



FIELD OF VIEW PODCAST WITH JOSEPH ARTUSO - S1E10 AUDIO TRANSCRIPT

SPEAKER: Brought to you by Accenture Extended Reality. This is field of view.

DANIEL COLAIANNI: Hi, everyone. My name is Daniel Colaianni from the Academy of International Extended Reality.

NICK ROSA: And my name is Nick Rosa from Accenture XR and this is the Field of View Podcast.

DANIEL COLAIANNI: So, Nick, what if I could tell you that you can control things with just your mind?

NICK ROSA: I would call probably someone that can help you with that, like a very good specialist or a doctor or something like that. I'm just kidding. I'm just joking. I would be amazed. I mean that's a super power, is a dream of a lifetime. We see all those movies where there are telekinetic powers and people that are able to control a machine just thinking about it and it seems that this is the future that this is happening.

DANIEL COLAIANNI: So what if I told you, it's not just the future, but it's now as well, it's real?

NICK ROSA: Well, I would say that probably you're about to introduce the guest that we have today, that is coming from a company that is developing an open source platform for brain

computer interface. Would you like to introduce our guest today?

DANIEL COLAIANNI: Yeah, sure. And as most people know, I think Field of View is all about finding that origin story of how people get into our industry and how different areas from you know everything from entertainment, such as Star Wars through to brain computer interfaces of all things. Things that seem like science fiction come together. And Nick and I host this on a bi-weekly basis to go through with some really fantastic people. And I mean today is where we have the unconventional side of this technology kind of come together with what we think is very futuristic. And someone who started their career really kind of in ad tech and in kind of the digital marketing sphere and kind of slowly, I guess, found himself in this place where we're making kind of future things happen. So, yeah, I mean I'd love to be able to introduce Joseph Artuso. Oh God, I messed that up. We can't re-record it though.

I'd like to introduce you, Joseph, kind of to the Field of View Podcast today.

JOSEPH ARTUSO: Yeah, thanks. It's good to be here and, yeah, kind of excited to talk about how I ended up in this XR space and working in neurotechnology as well.



DANIEL COLAIANNI: How do I actually pronounce your last name?

JOSEPH ARTUSO: Artuso.

DANIEL COLAIANNI: Okay.

JOSEPH ARTUSO: Italian family.

NICK ROSA: From an Italian family, right, of course, I can see the connection.

JOSEPH ARTUSO: Yeah, Sardinia and then where like the heel meets the boot, that's where my grandmother and grandfather were from respectively.

NICK ROSA: So Basilicata.

JOSEPH ARTUSO: Basilicata, exactly.

NICK ROSA: I'm from there. I'm from there.

JOSEPH ARTUSO: That's great.

DANIEL COLAIANNI: That's amazing. Tell us a little bit about why me and Nick here are talking about science fiction and I guess why the company you work for is just so cool?

JOSEPH ARTUSO: Yeah, so I work at OpenBCI. We have been making open source tools for neuroscience and biosensing since 2014. We kick-started as a company. We've never taken outside funding. That's kind of cool. I like that, but what's exciting about it for me is that we're making these products that make it possible - this is our site onboard. We make these little PCBs that have kind of electrode pins that you can plug in different sensors to and people are using them to detect electrical activity from all different parts of your body, mostly your scalp for your brain, but also your heart, your muscle activity. And what's just amazing about it is over the last six, seven years, it took a little while to gain traction, but we record all the citations that referenced our hardware and it's just growing. It's speeding up. We see more each year and we're seeing just like a wider area of

fields of study that are now using this type of physical data from the body. And two years ago, more than two years ago, but a growing trend we saw in the research being done was that VR was like an increasingly - in addition to our hardware, virtual reality headsets were becoming more and more like the other hardware tool that people were using. And just seeing how our users are applying our stuff gives us a lot of info on like where we go as a company.

So it's been cool to see exposed to all kinds of crazy research that's being done around the world. I can talk about some of my favorite examples later. And then to get to play a part in it and creating kind of what we think are going to be the next generation of tools for researchers and developers in this space.

NICK ROSA: And, Joseph, before we deep dive into all the different use cases for OpenBCI, maybe we want to give a little bit of a background of you. Can you tell us a little bit about your origin story which is the usual step before we deep dive into the technology? We like to understand a little bit more about the background of the people that we are having in our -

DANIEL COLAIANNI: Who's the superhero that's in front of us right now?

NICK ROSA: Exactly.

JOSEPH ARTUSO: Yeah, so I mean I - gosh, how far back should I go. Should I start at the beginning?

DANIEL COLAIANNI: I mean like you had like what, like a BA in political science, right? And so, I'm interested how something from there for it to bring computer interfaces. How do we make that connection, that jump?

JOSEPH ARTUSO: Yeah, definitely. So I studied political science at Columbia. While I was at



Columbia, I played rugby and was a roommate with Connor Russomanno, who would later go on to start OpenBCI, neither of us knew that at the time. He was a civil engineer saying that his job was to build parking garages. And I was studying how - really, I was fascinated with how political movements sort of gain traction, how they broke down. I was specifically interested in kind of the breakdown of existing institutions and then how like new norms arose and persuasion happened.

