.

Achin Bhowmik: It was a journey it has been, isn't it?

Dave Fabry: It sure has.

Achin Bhowmik: I can't wait to get back on normal time so we can hit the road again.

Dave Fabry: I do miss that. As much as I love these podcasts and I love the virtual trainings that we've been doing and launches that we've been doing, there's nothing quite like having the engagement of an audience in front of you to feel their excitement as they're responding to this technology that we're launching.

Achin Bhowmik: Yeah. Part of our job is to connect with the customers and patients and audience around the world so we can test what the user requirements are and how the products can fill more of their needs than they have done in the past.

Dave Fabry: Indeed.

Achin Bhowmik: So that's a part that we can do a better job as the world gets back to normal.

Dave Fabry: Yep. Fingers crossed that we'll be somewhere near our audience members soon. And let's talk a little bit. We'll get to the technology because I know that's both of our favorite topic, but I want to talk a little bit about your background in terms of how did you find your way to Starkey. And maybe begin with your more recent past at Intel. How did you find your way to Starkey?

Achin Bhowmik: Oh, that's a good question. So I think the way that I would start is by transcending myself of the companies and the structures and the processes. But



I ask myself of what do I find to be my calling in terms of all of the learnings and passion, where do I want to make the mark and an impact that all has been said about you have to find your passion such that work doesn't feel like work. So for me, I'll introduce some jargons, I'll define them. I call that perceptual computing. First, I'm an engineer at heart. I'm not a neuroscientist, but I spend a lot of time with them. And early part of that, I started with this desire to get into natural human computer interaction and what's natural, essentially how do humans do it? How do we do it in our normal lives?

When you start to ask questions and peel the layers and get deeper into it, there is no escape but to get an understanding of how our systems work, how does the human system work, more specifically, how do we sense and perceive and understand the world, which then leads us to interacting in the world the way that we do. And as an engineer, you look at all the components that we have. So the term that I have embraced along with other colleagues in the industry back then and at Intel when I started this initiative called Perceptual Computing, the whole idea there was to mimic biology. And a way that I explain to general audience is that we take our perceptions for granted. It's just, it comes so naturally and so easily to us. We wake up in the morning, open our eyes and a flash of light comes in, but we totally are not aware of all of the physical processes that go in.

When you consider the physics behind it, the light, the rays or photons that essentially come from the sun or through the light in the ceiling that get bounced around in the environment around you and enters our eyeball, which get transformed at the back of the eye in the retina into electrical signals in the form of neural impulses, which then find their way into the visual cortex first and then gets interpreted there and gets into a lot more sophisticated processing for us to understand what's going on around us. Combine that with other senses.

Dave Fabry: Yeah. I mean, that's just one sense.

Achin Bhowmik: Just a one sense of vision.

Dave Fabry: And going through and separating that out for vision and then you think about the ear. I mean, we been saying you don't hear with your ears, your ears act as sensors as your eyes do.

Achin Bhowmik: That's right. Yeah.

Dave Fabry: And then we have that whole process, but then in particular for vision and hearing are so inextricably intertwined. People say, "Oh, I'm losing my hearing a little bit now, I better learn to lip read." Well, we've been lip reading our whole lives and using that information and they both serve as sensory inputs, the two eyes and two ears.



Achin Bhowmik: The key is the multimodal aspect because we have all of these sensory modalities on all the time and not to leave behind touch, smell, taste and then the higher levels of deriving semantic information from it. Dave's smiling, the other person is looking confused. So it's combining all of the modalities of sensor data, eyes, ears, skin, the touch from the skin, the somewhat sensation, smell, taste, and then this our amazing ability to create a model of the world with all of the sensory inputs and that allows us to navigate in this world, understand it, interact with each other. So that's the whole field, I call it perceptual computing. And then the way I look at it, the parts of, we all got trained in science in high school and in the college physics, biology and all of that.

And then when you start to get into practice, it led myself into this natural human computing interaction world, where there was a clear, almost like a demarcation of the old world of computing and the new world of computing. And I'm just playing back to you the strategic thinking that went on in my head along with esteemed colleagues and inventors at Intel and other larger companies, Apple, Google and mentors in the Silicon Valley area. To us, it was clear that the world of computing as it evolves and there's not a simple line that divides the past from the future but there was this clear sense that the world of computing was fast evolving from systems that are stationary on your table and then it became the computer in your pocket. And then the computers are going to be just everywhere. The concept of pervasive computing, where the distributed sensing, computing interaction, think of cars that drive by themselves. What is that? It's a computer.

Drones that can fly around without running into objects because it recognizes what is around it, that's a computer. Hearing devices that are in your ear that's understanding what's going on around you, the acoustic environments, that's a computer, right? So the definition of computer was evolving. And to me, these were all perceptual computing in the way that just computing and logic was not good enough, you needed the computers to develop senses to understand what's going on around you. So that I think was the bridge between... And I considered that to be the bridge between my old world in my career at Intel to the new world at Starkey. I don't see the difference between the two. The fundamentals are the same.

