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AFC Pro - The New Standard for Feedback Management

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- [Erin] Hello, everyone. Welcome to our newest course, Sonic Technology, on the feedback management in our hearing instruments. My name is Erin Reichert, and I am the Director of Professional Services here at Sonic. Today I have the pleasure of explaining our new anti-feedback system which we call Adaptive Feedback Canceller Pro, and I will get to reveal all the reasons why it is Sonic's new standard for feedback management. But before we get started, I just want to take a brief moment and alert you to things that you are looking at on your screen should you have any questions or want to pull the files for later review. So at the bottom of your screen here, you will note that there is a questions pod. Please, don't hesitate, any questions throughout today's course, drop a message right in there, I will do my absolute best to respond to the questions as they come in. If for some reason I miss it in session, I will definitely address the question at the end of the course. To the right of that, you will see a file share, and our friends at AO are so incredibly helpful that they have taken today's presentation and ripped it into a PDF that you are able to access there for further review should you have any questions.

So that being the lay of the land of the screen you are looking at, let's go ahead and get started. In today's one hour course, we've got a lot to cover, just to be very honest with you, we've got a lot of great things to talk about. So here's our agenda for today. We're gonna go through a brief introduction, background on acoustic feedback, managing static feedback with phase cancellation, managing dynamic feedback with STM processing, using AFC Pro in a clinical setting, and then finally questions and answers at the end of today's session. But most importantly, CEUs, they are hugely important, and when you offer CEUs on courses, you do need to have some learner outcomes. At the end of today's course you, will be able to list the benefits of the AFC Pro feedback management system, explain how spectro-temporal modulation, or what I will lovingly call STM, because I'm a huge fan of acronyms in this industry, STM processing can be used to manage feedback in dynamic conditions, and finally, you'll be able to run the feedback manager in the EXPRESSfit Pro fitting system. For those of

you who may not be familiar, this new technology is part of our Sonic SoundDNA Technology platform, which you can see here in our starburst with the overview of all of the different components and graphics of very essential features in our hearing instruments. SoundDNA represents our core DSP, digital processing features, by a system of icons. AFC Pro is the feedback management system in the latest SoundDNA products from 2019 and onward, so for today, we're really talking about the technology that is in Captivate, and our newest product offering, Trek. The AFC Pro icon is easy to recognize as represented by the X, indicating that it stops or cancels the feedback loop depicted by the two arrows going around the exterior of the circle. With all that being said, let's begin with some background on acoustic feedback. So when you talk about background information, we need to really define, well, what is feedback? Feedback occurs when a sound is amplified, gets re-amplified and then causing that high-pitched squeal. The amount of feedback that you obtain depends on the venting of the earmold, the dome, or possibly the shell. In this example here, you can see a custom instrument. Most people are very aware of feedback if you go to a concert and you watch someone with a microphone get too close to the amplifier. When you get that, you get that very loud squeal.

But for a hearing impaired person, feedback in a hearing instrument can be incredibly problematic. So what is the feedback path? Well, when we talk about the feedback path is the acoustic path of amplified sound escaping from the receiver back to that microphone, and you can see here in this example, this graphic, it's a cyclic thing. It's gonna determine the frequency and the duration of the signal, and there are actually two types of feedback. There's a static path and a dynamic path. The static path is a leak of sound when the hearing aid user remains still, meaning they're sitting there watching television or engaging in conversation, but they're listening, their jaw is not moving, there's no movement whatsoever, that's what we call a static path of feedback. A dynamic path could be leakage of sound when a user moves or touches the hearing aid, so maybe they're putting on a hat, or they're on the telephone chatting,

they're using a phone up at the ear level, they're chewing, yawning, hugging, any type of movement that would cause that ear canal that sound lead to move. So no matter how well an earmold or hearing instrument fits in that ear canal, the feedback path will change with movement. A lot of people kind of forget that because we have a nice, when a care professional gets that impression, it is a very accurate, nice, snug fit, but as soon as they put that into the ear, there is movement, and it is important to be aware of said movement. So consequently, feedback suppression, it's absolutely necessary. It's valuable for the hearing aid manufacturers, it's valuable for clinicians and end users, it's kind of like the full trifecta, it helps everyone, and we consider this a beneficial feature that everyone needs access to, everyone, everyone, everyone. So we see there's really two methods historically that have been used to reduce feedback. We've offered notch filters, you can think of that as your typical gain reduction.

