EPISODE 335

[INTRODUCTION]

[0:00:00.4] JM: We view our phones as inanimate objects, but when we see robots such as the Boston Dynamics Machines that move with a motion that almost seems like an animal, that robot becomes alive. It's a much different sense than we get from looking at an iPhone. We feel more sympathy and connection towards that robot.

Today's episode is about the distinction between inanimate machines and machines that seem alive. Peeqo is a robot assistant similar to Amazon Echo, or Google Home. It was built by Abhishek Singh as part of his thesis. Abhishek wanted to explore the border between inanimate electronics and the electronics that we personify.

Peeqo is a cylindrical tube that bends slightly, like the human neck. At its head, it has a smartphone sized screen that displays gifts to reflect its feedback visually. Abhishek also has a company called Svrround, which makes 360-degree video experiences.

We explore the changes to engineering that are allowing someone like him to be involved in two cutting edge projects at one despite having a very few employees working with him. We went deep on robotics and we talked a little bit about this 360-degree video stuff. This was an energizing conversation. I greatly enjoyed talking to Abhisheck. I really hope to have him on again in the future, because he's got a lot of interesting things to say.

We'd love to hear your interesting things to say. We want to get your feedback on Software Engineering Daily, so please fill up the listener's survey. It's available on softwareengineeringdaily.com/survey. This is how we gather information to decide where we take this company.

Also, Software Engineering Daily is having our third meet up, which is Wednesday, May 3rd at Galvanize in San Francisco. The theme of this meet up is fraud and risk in software, and if you're in the Bay Area, we would love to see you there. We're going to have great food, some

great speakers, and a friendly intellectual atmosphere. You could find out more at softwareengineeringdaily.com/meetup.

Now, let's get to this episode.

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[0:02:20.4] JM: For years, when I started building a new app, I would use MongoDB. Now, I use MongoDB Atlas. MongoDB Atlas is the easiest way to use MongoDB in the cloud. It's never been easier to hit the ground running. MongoDB Atlas is the only database as a service from the engineers who built MongoDB. The dashboard is simple and intuitive, but it provides all the functionality that you need. The customer service is staffed by people who can respond to your technical questions about Mongo.

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[INTERVIEW]

[0:04:19.1] JM: Abhisheck Singh is the founder of Svrround, a 360-degree video company. He also built Peeqo; a robot assistant. Abhisheck, welcome to Software Engineering Daily.

[0:04:28.7] AS: Thank you. Thank you for having me.

[0:04:31.0] JM: It's great to have you. You have worked on two areas that I want to get into; robots and 360-degree virtual reality video. Let's start with robots. You built a robot assistant named Peeqo. Explainw hat Peeqo does.

[0:04:46.6] AS: Yeah, all right. I built, as you said, a robot assistant named Peeqo who's essentially a voice-activated assistant who responds entirely through GIFs, and I'm just putting it out there. I call it GIFs. Some people call it GIFs. It's like to each his own. Yeah, I call it GIFs. You can kind of think of him as the lovechild of, say, Amazon Alexa and a Disney character. I built him last year, kind of documented him several months later, put him up on Reddit and it kind of just took off from there.

[0:05:18.6] JM: Explain how the interaction between Peequo and a human works and how it differs from that of Amazon Alexa, because it's a similar unit to Amazon Alexa. Maybe you could describe it physically as well.

[0:05:33.2] AS: Yeah. Definitely, as I said, it's like the lovechild of Amazon Alexa and a Disney character. It's similarity lies in the fact that it is a voice-based assistant. You speak to it and then it responds, except as Alexa responds through voice, the query that you've asked. Peeqo, instead, responds through an appropriate GIF. Just as an example, if I was to ask him what the weather is in New York, instead of saying the weather in New York is light clouds with a chance of drizzle, he'll show me a GIF of a cloudy sky with some drizzle happening.

My entire thing behind this was it was more kind of like — I guess to some extent, it was a like a thought experiment to kind of see that the entire debate that currently exists around social robotics is that how do we make these robots kind of emote. How do we make them more approachable and relatable to us human beings?

I kind of thought that GIFs on one hand are kind of universal language of sorts, and especially a universal language across the internet, and they are able to communicate everything from

emotion, to expression, to information. It'd be kind of cool to see what the marriage of those two turns out to be.

How you would interact with him, as I said, is you ask him a command or you ask a query like you would to Alexa and he responds with a GIF which is then displayed on what essentially is his face. Kind of to describe what he looks like. He's a relatively small desktop robot. He's just over eight inches tall. He has a flexible kind of bendable body which allows him to twist and turn in different ways. It does actually a lot of movement. There's a lot of non-mobile communication that also happens to him. He can move, he can twist, he can turn, he can kind of bend which adds to the information and the emotion that he's trying to express.