Dave Fabry: Yeah. And you say the bridge between old world computing, new world computing, and I would even argue that the bridge between machine and human, there's no line anymore. I mean, I'm a good example of that. I'm slowly becoming a cyborg.

Achin Bhowmik: Suddenly we joke about that a lot. You're a living cyborg.

Dave Fabry: Yeah. And this issue of now your evolution, if you will, into our company and our world in the hearing space but knowing again, that there's integration from



sight and even touch. I'm old enough to remember hearing devices in the early days that use vibrotactile sensation. So right now we talk about vision and hearing, but there was vibrotactile sensors that would be used to help people differentiate between different sounds if they had profound hearing loss. So now the world that we live in has really led to this journey that since you joined us now when we launched Livio AI in 2018, we were the first manufacturer to introduce a hearing product with embedded sensors in combination with machine learning and artificial intelligence and we've been off to the races.

Achin Bhowmik: And I'll tell a little bit of the story from behind the scenes for your audience. You have heard me say these things many times, but for the benefit of your audience I'll just say a bit more details than I've shared in the past. So suddenly when I got to interact with Mr. Austin, I remembered that frank conversations we were having, where he would say, "I don't know much about this thing you call perceptual computing, but I like that. It's like learning from biology to influence technology." But then he said that with that, "I see what you're doing is you're using that knowledge and intuition to develop technology to make better technology."

Dave Fabry: Right.

Achin Bhowmik: So a car that gets you from point A to point B, but with this sophisticated technology, the car will be aware of its environment and take you from point A to point B. Or the robots, drones, computers that will let you just stare at it and recognize your face. So those are you're enhancing technology with the knowledge of technology that's inspired by biology. How about we make it full circle? His challenge was, can we then rather than working on machines, help humans sleep better lives with this knowledge that comes full circle, learn from biology, get inspired by how the natural world works, develop technology that's inspired by it and then use the technology to enhance human perception. So in ways to me it appeared to be the opportunity for making a shift from enhancing machine perception to augmenting human perception.

And the other ways and practical aspects as I learned about hearing aids from him and other esteem colleagues around me at the time, it felt like there was a time, an opportunity for us to migrate the hearing devices which were already playing an amazing role in connecting people with people, helping people hear when they can't without the devices. But then we had the opportunity to transform these devices from a single function product to a multipurpose device that serve many more purposes and help people in many more ways than their single function nature.

And you heard me give examples of how easy to look back and see an example in the past. When Apple introduced iPhone back in 2007, they took a device that was already popular already very useful, the mobile phone, but iPhone not only did everything a mobile phone could do, but over time it became your camera.



It became your GPS device. It became your pocket computer. It became your YouTube watching device, the media platform, gaming device. For us, there was a unique opportunity because nobody had done it before. And we had even better opportunity to leverage the hearing aid's ability to be with you without being aware of it.

People who use hearing aids, it's a killer application. I mean, people who have to use hearing aids, they will use the devices in there all the time. And while it is there, the three aspects, how can you make it do better job than it has ever done with new technology? Hopefully you get to talk about those sensors, machine learning. And then second, if it's in my ear already, and ear is the best place for sensing health and doing biometrics, why don't we do those and keep me safe? Hopefully it'll be aware of my health problems before even I know, or I happen to accidentally see a doctor. And the third, how do we make this device be the conduit to the world of information and become my very personal virtual assistant.

So all of those opportunities are there. So with that, with the bridge between the old one and the new world of computers that are stationary to computers that are with you all the time, they're pervasive, not even aware of them and those computers rather than just being a gadget that helps you entertain yourself, something that helps you live better lives. So that is how in a short while I would say my recent journey from the days at Intel as a leader for a new group there working on perceptual computing to the opportunity at Starkey working with you and others in transforming hearing aids into the next generation wearable device that you want to have, not just because you need to have them.

Dave Fabry:

Exactly. I mean, the stigma surrounding hearing aids is very different than what you had in terms of working at Intel with drones and computers, people want those. And initially, was that a challenge when you came to the hearing aid world, given that no matter where you are in the world, even if you're providing them at no cost to the end user, less than half the people choose to use them? And I think that's a very important point that you raised that right now people feel like they have to wear the devices, but they're in at least an approach avoidance, if not an avoidance, avoidance conflict.

They're not crazy about having hearing loss or about using hearing aids, but the mission is to transform them into a want-to-have kind of device like you've been working with in the past by increasing that multi-purpose, multi-functionality in effect we're sort of augmenting, giving them a superpower not only in the hearing space, but then with the ability to sense health and wellness, to be able to use it for as Jarvis, as an additional communicator or robot and accessing the internet. And what would you say when you joined our company?

Achin Bhowmik:

So let me start with the stigma side.



Dave Fabry: Yeah.