On top of that, we also have offered historically phase cancellation. Quick note about notch filters, they were used in most hearing aids until 2004. Some of those hearing instruments that had maybe trimpots on them themselves, I remember when I would be fitting my hearing instruments, they'd have a high cut notch filter, a high notch filter, and you'd put the hearing instrument in and if you get any feedback, you just take your little screwdriver, I'm dating myself here, but you take that little screwdriver and you turn it down just so you stop getting that feedback. Well, what it was essentially doing is it was reducing gain in the frequency region where feedback occurred. It successfully, it definitely took care of the feedback, but if we're decreasing the gain, guess what? We're reducing the gain for target signals like speech. So it became a double-edged sword if you will because we definitely didn't want that hearing instrument to have any type of annoying feedback that would be distracting for that listener, but also, unfortunately that it reduced, it resulted in reduced speech intelligibility. So all things considered, completely not ideal, absolutely not ideal for all situations, I would say. So, in comes phase cancellation, and this was genuinely, it was like a phase cancellation to the rescue. The phase cancellation is gonna generate a

new signal 180 degrees out of phase. So if you're taking a look, you see a sine wave here, we would invert that 180 degrees to cancel the feedback signal. Now, this was capable of suppressing feedback without degrading the audibility of speech, which is proven in an article of Hearing Review. This type of feedback cancellation is currently considered the industry standard. I can't think of anyone out there, any of our other manufacturing partners and competitors, everyone out there is using phase cancellation. And as we indicated previously, it was really about 2004, 2005 that these systems really got into play with this inverse phase canceller. But, systems with phase cancellation effectively control the static feedback path, because when that patient is in your office and you are running that feedback cancellation system, you are measuring with, what? A patient sitting there, completely not moving, and completely silent. We don't want them chewing, we don't want them moving and talking, background noise, we don't have them putting a hand over their hearing instrument, putting a hat on, it's very much a static feedback path. But in some products, challenges still remain with that rapidly changing feedback path, that dynamic path. So let's take a look. There's a lot of content on this slide and this is taking a look at the phase cancellation systems that are effective when the actual feedback path matches the estimated feedback path.

So what's going on in this image? On the left side, you have a hearing aid sitting in the ear. The block diagram in the middle shows a red dashed line exiting the receiver, traveling back to the microphone this is illustrating the predictive feedback path in that static situation when the hearing aid is sitting in the patient's ear. Also please notice below, we see the feedback signal represented by that yellow line starting on its path to be controlled by the anti-feedback system. In a static situation, the signal will be, it will be an equal match to the predicted feedback path. So this example, the phase canceller stops the feedback. This is that inverse static situation, feedback presents, we invert it, we take care of it and we eliminate it. So in this perfect example, this one situation where there's no movement in the canal, the static path, it absolutely

executes quite well. But of course, I want to talk about dynamic feedback. This is where the different technology needs to be considered, so in this example on the left, the hat starts to cover the ear with the hearing aid in place. It's winter, I think the temperature here up in Minnesota today, I think I just saw that it was above zero, which is super exciting, so everyone is wearing hats up here. So imagine now, that user, they put their hat on their hearing instrument, now we've created a dynamic condition. In the block diagram, this action is represented by the blue dashed line, indicating the dynamic path does not match the estimated feedback path, which is the red dashed line. Below, you see the feedback signal in yellow, we're not gonna be able to control it, it flat-out can't be controlled, and audible feedback may occur since the phase canceller can't act quickly enough to cancel it in a fast acting, very much dynamic situation.

Putting on a hat will stress the system the least compared to other activities. Think about when they pick up a phone and put their phone to their ear, laughing, if you have someone who has incredible ear movement with their jaw, I remember one patient in particular that I was fitting, they, it was, I've never seen, I can't say I've honestly ever seen it again, when this patient would speak, I could actually physically see their ear moving. They had a tremendous amount of ear canal movement every time they simply spoke, so that's a very dynamic situation. So how are we gonna handle this particular situation with a static system? So let's talk about managing static feedback. As we've seen, there are two situations that can occur. We have the feedback from the static path, and feedback from the dynamic path. We're gonna first take a look at Sonic's technology in how we handle the static feedback, and I will say we do an excellent, excellent job in managing static feedback. So our current system for static conditions is what we call our AFC, our Adaptive Feedback Canceller. It is absolutely designed for stable conditions and it's using what we call this feedback monitor. It identifies the signals that have already been amplified and identifies its own input. Then it uses this adaptive filter to cancel that feedback signal via phase cancellation. It's pretty logical,

but that identifier, that monitor is what really kind of separates our current system from others. So the phase cancellation is gonna eliminate feedback signals that occur in the estimated feedback path of the hearing aid while in the ear canal. Now, the AFC needs more time to cancel feedback from a dynamic condition, roughly about 200 milliseconds. Now you may say that is incredibly fast. Well, if you listen to other courses that we have, we have an incredibly fast, robust, super engaging, super active DSP. For us, we believe speed is absolutely essential to being successful with a damaged ear, the damaged hearing system, so we really focus in ensuring we believe in the cochlear amplifier model, things have got to be fast. So 200 milliseconds may seem like ooh, boy, but, yeah, we have to have something that quick. AFC is challenged by more open fittings, high-frequency ski-slope losses, fittings with more power, or even unusual ear acoustics. It was very interesting, I was actually questioned by a family member, they had went and they had their hearing tested and they sent me their audiogram and they just couldn't believe that they, they knew that I struggled hearing in noisy environments and when they went to a restaurant, but they were so shocked when the clinician explained to them what this loss was, and I took a look at it, and to be honest with you, I was even taken aback by it because it has such a monster ski-slope loss.