He had kind of a notification LEDs on the top of his head, which is very similar to what Alexa has which lets you know that he's actually paying attention to you or what kind of state he currently is in, and that kind of supplements the GIFs that he's showing as well as the movement that he's doing.

[0:07:43.7] JM: You've added two modalities of interaction to the Amazon Alexa/Google Home model. One of those modalities is the visual GIF interface. It's a smartphone-sized screen that displays a pair of eyes. It looks like WALL-E almost and when you say something to Peeqo, he will fulfill your request but he's also display the GIF and he will have some physical movement.

I know you spent a lot of time working on the contortion that if you just imagine like a flexible cylinder that can almost bend a little bit. Those emotional characteristics add a real degree of — I don't want to say humanity. I saw a video where you said that humans have an innate desire to connect with robots, and I am in complete agreement with this. I'm probably — I agree with this to the degree that it goes beyond probably some opinions that I would feel comfortable expressing on the air.

You post an interesting question, which is why do we personify something like Peeqo, which is just a GIF interfaced that moves around a little bit. It's almost like a little animatronic thing, but we see an inanimate object. What is the answer to that question? Where is the dividing line between what feels inanimate and what feels alive?

[0:09:22.1] AS: Yeah, I know. I wouldn't say it's a fine line, but at the same time it comes kind of naturally. When I see people interact with Peeqo, they almost always refer to Peeqo as either a him or a her, but that's immediately like some sort of personification. You don't your iPhone a him or her. You refer to it, as I said, like as it.

I think that kind of comes with the combination of the things that I've put into him, it's like resemblance of personality. It's obviously not a real personality, but resemblance of it actually having a personality. Adding the face to it, and there have been studies that have been done on this that adding like a face with eyes, they kind of help people relate to him.

At the same time, I think a lot of the movement also gives this — It's not robotic movement. It's not like this — As you would imagine, this really cut and dry robotic movement. I spend a lot of time trying to figure out, as you said, this cylinder that could bend and twist in ways that would feel very organic, and it's kind of akin to what the human neck is. I think all of those together have kind of helped in creating this dividing line between it's still a device, but it's a device that people want to interact with, and it's a device that people at least feel and are delighted by. They feel that it has some sort of personality.

[0:10:46.4] JM: It's clear that from your thesis project, which is Peeqo, you were trying to accomplish a technical goal which is this incredible feat of constructing from the ground up basically an Amazon Alexa style thing in terms feature robustness and the hardware work you put into it, that 3D printing all of the different components that you had to order. Also, I think the higher level goal of this project was to provoke people's thoughts and to explore what is unexplored in this medium.

I feel like you're really provoking at the boundaries of what has been explored in terms of robotics and human computer interaction. What were the goals with the thesis? What were the questions that you were trying to answer?

[0:11:45.4] AS: Exactly. Like you said, I kind of put it as in addition to undertaking it as a technical challenge and undertaking it as a skill building challenge. I also wanted to create something that would delight people in a way through the interaction. That will get people thinking about what is currently being done and is this something that even if it's not a feasible

robot, is this something that, I guess, spark some creativity or spark some thoughts in people's minds on working on this. I've kind of seen that when people are working in social robotics, they're working on robotics, that they're trying to make similar to human beings.

They're either spending a lot of time, a lot of resources and trying to mimic facial expressions. It's like through expensive, complicated actuators. Maybe that's not necessary. Maybe you just need a common language to communicate with, and maybe that language is GIFs, because GIFs is something that all of us kind of relate to and it's across cultures, it's across languages, it's across all these things. Using that to create a common language between a device and a human being was something that was extremely interesting to me.

Some of the questions that I essentially wanted to answer was by adding this, are we able to personify, or are we able to add some sort of personality to devices that are becoming more and more part of our lives on a daily basis. I personally think it's almost a certainty. Maybe it's not in the next 10 years. Maybe it's not in the 15 years, but robots are going to move from where they are currently are present is mostly in manufacturing, and industry, and then start going to move into our homes.

Amazon Alexa too, or to some extent, also can be considered a robot of some sort which has moved into our home. As that kind of happens, we have to consider the interfaces that we're building for these robots so that they become engrained in our lives, but at the same time, interacting with them on a daily basis is something that causes some amount of fun and delight. That was the entire thing around it.

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[INTERVIEW CONTINUED]

[0:15:42.4] JM: There is a video on YouTube, it's a movie that Ray Kurzweil made or he started, and it's about the singular — You know who Ray Kurzweil is, right?