Achin Bhowmik: Because I want to add my bit to it. Which engineer doesn't want a good challenge, right? So it's all about problem solving. If you think about the world of technology and engineering, there is curiosity part of it where we just want to know things, we want to know how things work. And the moment we wanted to call ourselves engineer, we take on an additional responsibility of solving problems. And when you explain those, I heard a lot in 2017 when I joined, there's this big stigma about hearing aids. I think we still have them. We haven't solved them quite, but what a challenge, right? Because if a device has become so useful and essential for someone who cannot leave their lives without it, I've seen plenty of them, people come in struggling to hear, they get a good pair of hearing aids, perfectly fitted with a capable professional and then they leave in tears. They cry, right?

So suddenly the product is awesome or the technology connects people with people that they were not being able to do before and it leaves them in tears. So the value's clear. Well, then there's this stigma, what an awesome problem to work on, right? So how do you go about that? Well, first of all, make cool devices. This thing is said about how when you pick up an iPhone or a good well-design piece of technology, get into your Tesla car or your Apple watch or any good device, it's got a coolness with it. It's the way the industrial design goes, right? And you look at modern hearing aids that we are built now, we are started shipping Evolv where I hearing aids.

So I'll tell you this, right? When I... I've told this story long times, many, many times that I don't have hearing loss, but I'm hooked to my hearing aids. And people might say, well, of course, you're CTO for Starkey, you're going to use your hearing aids. But genuinely there is this value about this device. So first of all, when I pull out my hearing aids and I do that admitting, let's say, a conference in Silicon Valley, or at a meeting at Apple or something, first of all, people, their jaw drop. It's like you had something in your ear? We didn't see it.

Dave Fabry: They didn't even see it.

Achin Bhowmik: Yeah. And then I'll show it to them and they'll say, "Wow, that's a well designed device." And then you'd say, "I can see you wearing it all day," because you can forget about a device like this. It has nothing dangling from your ear. It doesn't create a tug. There's no fatigue about it. So the amount of design work that has gone in making these devices cool over the last few years versus the ugly pictures that you see in Wall Street Journal, New York Times when they talk about hearing aids, these big devices from-

Dave Fabry: It may as well be in ear trumpet-

Achin Bhowmik: 10 years or 20 years ago, right?



Dave Fabry: Yeah.

Achin Bhowmik: So the devices have become cool. One way to remove stigma because you see people in the planes now with devices coming out of their ear. And if you have such cool devices they call hearing aids, it removes the stigma because it's cool devices. Number two, who doesn't like to be told of a problem that they might have in the future? That's the path we're on with sensors built in, with machine learning that tracks my physical activities. So I don't need to get other peripheral devices around my body because these device's multifunctional and that does it all. And how cool is it? My gardener who's a Spanish speaking individual, I don't speak Spanish, she doesn't speak much English. But I can double tap and bring up a translator or go to my mobile app and bring up a translator. And my hearing aid now being connected to the cloud via the smartphone has infinite amount of computing resources available to translate from any language to any language between 27 languages.

It allows me to have a one-on-one conversation. I do have to be patient with the 50 millisecond delay that's required for the cloud, but guess what? Much better than having a human translator in between me and my gardener, right? So this device, I believe we are way on our journey to make it so essential and cool that we will chip away at the stigma.

Dave Fabry: Well, two things that come to mind when you recount that. One of the very first times we traveled together, we went to Tech Crunch in San Francisco.

Achin Bhowmik: Right.

Dave Fabry: And they had set up some interviews with various media agencies. And remember there was a TV reporter who came and he was like, "Oh yeah." And there's all kinds of cool tech that's around there. And he was like, he was just going to do a vignette of all different technologies that they were seeing at this Tech Crunch. And suddenly he said, "Well, what do you got in terms of the hearing aid?" And we started talking about the features just as you have now. Suddenly he said, "Really, you can do that?" And we had a remote mic and remember we were replaying. He did a whole segment on local TV that night.

Achin Bhowmik: I remember that he said-

Dave Fabry: Because we nerd jacked the conversation and took it over.

Achin Bhowmik: He said he didn't have much time left for us. He said, "Oh, a hearing aid company, tell me what it is because I need to go check so many other things." And he ended up spending an entire evening with us and then he packed up and went home and did the entire episode on us.

Dave Fabry: The whole segment was on us.