Now this is someone who was just, presbycusis was not necessarily in very large, loud noisy environments in their lifetime, wasn't around massive, loud sounds, wasn't a hunter, didn't do this, didn't do that, and the other thing, but really had that massive high-frequency ski-slope loss. And I remember in private practice, that was a loss that I would almost, ugh, I'd be nervous to fit because that's a really hard thing because we know they need gain, we know they need speech, help in those poor speech regions, but how can we handle it with feedback control? It's built-in, it's a software, a precaution if you will, we do, we have the ability to limit the gain to prevent feedback if acoustics are more vented or open than what the software recommends. And this could affect your target matching, for those of you who are using validation equipment.

It's a problem for end users who require more high-frequency gain for those soft speech sounds. Now I will say that our products used with our current AFC system, they're incredibly, they do a great job, as I mentioned, that memory component of that signal, that's really what separates our current system, our AFC from others in the industry, and it does a very good job but, as we are starting to see more and more of these open fittings, they want something, our patients want something small, they want discreet, the right products if you will, receiver in the ear technology has taken over the industry by storm and a lot of people want that open sensation, that open feeling, they don't want a plugged ear plug, if you will, the closed dome. Our current system really, really does a good job. Let's talk about recommended acoustics. So in this example, we are showing an Enchant MiniRITE device. So Enchant is our product offering that has the AFC, they don't have the AFC Pro, but it definitely has our Adaptive Feedback Cancellation System. So in this example, again, we're talking about the Enchant MiniRITE, and with an 85 dB receiver and a base dome which was recommended, as you can see the screenshot in the lower left-hand section that target there, that means that's the recommended setting on the right side, then you'll see the fitting software displaying the feedback margin, and that's that dark gray zone. And you can see here, it's sufficiently above the prescribed target curves.

So in this particular example, if the clinician is using that 85 receiver with a base single dome, we should be good to go. However, let's talk about this example here, again, same instrument, the Enchant MiniRITE, you can see you're using the same receiver, but here, you're using the micro mold, which is short with a very large vent. Now here, you see the gray zone has changed, the dark gray zone showing reduced feedback threshold margin because you selected a more open fit acoustic. When that large vent is needed for that, for their own voice issues, their own comfort, it could lead to compromised gain in the scenario. Note, now I do want to note that the gain can be adjusted to go into the feedback zone, so you can still amplify there but you do have a higher risk of feedback when you don't use the recommended acoustics. Now, we do

a ton of research development to be able to calculate really which receiver, which dome, what type of venting, the software is going to help you with that, but in a real life scenario when you have that end user in front of you and they are feeling occluded, they are feeling plugged, of course as a clinician, we need to make sure that they're happy with their own voice. So in that example, what would you do? I would absolutely go to a more open solution. But how am I gonna make sure I'm getting enough gain there without a problem with feedback? So in a feedback system goal, you know what does, question number one, does an ideal feedback system exist? Does it exist? I can say absolutely it does in our technology that we're talking about today, but ideally, we view that the system should achieve three primary goals. Goal number one, we need to decrease the occurrence or annoyance of audible feedback in static and dynamic conditions. Goal number two, at that same time, we need to maintain speech intelligibility. We absolutely need to because that's why they're here today, that's why that patient's in front of us looking for help.

Finally at the same time, we need to provide open fittings with excellent sound quality. So that second goal there I would say is really hearing care professional focused because that is what we are doing. People are there, we are helping them with their, to maintain speech intelligibility, but number three, that second goal, or that third goal rather is really end user focused because that is their perception of sound quality. That's their perception of not feeling occluded, not feeling plugged. So let's take a look, a deeper dive if you will into what do all of these goals really entail? Focusing in on goal number one, this is a given. We need to decrease occurrence and annoyance of audible feedback in both static and dynamic situations. If feedback occurs, it's best if it's soft sounding and not loud and not annoying, it has to be short in duration, and if it's going to occur, it cannot be distracting or noticeable by others. I can tell you about a time historically that I'd be in a store and I'd walk past someone, I would recognize feedback because my ear is trained for it, I know what I would be hearing, and it's like, find the person, find the patient that's got the hearing aid. That's a struggle, imagine

how embarrassing that would be for that person. So these to me, all of these things with regard to rule number one are an absolute given, I mean, it's a logical approach. Goal number two, maintaining speech intelligibility. This can be accomplished by having the ability to have higher feedback margins in the fitting software. The ability to fit prescribed targets of fitting rationales for the selected instrument. And finally that third component of goal number two really is a larger fitting range for more headroom, because odds are, that hearing loss is going to get worse over time, we know that it's going to happen. So all of really goal two as I alluded to previously, this really helps the hearing care professional, it helps you meet that patient's needs. Now goal number three is providing that open fitting, that opened high fidelity sound quality.