[0:15:52.4] AS: Yes. Of course.

[0:15:53.2] JM: Yeah. You know his Singularity thesis and his beliefs. He's got some extreme beliefs about human computer interaction, most of which I think I actually agree with, maybe not the timeline so much. One of the things that he said that has always stuck with me, he said in that movie, and you could find it. I think it's The Singularity is Near. I think that's the movie, it's like the movie version of that.

He talks about how robots are an artificial intelligence. It's not going to be this non-emotional entity. It's going to be an entity that displays a scope of emotion that is wider than any organism before it. With Peeqo, you start to see this, because you look at GIFs as a medium of interaction. The GIFs — GIPHY had this brilliant insight, which is that there are all these GIFs throughout the internet. It's almost been this compound interest function that's just been generating GIFs and GIFs and GIFs and then suddenly they realized, "Oh my goodness! There are these throve of GIFs. Why don't we just stand up a search engine in front of it?" and they built a billion dollar business by just searching through GIFs.

The consequence of that is we've suddenly got this media format, and we're starting to communicate with it. The fact that Peeqo can query that search engine in probably a more

sophisticated way than the average human can on the fly. If I say a query — In your example, I could — You can tell me if I'm wrong, but in the examples I saw of you talking to Peeqo responding with a GIF, it seemed like Peeqo was really good at understanding the semantics of the query and responding with a GIF, and it would be some really obscure GIF from Seinfeld, or The Simpsons or something, and it would just be like, "Yes! You are capturing the moment visually in a way that no human would be able to." You would say something to Peeqo and it would respond by fulfilling your command as well as displaying a clip from The Simpsons that totally silent, but is not something that I would be able to exemplify through my own body language. In some sense, this is the embodiment of what Kurzweil is talking about with the wider degree of emotional interaction that a robot can deliver, an artificial intelligence can deliver.

[0:18:34.5] AS: Yeah, exactly. Look at our own kind of messaging patterns, from text, moving to emojis, and from emojis, we're moving to GIFs, is just because they can communicate so much more in terms of expression and information in such a condensed package. It's difficult to communicate sometimes emotions via text. It's difficult to communicate emotions by words. Imagine if it's difficult for us to do that, it becomes even more difficult for us to program robots to be able to that. Using something as GIFs kind of gives them that ability. That ability still is not perfect at times. It's not always that Peeqo shows the perfect GIF. Sometimes it might not be the case. At the same time, because I have kind of built this bond with him and because I kind of feel, to some extent, that he's just not just a device, I'm very more forgiving of the mistakes that he makes.

At times, I even enjoy the mistakes he makes to kind of see what the result of this coming out of it, because something that I feel is if you have an interaction with a device, the interaction is always consistent. You do X and you expect Y and you always kind of expect Y. Similar with Alexa, you ask her something, she will respond with a same answer no matter how many times you kind of ask the question.

The thing is the same with Peeqo, you will ask the question and you'll expect the same answer, except the method of communicating that answer will be different. It will be either a different GIF. It might be a different movement. It might be something else, but that keeps the novelty alive

and that also keeps the fun and delight and the interactivity alive, which I also feel kind of separated.

[0:20:18.5] JM: Let's talk about the tech stack behind Peeqo. Describe the hardware that Peeqo is composed of.

[0:20:24.9] AS: Peeqo's brains are Raspberry Pi 3 and he has two Arduinos which — Raspberry Pi 3 is basically like, as I said, the brain and it controls everything. It has two Arduinos. The Arduinos are responsible for the actuation, so the movement as well as the LED notifications. The actuation is controlled by six servo motors which are in the base, which essentially form a stewart platform.

A stewart platform is something that is used or was used a lot in these flight simulator kind of seats that would allow six degrees of freedom. I created a really modified version of that and kind of stuck it into his body which allows him to move with six degrees of freedom. In addition to that, there are four mics, and these custom built microphones kind of placed around in an array which allow him to kind of listen even if you're speaking from behind him or from the side of him.

There's a camera right under his face, and that allows him to actually capture GIFs, so you can take time to capture a picture, but instead of a picture, because he's completely GIF-centric, he captures like a three-second GIF and then you can either share it or do whatever you kind of want with it. His flexible body is actually made — Most of the body is 3D printed and the center cylindrical section of his body which allows him to bend and move is made out of a flexible fabric.

[0:21:53.2] JM: What's the workflow for getting all of that hardware wired up properly and getting the 3D printing done, because I assume as you were — Software people have it easy. For software engineers who will pass judgment on engineering of other types, we have it easy, because you just click build and it makes a new build and it's fine. It garbage-collects the old one. That is not the case with hardware.

