Steve Weichhand:
Welcome to The Vurge Podcast, where we bring together groundbreakers and industry disruptors from various corners of the virtual world to ponder the future of technology innovation.
I'm your host, Steve Weichhand with Divurgent, and today, I'm with Hope Young, the founder and CEO of Biomedical Music Solutions. Biomedical Music Solutions, or BMS, uses the power of artificial intelligence to advance the capabilities and global reach of music-assisted rehabilitation. BMS recently was awarded the Tech and Innovation Award from the Austin Chamber of Commerce, and the results from their product, SoundSteps, were published in the International Journal of Neuroscience in early 2020. Hope has been widely recognized for her contributions to music therapy and the integration of it and biotechnology. And it's a privilege to have her as a guest on this episode. Hope, welcome to the show.

Hope Young:
Thank you, Steve. I'm excited to be here.

Steve Weichhand:
All right. Well, before we jump into the interview, I just wanted to call out a couple of things. I'm going to try to focus the discussion on how technology plays an important role in scaling and advancing important therapeutic approaches, but I'll start by asking some basic questions around music therapy. Also, as you'll hear from Hope, while music therapy has been used for decades to stimulate neuroplasticity, or the ability of neurons to make connections in the brain, it's at a really interesting turning point as advances in biomedical devices in our ability to use data to personalize treatments allow music therapy to be more effectively deployed. So, Hope, many of our listeners are nonclinical like me and might not be as familiar with music therapy. Would you begin by explaining how music therapy works?

Hope Young:
Sure. So, the simplest explanation is when you take therapeutic musical interventions and you design them to achieve specific non-music outcomes. So, these type of non-music outcomes that we're designing it for is, such as the first use case you said, which is rehabilitation, and that's where my product is to market right now. Also medical. When I say rehabilitation, we mean speech recovery, walking, balance, the use of your hands.
When we talk medical and we're talking things such as pain management, opiate, replacing music for opiates to use in surgery and pain management, cancer treatments to reduce pain, nausea, other kind of outcomes or problems when you're going through chemotherapy. We've, for years, been in education, so with special needs children as a related service in public schools

here in the United States to help with overall development. Again, speech, learning, attention, cognitive development.

When we talk about psych, everybody pretty much always goes immediately to trauma. We know that for years, we have used music all throughout the centuries, even in Biblical times, soothing the savage breast, soothing Saul, soothing David. Right? With the harp in Biblical times. So, that's one that we think of the most for relaxation, anxiety, alleviating depression, again, dealing with traumas such as war veterans and sexual abuse survivors.
So, those are the areas that we're, again, we're designing very intended, specific therapeutic interventions using music, but it's all to foster accelerating your outcomes for treatment and recovery in those areas that are non-musical, versus music ed or performance, where the goal is higher-level music development in you, or as for media or performance platform.

Steve Weichhand:
I know, and just from what you said there, the applications and the sciences behind this is really fascinating. So, you mentioned some of the common conditions or use cases there, but can you talk about more how it works or what results can be achieved using music therapy?

Hope Young:
Yeah. I'd be excited too. So, when I mentioned those therapeutic outcomes, one of the exciting things that you can see universally with music, it's a human phenomenon, and it has been for 40,000 years of human development. The control center of the body is the brain. Right? So, music is one of those natural phenomenas that can activate all areas of the brain simultaneously. Nothing else can do that. So, when we're talking about specific outcomes, and we don't want to be sloppy and just light up your brain like a Christmas tree all the time. Right? We don't want all whole brain activation. In those rehab outcomes that you'll hear me talk more about as I drill down in our use case right now, we have...

Let's talk walking, right? So, when you're doing walking, you don't necessarily want to activate every area of the brain. You want to activate the motor cortex, right? And all those things that happen with your auditory cortex coupling. To improve somebody who has been with Parkinson's disease, they have what's called freezing of gait, and then the freezing of gait leads to something called festinations. So, you may have seen somebody, your grandparents, suddenly they're moving, they freeze, then they had these stuttering little steps, and boy, they lose their balance. They either catch themselves or they fall. With the auditory coupling of the brain with music, we stopped the freezing of gait from occurring, or if it's occurred, we quickly stop the festinating and they have control of their movement and it prevents the fall and they walk.