This system should offer more open fittings to help with any voice or own voice concerns, flexibility in fitting larger vents with less feedback risk, to decrease the occlusion effect, and finally an advanced anti-feedback technology that doesn't degrade the sound quality. We want a high fidelity signal and this focus right here really helps that end user better enjoy their hearing instruments. It's a smile that they put on their face when they put in their technology in the morning and not, "Ooh, I'm gonna get feedback or I'm nervous "or I'm worried about going outside "and putting that winter hat on "because it's absolutely freezing cold outside," there should never be a trepidation that that instrument user has. So, that was our focus on our beliefs for managing static feedback, but now let's talk about really delving into this new technology to successfully manage dynamic feedback to achieve those goals. So, voila, here is our algorithm, our new AFC Pro. And again as I mentioned, this is exclusive to products that were introduced from 2019, 2019, and on. So in this example, we are talking about the technology available in our Captivate product, as well as technology in our Trek, which is our superpower, ultra power product offering. This introduces what we call a second anti-feedback system that runs concurrently with our Adaptive Feedback Canceller, so it's really two anti-feedback technologies working together in one total feedback management system. Call it the two-fer. This

new technology is what we call again STM processing. AFC Pro is an adaptive phase cancellation system that combines that second system, anti-feedback system in play. And this, it's that new component, that STM, spectro-temporal modulation is new, and what we refer to as like, the greatest thing since sliced bread when it comes to feedback cancellation. It is designed to attenuate feedback from fast-changing dynamic conditions. I used to be the person, and when I was in the tech support team right when I started at Sonic ages and ages ago, I'm dating myself, but I would say that I would counsel people that would call in for help with feedback that unfortunately, it's likely you'll have feedback just like the sun comes up and sun comes down, because when you get small, tiny components in a very small space and then you introduce a lot of gain with an open vent, like it's just, you're gonna have feedback, you're going to have feedback. And I am not a person that is just blown away with a technology because in today's world, that is not our scenario.

We have completely, it blows my mind, boggles my mind because in a lot of our instruments, you cannot get feedback. You cannot get those instruments to feedback, and I will tell you in the superpower and ultra power offering with Trek, holy cow, it is just an incredibly robust system that is so strong and able with both the AFC and AFC Pro, both systems working together producing a tremendous amount of gain and output in the instrument, in our patient population out there that needs that superpower, ultra power, the profound users are hearing a phenomenal sound quality without the risk of feedback. To me, that's like the biggest victory of all. So I am positive you are saying, "What on earth is STM processing?" And this image here is an example of an STM pattern. In short, it's a brief breaker signal that the system applies when the risk of feedback occurs in a dynamic situation. So again, this is a separate system, and it's an added signal, that breaker signal that attenuates the feedback path. Presenting the breaker signal prevents feedback from occurring, so it actually gets there before anything could be a problem. And it replaces that traditional loud annoying whistle, if you will, with a soft, non-intrusive STM process sound. So the days

of that squealing instrument, they have fallen by the wayside. Now this is absolutely patented. It is a patented technique with our colleagues and research for this technology has been documented and presented and published in the IEEE Journal, and you can see the citation here. I strongly encourage you to go ahead and take a look at this particular article on the use of spectro-temporal modulation in assisting adaptive feedback cancellation for the hearing aid application. I had the opportunity to speak with the engineers that developed this, and it is, it's so neat to be able to have that conversation with them 'cause they get all excited and what this has done and what this can do for our hearing aid population out there, and it is, it's a hard article to read because again, it was written by our tremendously talented engineers, but definitely something you should take a moment and go explore. I am going to give you a brief abstract of the article for those of you who don't have time to go and take a look at this peer-reviewed paper. So overall, feedback cancellation is often performed using adaptive filters, this is what we call the phase cancellation historically that we have chatted about. This leads to slow feedback cancellation upon rapid feedback changes. So again, when that phone is moved up to the ear or moved away from the ear, as we are alluding to in this example.