[0:22:22.3] AS: Yeah, I know. I wish it was much easier to iterate on hardware once you make a mistake or once you make a mistake with hardware and you've like printed that part of your leg, included that part, you kind of just stuck with it.

There's a significant portion of software. Not to be wrong. Without the software, the hardware is kind of useless, because the software is what brings the hardware to life, but the hardware and the software kind of go together. The hardware is going to set in stone once you do that. You can keep improving on the software, but then the software is limited by what hardware you've kind of set in.

The hardware is kind of — The build process was definitely complicated. I think that the toughest or the most difficult or challenging part of the entire process was kind of balancing the sourcing of the bots with the design that I wanted, because sometimes bots that I wanted and the size that I wanted were not available, so I had to keep adjusting my design based on what was available.

At the same time, kind of source these parts from different parts of the world. At the end of it, I think I got parts from, I think, 9 or 11 countries across the world. I think balancing that, figuring out the final design based on the bots that I had access to was the toughest thing, because it was like fine balancing, like this is the design I like and this is the design I can achieve based on the bots that I have

Eventually, I was really happy with the result. This was definitely the longest period, and I spent the most time ensuring that the design and the final form worked perfectly before actually printing it out, because 3D also — It's not that long a process. This entire 3D print took 72 hours to do, but it an expensive process, so I definitely didn't want to repeat that process just because I've forgot to put a screw somewhere or some parts didn't kind of fit. I'm happy to say that I printed it only once in the end, but it was only after ensuring completely in a CAD program that everything fit together. Everything was positioned exactly like it should be that I went ahead with the printing process.

This was including, ensuring that all the parts that I would source, even though I didn't have the sourced parts, I would create 3D models of them and place them into the CAD file to know that they would fit perfectly in the areas that were designated for them.

[0:24:40.0] JM: The 3D printing part is largely decoupled from the software and hardware engineering and it sounds like the CAD program is a pretty good bridge between those parts of the engineering. Can you describe how the CAD software integrates with the software and hardware design process?

[0:25:07.1] AS: For the CAD program, to be honest, I did not have any experience with the 3D CAD program prior to taking on this build. I kind of learned along the way. There's actually — If you see some of the documentation online, you can see the progression of my skills through the build process. I started with basically simple — Placing simple cubes to being able to create the fall factor. In terms of integration, like I said, it was a fine balance between figuring out the parts that I have access to and the form factor and the size that I wanted.

The process was like, say, I wanted to include the Raspberry PI and the two Arduinos and my custom printed circuit boards. I would create 3D replicas. I would create 3D CAD models or replicas of the exact dimensions of all these parts. Once I created the exterior, I would place the parts exactly in the positions that I expected to place them. I created 3D models of essentially everything, from the servos, to the servo arms, to the Raspberry PI, to the screen, and to my own custom circuit boards, to the LED ring. Basically, anything that went into the final model and that went into the final prototype was first 3D model and placed in a CAD environment to know that every millimeter was being used efficiently and that everything would be guaranteed to fit eventually.

Because a lot of the back and forth was on trying to reduce the size and trying to bring him down to a fall factor in which that if I kept him next to my laptop, he would look good next to it. I didn't want him to be too large. I didn't want to him to be kind of too small. It was just about shaving millimeters and I started off by shaving centimeters, then shaving millimeters, and then just continued shaving until essentially everything can only fit if I put it in a certain way, and that's about it.

[0:26:58.9] JM: The use case — When I first saw Peeqo, I was like, "Okay. This is some triviality," but the use case of having a little robot next to you as you're working in front of your laptop, or in front of your desktop computer. I put my phone down in front of my — Right next to my laptop, because the phone is a great feed of things that are going in my life. You see that lock screen and it's just got all your notifications. I assume you do something similar. You put your phone down right next to your computer and when you get a little calendar buzz, you don't have to context switch to another part of your workflow. You can just glance at your phone. This is something where Peeqo or something like Peeqo could actually be really useful.

[0:27:51.5] AS: Yeah, definitely. That why I'm kind of built-in or I'm building in a lot of these interactions, kind of like just a quick calendar notification or see whose email kind of notification kind of came in from. At the time that I was building him, there was a feedback from some people that instead of building him like the way that I built him to be essentially an independent moving computer, except housed in this robotic kind of form, I could perhaps just make him a like a holder for my phone and my phone into him and build an application just for my phone.