Other examples are like Gabby Giffords. I don't know how many of your listeners out there know Congresswoman Giffords' story, but she took a pretty up close and personal gunshot to the brain, lost her ability to walk, lost her ability to speak. If you know TIRR rehabilitation in Houston, the music therapist there, Meghan, was my intern here in Austin before she went to TIRR. So, she trained in neurologic music therapy with me, and she was able to bring that intervention of speech and walking to Congresswoman Giffords. And if you watch the YouTube videos, you will see Congresswoman Giffords learning how to speak again through these singing techniques that lead back to speaking. Congresswoman Giffords does not need to sing her speeches today.

Thankfully, the pattern of relearning music is a very pattern sensory experience for humans, so those patterns of singing are exaggerated. And then the normal speech pattern like, "Good morning. Good morning. Good morning," it is musical features that, Steve, you just... I see you nodding your head. That you know the difference in the speech, right? That you recognize the rhythm change, you recognize the timber, the melody changes, those things, and it's only one word. But it's those musical features that recover the brain's functioning for speech.

Steve Weichhand:
Well, those results sound like they can really be outstanding and have a profound impact on all of these in individual's lives, so thanks for sharing that with, with us. So, now that we have more of a basic understanding of the impact that music can have on the recovery or the treatment of these different medical conditions, talk to me about some of the challenges that the industry faces and getting this type of treatment out to the masses.

Hope Young:
One of our biggest issues is scale, and by scale, I mean, access to the service. So, Gabby Giffords got to go to TIRR where she had a music therapist that was trained specifically in neurologic music therapy to recover her speech and training. But if she had just general music, she would have had all the passive. Right? All the passive benefits we know from music. Right? Relaxation and romance and healing. Right? But how many people on the planet do you think there are that could have recovered her speech to the level and worked with the medical team to get her walking and balance and cognitive functioning back? That's a very specific skill set that only... There are only about 8,000 to 9,000 music therapists in the United States today. All right?
So, let's compare the problem that we're having. Let's take one diagnosis all ready mentioned, Parkinson's disease. How many Parkinson's patients are in the United States, diagnosed Parkinson's patients? One million. That's one diagnosis. Okay? 8,000 to 9,000 music therapists. You can see that we have for the market, when you talk as a businesswoman, which I am, we

have a problem with scaling that because music therapy, to get those kind of results, is all done one-on-one, by a music therapist who's trying to literally change the music and personalize it to Congresswoman Giffords, to you, to whoever the patient is. We change it in real-time to exactly what that patient needs. So, there you can see one of the big issues.

The other issue is when you're doing music therapy in real-time, as a trained professional, making the music to that intended outcome, it's very dynamic. You're changing frequencies, my voice, just like, "Good morning. Good morning." We literally are trained in our degree to be masters of changing the voice, using a guitar, finding the different voicing or frequencies to get that brain to change very precisely to what we need, or getting the pain centers to really sustainably register. And we're surrounded by medical devices in our environment. Right? We, music therapists, are reading oxygen saturation, we're reading gait metrics, we're reading all kinds of brainwaves, depending on the tech. But if you just want your music, if you want to pull your iPod, is it designed to all, to respond to the sensors, respond to that patient? What we know, their size, their age, their diagnosis? No. So, we have a real problem with that, as well, on the technology side.

So, those are just a few of the examples, but one of the other big issues is medicine is moving into what's called precision medicine. So, again, when we're using music and we use scalable` music, it's incredibly sloppy. It's going to activate a memory. If you pull up from your podcast right now, music that was significant to you at a time, let's talk grief or trauma, that helped you out here in the sound waves going out in the world, that same song may be associated with a very different autobiographical memory and trigger a completely unintended consequence. Right? Because it's been so masked to your memories at a certain time overnight, it's been coupled. So, in precision medicine, there's not room for that kind of sloppiness. Right? That you just unintendedly sloppily take music not designed for medical use and you scale it and just throw it out there to the masses the way we do music to the masses for entertainment. So, those are some of the problems

Steve Weichhand:
Yeah. That makes a lot of sense, that you'd want to avoid those unintended consequences when you're hoping to use the music to achieve a more positive response. And what you talked about there with the supply and demand equation really illuminates the need for technology to make this treatment more broadly available. You mentioned a few of the different biomedical devices that would be good candidates to incorporate this technology into, but can you expand more on that? Where have you, at Biomedical Music Solutions, found success and incorporating your music therapy into devices. Where are you today? Where are you hoping to go tomorrow?