The research introduced this new method called STM processing in combination with the adaptive filter, so again, two systems working together as one. When the adaptive filter method fails to cancel the feedback for that rapid, dynamic change, the new system removes feedback absolutely, immediately. And that is the important component of how, or the time frame of, again, we believe you have to have a fast, incredibly fast and rapid system, just really layers right into that well. So why does this work? Well, it adapts incredibly quickly to the changing feedback path. It briefly applies the modulated signal to break that loop to stop that breaker signal, as we like to call it, the breaker signal to break physically, to stop that feedback loop and suppress the feedback. It also then gives you an additional six dB of gain before feedback. So remember we talked about that, wanting that additional headroom, that's fantastic.

Now I do want to note that STM, it may be perceived by some listeners as a slightly noticeable soft, non-intrusive sound. I'm very lucky that I have normal hearing, so when I take a look and I did various testing with this product, or an instrument that has this, I'm putting it in the, what we call the worst case scenario of trying, 'cause I want to hear it make it whistle, so I could hear what it sounds like it. It is the absolute slightest, noticeable, I mean, you can't even say it's noticeable, it's such a brief flutter, if you will, I'm trying to come up with the right word, I would say it's a brief flutter, but no one else was able to hear it. So a person standing standing six inches from mem they were not able to hear the sound. I was, again, through my hearing instrument that I had, an earmold that I had a giant slice in the tube, so I should get feedback with a giant vent and a ton of gain, no one standing anywhere near me was able to hear anything. So as a user, I heard the slightest non-intrusive signal, but that versus a traditional squealing, whistling, annoying, nerving-type signal, I would choose the STM breaker signal everyday and twice on Sunday because it made just that much of a difference, and this is why it works.

So we have some images that we're going to show you today and they're kind of, they're very powerful from my perspective. Here are two spectrograms. The top picture here is without STM processing, and you can see here, we show strong feedback indicated by that dark blue color you can see on the image there. So where that red arrow is, that's where we have a strong feedback signal. The bottom graph, the bottom spectrogram rather shows STM engaged with a feedback canceller, and it shows as an incredibly less magnitude indicated by the lighter color. So you again can see the bottom arrows, again, it's exact same signal, but when we activate STM, and when we don't have STM activated here. Now, in some situations, it is much shorter in time and lower in some levels than the feedback distortion per our engineers, but you can see here just from a visual representation, you can see where there is that burst, that energy by that dark blue when their system doesn't offer STM versus the bottom image where you have the exact same input coming through, but you can see a much lower

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magnitude with the STM engaged. So when we take a look at the STM processing, our overall conclusions, let me summarize what we just learned in these three points, in three points here. STM is applied only when the adaptive filter is insufficient to cancel feedback. That's important to know because again, because of our fast system that we have, our engine if you will, it only engages when it needs to. So when the AFC itself, the Adaptive Feedback Canceller can't remove, that's when the STM engages. STM improves feedback cancellation in very challenging, dynamic situations during a rapid feedback path change, like we mentioned, putting that phone up to the ear, putting that hat on the ear, without changing feedback performance in other situations. It's important to note, we're not going to, it's not like it's gonna set that this is the new rule forever, it is handling that exact environmental change right then and there, it's a very dynamic system. And STM simulations show that it is able to keep the hearing aid system stable to avoid feedback whistling sound, that annoying, that high-pitch squeal, it's really just generally aggravating.

This proven concept makes it ideal to implement in hearing aids to advance our progress over previous technologies. That was the overall conclusion of the paper. So we have, the paper has identified here's the problem, this is a new system, and we feel it is absolutely essential and it's the new method of assisting that adaptive filter. So how are we gonna do it? There we have it, now we have this brand new two-in-one system for best-in-class in my opinion, but better feedback control with AFC Pro, these two systems working together as one. Do I have any questions thus far before I get into the block diagrams? All right, we'll continue. It's a lot of technical information, so I just want to make sure I took pause there. First, let's take a look at how the feedback managing system is implemented in a hearing aid by looking at what we call the block diagram, that concept again. So back to our block diagram, here is a block diagram of the systems we had up until now. So this is our adaptive feedback cancellation. We have two microphones, one to two microphones, depending on the instrument, most likely everyone, or the vast majority of humanity right now is fit with a dual mic system,

so we're gonna, in this example, we're saying our two microphones are picking up the sound. The first block processes the microphone signal. This is including directionality, noise reduction, those types of components in the system. The existing anti-feedback system estimates the feedback signal coming from the output to the input. And the estimated feedback signals are subtracted from the microphone signal to cancel that feedback. Now, when we get into AFC Pro, we introduce our STM processing as an add-on block to the existing anti-feedback system. So you can see in this graph, that center circle in that block was the anti-feedback system, and now, we've broken it up into two. When it is activated, and again, it only activates when it needs to, it removes the feedback, replacing it with that STM, that breaker sound, and this is our new AFC Pro block diagram. Now in this scenario, the existing anti-feedback system operates in the background, it's still working like it has and it's doing a great job of processing that signal. The amplifier block therefore provides the gain and compression according to hearing aid loss, that patient's loss, and the fitting rationale that you have selected in the software. The receiver plays the processed and amplified sound and feedback is controlled.