- Achin Bhowmik: That's the secret we need to get it out there, let people know of this amazing technology that enhances their lives. We just need to tell our story.
- Dave Fabry: It's happened many times on a plane, the litmus test for me too on a plane sitting next to a millennial while I'm finishing up a phone conversation with a colleague or my wife and then they say, "Were you just using those hearing aids for that?" And then I say, "Oh, but I'm just getting started." And when someone says, "I don't have a hearing loss, how do I get that?" It's sort of, that's the battle that we've been facing is fighting the stigma, improving, first and foremost, the people's ability to hear better, but then translate that into live better through providing this health and wellness features and the communication features.
- Dave Fabry: Well, let's transition into the technology a little bit. You come from this world where AI is commonplace, but to the hearing aid space, I mean, can you talk a little bit... I mean, I say on the one hand in our industry, AI is ubiquitous and yet it's meaningless. Everyone's using a little bit different definition, a little bit way of looking at how they define AI, machine learning, deep neural networks or deep learning. Can you talk in simple terms about the differences between those and how we're defining them?
- Achin Bhowmik: It's a good... I think all in need to do is like explain the paper I wrote recently at Seminars of Hearing and also Itripoli Computer. So I would approach it for your audience from the viewpoint of what is in there for me the user. So there is the world where everything needed to be set for the environment that you are in. So now let's discuss that a bit. So let's say I have my hearing devices and it's designed to take in sound and amplify it. Well, it sounds very simple except in real world, the sound can mean many things. We know in our ear, the conduit to the mechanical vibrations of air and it's getting what I call a cacophony of sounds from all different sources.
- Fortunately, you and I are having a conversation in a quiet place now, but most often we find ourselves in a coffee shop, in the restaurant where the nature of sound switches from being sound of interest to sound of source of annoyance. We are having a conversation right now, I don't care so much about the music around us. But we'll soon be taking a pause and then I want to enjoy that music and the device if it was dumb, if it was amplifying all sound that's coming into the ear the same way, it would be annoying device. When you'd be talking, it'll amplify your voice. And then there is background music it'll be amplified at as well and it'll make it really hard for me to understand what you're saying. Imagine somebody suddenly bringing a vacuum cleaner and starting to clean, a truck passing by, or as soon as I step outside, there's a big wind hush coming in and creating sound that will get amplified. That's the world of the old hearing aids.





What AI can do. And when I explain what it can do, people say, "Can I have it now?" So we get often caught in technology, jargons, machine learning, deep learning, artificial intelligences that gets scary for our patients. But if we explain to them this way, imagine a device that is smart, intelligent, it knows what sound should be amplified, should be of interest to you. Because we are now having a discussion, perhaps the speech component of the sound should be amplified and then the background music should be decreased or not amplified. And then the moment I stop talking, perhaps I am now paying attention to the surrounding sound, so they should be given a bit of priority. Or I now stepped outside and it should automatically detect the presence of wind noise and suppress it. That's what is possible with machine learning that was not possible beforehand. Why is that? Because the old world of computing prior to AI was all about engineers coding up the rules saying it's this, if this, then that. Conditional statements that sort of was the heart of computer programming paradigms prior to machine learning and AI.

I needed to code the rules into the program for the device. If you see this, do this, if you hear this, do that. If the signal has this patterns, do this. And I could do that for maybe a dozen rules, maybe I can put in 100 rules. Maybe I can put in 1000 rules and have gigantic program that require a lot of memories in the device or we could rely on this really exciting development that's taken place in machine learning. When you pick up newspapers or listen to news and hear AI is taking over the world, it's been called the new electricity. AI is the new electricity, Andrew Eing at Stanford, a good colleague of mine said. And there's truth in that. If I had a longer time I would get into more detail, but believe me when I say the world the way it's shaping up in every aspect of our technology is going to change with AI. Cars are going to drive by themselves and fatalities are going to be orders of magnitude lower. And just look at the junk emails you used to get three years ago versus today.

Most of the junk emails get automatically understood to be junk and categorized as such. Without that, you'll not get the Gmail experience that you get today. Or keeping your bank accounts safe because AI can do much better job in detecting anonymous transactions and is doing better job than human doctors in reading radiograms detecting cancer. In our own world, what does that mean? The devices with machine learning algorithms can do millions of automatic classifications. And we said these numbers and people got stunned, the device makes 55 million automatic adjustments every hour.

Dave Fabry: This is on Evolv AI.

Achin Bhowmik: Evolv AI product.

Dave Fabry: 55 million.



Achin Bhowmik: Yeah. For me, it's a billion adjustments every day. Think about if I had to make billion, forget billion, a million, forget a million, if I had to make 100 different adjustments every day, impossible. I just want to go about my life, I want to talk to you and to say hello to people. I want to be in a meeting. I want the device to be in the background, be so smart that it makes a billion automatic adjustments based on its artificial intelligence and that's what our devices do. So when people talk about AI, it's not 10 years from now.

Dave Fabry: It's now.

Achin Bhowmik: It's what you're making it, thanks to what? The last two years, two years. And just close your eyes and imagine what we are going do two years from now.

Dave Fabry: Well, and think about that. Like you said, continuous improvement, we have very highly accurate automated classifiers now. So that just for people that have worked with hearing aids for quite a while, like I have, it used to be that if we had directional microphones or noise management, people had to access a separate program when they went into noise and they switched programs. Then they went if they wanted to listen to music or they wanted to be in quiet, they would switch those programs manually. Now machine learning, AI, does that automatically. But yet the problem that you raise is that sometimes speech is a signal of interest, sometimes it's a noise. Sometimes music is a signal that I want to hear and other times I don't. And I may even want to use different algorithms to process that music so I can enjoy it fully.