Hope Young:
That's an exciting question because I am really excited by our partner with.. It is Biodex Medical Systems out of long Island, New York. We went to market with them with our first beta version that we created biomedical music, and we integrated it with their gait trainer three treadmills system. And that system has been on the market for, I think, about 15 years or more. It's used all over the world, so it's in leading rehabilitation institutes all over the globe.

And what they've had for years, Steve, is they've all ready had biofeedback in that system. It's a treadmill with sensors in the belt, underneath the belt. It has the software that has all the gait kinematics on the screen. So, it gives visual biofeedback of the normalized data, which is just what for your age, for your walking, it'll create two green lines, and when you see those sensors create little foot falls and your feet hit between those two green lines, it goes green and you know you're good, Steve, and that you're walking normally. Right? If you're walking in the feet fall below those lines, it goes yellow, or it goes orange. Right? Knowing that you're getting more impaired and you visually have to hit that target. It also had audio feedback, and the audio feedback only clicked when your feet hit them between those two lines. If it did not hit in between those two lines, you knew that you needed to walk longer on one side. It literally tells you that.

So, this system is all ready deployed throughout the world. It's FDA-approved. It has visual feedback loops. It has auditory. So, what we did is we went in there and we were an upgrade to that audio. Using our precision software capabilities, we went to market with audio output specifically intended for Parkinson's patients that were stage one, two, into stage three Parkinson's disease. So, with those capabilities, what's so exciting is you speed up to today, we have over 250,000 users that have now accelerated the gains in their walking, made better gains faster than ever before possible with just that simple precision audio upgrade. That drives from the data that we receive from the software and the sensors information, it picks the audio output that you need to quickly get you into the green, instead of waiting for your visual to tell you and you wait after you did the action to know.

And you also have this cognitive with our precision capabilities. I didn't go into it, but cognition is a big component of music. You automatically get this boost of attention, alertness, and processing. You become more efficient in the way your brain talks to other sides, like super speed computer to when you're just doing movement without better audio precision. So, we get people walking better, faster, and the research that you're pointing to that you mentioned, the International Journal of Neuroscience. In August this year, there was another research study with

Parkinson's patients who are more severe, who have DBS. DBS is a brain implant, a stimulator in the brain. So, those are more severe Parkinson's patients. When they added that audio upgrade with the Biodex, they got better significantly faster and their balance improved. But the great thing was they also, on the EEG that they're using, they saw how much your brain efficiently communicated with each other to make all those outcomes possible. So, that's one that we're all ready in, and we intend to continue in the stationary systems.

But our biggest market is wearables. So, wearable people are wearing Fitbits. Your Apple Watch is a wearable. There's a wearable that we're in the process of integrating with, that we're an NIH type collaborations with. It's called the Sensoplex. It's a rover. It's more advanced gait analysis, like the Biodex, it's more clinical and research grade. But we also have met with Fujitsu in Japan who has a wearable that's an install. So, their interest is not only for Parkinson's and gait, but for Alzheimer's. So, with that same auditory upgrade, you have auditory cues that would let you know who you are and hopefully turn you around, because in Japan, they age in place. Here, we tend to age in nursing homes and assisted living. There you're out in the community.

So, that's where we are right now. We have partners that were actually in the beginning of discussions which that have infusion pumps that are used in pain management, surgery, and cancer treatment. So, the same kind of feedback loop with sensors, software, those personalized data sources with a patient. We upgrade those audio beeps that you hear all the time, because that's all that Biodex had. They had a beep. Really exciting stuff, isn't it? Beep. So, when you make the output, which is literally an auditory outfit that we make it sound musical, but it can change dynamically to be in that feedback loop that we know what the target, is how much morphine the doctor wants to use during the surgery, and reduce that.