So I was studying that, I didn't necessarily want to jump into politics myself. When I was graduating, I had a couple different opportunities, one of which was to work at an advertising agency in New York called the Media Innovation Group. And it was either that or become a third grade teacher or work at like a consulting company. And I picked the advertising because I found out I really did have an interest in like the science of persuasion. I got sort of fascinated by the quantification that was happening in the digital advertising space to this old industry of persuading people. And it was how new tools and the internet were being applied for that.

So I worked in Ad Tech for a while. I got to move to London with that job. I moved to London and started working with Zaxis and WPP. And then they sold off part of that business to App Nexus, which was later bought by AT&T. I had like five different jobs with only ever interviewing for one. I've been through multiple acquisitions, learned something from that.

And then, I moved back to the U.S. in 2017. I did a short period of time where I was organizing concerts and like events around New York City. I thought that maybe the music industry or something in that space would be would be an interesting next step in the career, but it was - I found out that I was really more interested in that as a hobby, rather than a profession.

I worked at Salesforce for a few more years. I learned a lot about running a team. I learned a lot about big organizations and how enterprise companies quantify and value the technology that they buy and also the data they collect. But pretty soon, I was reaching a point where I was still feeling - I'm still pretty young. I didn't need to be - I wanted a bit more risk and I wanted to try something completely new and outside of my comfort zone more so than climb the ladder at a world-class institution like Salesforce.

And I kept talking to Conor, you know, my friend, Conor would hang out and I'd been helping them out with advertising for years for OpenBCI. I've been doing their search and social advertising and it really helped that background just learning the lingo and learning the vocabulary of the industry.

And then, two years ago, I started working full-time there taking over kind of their marketing capacities, but also business development, really everything related to like commercialization and kind of the communication that the company was putting out.

And so, my background was more, okay, what is the stuff that we're writing that people are interacting with? What are the parts of our documentation that people are most interested in? How can we use that to guide what types of content we're creating? It's a really small team actually. We punch well above our weight as a company, I think. People are always surprised when they're like it's just like, wow. And we have to be pretty strategic about where we spend our time and also, how we leverage content that's being created by the community of users that we've seen. I think that's a big thing that I focus on is just finding stuff that's been created that we might not be aware of and then, rewriting it, featuring it in a new way and combining it with other educational



content that other people can see that as inspiration.

So that's my kind of roundabout trip, Ad Tech, back to New York, kept talking with a friend of mine who had an interesting business going and doing it as a side gig for a while helped me as well.

NICK ROSA: And right now, Joseph, you are in touch with this community of innovators that are working with your platform and are using it for the most different use cases and goals. What are the ones that impressed you the most in the last 12 months?

JOSEPH ARTUSO: It's a good question. I think some of my favorite things - so there's one that really captivates people's attention immediately is using your brain to move things, being able to issue commands entirely just by thought rather than any sort of muscle movement. That one's really cool. It's happening. It's called Motor Imagery, it's the field related to that. It's very interesting, but I actually really like the ones where people are using EMG, which is like muscle activity, electromyography. So people using muscle activity to do things. Because as far as everyone's very bullish on brain computer interface technology and are using our brains. Our bodies are actually quite incredibly - our hands are remarkable brain computer interfaces. They can issue a ton of commands a second with very high rates of accuracy that no brain-based system is quite there yet.

But one of the really cool ones was University of Texas, Austin, they made a drone. They put these electrodes around the eyes, so there was like muscles - actually it was detecting your eye movements like quadrants of eye movement, not image-based eye tracking, but electrical eye tracking. And they used it to fly a drone and like they could make it go left, go right, go up, go down, forward, back. It's really cool. There's a video of that that I love to share with people.

And then, in the XR space actually, one of the really cool ones was this project from - there's a group in Australia called The Exertion Games Lab. I think it's like a lab within a university there. And they created this thing called Neo-Noumena was the name of the project. And it was taking one of our EEG systems and then wearing that underneath Microsoft HoloLens. And the researchers had created this - they built on research that had already been done about classifying brainwave activity into sort of a quadrant of emotions. And they used that, they created then in the HoloLens, they created these shapes that would display around the person that corresponded to different emotional states.

So the study that they ran, they gave like pairs of people who lived together, they gave them two setups and they would each spend an hour or two a day wearing the HoloLens and the EEG headset. And the other one of them would be able to see these little like squiggly red shapes or green or blue shapes that corresponded to like what the data was saying this person's emotional state was. And it was really interesting.

I did an interview with the guys that created that, Nathan and a long Greek last name that I won't try and pronounce on this podcast for his own sake. But you can look it up. It was really interesting because they were like one of the studies or one of the subjects was playing cards, they would like play card games with each other while wearing this thing and they said that it was like giving away the other person's - like when they had a good hand versus a bad hand. They could see it in like an adjustment of the shapes that were being displayed in AR.

I thought that one was just like really cool in like real. You know, just he wanted to increase the ability to communicate emotions because it's notoriously sort of difficult and cause a lot of



relationship problems if you're not able to tell how they're feeling in the right moment.

DANIEL COLAIANNI: Joseph, some people might be sitting here as well and watching and then thinking, so what is like how really relevant is BCI and the technology that you're doing to XR? I mean, obviously, that's one really kind of niche, kind of example. How relevant is it going to be and then how relevant is it?