The issue is even the best automated classifiers are challenged to be perfect given those last two scenarios, the speech as a signal or speech, a noise or music as a signal, as music as a noise. So talk a little bit of about the way that we developed Edge Mode as a way to really provide this human machine interface that puts AI at the patient's fingertips, if you will.

Achin Bhowmik: Yep. That's a good question. So one thing we haven't found out in the entire scientific community yet is there's all excitement about perhaps there is some way to picking into your mind and see what you're thinking. I could be sitting here, I want to enjoy music and in other environments, I just want to pay attention to what you're talking about. So there's this intention that I have that only I know. And then you want that AI system to be such that it should take simple cue from me. And so for us, the first instantiation for that is Edge Mode which, as you know, is wildly successful.

Dave Fabry: Yes.

Achin Bhowmik: People are just unbelievably giddy over it. So you just simply tap. And despite the complexities in the acoustic environment, it's going to prioritize speech and clarify things and it's powered by AI. So we are able to take a snapshot and the system automatically determines what are the best parameter setting for that



environment. Because what's fundamentally most exciting about AI is its ability to continuously learn from data, learn from experience. It's like a human child. So we learn along the way, right? The first time I saw perhaps a flame, I might have put my finger in it and then I realized not to do it again, right?

Dave Fabry: Right. Or even more primitive than that, a baby doesn't have any rules for how understand or learn language wherever they're growing up in the world. But they have their parents and they see them saying some things and reacting if the child is starting to utter back to them. And the first time they happen to say mama or dada and the mom or dad reacts, they get reinforcement. They don't have any rules, but they know when I did that, she laughed or she approved or she picked me up and carried me around. And that acquisition is truly deep neural network that they don't have any rules when they're starting. Is that the differentiator between machine learning and deep?

Achin Bhowmik: Yeah. I think I would say technical term for that we would say is learning from data or learning from experiences. So when you say we learn from experiences, essentially what we're saying is that when you get exposed to more information, we are able to tweak the model of the reality in our head. And so that's essentially what a learning machine should do. It continuously should adjust the model with new information and new data.

Dave Fabry: Yeah. And in turn, we continue to improve it. I mean, initially we took advantage of the fact that we have sensors embedded in the devices that are worn in or on the ears and in the same way that they track physical activity, social engagement, falls, as you mentioned, they can also pick up a double tap. We did have some patients say that rather than always having to double tap, which is not all that obtrusive, but they would also like to be able to discreetly engage edge mode in the application and now in Evolv AI we can do that too. So they can very discreetly just activate that when they have their cell phone with them.

Achin Bhowmik: Yeah. And the world is such that the mobile phone has become a ubiquitous as part of many patients lives and everybody's familiar with the apps now. They're using app for controlling everything. And we should just respect that they might want to use the app as a control for things including invoking Edge Mode when they need that extra help for understanding speech.

Dave Fabry: So I'll ask you the question that we always get asked, if Edge Mode is so good, why don't you just simply use Edge Mode all the time?

Achin Bhowmik: That's a great question. So just think about the optimization that the device does for your surroundings. If you're staying in that environment for long period of time, it'll be optimal setting for you. So let's imagine the situation where I am in my study room and just two or three people around me and talking and there's this little background sound. And I chose to invoke Edge Mode for that environment and I double tapped, the device recognized that as a request to



optimize for that environment. And then I walked out and went to a defined environment. I could choose for the devices automatic classifications to be good enough for me, but if I need that extra help for that challenging environment that it has not been subjected to before, I might double up again and have that device quickly capture the new acoustic environment around it and optimize for that environment.

So it's that... We call it putting AI in the fingertip of the patient. It's getting amazing feedback saying that I feel like I'm in control. When I need that extra boost for a particular challenging situation, my device can do that. It's the AI that listens to me.

Dave Fabry: Yeah. And Edge Mode right now is optimized for audibility. Some people may not always want to be optimizing for audibility but for other purposes at other times. And we continue to improve this feature and the flexibility and the automatic aspect of that as we develop initial applications and future applications.

Achin Bhowmik: That's a good point you bring up. So I often explain this as the two ends of the spectrum for speech. If you prioritize understanding of speech, then we might do signal processing very differently. On the other end the spectrum, you might want to have it sound natural. That might be at the expense of understanding speech like word error rate and stuff so that where the dial needs to be should be subjective individual and AI needs to be smart in understanding when to prioritize speech or maybe can get a cue from the user that now I want to understand speech better or no, now I am enjoying the ambient sound and I'm actually sitting in a cafeteria. And like you said, the background noise actually is what's my signal at this time. I'm enjoying it. So don't suppress it.

Dave Fabry: Yeah. And so don't give away our entire product roadmap, but stay tuned because there's more to come.