Because with surgery, if the music is used correctly with the right protocol and method, you can reduce the amount of anesthesia that you need 50% across the board, and that's huge. That's replacing the opiate and creating music as an effective pharmaceutical for pain and anesthesia. That's what we're showing with Parkinson's. We are getting higher gait and balance outcomes than are available through any pharmaceutical intervention. We're getting physical therapy past outcomes. We're blowing the ceiling off past outcomes. They're getting there faster and better. So, it's an exciting time.

And even in NICU, we have future intent. Right now, music in NICU is done through a pal or through music therapists, because babies that are born premature, that auditory system in their nervous system is undeveloped and can't handle audio overstim. If you've ever seen a NICU baby, their fist clench up, they have real issues where you can do a lot of damage. But with that

precision capability, instead of when the baby listens to music and nobody's paying attention, that baby goes from struggling with their breathing... Do you know what oxygen saturation is? They're struggling getting oxygen. When you play music, that oxygen suddenly can spike up, which is what we want the oxygen to go up, but it spikes so quickly that the babies can become blind. You do damage. With a feedback loop where the sensors are monitoring, you have the correct audio being used, you know that the oxygen can spike up, you have an algorithm that predicts that, and you do the correct precise dosage to the baby with the audio output so the oxygen adjust gradually, and knows that's going to happen and you don't do harm.

Steve Weichhand:
Wow. Wow. I mean, there's so much there to unpack. I mean, I think two of the things that really stand out, based on what you described there, first the outcomes. These outcomes are really, like you said, blowing traditional approaches out of the water. And like what I mentioned earlier, and you alluded to, these are scientific journals, highly reputable scientific journals that are publishing peer-reviewed articles on how these outcomes are dramatically changing the therapeutics in certain areas, which you described such a broad array of different applications. So, one is the outcomes, and two is, the second part that really stands out to me there is how technology can solve that problem that you refer to, this supply/demand problem, and get this technology out to the masses. You mentioned the Biodex Gait Trainer Treadmill really is a beta, initial launch of this technology, at least that you were involved in, and how that's reached hundreds of thousands of patients all ready. When you apply that same concept to all of these other areas, the reach, it really just compounds many times over and can really have a major impact to so many lives. So, it is really exciting, like you said.

I want to dig a little bit more into the personalized medicine comment that you made, and you refer to this in your last answer, but just in a simplified way, maybe taking two more extreme examples of an athlete versus a patient in rehabilitation, just learning to walk again or learning to walk for the first time, how is music personalized to those extreme examples? Just for our listeners to simplify things. Could you give an example of how that music is personalized in those extreme examples or any others that you feel would help clarify it?

Hope Young:
You bet. That's an exciting question, because let's just start with the use case that we all ready have, a half a million users and growing. And you're right, they're on one side of the spectrum, which is impaired motor system. Correct? So, we've got a disease process or injury working on that brain, but we're coupling what's called the auditory system, what you hear or what you sense is hearing, even if you're deaf... I'm hearing impaired, so I know this, I can speak to this. You

still respond to music. We are still musical beings. So, when you have damage or impairment, you're linking the auditory system with the motor cortex in a very precise way, and we do it through what you said, personalized auditory outputs that are then paired with predictive algorithms to get ahead of things. Right? We know from the diagnosis like Parkinson's, we know about freezing of gait, we know about festination.

So, in that case, when you get ahead of that, and I'll talk later about this, about the collaborations with researchers and institutes and everything, how we're getting ahead of that, it's not just enough where we are right now to just say, "Okay, we're done." And we've worked with impaired folks, and now suddenly we've shown that somebody like Laila, a little girl that we first used the tech on, she was eight years old, she'd had cerebral palsy since birth, she'd had PT every week, several times a week since she was born. And by eight years old, she still had three major falls a week. All right? So, this level of impairment is... Cerebral palsy is a lifelong condition. Well, we took that little girl and we were able to couple in a precise way, and within the second week after she started the clinical trial, she had stopped falling. By the end of eight weeks, she was starting to run. By six months from the end of the trial, she ran in Capitol 10K with her dad, the last quarter mile.