JOSEPH ARTUSO: Yeah, so about two years ago, two and a half years ago, we started building a new product, which at first, it's called Galea, if you look it up. What it focuses on is combining many different types of physiological sensors with a – first, we're doing a VR headset and then we want to expand it to AR and to multiple other headsets. So we started on that project a couple years ago, based on the interests of Conor's own interests and previous work that he'd been doing at the company, Meta, but then also, we started collaborating with Guillermo Bernal at the MIT Media Lab, whose PhD work focuses on this area.

But the third reason that we kind of pursued this was because of years of feedback from our customers. You know we run we run surveys all the time. We're asking them what they want to see, what they're using in addition to our hardware and one of the number one requests was – or number one other types of hardware being used was VR headsets. And it's actually because over the last - I think it started further ago, but maybe the last 10 years, there's been a real renaissance in neuroscience, thanks to VR and thanks to - and AR as well. They're figuring out ways to use it, but it was really VR that allowed them to run much more realistic experiments that are still in a controlled setting that wouldn't be possible in the real world.

And that's kind of our background is more as like a neuroscience hardware company and that's how we started to get exposed to the XR

scene was by artistic applications that used our hardware, but then also research and scientific work. And so, we were hearing that and it aligned with Conor and some of our other engineering talents own beliefs and interests and fields of study. So we think it's going to be extremely relevant to the future of not just XR, but really the future of computing.

We think it's going to be head worn. We think the displays are going to be head mounted. We think the computers are going to be integrated with more parts of our body than just our eyes and our hands. We think it's going to be using your heart rate. It's going to be using information from other areas and other types of sensors.

I don't think this is something that's going to be happening with the Quest 3 or with any of the immediate, but I think right now, we're building the tools for the people that are exploring that and it's sort of around the development to be done before people are figuring out what is the right sensor to put on the right part of the body for a mass consumer product. But we have a strong belief that, yeah, physiological computing is a term that we've used before really just that you're going to be more data from more parts of the body is going to go into sort of what operating systems are using to customize your experience.

NICK ROSA: This is so fascinating. And, obviously, this is going to open up Pandora's box both of research and new insights on how people think and how our brain works. But at the same time, it's going to interconnect us even more deeply with digital technologies. Do you think that this is going to accelerate the way that we communicate with digital interfaces?

JOSEPH ARTUSO: Yes. I think it will - it's hard to say exactly how it's going to be built and what it'll look like. We have this thing that we talk



about internally kind of we sometimes call it like Jarvis, like the Iron Man Jarvis kind of AI. Sometimes you talk about like Jiminy Cricket from Pinocchio, like I think that there's going to be what I'd like to see in this space is more of a personalization of digital assistance and just kind of like operating system environments.

I think that if we're able to get past the hurdles of how to share the very personal data that these types of sensors will collect, in a way that there's trust with the with the companies using it, there's a huge opportunity for kind of for your digital environment and your operating system or this kind of agent that is helping you interface with digital environments to kind of know what your intentions are and help you know that, hey, that was - you didn't really mean to click that or what you're trying to do is you're trying to select this layer of the Photoshop instead of this layer. Like just helping speed up some of these everyday actions that we take, as well as depending on how much control we're able to give or willing to give, it can try and help guide some of your habits to healthier areas.

A lot of interesting opportunities once you start to bring in data from the body itself and it lets you quantify a lot of other states like your attention and stress, your mental load, cognitive load, I think there's going to be a lot of interesting things that happen when we start to like - if we're able to combine that with Siri or something else like that, but we really do have to figure out the way to do it that the users are owning the data and not –

DANIEL COLAIANNI: I was going to say, you said a key word there, which is trust, right. And we live in a really privacy concerned world nowadays and especially some people might also be listening and saying, oh, he's got a background in Ad Tech.

JOSEPH ARTUSO: Oh, yeah. Yeah, I mean trust is low at the moment. I think trust in technology - we will use it, we trust it to a certain extent, but there's high suspicions and perhaps rightfully so. Our current approaches and the ones that I've saw in place in my time in Ad Tech, I hope don't carry over to the neurotech world. And, in fact, I think there was - we participated in a like a neuroethics panel run by Columbia University last week and this guy, Rafael Yuste, has a lot of good things to say on this. And he's kind of one of his more accessible and repeated points is like all of this needs to be treated like medical data. This is medical data, not clicks and impressions data. That we do have other industries have frameworks for treating this type of data in ways that are more privacy oriented, more regulated, more strictly controlled. And I think we need to start approaching all of our interactions with computers with some of that lens more so than kind of the advertising world's approach.

NIKA ROSA: But I mean I think that this is an interesting angle that we can approach right now and, Daniel, this is the moment for my provocative question.

DANIEL COLAIANNI: Oh, this one's an early one. Usually, we have Nick's provocative moment later.

NICK ROSA: You have to know, Joseph, that during our podcast, there's always this provocative question moment coming from me.

JOSEPH ARTUSO: It's like the daily double being in Jeopardy or something.

NICK ROSA: Exactly, exactly, exactly. So my provocative question here is that, obviously, where there's an opportunity to collect data, there's also a big opportunity for business. Ad there is this thing that is very hip at the moment in the advertising world which is neuromarketing. And this neuromarketing not only is driven by neuroscience laws, but also by



artificial intelligence that is able to create predictive models of behavior of people.