Now, I have some new spectrograms for you here, and these are important for you to understand. I'm gonna bring over the audio, so hang with me just a moment here. Okay, so we can listen to an example of AFC alone, so where the STM processor is not engaged, and then AFC Pro when we engage STM processing, and where you won't hear that, emit that feedback. Okay, when we take a look at the example here, I want to point out that the white, so the top image there, the white lines in the box with AFC only are feedback, and the black dashes in the AFC Pro box are the STM sounds. So please note that this is different than the previous spectrogram on the previous slide here. Previously, the dark was what was indicating the feedback and then it was gone, in this example, it's kind of flipped. The white in the top image is where you'll see the feedback, the dashed lines in the bottom image is where STM is engaged. So I'm gonna go ahead, I'm gonna play these sound signals a few times here so you can hear

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it fully. So that's traditional feedback, right? And I'm telling you, we are taxing the system very aggressively in both the cases so you can understand and you can really listen to how the hearing instrument's performing. So here again is AFC, that after feedback canceller system, just the phase canceller. Now the exact same scenario when we engage AFC Pro.

- [Woman] Here is her rule though is far-reaching.

- [Erin] I'm gonna play that again.

- [Woman] Here is her rule though is far-reaching.

- [Erin] So if you, it's almost like you have to close your eyes to really listen to hear that flutter, if you will, that STM, that breaker signal. Imagine though, just take pause and imagine being an end user-- Listening to that signal, versus being an end user listening to that. And now I introduce additional speech into it, which makes it even more of a challenge, but it just was mind-boggling to me when the engineers gave us these sound files, I'm like, "I can't believe this." And this is before I had to spectrogram to really analyze it it blew my mind. It absolutely blew my mind to have the ability to go from this type of signal-- To this type of an introduction signal. That's a big value add. And if we can create a more positive experience with an end user listening to our product, that's what I call a Yahtzee moment, for any of you who play Yahtzee. It's one of those moments that it's just, it's almost an instant victory because we are giving our patients more confidence in their product, which therefore, they have more confidence to go tackle the world around them. Any questions? All right, so now here in this example, another visual example here for you, here's another way to look at it. This time with the feedback signal appearing in the shades of red. What can we infer in this? If you take a look without the Adaptive Feedback Canceller Pro versus with the Adaptive Feedback Canceller, I mean, I could ask my nine year old, what does she

think about these two images? And I'm sure she would say, "Well the one on the right, "it's not as scary, it's not as aggressive, "there's not much color," and I would explain that to her, that's a much more positive listening system. So when we take a look at this, without using AFC Pro, when we say without using an AFC Pro, that's still using our traditional Adaptive Feedback Canceller System, it just is a matter of engaging or disengaging the STM processor. The spectrogram, the hearing instrument output with and without AFC Pro is pretty eye-opening. I would say it's pretty eye-opening. For this test, each device was programmed with exactly the same gain, each was covered four times with a hand to stimulate movement towards the hearing instrument. So the image at the top, four times a hand came in, and was moved, came in and was removed. The feedback represented in red. And the results truly show a significant audible feedback for the device without AFC Pro.

That's pretty significant, when you take a look at that dark red component that indicates that feedback in loud and long duration, but when you engage the STM processor which we call our Adaptive Feedback Canceller Pro, when you engage that system, it's negligible. It's genuinely negligible, nearly all audible feedback is eliminated from that output. If you have a giant monitor that you're looking at, right now, I've got mine projected on our TV in our conference room, if I really get in close, I can see some faint, faint red, if you will, and that would be again that breaker signal. This is impressive, it is flat-out impressive technology. So, before moving onto the final section, now it's a good time for me to pause talking to you and we're gonna watch a short technology animation to review what we just learned. So I'm gonna go ahead and put my microphone, and we'll go ahead and get the videos...

- [Announcer] The Sonic SoundDNA platform makes everyday sounds better with Adaptive Feedback Canceller Pro. Also called AFC Pro, this innovative feature uses two anti-feedback technologies to create one proficient system. Let's see how they work together to reduce the risk of feedback. When an incoming sound reaches the

hearing aid's microphone, it gets amplified and sent through the receiver into the ear. Sometimes the microphone picks up the amplified sound after it's left the receiver. That sound is amplified another degree, and the process repeats, turning the sound into an unpleasant squeal called feedback. That repeating cycle of sound between the receiver and microphone is called the feedback path. Sonic's Adaptive Feedback Canceller already monitor signals to see if they've been amplified before. If so, the anti-feedback system estimates the sound's feedback path and sends a counter signal to cancel the repeated sound. This breaks the feedback path. This system works well in stable situations when it can estimate a sound's feedback path, then match it to the actual feedback path in the ear canal. However, feedback can also occur when the feedback path is more unpredictable. Quick movements near the hearing aid like putting on a hat or making adjustments to the device can also trigger feedback. In these cases, the system can't respond fast enough, and the estimated feedback path doesn't match the real feedback path. Sounds that fall outside the predicted feedback path are picked up from the receiver and start to amplify. SoundDNA with AFC Pro now includes a second system to control feedback from rapidly changing feedback paths.