Achin Bhowmik: Yeah. We're just barely getting started on-

Dave Fabry: Barely getting started on this.

Achin Bhowmik: ... the tapping into the power of machine learning and AI.

Dave Fabry: Now, the other thing I want to talk about is, and I'm holding in my hands the CIC device that is connected directly to a smartphone, a major achievement where they're first to introduce a product this small that connects directly with an Android or an iPhone. And I think maybe people coming in from the Intel world don't appreciate fully the computing power and also the batteries have to be so small to pull this off plus to have an antenna to transfer around from one ear to the other.



Achin Bhowmik: Right. So let me put the engineering hat on and just explain to your audience just the complexity of it. Why is it that we are the only ones shipping this device from factory and no other company's doing it, because it's difficult. But you also know we have a principle in Starkey research and development that if it's difficult, we work on it right away. If it's impossible, it might take us a little longer, right? So it is a difficult problem for all the reasons you mentioned. And here you have an optimization issue, people want their hearing aid to be as small as possible for custom devices so they don't stick out, they're discreet. At the same time, they want to enjoy the direct Bluetooth connectivity with iPhones and Android phones for streaming phone calls, audio books.

And what makes that hard? Well, human body is full of water. And as a result, it absorbs 2.4 gigahertz radiation really well, Bluetooth, which is what Bluetooth is used for. There's a good reason why microwave oven that heats up our food uses 2.4 gigahertz radiation for heating up because the water molecules in food absorb those frequencies very well and resonate and vibrate and heat things up. Unfortunately, if you put the radio deep inside, it's going to be absorbed by your head and no signal is going to come out to carry the signal to your phone.

So it was a very difficult problem for our radio frequency and antenna design team that designed an amazing job in converting that little pull handle into a radio frequency antenna such that the device is still small and discreet and yet we have the ability for the Bluetooth radiation to come out and connect, not only with the smartphone with you to allow for direct audio streaming, but also ear-to-ear communication for you want to control one hearing aid and the same instructions need to propagate to the other. So it's an example of how I have to say in the hearing aid world, where we push the limits. And we are just... Here, I have to say that we are continuing on a tradition of that, Mr. Austin has done that for decades.

Dave Fabry: Yes.

Achin Bhowmik: We have always-

Dave Fabry: He provided the roadmap for this by focusing on the needs of the patient not only to customize the acoustics of hearing aids, but the form factors to make them comfortable, to make them cosmetically appealing and small. And one of the other things I think that you've really driven is in many cases in the past when you chose a small form factor like this Completely in the Canal device that I'm holding, or even In the Canal device, it's often the case that the professional feels like they have to make a concession that they can't use directional microphones because they really won't benefit that much when you have the microphones down in the ear versus on the Behind the Ear or RICs where they're up and they can really get different timings and to take advantage of that with directionality. But what we've done now with the Table Mic and the



other accessories is enable beam forming microphone arrays to provide very sophisticated processing.

And it pairs directly with a small cosmetically appealing device like the CIC so that the professional and the patient don't have to concede, they can have the benefits of both. They can have a small custom device that connects directly to their phone and in noisy environments or classrooms or places of worship, they can have the benefit of that remote microphone.

Achin Bhowmik: Yeah. So it goes back to human perception. For individuals with perfectly normal hearing, we are using our directional sensors to cut down on the signals that are not interesting to us. So I'm able to get directional signal and use my signal processing in my head, if I can say that, based on natural learning, not machine learning to understand the content of the signal. So what this Table Mic does is basically provides a boost to that sense of direction when I might have lost that capability with my degradation in hearing. This device is amazing. It provides what, Eight to 10 decibels of additional directional benefits.

Dave Fabry: Over what directional microphones on hearing aids alone can provide. That's eight to 10 d B more benefits that it translates to.

Achin Bhowmik: And basically results in the... It's a difference between not being able to hear you in a noisy environment versus hearing you much better and understand what you're saying.

Dave Fabry: This goes back to the superpower. It actually, to the degree that the hearing loss allows, it gives the hearing aid user the ability to outperform their normal hearing counterpart.

Achin Bhowmik: Right. So another example how technology is like beam forming, signal processing coupled with the in-ear devices with Bluetooth connectivity for audio streaming can do miracles in terms of allowing people to perform better than they could. In fact, we talked about how superhuman hearing not just have them hear better than they could, but we are on the verge of being able to enable them to hear better than even normal hearing people which is why I use my hearing aids in challenging listening situations because even with my normal hearing, I won't have as good signal-to-noise ratio as I have with my devices.

Dave Fabry: Certainly with the Table Mic or these Remote Microphone Plus and the remote mic giving that capability to allow the professional to choose a small form factor without conceding on performance in noisy or challenging listening environments.