This kind of technology that you are creating there at OpenBCI, if applied to any kind of interfaces that could be like, I don't know, Smart Glasses or can be even mobile phones or any other kind of digital device could be an incredible opportunity for many companies that are looking to understand more consumers. And potentially, there will be a lot of consumers that would be willing to give away data about their emotions in exchange of services or rewards and stuff like that. Do you think that we are going towards that future or do you think that, as you said before, the future of neurotech is going to be more protected in terms of privacy like a little bit more like what Apple is doing right now with their products, like closing up and giving control to the user of what they want to do with their data or not?

JOSEPH ARTUSO: Right. Yeah, I don't think it has to be one or the other necessarily. It doesn't have to be sort of closed versus the opportunity to be monetized. What I want to see is a future where the data is user owned, not device manufacturer owned or device - right now, the big part of the power is in either device manufacturers, like Apple or even Apple - Windows where Microsoft, Google, people who make your phones, they have a huge amount of control over what the data's can and can't be used for or even like device owners, which is could be either you as an individual owner or like your company. If they own your device, they have a large amount of control.

What we want to see is an increase in power for the actual users who are sometimes the device owners, but not always. I want to see it where you get to permission all of this. The missing layer in the future that I want to see built with the technology that we're creating is kind of this, the permissions layer to all of this. Some part of either the hardware or the operating

system that lets you say, yes, I want to participate in this marketing survey and I will allow this list of data for this period of time to be used in order to gain insights or yes, I do want my voice assistant to have access to my heart rate or I don't. I really want to see that done well.

Because there's a huge market here for user experience research. We think that's a major area, better game design, but game design extends to any digital experience and then user training. The VR training applications that are sort of one of the more proven business models for the technology at this point, adding the ability to quantify things that were otherwise more qualitative and handled in user surveys being able to add data to that, I think is very positive.

So I guess, yeah, I want to see somebody really handle the like permissioning well because I do think, Nick and Daniel, what you said, yeah, it is just like people will use this, people will find a way to make all of this happen and use it for advertising and use it for other industries. And as long as there's an option for users to control it, I think it'll be better than the alternatives.

DANIEL COLAIANNI: So some would say, I guess, it's going to sit in there that surely the responsibility of that might be in the hands of the manufacturers of the companies making this stuff in terms of being able to limit like how the data is used. For example, I can think of like Open AI, they've been very careful about who has access to certain things and also, how they roll out that kind of infrastructure, software, hardware because of the potential dangers that it that it can oppose.

JOSEPH ARTUSO: Yeah, one of the things that I - kind of like a subtle change that I really celebrated and kind of paid close attention to, I don't know when it happened. I have to go - you know how when if you have an iPhone or if



you have an Apple device and it asks you – if you open up a website or another app that wants to use your location, you know if you open up Uber and it used to be you had two options. You had like, yes or no, and no would usually just like close the app and not let you proceed with the service you were trying to access.

Now there's a third option. There's like a only while I'm using this app option and that didn't used to be there and I think it's a huge improvement. And it was kind of a quiet change, but I think it was a really important one and one that if we sort of push further in that direction, both from, I think, the hardware manufacturers and really the people creating the operating systems. I think it's iOS that lets you dictate those terms. And similarly, Android, but if it's Microsoft with their operating system they've built for the HoloLens or Facebook, how they're approaching things with the Oculus. I want to see the controls built into those that let users decide, yes, no, only when I'm using the app, that certain types of data is available to programs.

DANIEL COLAIANNI: Yeah, but you guys have got the new gen - your next generation product, right, which is Galea. So I mean like how is that different, I guess, from the current device that you have now and, I guess, where you where you see that taking this particular technology then?

JOSEPH ARTUSO: Yeah, the big difference with our current or the thing we're building is that it's just it's a lot more sensors, all in one and it's integrated into the form factor of a VR headset. So we've got –

DANIEL COLAIANNI: It looks a little less scarier as well.

JOSEPH ARTUSO: That's good. We'll tell our industrial designer that you guys are fans. Yeah, maybe we can pull up a picture at some point,

but it's got hardware for - it's got EEG sensors for brain activity, it has EMG sensor, it has a bunch of other sensors in the face pad for doing muscle, eye movement, your heart rate, but then also, electrodermal activity which is like skin - changes in like your skin sweat conductivity. That stuff's been used a lot to quantify stress and other certain emotional states.

We see this product as really more of a - it's a little different than our existing stuff in that it's more for - it's for research. I mean it's similar, it's for researchers, but also for business R&D groups. We think that this is going to be more of a developer kit. It's not a consumer product. I don't think that if you're a gamer, that you're going to buy this to upgrade your Valve Index with brain sensors. But I think that if you've got the budget or if you've got the interest, we've already talked with game studios. We've also talked with R&D labs at consumer tech companies that are like already looking at this. We're using these individual sensors. The idea that you could give us all of this in one hardware package and one connected data stream, it's happening. People are already - I'm not having to convince people that this type of sensors are worthwhile for their work. It's more detailed questions about can it do this, can it do that, what's the resolution, what's the sampling rate.

So it's kind of interesting to see. I was anticipating a lot more like Neuroscience 101 when I was talking - going out on the sales pitches for Galea and it's been a lot more like we're already doing this. Here's where it's falling short, is yours better? So that's kind of cool to see.

NICK ROSA: And, Joseph, I noticed that there's a remarkable similarity between your device design and the one in a very old movie that I really love that is called Strange Days from Catherine Bigelow.