I felt that was kind of restrictive, because if I get a call, then I now I have to reach into him, pick my phone out and now kind of like speak on my phone, and that interaction just felt a little jarring to me. I wanted him to be a completely independent unit, which would supplement a lot of the thing that we use on the phone. Just like a quick glance, except provide the same notification. Provide that same information in a more fun and engaging way.

We have him kind of sitting there. I'm still doing my work. He's keeping track of also the work that I'm kind of doing. At the same time, I'm also building in the thing that he knows when to disturb me, or he knows when I should not be disturb, and that's something that perhaps a phone might find difficult to do.

[0:29:12.3] JM: What's the software stack?

[0:29:14.0] AS: The software stack, he's built completely using web technologies, but it's packaged using this application by GitHub which is called Electron, which allows you to use web technologies to build essentially native apps. Since he's running on a Raspberry PI, its Electron is then compiled to be like a native Linux application.

In addition to that, obviously, he's got the Arduinos. That's written in C, and there are some amount of Python also that is doing some specific things such as like finding out the length of a GIF so he knows how many times to display it. Those sort of things like you kind of need to take into consideration, like some GIFs are relatively short. Some GIFs are relatively long.

A short GIF is something that you're more likely to miss, so it needs to be repeated a couple of times more than, say, a long GIF, which is like seven or eight seconds long, which it's kind of fine. You don't want to see that twice.

Python is used a lot for like kind of scripting kind of those things, but most of the application is Electron, which is essentially HTML, JavaScript, Node, and CSS.

[0:30:20.9] JM: The command that you speak to Peeqo is outsourced to the Google Speech API. Can you give an explanation for the parsing and the response? Just give me end-to-end process of a command.

[0:30:41.7] AS: It isn't immediately streamed. There are a lot of privacy concerns when it comes to Amazon and when it comes to Google. Is it continuously streaming everything that you're seeing? Is it listening in on everything?

I purposely — I still need to use Google, but what I do is I instead wait for the keyword Peeqo to be heard using an offline keyword detection, and only after the word Peeqo is heard is like short stream sent off to Google. Which is basically kind of to some extent, ensuring that what is being streamed out to an external service is only being streamed out when the user has expressly wanted that to happen.

What happens is as soon as you say the word Peeqo, I'm using an offline keyword detection engine to listen for that specific word. As soon as that specific word is heard, you can say the rest of the command which is streamed out to a Google speech engine which returns basically a text transcription of the entire audio.

Based on the text transcription of the audio, I currently am tokenizing the input that comes in and passing out what I like to call like an intent from it. Just an example, if it contains stuff like, "Hello. How are you?" Then I kind of know that the intent is some sort of greeting.

Based on that, either query remotely for GIFs, which means I normally use GIPHY for my external queries. If that query is returned successfully, he will display the appropriate GIFs after finding out how long he should have displayed that GIF for.

If it's not the case, then he will show some sort of error message, which could also be in the form of kind of a GIF. When I said remotely for GIFs, it's actually like — I have two systems. He can either query for GIFs remotely, or he can query for GIFs locally, which are basically GIFs we just stored on the local file system. He can switch back and forth between those two depending on the internet connectivity.

Sometimes, going querying out a GIF from a remote system and getting it back can take a few seconds longer especially if your internet is not really good. In that case, it queries the local file system for being a little more responsive in his replies.

[0:32:49.3] JM: I want to talk more about Peeqo closer to the end of the show, but I wanted to discuss Svrround, which is a platform that you're working on to easily create and share 360 video streams. This is spelled Svrround for people who are curious and want to check it out. That's a really cool demo on your website.

Explain how Svrround works.

[0:33:12.3] AS: Okay. As I said, Svrround is a platform that we've built to create and share what we like to call like augmented live 360 video. 360 video just for people who are kind of curious, is video that you can look around in all directions. It's captured using a specific kind of 360-degree capable camera which is capturing — Which, in most cases, is like two fish eye lenses back to back and which are capturing an extended kind of 180-degree view, and then that's kind of stitched together.

We kind of created this platform that allows people to live stream quickly, so you can kind of think of it — You can kind of think of it like a Periscope 360, except that it's not just about streaming it live, but it's also about augmenting what you're streaming live. We've build an extremely simple kind of like — Simple to use web toolkit which allows people to augment the stream in real time as they're streaming it out, so you can layer the stream with — Because the thing with 360 video is that it gives you much more real estate as compared to 2D video.

The other thing that it does is that it puts the viewer in control as compared to what we normally use in which this person who's streaming on the editor is in control of what you kind of see. The fact that it gives you access to so much more real estate, is that you can utilize that real estate in creative ways depending on what you're kind of streaming out.