This new approach is called spectro-temporal modulation, or STM processing. As sound enters the hearing aid, STM processing detects feedback from dynamic conditions and applies momentary attenuation only in the specific frequency bands of the feedback. The STM system rapidly eliminates feedback signals from dynamic conditions, while the traditional anti-feedback system cancels feedback from static conditions. Together, these two systems are called AFC Pro. Let's compare graphs with and without this technology. Here is a spectrogram of a hearing aid's output without AFC Pro. The acoustical feedback is shown in red. This spectrogram shows the same hearing aid's output with AFC Pro. The acoustical feedback that was in red is gone. With the new technology, nearly all audible feedback from the output has been eliminated. AFC Pro removes offending feedback signals often before they are even

heard. The patient enjoys a reduced risk of feedback. AFC Pro is easy to use in the fitting software. First, place the hearing instruments in the client's ears correctly, and ensure background noise is not present. Click Measure to run the measurements, then choose Accept to apply the measured feedback margins. Listeners will appreciate the advantages of this two-in-one system. AFC Pro means fewer distractions from the annoyance of feedback whether in stable or changing conditions. Soft speech sounds are more audible for a better target match. And because it reduces feedback that can come from motion near the hearing instrument, AFC Pro delivers more open fit possibilities. Listeners can hear the sound of their own voice in a more clear and natural way. With the advanced feedback management system of AFC Pro, patients enjoy a truly individual hearing experience. The SoundDNA platform is one more way Sonic Technology makes everyday sounds better.

- [Erin] I guess it helps when I unmute the microphones when I start talking. I love that animation, I think it gives, gives a really nice synopsis of what AFC Pro really can bring to the table. So hopefully at this point in the presentation, we're all very clear about the two systems. Before moving on to our final section, which is AFC Pro and EXPRESSfit Pro, the clinical applications. I should stop, does anyone have any questions on either the Adaptive Feedback Canceller, or Adaptive Feedback Canceller Pro that's available in Captivate and Trek? Alrighty. So here you can see a screenshot of our EXPRESSfit Pro fitting system. This is our fitting software that, it's just so awesome, it is just such a great software because it's very intuitive and very effective to be in and out so you can make sure you can have adequate time for counseling with regards to your patient. So on the left-hand side of the screen, you click on the instrument, and then at the top of the screen, you'll see different tabs. And the feedback manager screen is in the feedback manager tab there, it's the same as before. You won't see anything different with regards to the AFC versus the AFC Pro. So there's nothing, there's not an extra step as a clinician that you need to go do, there's nothing you need to uncheck, recheck, do anything, just by going into the feedback manager and measuring, it's the

same as it's always been. Easy to apply, easy to measure, same as before. In EXPRESSfit Pro, you will see the predicted threshold of feedback. You'll see it's higher for products with AFC Pro versus the products that have AFC, with the exact same hearing loss. And that predicted threshold of feedback is that darker gray region. This means that a higher number of patients can be fit without the risk of feedback. It also provides a positive impact on your fitting range, you can see that we have more headroom when you do a comparison, side to side comparison, if additional gain is needed. And I would like to share with you some examples. So, in this example, you can see the predicted threshold of feedback which is again that darker gray region for AFC products versus AFC Pro. Now I promise you, these are the exact same hearing loss, same acoustics, and you will see the top is the feedback margin for AFC, so that's an Enchant product and you can see the higher feedback margin for Captivate, you can see a much, a massive difference there between, with regards to your headroom.

And you can actually access this if you want to try this on your own, you could actually have this comparison view available in that transfer setting screen. Now if we zoom in a little bit here, I also want to point out the targets. Now, the targets are for the exact same hearing loss, exact same acoustical configuration. Here you will see that AFC Pro offers you a better target match at soft and medium inputs. You can see that additional six dB of added stable gain in the high frequencies between Enchant and Captivate. This is therefore gonna offer more patients to be fitted with that audibility and less risk, or less chance of feedback, therefore positively impacting the fitting range of the headroom for that particular patient, allowing for more open fittings with natural own voice and less chance of feedback. Now I will, do want to note for those of you who haven't spent much time in our software, the fitting software will allow you to raise gain into the feedback zone, but then it comes again, like with that Enchant, it will come with a greater risk of feedback and takes more fine-tuning adjustments to achieve enough gain without feedback. Now again, AFC Pro is not active when there is no