JOSEPH ARTUSO: Okay.

NICK ROSA: And in that movie, you could wear a device like the one that you have in order not only to record experiences and your emotion and so on, but also to relive the experiences. Obviously, right now, the communication between the neural machine interfaces is a little bit one-way. I mean the return is usually visual or audio-visual. Do you think that's in a future, the future of a neurotech is a two-way communication between the machine and the interface directly through the neural machine interface?

JOSEPH ARTUSO: Yes, and you hit on there's a distinction that we use to vote, there's read and write. So like what OpenBCI does today is we - most of all of our products are focused on reading. We read information from the body. We read information from the brain. We're not writing anything back yet, as a company, other than like you said, the audio-visual experience is a huge - like huge pathway for modulating the way your brain and body works and one of the best, in fact. But there are other ways that people are exploring, electrical stimulation, magnetic stimulation, ultrasound stimulation in the brain and then also, what's the - I can't remember the term, but there's an interesting one more specifically related to VR where you can electrically stimulate an area behind the ears and it helps with - you can change your balance that way. And you can force a feeling of - if you're doing a fighter pilot simulation, you can actually make it feel like you're spinning or climbing or falling with electrical stimulation. That's being explored by some researchers.

So, yeah, I think that we will be doing more writing into the brain, but I think the reading side of it is 3 or 5 years away. I think the writing side is 7 to 10. It's just a little more difficult and the science behind it is more - yeah, we know it works, but we're like shooting a fire hose of electricity into a very large brain region and it's

doing what we want it to, but also other things that we don't deeply understand quite yet.

Although, I should qualify all this with I am not a neuroscientist or have a deep scientific background in here. So I encourage you all to find specific experts on right technologies and do your own research. But I think it will be part of the future.

DANIEL ARTUSO: Does this mean that, I guess, we can eventually - I mean do you foresee this has been a realistic thing in terms of the future where we're talking about having VR headsets, for example, and the partnership with like Valve, where we would be able to get rid of the headset completely and be able to have these visual experiences without a screen?

JOSEPH ARTUSO: It's funny you say that. So, yeah, as part of the Galea project, OMBCI has partnered with Valve, the makers of the Valve Index and Steam. They've been great partners and it's very interesting to speak with them about their own views about BCI technology and neurotechnology and why they're interested.

NICK ROSA: Correct me - sorry to interrupt. Correct me if I'm wrong, I think that I've read somewhere that Gabe Newell said that the next big thing after VR is basically neural machine interface. Was he referring to OpenBCI?

JOSEPH ARTUSO: He is very bullish on this space in general and he gave an interview back in January, I think, is this what you're thinking about?

NICK ROSA: I remember that.

JOSEPH ARTUSO: I remember it because I immediately quoted something he said and was just like we're going to use this later in our marketing materials. If you don't - he's speaking more generally, I think, about brain computer interfacing and the opportunities that



it has for user experience research. And he's saying if you don't have one of these in your lab in 2023, you've made a mistake. And that's something he believes. We believe it as well and I think that's why we're able to sort of partner up on this project. He also, you know, to Daniel to answer your question, I think if you ask Gabe whether we're just going to drop the displays and be putting audio visual data directly into the brain, he's going to say, yes. I think we're further away from that. I haven't seen the inklings of technical progress to get us there. The closest thing I've seen actually is more - there are some studies where it's like people can try and recreate an image you're looking at based on your brain activity and that's like incredible, but that's sort of as far as I'm aware that we've made progress in that direction. I think we're pretty far from like inducing an experience through any kind of stimulation or direct writing information into the brain, our eyes and our ears are already extremely well engineered with our brains to do that and are still kind of the best pathway.

DANIEL COLAIANNI: But how did how does a relationship like that even begin to blossom between BCI and Valve and also, it was MIT as well, right?

JOSEPH ARTUSO: Yeah, making Galea has been a crazy three-way collaboration and I think it's only been possible because of our open source roots. So like I said, Conor Russomanno, our founder, he was working at Meta for a while. You know, he did a brief stint at Meta sort of exploring how some of these sensors could maybe be integrated into future AR headsets. And during that time, he was just in San Francisco with Guillermo Bernal, who he had met previously at the MIT Media Lab. You know, they use our hardware in their classrooms and we go up there every now and then. We got introduced and Guillermo, he had created this Facepad thing called PhysioHMD

and it was a bunch of muscle sensors, but then also like a heart rate sensor and a lot of the stuff that's basically what the Facepad of Galea was based on. It's like a next generation of that project that he made and he used it to bring like facial expressions to VR avatars, through like muscle - into the muscle activity. Really cool videos on that project.

And we were able to collaborate with him because of MIT has certain guidelines for how that research can be used if the end product of it is going to be open sourced. So we will be releasing kind of the electrical designs of the system we're building, most of the software that we're doing is open source as well. And that's how we got started with that connection.

And then, Valve has been a customer of OpenBCI's, just our existing products. And this guy, Mike Ambinder there, who's kind of a psychologist that works at Valve. You can go back and see talks that he's given at game developer conferences about how they're using EEG in their own work.