We give people like the toolset to be able to augment and utilize that 360 space. Just as an example, you can embed rich text into the entire scene. Another example, if you are, say, create a virtual newsroom of sorts, you could essentially embed virtual screens in the entire 360 studio that you're streaming out of. Some of the streams could be showing infographics, some of the screens could be showing other live streams coming out from the field. Some of the streams could just be showing images which have been sent in by users, and all of these is also then supplemented with, say, like a live chat of people who are then viewing what is happening. They can interact directly with the streamer and get response practically in real time.

The uses cases for this is kind of plenty. It's just a completely a new medium and people are kind of still figuring out what they can do with it and how they can kind of utilize it. We want to make the creation and distribution of this kind of content which is interactive, immersive, as easy for people as possible.

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[0:35:49.4] JM: For more than 30 years, DNS has been one of the fundamental protocols of the internet. Yet, despite its accepted importance, it has never quite gotten the due that it deserves. Today's dynamic applications, hybrid clouds and volatile internet, demand that you rethink the strategic value and importance of your DNS choices.

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[INTERVIEW CONTINUED]

[0:37:50.1] JM: Are you pursuing Svrround as a full-time endeavor at the same time that you pursue Peeqo?

[0:37:57.4] AS: Yes.

[0:37:58.4] JM: I admire that, and I want to talk about that stuff, because — This is something I do, basically. Software Engineering Daily is a fulltime job, sort of, or it's a project that takes up a ton of time, but I also have a company that I work on, called Adforprize, and there are four people working me on that, and I'm doing both of these things.

If you read most of the startup literature or productivity literature people say you should focus on one thing. Do one thing really, really well.

[0:38:35.9] AS: I've heard that a lot, yes.

[0:38:37.7] JM: I think for many people, that does make sense. If you feel like you can get your footing in life, yes, focus on one thing. When you start to feel pretty productive, when you feel

like you get the ball rolling and you want to start a different project, if you are somebody who's really dedicated to technology and you're plugged in to technology, there has been a change recently, and that change is that our technology is getting so high leveraged.

You look at Amazon, Instacart, Slack, these things subtract the amount of time that you have to allocate to annoying everyday tasks and they free up your time. You can outsource really annoying stuff. Uber is another thing, can outsource driving. With that freed up time, you can do more.

[0:39:27.8] AS: Exactly. I also feel like it works different for different people. For some people, as you said, it kind of works to put your head down and focus in one thing. For me, personally, like I've always kind of been interested in a ton of thing, been fascinated, but I don't think always wanting to experiment with a bunch of things.

Also, for me, I feel like some of my best projects or best work kind of come out at the intersection of seemingly disparate things, which I don't know if they'll ever work together, but at some point of time they kind of do. Even just to go back a bit, Peeqo is like — Peeqo kind of existed at the intersection of completely unrelated things. At least when you look at it, it would be completely unrelated things. It's like, "Oh! I really like GIFs. I really like building things by hand, and I really like animated movies." Peeqo kind of sat at the intersection of these three little things.

If you're to draw that Venn diagram, like that tiny little intersection where those three circles intersect is where kind of Peeqo existed. For me, I personally always like taking on new challenges and taking on different projects, because I feel at some point of time, all that is going to come in to one project, and that project is something that I would like a lot.

[0:40:47.1] JM: Or maybe it's just a company. Maybe it could be conglomerate —

[0:40:50.3] AS: Exactly.

[0:40:51.2] JM: There are obvious synergies that could occur between Peeqo and Svrround.

Abhisheck, the thing that comes to mind is the technology companies that have been developing over the past decade, two decades, they rely on a steady influx of talented technologists who will come and work at the technology company on something super boring. People like you and I, there is nothing special about either of us.

I'm sure that you feel like you just got your knowledge from reading stuff on the internet and tinkering and executing. There is no genetic specialty to what you or I do. It makes me wonder — Also, the number of opportunities that I think of on a daily basis where I'm like, "God, I wish I had time to pursue this." I'm sure you have the same feeling. There's no shortage of opportunities. There's no shortage of opportunities.

My question is; how the heck are these companies, these giant corporations going to keep being able to recruit people when you can just go off and tinker on your own and have something like Peeqo, or Svrround and that becomes the thing that you are completely in charge of?

[0:42:09.1] JM: Yeah, that's definitely the thing — I don't know how this company — This company is going to obviously attract a lot of talent, because I guess, to some extent, I wouldn't say all the projects that they're working on are boring and I don't think everybody who goes in there doesn't get some kind of ownership over what they're kind of building.