I want to talk about one other thing with regards to the CIC. I'll let you talk about it, but a really exciting feature that we've added recently for iPhone users is the ability to use the hearing aid microphone to pick up my voice when I'm



talking. It's really a benefit for the person on the other end of the phone. It allows true hands free for the hearing aid users. So I'm not having to talk into my phone mics, but for the person on the other end, it also provides benefits to them and better quality of my voice that they hear me.

Achin Bhowmik: And this was clearly a feature that was of strong demand. And I've learned from you and others that when you had the first hearing aids in the 2012, 13, 14 that could actually stream audio from the iPhone and subsequently from the Android phones into the hearing aid, the value of the hearing aids went up for people because suddenly it has become their ear bud for taking phone calls and streaming audiobooks. Natural next step was just next steps in technology to have this to be bidirectional. So the hearing aid's microphone can be used for picking up your phone call so you can have the phone somewhere else. You don't have to hold it like this.

We are the first ones to announce the readiness with this technology and just a great testament of partnership between Apple. I don't know, the Apple director for accessibility programs joined us at the Starkey Expo, talking about how we were working on some stuff. And she couldn't quite tell what are the stuff you're talking about. Well, so this is the first fruit of the collaboration that we are very happy to see in the market.

Dave Fabry: The deep collaboration and Apple's commitment to accessibility and our knowledge in this area of those with hearing loss.

Achin Bhowmik: Yep. And then we have many more things to go and your audience just have to wait for us to release the next set of features.

Dave Fabry: Yes. It'll just take a little while, a little longer, some of those impossible ones. The issue with falls, I mean, you talked briefly about that, but one of the things I think we're particularly proud of is that because we have the sensors in both devices, if someone falls while they're wearing them, the fall detection algorithm that sends a text and their location to trusted contacts is more accurate than the chest worn type devices.

Achin Bhowmik: So first I have to give you hard time on air, which is that I was doing a demo for fall detection, and you are one of my receivers for the signal. And I get a message back from Dave, "You fell again, get up." All right.

Dave Fabry: Yeah. My wife and daughter insist I'm empathetically challenged. So just get up but...

Achin Bhowmik: Anyway, so let me get back to... So the number of things that are quite amazing about our fall detection technology, number one, the biggest value I believe is that you have hearing aids with you because you need the hearing aids to communicate with people. And now fall detection comes free, right? If you fell,



the device is going to detect and alert your loved ones that you have selected on your app beforehand. You don't need to worry about those other accessories on your body that might be out of charge. In this case, you don't have to worry because you know that your hearing aid's working, it's amplifying sound and the same device is going to keep you safe, because if you fell, it would send an all alert.

Number two, you mentioned how we have two fall detectors. There's one on the left, one on the right. So the way that I explain it is if my left detected a fall, it would quickly check with ear-to-ear communication with the other one, "Hey, I fell. Did you fall?" So sort of like comparing notes and reducing the false positives versus one device that might be a pendant which might flair around as I'm walking. Head is a much better place for detecting whether you fell or not. So it's quite amazing in my view of this.

Dave Fabry: And of course, a fall in many cases is too late. So some future views is if we could work to enable these devices to not only detect falls, but prevent them are ways that we could expect future innovations.

Achin Bhowmik: Your audience would be happy to know that we are embarking on a research partnership with Stanford University School of Medicine, where we are going to want to look at people's gait, their balance, because we want to reduce the incidence of falls. Today we can tell when somebody fell, we really want to keep them safe and we want to know about their deterioration in the gait before a fall happens. That would be just an amazing contribution to the world of healthcare.

Dave Fabry: Yeah. Very excited for that collaboration moving forward. So the last thing I'll say about the existing technology and for people interested, they can go to [www.starkey.com](http://www.starkey.com) and see some of the additional features that we didn't have time to get to today. But one of the things I'm particularly proud of is fall detection, Edge Mode that we discussed, even reminders, audible reminders for appointments or to take medication or to drink water are all cascading not only in the premier products, but are coming down to the other technology tiers too.

Achin Bhowmik: I must say everything is said, even just a reminder, we think of just a feature, but I was in an event presenting about it and they said, "Look, do you know how big of a problem this one is of the lack of medication compliance, where of good intentions I forget to take my medicine, particularly people with challenges remembering things and you have to take 12 different types of medicines in a day. And you completely forget when you need to take what." Now you can program your medication requirements into your Thrive app, that's a name of our app and your hearing aid is going to remind you at the time, "Dr. Fabry, now is the time to take this particular medicine." That lifesaving is pretty amazing. This is where the third vector for hearing aids to become your personal assistant is coming to fruition.





Dave Fabry: Yeah. And what do you think it's going to take for the industry, and we talk about awareness, what's going to take for the industry potential patients to recognize a hearing aid company as a healthable company?

Achin Bhowmik: So I think that we are already a health company...

Dave Fabry: I think we are.