Want to talk about... That's exciting, right? So, that's taking those kinds of outcomes. Well, if we take the advances in algorithms with those sensors and AI, and you take it to a fine tuned athlete that doesn't have those kinds of obstacles, what we know is you still have the same system working for you. But with a high motor athlete, it has to happen quickly. Laila, we started at 68 beats per minute. Right? Impaired walking. Those high motor athletes are like 200. Right? The response cycle. The thing about your audio and your auditory is music, what is it? Is it the frequency of the music that got Laila doing that?
Well, with our capabilities, our software knows what those frequencies were that matched to her body type. We know how the music had to change. Literally musicians have to change the way they play an instrument to get the outcomes we got with Laila. Because music doesn't usually happen below 40 beats per minute, 60, definitely at five where Laila learned walk. Athletes, though, you have to go very fast, so how much time do you have between a beat and a space in the next beat? You don't have much. So, how are we going to isolate and study how to get that millisecond difference they need in high performance athletics?
So, let me talk about a conversation we had with Air Force at AFWERX here in Austin, they're the incubator for the Air Force here in Austin, they asked about our capabilities and a use case where they were training fighter jet pilots in a stimulator, and they have all kinds of audio going on there. So, they wanted to know about capabilities there. So, when we start talking about those capabilities, we have to splice it down like CRISPR in milliseconds. What is going to happen?

And what's happening on frequency, in pitch, in volume, and then layering in harmonies and textures to get those millisecond kind of twitch responses to more accurately drive that motor system?

And that's exciting, right? That's really exciting. And that's the kind of capabilities our software has to bring in a new era of audio outputs and investigation and research to really slice and dice exactly what has to happen. Because we have the AI. Right? AI is like a clerk on steroids, going through all the information, recognizing the patterns, put that with the software, put that with how many hundreds, thousands, or millions of users, and then we can take that into really defining the cognitive motor response that in a simulator would need with the audio output to give that edge to our fighter pilots in training.
Let me say one other thing that we discussed with the Air Force there about high-end athletes, and especially in those kinds of situations. My husband's Army, so in war situations, they're very dynamic and you have a lot of acoustic blasts going off. For a fighter jet, you have all kinds of acoustic phenomena that are abnormal, that, Steve, you would not necessarily ever experience in your lifetime. Thank goodness. But with the auditory environment, if you can control offsetting the damage that's done by those acoustic process by that same system, learning how to recover and heal, that's another area we're investigating, looking at simulators for those kinds of high performance athletes.

Steve Weichhand:
Well, it really sounds like music therapy's at a point where innovators like yourself really need collaboration across a lot of different stakeholders, like biomedical device manufacturers, academics, musicians, healthcare providers, or payers. So, talk to me a little bit more about where you're at in working with these types of organizations to make music therapy more widely available.

Hope Young:
We are at an exciting point where I think it's the advantage of being my age and being 30 plus years in the field, also developing an incredible network of friends and colleagues across the world. And then every time that we have a new partner like Biodex, that network grows.
So, let me go back to the Parkinson's example. So, with the freezing of gait I mentioned about, Parkinson's patients tend to freeze, so do children with CP, they often freeze. That's why Laila would fall. Her motor system would lock up and she'd fall, right on her face. Bless her heart. And that happens with a lot of our folks who have Parkinson's. So, right now we have a collaboration with a postdoc student who has developed an algorithm at the University of Tennessee in the Department of Biomechanical Engineering, coupled with a bioengineer that is

that UC Davis that is studying biomedical tech. And then we have our Sensoplex, our friends there with the rovers. Then you have my company working with University of St. Augustine and their PT departments.