The same time, you have to kind of pay the bills. It's not — In an ideal world, it would be great if everybody can just kind of work on the things that they're passionate about and on a living from it, but I don't think that's always the case.

At the same time, I think for some people, working in one of these companies does kind of expose you to a network of people. Well, a really good network of people, in one network of kind of smart people. Also, just — You can do it two ways; you can either spend two years tinkering around figuring out stuff for yourself and learning there, or as most people do, is you kind of learn on the job. Again, I think it's like different strokes for different people, basically.

[0:43:13.2] JM: I completely agree, and I didn't mean as a statement to denigrate anybody that goes work at these places.

[0:43:17.4] AS: Yeah, not at all. Not all.

[0:43:18.9] JM: I think more in terms of the big companies that I've seen, they have so much stuff that needs to be maintained just to keep the lights on. The deal of going to work at one of these companies and do maintenance work is just getting worse and worse and worse relative to what you can do on your own for just exploring. Anyway, I don't know. It'll be interesting to watch.

[0:43:45.9] AS: Yeah, it'll be interesting to see. I guess it just depends completely on the kind of person you are. There are some people who I think work at these companies and at the same time are spending a lot of time on their own projects on the side.

There are some people who are kind of happy working for these companies and making an impact through that. I guess for some people like us, it's completely different.

[0:44:06.4] JM: Sure. You look at Yahoo though. Yahoo, I think of, is the earliest example of a company that became a technology of utility, like Yahoo Mail. Then, as the brain drain started to happen, "Uh-oh, massive security breaches." "Uh-oh, very simple mistakes that people made." I really hope that this doesn't happen to the other big companies that have become so much more fundamental to our everyday life.

[0:44:35.8] AS: I know. I know. It kind of feels like the world is just made up of a couple of monopolies at this point of time. Yeah, it's kind of true. I guess a lot of that also depends on, I think, one is if they continue innovating at a pace. I feel if they stop innovating at any point of time, that's kind of a deathblow to them. Also, the culture they continue to maintain.

I feel that maybe Yahoo got complacent. They had 80% of browser home pages was Yahoo at one point of time. To imagine at that point of time, to fall from that, it's difficult to imagine. Who would have thought that would kind of happen? Complacency, lack of innovation, and I think a change in culture, and that that's kind of a deathblow.

[0:45:19.8] JM: What are your predictions for how VR and AR will make their way into the mainstream?

[0:45:26.3] AS: VR and AR. Mainstream — It's kind of everybody's kind of predicting the same, right? Is that VRs main adoption, early adoption, which is we also kind of see is going to be in gaming. AR is going to be bigger. It'll take VR longer to kind of find its footing, which I do agree to some extent with, is that it is still a relatively new market. Even though we are trying, people — We, and people in general, haven't really fond that perfect kind of use case. It's like that one thing which everybody is like, "Oh! Because of this, I need to go out and pick up or buy a VR headset for myself." It's that one kind of big use case that comes out that makes people just do that.

At this time, people who even have VR headsets, there might be a lot of facts and figures about the number of VR headset that are in the market. The ultimate thing is that repeat use is not there. I might have a VR headset, but putting on and using it regularly on a daily basis like I use my phone or as I use my laptop, it just isn't there yet. We have to kind of help people build the content, which kind of influences people to that. That's why we are kind of building a toolset which allows people to easily and quickly create content experiment and see what works and what kind of doesn't. Yeah, till we get people to use it a lot, it's difficult to day.

[0:46:59.6] JM: When I go to the Svrround homepage and I mess around with just the demo that you have and also when I have — The couple of times where I've tried VR, it is so engaging. It is almost scary to me how engaging and how fun and eye-opening it is. It's like a drug.

[0:47:20.8] AS: Yeah. I've spoken to a few people and they've said exactly this, is that it's like the first time you put on a VR headset or the first time you kind of see something like it, it's like a completely wow moment. It's something you haven't seen in a really long time, or you've never seen in your life. It completely blows you over.

[0:47:40.8] JM: I would describe it as an almost religious experience.

[0:47:43.5] AS: Exactly. The thing is like when you back next and you've shown the same experience, it's not blowing away anymore. Now, you want to see something more, and that's where the problem of content comes in, is that until there's good content, which people are willing putting on the headset repeatedly on a daily basis, that's where I personally feel the industry is kind of lacking.

[0:48:07.0] JM: Of course, content is a feasible problem to solve.

[0:48:09.3] AS: Yeah, content is king. Exactly.

[0:48:13.5] JM: Obviously, because content isn't an easy problem to solve. Utility is a bit harder, but I think you'll agree with me that the utility of VR will emerge eventually.