Achin Bhowmik: Because hearing aid is a health device. It keeps you safe. I think what you owe to our customers and patients to quickly learn about is that we are adding a lot more value to keeping you healthy. Hearing better is already living better, but now we are going to keep you and your loved ones safer by alerting you if your loved ones are lacking social engagement, because we know being lonely at your home, getting socially withdrawn, the early symptoms of dementia and Alzheimer's and cognitive declines.

With machine learning capabilities, our current hearing aids were the only ones where we can measure your social engagement. So we can keep your loved ones safer by alerting you that you bought a set of hearing aids for your loved one and they're suddenly socially withdrawn, or they used to be physically active because the built-in embedded sensors, we're the only ones measuring steps. The person was taking 10,000 steps a day and suddenly for the last few days they're not taking any steps. So the hearing aids now with these additional functions, what you call health-able technologies are going to help people live better lives more than their core function of the hearing enhancement, which already leads them to live better lives.

Dave Fabry: Yeah. I think it's that table stakes of better hearing performance, but then the connection, as you say, to health and wellness and there are so many well published studies now that show the comorbidity between hearing loss and cardiovascular disease, cognitive decline that the need for physical activity so we don't get fatter than we already are to be healthier because all of those things have high comorbidity between hearing loss and the more that we can connect to that overall health and wellness, the better in addition to that basic function of hearing that the better people will perceive and again, transition from have-to-wear into want-to-have.

Achin Bhowmik: And I'll share with your audience. In addition from my conversations with Mr. Austin, he's impatient. He's almost you leave the sense that we have this responsibility. We own a real estate in your body that's such an amazing place to deliver more value, keeping you safe, make it early warning system for your health issues. There's a sense of not only the desire to do things, but also a sense of responsibility of doing it just because we could in this form factor that you could not do in other wearable devices or other technologies. So you can't wait for this feature to shape up and we are on our way.



Dave Fabry: Excellent. Well, it is the new year now. So in addition to new year's resolutions, I think the first that if someone is listening who has noticed difficulty with hearing, one new year's resolution that you can do very easily is to get your hearing tested and see if you have a hearing loss. And there are a number of ways that you can do that through apps, through online tests, we have one at [www.starkey.com](http://www.starkey.com) to go to see a professional and have a diagnostic test to determine whether or not hearing aids might be for you. But then now specific to your role, what are some of the new technologies that are on the horizon in 2022 and beyond?

Achin Bhowmik: That's a good question. And I am just boiling inside to tell you and your audience the stories of what's coming, but I'm going to be cryptic about it. The devices that we already have now, for all of the reasons that we discussed over the last half an hour, they're already just miraculously better than these devices used to be years ago. And the pace of innovation is increasing at an exponential pace, not at a linear rate. All of the things we talked about: new sensors that are being embedded, the capabilities of machine learning and artificial intelligence with enormous amounts of data that we're collecting and utilizing for developing new features or making old features better, new form factors.

Dave Fabry: Well, the sky's the limit, and we're happy to have you at the driver's control here. And as they say, when you're given a seat on a rocket ship, you don't ask where to sit, you just sit down and get going. And it's been a pleasure working with you for the past over three years and I look forward to the next three years to see what we're going to deliver.

Achin Bhowmik: I have to say part of the excitement at Starkey is the talented teams we have. I'm learning every day from you about the human side, the audiology, the patient's rejection or acceptance of a feature, the way the... Technologies need that because we are here to solve a specific problem or provide a specific value. So I think it's through the interactions with the users, the patients and engineers is when miracles will happen and doing such a fabulous work in bridging the tools together. Thank you.

Dave Fabry: Oh, it's my pleasure. And one last question and then we'll wrap up here. You've mentioned the role of mentors in the past and how that's been important to you, but now you're in a position where you are leading large teams and mentoring them, what advice do you have for maybe engineering students, audiologists, dispensers, physicians? Based on your experiences, do you have any pearls of wisdom to share today?

Achin Bhowmik: So I think the best I can do is just pass on. So I'll say I have, through my life, benefited tremendously from people I've looked up to called the mentors, I still do, and will continue to do it. We never stop learning or getting inspired by people. So I'd say it's sticking to the basics, not to overthink your entire life but I will always challenge people to do the best of the moment and learn the most



you can, make the biggest contribution you can, and then the dots connect themselves and you look back and you're amazed yourself of the path that you have taken. So just enjoy the window of time around you in both maximizing your learning, making the biggest contribution you can, and just be nice with people around you. It's about having fun along this journey and then we can leave a mark in the world if we do that in positive ways that will benefit us and benefit the society around us.

Dave Fabry: Well, thank you for that. And in your short time in our industry, you've already left a mark and we look forward to future innovations together.

Achin Bhowmik: Thank you.

Dave Fabry: And so thanks very much for being here today. To our listeners, thanks for listening to this episode of Starkey Sound Bites. If you enjoyed this conversation, please rate and review us on your preferred podcast platform. You can also hit subscribe so that you'll be sure not to miss a single episode. And we look forward to seeing and hearing you next time. Thanks for listening.