We connected after one of those, one of his talks and we had a few back and forths and eventually kind of led to us getting to really sort of pitch them on what we were building. And I think it was interesting because at the very beginning of the meeting, we were just sort of getting grilled on like why are you open source? Why did you do this? Why wouldn't you do this? And I don't know if we knew this at the time, but I think we just like accidentally said the right thing which was just like we wanted to get as many people to use it as possible, which is why we like release stuff under the MIT license and make it so that you can customize, modify, redistribute even re-commercialize the code that we're putting into the world. And I don't know, you'll have to ask the Valve team what their own decision making process was like. But I do think that that was kind of a key checklist for them, was like they want to see



this stuff advance sooner rather than later and the idea of putting something out there that other people can customize and modify has a multiplying effect beyond what us, as a company, can do.

NICK ROSA: And the kind of model that you have as open source, I believe that it is probably crucial and fundamental for emerging technologies as VR and obviously brain machine interface. We've seen a lot of companies embracing this kind of model. I mean Valve open up their Steam VR and with OpenVR and OpenXR, are working exactly in the same way. Do you think that's for any emerging technology, there's a need of opening up and sharing more information? We've seen a lot of companies that are closing their ecosystem. They're closing their technology. They're not sharing anything. But is open source that you know the real true part to innovation nowadays?

JOSEPH ARTUSO: We think so. We think it builds better tools. We think it builds a better end product when it's transparent and anyone can kind of point out the flaws. If you're hiding it, it's like, yeah, you may get away with nobody knows that that's how the end product is made and that there's a mistake. Like we've had people contribute back to our code base that are just like you did, you don't, you guys need some better Python developers or you know whatever. And it's a huge help, but I also think it - we know that like we are a small company, we've got big ambitions, we've got some big plans. But like our sort of ability to impact and guide the rollout of this technology is somewhat inherently limited by our size. And we think that a way for us to really amplify our impact and encourage things to develop in the right direction is to make it so that any - like we want to raise the floor that other people are starting at by providing open source hardware and software that they can use as a starting point.

And we think by putting out transparent open source code into the world, you're just growing the pool of people that can contribute to the advancement of any industry whether, it's XR or neurotechnology.

And our hope is that by getting more people involved in it, by making it easier for other people to contribute alternative models for how these tools should be applied, that we'll end up with something that at least options between what if it's all closed source, if it's all being done behind closed doors, at major companies with big budgets, they get to make the decision about how it's all rolled out and it's going to take years to come up with an alternative.

We do think that the open source method just gives the world more options for building lots of futures.

DANIEL COLAIANNI: I guess it's about trust as well, right? It's like if someone needs to put something that can both read and write on their brain have no trust of, hey, this is the code that we're using. This is like how it works. This is the hardware. It makes a lot more about consumer trust with that as well.

JOSEPH ARTUSO: How do you guys feel about like brain data or even giving your phone or computer kind of access to more data streams from your body?

DANIEL COLAIANNI: See, I was going to ask if you guys have done any focus groups, but I guess we're one of them. I think it's interesting because all throughout this entire conversation, I've been trying to ask myself, okay, would I actually use this on a day-to-day basis? And I think it really like for me like on a personal level, I can see 100% how it's going to enhance my life, how it's going to make the changes of the things that I can do and allow for a lot more accessibility.



But I still have my reservations when it comes to trust in the device, I guess. And, I don't know, Nick, you might be completely different from me?

NICK ROSA: Yeah, so it all comes from a sort of a reward in some way. I mean you give away something in order to receive something. Obviously, in order to receive this kind of superpower, commanding technology with your brain, you have to give up some of the data and eventually access to your emotions and so on. But at the same time, we already giving away a lot of data about us. Just think about Alexa and think about Google Home. There are microphones that are always listening and always there.

DANIEL COLAIANNI: It's the idea that you're consciously doing it, right. You're consciously putting on your head to do that. When we have like a phone device or something like that or an Alexa, it's just going to sit in there in the corner, right?

NICK ROSA: Yeah, I mean I hear what you say. It's a little bit like, for example, thinking about something or saying something. When you say something like the stuff that you say to your Alexa or to your Google Home, obviously, is not exactly what you think. But with technology that is able to understand your thoughts, then everything that goes through your brain is unfiltered. So using the right algorithm and machine learning models, it would be possible eventually to create a model on how you think in the future, which is quite scary to be honest.

But I mean I'm thinking about the kind of applications that this could have for healthcare. Imagine people that will be able to walk again controlling their virtual legs or their prosthetic legs with a brain or eventually, I'm thinking also about telerobotics, which is extremely fascinating as a field. Feeling, being into a digital body hundreds or thousands of kilometers away

from where you are just because you're thinking to do actions and you can see the robotic limbs moving and eventually wearing a VR headset for telepresence in real time. This this is really a reality.

I mean we've seen also some really interesting examples from companies that are doing optic feedback like optics, that are doing a lot of research in that field. So the perception of reality and the perception of presence, obviously, are going to be blurred in the future with the advent of all these technologies. Obviously, we're talking about more –

DANIEL COLAIANNI: I'm going to say like this is what's interesting to me about it is like I'm sitting here right now and I know if we go back even just kind of 30 years or 20 years or whatever and then we would tell someone about the idea of having a smartphone in your hand that can read everything, do everything and see everything that you're doing, those people would probably be saying the exact same things as what I'm saying right now.