These are the kind of friendships, and what we call playing well together, that really has to happen in order to drive for you or your grandmother or your somebody that you love to have in your pocket a cell phone that's connected to a wearable that that algorithm can be tested. We work together, we integrate. It's called collaborative competition, I guess, to get to market and scale so millions of people can have an algorithm put in a rover device with music integrated. So, we don't have, when freezing of gait happens, we really effectively stop the fall before it ever happens. Those are the kinds of things...
Like Fujitsu. I was really excited when I was in Japan, working with... Fujitsu collaborates very well with the Japanese government, and all of the research institutes that went in to making the insole in their shoe and the use case around the whole family's desire to keep their parents at home, and with the wandering and the getting lost that happens with Alzheimer's and dementia, that we would use the gait component to keep them able to go out and use public transit. Because Japanese people don't just get in cars and drive around. There's too many people and too little space to do that. So, they walk around. And then they wanted the component of the cognitive from us for their audio so that person could recognize where they are or we could cue and recognize and help them turn around and come home with tracking.
So, it's never going to be somebody that has the silver bullet and is like the answer to everything. Right? You have to play well globally. We have institutes in Sweden using it and working with us, researchers with the government there. We have Dr. [inaudible 00:31:15] in Italy who did those studies and published those in the International Journal of Neuroscience, working with all his PTs and patients. We have Biodex, we have rovers. You can't do it without researchers, clinicians, engineers, marketing people. The human family takes a lot of care for innovation at this level to happen. As well as the Department of Defense. Right?

Steve Weichhand:
It takes a village.
Hope Young:
It takes a village, and you've got to play well with others. So, biotech is definitely a different sector and beast. Let me just say, one of the things in this that I have to bring up is realize that music therapists are trained in music, so we are from the music sector, trained as specialists to work in the medical sector and now we're adding the tech sector. You want to talk about really having to get people who really want to play well together because those sectors do not talk the

same language at all. So, it's really exciting, but it does take people playing very well together. And it's wonderful to find those relationships so globally.

Steve Weichhand:
Great, great. Last question for us before we wrap things up. Can you just talk quickly on what you think the future of music therapy will look like five or 10 years from now?

Hope Young:
One, I think we're going to have a much stronger workforce pipeline. One of the things I think music therapy has been lacking in is innovation. If you understand being a musician, we are in love with the past, so when you're trained, you are trained that Mozart and Bach and all of these, everything that was in the past is what you're trained for and you're excited about. We're one of those sectors that Bob Dylan was the best until the new guy shows up, or the new gal. Right? We don't put as much time into innovating the future the way the rest of the sectors do. Now, medical sector is a little bit behind, but then you get to your pure tech, fast models, they go really fast.

So, for music therapy, what's going to be changing is with these partnerships I was just discussing, it really lifts them up to be trained not just in the music sector, but with tech, just like across all training you see in education. So, that's going to increase revenue, market. Right? With the market. Just if you look at our market success and what's ahead for us, you will show a financial model that the music therapists are going to have tools in their hands, like we're developing, that one music therapist who was able to see maybe 25 or 30 patients a week and help with, now is going to be able to see hundreds. So, there's financial models that it's going to lift. It's going to lift the ability to ask deeper questions from the researchers to really slice and dice, because that's the difference in being trained as music therapist. It is so precise, versus media and entertainment.

So, you're going to see a lot more outcomes improve, a lot more access, but you're going to see the revenue. Because music therapists, on average, make about 40,000 a year. A physical therapist walking out with a degree makes about 80,000. Right? Or more. So, those things are going to change. You're going to see possibly a new field emerge with the ability to ask these questions. We may see a whole nother category where you don't have to just get the workforce pipeline only from the music departments and only the percentage of the music department that is interested in a close personal relationship with bodily fluids, which is what music therapists do every day. We have saliva, bodily fluids. We've been playing in gloves and masks for decades in

hospitals. Most musicians want nothing to do with that. They have to do universal precautions and work.

But with these biomedical device integration, of course, doesn't that allow that to happen better and in remote. You're going to see music therapy all throughout the world in the desert, in remote and isolated places that you had music, but you didn't have that kind of capabilities for that level. I think just as tech continues to grow, where everybody who has a phone in their pocket has now access to a world of information that was unavailable, we're going to see precision music available in those outcomes, and we're going to see a real drive to new levels of non-pharmaceutical interventions. And I really believe it's going to be a new pharmacology.

Steve Weichhand:
Well, it sounds like it's a really exciting time to be in the music therapy field, and I do want to thank you for your service in this area of great need and, as you noted, this area of great opportunity. And really just to close out, I just want to say that I know I, and I know that our listeners, really appreciate you sharing your time with us today, so thank you for being with us.

Hope Young:
Steve, it's a pleasure. Thank you.