feedback risk, it only engages when that threat or that opportunity for feedback exists. So it decreases sound artifact that may occur, it maximized sound quality, it uses the feedback monitor to identify those sounds that were previously un-amplified, and using like total sound and music, it's going to automatically do this, again, the patient doesn't have to anything unique, they put their hearing instrument in, you have already run the feedback cancellation, the measurement system, and you are effectively good to go. So let's revisit our goals. We talked about our goals earlier in today's session. Goal number one, the most logical goal of any adaptive, or any anti-feedback system, we want to decrease the occurrence and annoyance of audible feedback, we want to maintain, number two is maintain speech intelligibility, number three is those open fittings, we want more open fittings, we want access to open fittings with a high fidelity sound quality. Now, isn't that a cute little picture of that present? Did we wrap everything up with a cute little bow? 'Tis the season, I would say, but but does the AFC Pro system deliver? Does it deliver on all three goals? A lot of check marks you see there. Goal number one is to decrease the occurrence and annoyance of audible feedback. AFC Pro rapidly controls feedback in static and fast-changing situations. With AFC Pro, it's again our two systems working together.

So we have our system to manage static and our system to manage dynamic situations. If feedback occurs, it's soft-sounding, it's not loud, if feedback occurs, it's gonna be short in duration, it's not long, and if feedback occurs, we have less distracting or anything noticeable by others. Again, that breaker signal that you can see in this image here is virtually invisible. So I feel confident saying the AFC Pro helps achieve goal number one. Goal number two, does AFC Pro maintain speech intelligibility? In my opinion, absolutely. AFC Pro offers higher feedback margins in the fitting software, it offers the ability to fit prescribed targets of fitting rationale, and you have a larger range, fitting range or more headroom, if you will, possible. So from my perspective, AFC Pro absolutely helps achieve goal number two. Now finally, goal number three. Again, this is what it's all about, right? This is about the patient

themselves. And AFC Pro provides more open fittings, helping with voice issues, flexible fittings for large events, so we have less chance of feedback, we have a decreased occlusion effect, and finally, it reduces the risk of artifact for sound quality. It only engages when it's needed. It's not constantly on, it's not altering the signal in all wide varieties of environment, it only engages when it needs to. And when you take a look at this graphic of AFC versus AFC Pro, that's a major, it's very, very telling. So again, in my humble opinion, AFC Pro helps achieve goal number three. So in summary, AFC Pro absolutely is a two-in-one system. It is an adaptive phase cancellation combined with our spectro-temporal processing to reduce the risk of feedback in stable and dynamic conditions. Phase cancellation cancels that feedback in static conditions.

STM cancels that feedback for dynamic conditions. And feedback is suppressed without limiting gain for external signals like speech and environmental sounds. It is absolutely considered to be one of the most beneficial technologies on the SoundDNA platform. And as I've mentioned today, it is available in all Captivate products, all technology levels, it also is available in all Trek products with all technology levels. To have access to any of these programmings, or to have access to be able to program these products, you would need EXPRESSfit Pro 2019, either dot one or dot two, we always say you want to have the most current version software. Right now, we are actively shipping 2019.2, which introduced when we launched Trek, again, our superpower, ultra power product offering. So, now that you've joined me for 57 minutes on feedback cancellation, if you want to know more, we have a wonderfully well written article, it's one of our Sonic Spotlights, and it's called Adaptive Feedback Canceller Pro. It is a really easy read. It's very similar to all the things that we've chatted about today. It is available on our website at www.sonici.com. Tara Helbling has done a tremendous job writing this article and it has a lot of very helpful information if you want to know more regarding the AFC Pro system, which is a part of Sonic's SoundDNA technology platform. Thank you. Thank you, thank you, thank you

for joining me today for our course, AFC Pro, The New Standard for Feedback Management. We talk a lot about our 4S Foundation here, and this to me, the AFC Pro, I could find something in all of my S's that this is important with; Sound that is natural, speech understanding in noise, simplicity in all we do, and style that stands out. AFC Pro is a game changer, and is definitely something that you should be offering in your clinic for all patients that have the potential to struggle with feedback. Should you have any questions, please don't hesitate to reach out to us. We have one number, one phone number to reach absolutely anyone in the organization. That phone number is 888-423-7834. And you are welcome to ask for me or anyone in our audiology team can do a deep dive with you on this particular topic. Our website address is www.sonici.com and we also have a portal for a customers out there for more information, and that address is www.mysonici.com. If you don't have a chance to pick up the phone and call us, we are also available for email support. Any questions come in, our audiology team manages this inbox, and that is support@sonici.com. Thank you, thank you, thank you so much for your time today. I appreciate your focus and your attention to all of this detailed, very technical information. Have a great day, everyone, take care.