NICK ROSA: Yes, but it's the same thing that people would say, but it's exactly the same people, the same thing that people said when Henry Ford presented the first cars. Nobody will want to have a car because we already have horses to go from point A to point B. And then you get a car and it's a super power because you can go further away and you can you travel long distances. And the same thing even for mobile phones, I remember the first mobile phones arrived and people said, I don't want to have a mobile phone with me because I don't want people to bug me when I'm away.

Now if we are without mobile phones, we feel lost, right, because we feel disconnected. What is it going to happen in the future where people will be able to connect telepathically and communicate with each other?



DANIEL COLAIANNI: Never going to use our voices ever again.

NICK ROSA: But imagine the kind of empathy that could be created in the future? I mean that experiments that you mentioned before, Joseph, it was quite fascinating to me because –

JOSEPH ARTUSO: I love that one. Yeah.

NICK ROSA: Yeah, it's wonderful and I would love to know more, by the way, maybe after that you can send me some links via email. It's incredible because I believe that most of the misunderstanding of this world and most of the problems of this world come from a massive lack of empathy. And we know that VR is an empathy machine and VR has been used to raise awareness about social issues in the past, but imagine being able to visualize your emotion and being able for the other people to understand your emotion more deeply. I mean people are more imagined and they're more lonely than ever right now because, obviously, we all live in our own bubble and we are unable to connect deeply with other people. It's all very superficial.

A tool like this one that you're creating at OpenBCI could be a very interesting empathy machine for the future of humanity.

JOSEPH ARTUSO: I am very interested in the opportunities for physiological sensors to add a layer of emotional communication that's not possible just through the usual 3D avatar kind of the presentation method. I don't know if whether - I bring up the facial expressions thing, we're doing it with muscle sensors, but it could also be a camera, it can also be - there's other approaches to incorporating facial expressions, but I think that like crossing that bridge - something like VRChat and Rec Room where you've got the ability to add another layer of humanity to the characters that you're interacting with or interacting as is really interesting.

And then also the data, that experiment I referenced with the HoloLens. If it can't be as the same kind of voice and face expressions that we're used to using to communicate extra layers of emotional information, what else is there? We've got this digital 3D environment. We don't have to stick to what's worked in the regular world. You can add auras and colors and shapes and modify other aspects of the avatar itself to change and communicate like I'm stressed out, I'm not stressed out, I'm calm or whatever it is.

Guillermo's work also did that. He had these kind of - the avatars he made were these sort of like it was almost this like big hairy - like these long strands of fabric or hair kind of from these like humanoid avatars and it would - he would modify like the color of it and also sort of like the how much they're standing up or down or kind of like the shape of the character itself based on some of the emotional data that the hardware he built was reading. And I think that that has an opportunity to just really make the telepresence scene so much more human than it is and, therefore, cross the main hurdle at the moment that's like it's not as good as meeting in person. It's great because it's so convenient, but like you lose something.

NICK ROSA: Yeah, and a lot of people are complaining about the loss of the emotional aspect of digital technologies and VR in this way. Basically, you're broadcasting your emotions, you make them readable to other people.

JOSEPH ARTUSO: Yeah, and I just want to be able to say on or off, like –

NICK ROSA: Yeah, of course.

JOSEPH ARTUSO: I'm in a private space and I do want my like - I want everybody to see it or it's just like, no, like I'm at a business meeting and I'd rather not everybody know how stressed out I am and how much my legs might be shaking



while giving this presentation. So I'm going to toggle off some of these extra layers of communication at the moment.

NICK ROSA: Okay, you're opening up Pandora's box of possibilities right now because I'm thinking about another very old movie, wonderful movie, one of my favorite movies. I'm a big fan of sci-fi, but I'm also – I'm very old as well. So this movie was called, Gattaca, or was with Itanok, where he was faking to be a sort of a superhuman, genetically engineered space explorer that was supposed to go on a space mission while instead he wasn't genetically engineered. He was born naturally from the love of his parents and he was using all different acting device to avoid the tracking and to fake his calmness during interviews or is a heartbeat during a running and so on. So I'm wondering if - I mean, obviously, with every technology there's a way to hack the technology. There's no technology that is unhackable. I mean recent news is that people have been able also to hack blockchain system as well which is quite weird. But I mean I've read this news and I was shocked about it.

So in the future, there will be also this kind of possibility of faking the emotion that are recorded by system for neural machine interface in order to take advantage eventually in, I don't know, analytics and performance achievements and stuff like that. It's a fascinating possibility, don't you think?

JOSEPH ARTUSO: Yeah, it can happen you know just if there's a data stream that an algorithm is picking up to classify your current state, like cool, figure out a way to plug in different data or modify it. What you're talking about also is kind of cool. There are some positive applications for it like this whole sort of field of like it's called neurofeedback or biofeedback, where it's like the human brain is like we're better at learning things than we realize. And like, we can pick up on a signal or make a game

out of something and get better at it very quickly. What's one of the ways that that gets used is in training scenarios that do use some of the types of sensors that we work with, what we've seen is people - maybe it's like a muscle activity. Let's say like another - I'll use another example from Guillermo's work because we've talked a lot. He made like this sleeve that had a bunch of muscle sensors on it and then it had some LEDs, some like red, yellow, green. And he took it into a pottery class and he had the expert wear the sleeve, record the muscle motions of them like throwing a pot the right way. And then, he put the sleeve on the amateurs and like if they were closer or further away from the sort of the muscle patterns of a professional, of the expert, they just got like a light. They got like a red, yellow, green on kind of the –

NICK ROSA: You're talking about predictive analytics for human errors in real life scenarios?

JOSEPH ARTUSO: I guess. Maybe that's the –

NICK ROSA: It's a fascinating topic because I've been talking about this topic about three years ago during a conference in AWE in 2018, I think. And we were doing some work in the field of machine learning with the same kind of a similar scenario, but using only VR and only using hand tracking and vector tracking. But this looks a little bit more advanced, obviously, because it's using sensors.

JOSEPH ARTUSO: Yeah, so I mean this was - the point of it was that he gave this sleeve that was giving some real-time feedback of whether you're kind of matching this this pattern. And the people that wore it got better faster than the people who didn't. And that's a pattern that if you give somebody - one of the biggest applications of the EEG technology that we make is like for meditation experiences. There's a company called Muse that has maybe one of the more commercially successful like



consumer devices, widespread EEG headset. And they use it for like giving you feedback, giving you real time like this is your brain is in a pattern that you say is when you're relaxed versus not relaxed. And when you're doing that and you're first getting used to meditating, it helps immensely to know like I'm getting closer towards it or further away. And even if you don't know how to change it, your body like figures it out.

If you give them a little bit extra, one extra axis of information like I'm getting closer or further from this goal that I didn't previously know how to quantify, your body like quickly kind of goes, okay, I'll figure out how to get closer to the green light even if I don't - wouldn't be able to explicitly articulate each step that I'm taking to get there.

NICK ROSA: This is sort of a positive reinforcement?

JOSEPH ARTUSO: Yeah, and I think this is like - I think that is the training, the opportunity to like give your body more - I don't know what the word would be like, yeah, just more feedback on you're in the zone or you're not in the zone. It accelerates the rate that you can learn new tasks and I do think that that's an area that like the applications for that are -

NICK ROSA: It's sort of a lighthouse guidance that you provide to the body. I mean this is the direction, that's where you have to go, that's it's up to you to understand how you have to go there.

JOSEPH ARTUSO: Yeah.

DANIEL COLAIANNI: So I'm sure like, as you probably can tell, Joseph, me and Nick are super entwined into this conversation, really excited by it. But I know we're sort of running out of time, which is why I wanted to ask as one of my closing questions really which is or conversations really, which is I guess - you've

been in this space for quite a while now, you've got this new device coming out and things like that, what are you hoping to see from the XR space, in particular, developers and academia and different groups that could use this device? What are you hoping to see it can be used for? And I guess how can people do that and get involved in that?

JOSEPH ARTUSO: Yeah, so we are - a global electronics components shortage willing, we'll be doing a manufacturing run of our Galea beta device. What I want to see and what our approach with putting this device into the world is we only want to make maybe a 100 initially and find beta partners that we can work closely with who are going to help us pursue different use cases that we wouldn't be able to do ourselves as a company. We have a limited set of expertise. We know that we're not going to tackle every approach. But I would love to find - I want to find the training application for how can I incorporate heart rate into a training program that I'm already using and show how that - explore whether or not that increases its efficiency.

I want to see the gaming application. I think that there's really cool ways to use just even like the eye - you know, the eye movements or muscles on your face to control in-game activities. We have at Galea.co, we have kind of our beta program application/ And we've been collecting applications from everyone on what would you do with this device, what are you looking to achieve, what are the things you're the most interested in? And I read through every single one of those. So if you're a creator or a developer or a company out there and you've got some ideas, send one in.

But our plan is to put about 100 devices into the world next year. We're going to pick the people we work with based on the applications that they're pursuing and try and use that as a way to see, okay, this is what it can be used for well,



this is what we would change in future versions, these are the types of sensors that are the right for different use cases. That's kind of our plan at a high level and then, two to four years out from now we'll be, okay, do we continue? Do we need to continue making kind of the all-in-one everything Dev kit version of this or are we picking individual sensors and trying to minimize it down into more consumer-oriented use cases?

DANIEL COLAIANNI: Interesting.

NICK ROSA: Fantastic. Thank you very much, Joseph, for being with us. And, Daniel, would you like to remind all the channels where our followers can see the podcast?

DANIEL COLAIANNI: All the channels. Yeah, I mean like if you're a visual person, you can watch this on YouTube and you can check it out.

NICK ROSA: If you're a visual person.

DANIEL COLAIANNI: Yes, yeah, I mean if you can see - if you want to see me and Nick's lovely faces and, of course, Joseph's too, check us out on YouTube. But if you just want to hear us, maybe you're in the car, maybe you're working or whatever, we're on Apple music, we're on Spotify, Google Podcasts, all of those locations. I think there's even - our producers looking at me telling me there's a lot more than that. So there's lots of different areas to catch this and I think the key thing here is that we want to hear feedback from you as well. So if you want a particular type of guest, a particular type of product, particular type of topic to talk about, let us know. Me and Nick are really open to those discussions and I think this has been a really exciting kind of talk about the brain interfaces and these kind of things, but there's so much more out there in the world of XR as well.

NICK ROSA: Joseph, thank you so much for being with us and for doing this such an

interesting conversation, running such an interesting conversation with us was great.

JOSEPH ARTUSO: Yeah, it's been great talking to you guys. Thanks for having me.

NICK ROSA: Thank you very much. See you around.

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