[0:48:23.7] AS: Yeah, definitely.

[0:48:24.5] JM: Perhaps after — I feel like there's still some maybe rendering issues that VR has to overcome, or maybe we need web assembly to get these things smoothed out. What about AR?

[0:48:38.9] AS: I don't think technology is going to be the limiting factor. Technology is something that can be overcome, like the amount of billions of dollars of money and resource that are being put in by the largest companies in the world. I don't think that is going to be a factor. It's ultimately what the consumer kind of likes. If you can create something that delights the consumer and if you can create something that continuously brings them back, then that's what they're going to do.

[0:49:07.6] JM: Abhisheck, I can tell you think a lot about here we're going and where these technologies asymptote towards. The questions I have been asking myself a lot recently are what are the fundamental cultural practices that are going to change when we get things like artificial general intelligence that seems human-like or beyond human, robots that are implementing that artificial intelligence, fully immersive VR along with utilities to make that VR practical augmented reality.

The number of trends that are impacting us day-to-day; speech recognition, speech mimicking, video mimicking, video recognition. It is too much to handle for our current cultural. Our culture is going to shift. Our society is going to shift. It's going to affect — It's going to shake the perception we have around relationships, around marriage even, around employment, around our sense of what is reality, our sense of religion. There are so many things that are on the precipice of change. What are —

[0:50:29.6] AS: Exactly. I think —

[0:50:31.2] JM: What are the most salient examples of that? What are the things that keep you awake at night or keep you excited all the time?

[0:50:36.8] AS: I think the things that keep me excited — Exactly this. I feel like all these technologies, like I mentioned, if you take AR, VR, particularly artificial intelligence, machine learning. They are relatively old technologies. It's just that I think now we are at the tipping point, because a number of factors are working in their favor. For AI, we finally have computers that are fast enough to do things and we have enough data to kind of do things with.

For VR, also, we're finally seeing a lot of these issues that used to exist with all your VR headsets now being tackled. We definitely — As I said, we're on the tipping point. I personally feel that over the next 5 or 10 years, everything is going to change completely.

The biggest change for me personally, I think, is going to come through artificial intelligence and the things that we can't even imagine is going to do it, it's going to be able to do. VR and AI, yes. Definitely, it's going to change completely like the way we work, the way we kind of engage. Even something as — Or something like maintaining long distance relationships or being able to teleport ourselves into locations that we'd never thought previously like imaginable. Maybe, it completely changes the way we travel or experience things, or go to concerts, or go to exporting events.

Even in terms of AI, maybe it's not robots in the next 5 or 10 years entering our homes. With just, I think, the proliferation of AI in all the products that we use, will completely lead to a new form of interaction, a new form of interaction which maybe we don't even need to click button

anymore to ask for something. Maybe we just are shown the information that we need at that specific point of time.

It's difficult to comprehend and it's difficult to even envision what would be possible. All I can say, for sure, is that what are seeing today and what we'll see 5 or 10 years from now will be — It's like seeing an iPhone compared to a flip phone from 10 years ago. That's what I feel would be the change, and not only in the Internet but in all of these technologies.

[0:52:45.1] JM: Right. When I think about how this changes my everyday behavior, I think about things like getting a mortgage, or investing in retirement, or marriage. These sorts of long-term commitments that are based on a world that will no longer exist in 5 or 10 years, and it makes me wonder; what are the fundaments of society that we should even be keeping track of today? Should we just keep operating? We should be getting — Yeah, I'll get a mortgage. Yeah, I'll plan for retirement when robots are just going to be taking care of me anyway just because it's socially acceptable. Yeah, I'll get married just because it's socially acceptable even though perhaps a robot mate will be more appealing in 5 or 10 years.

These are realities that we're going to have to deal with, and it's like you can't even — It's almost taboo to talk about taking these things to the extreme philosophically or anticipatorily, but we're going to get there. It's crazy.

[0:53:55.9] AS: Yeah, it' super exciting. At the same time, there's a completely — And a valid point of view, is that it's going to completely change the entire job market. They'll completely change the entire employment market. It's going to make jobs that are currently necessarily, completely redundant. Yeah, it's going to affect employment like something we probably never seen before. At the same time, I feel that, okay, if it's going to affect employment in that way, it's going to not only create new jobs which will emerge out of this entire thing, but it'll also free our people — Like you said, like Uber, Instacart, Amazon, they're freeing you up from mundane repetitive tasks. It's going to free our people from all these tasks that they're now free to completely devote the energies and creative pursuits towards their passions.

If it's going to have a — It's going to be a really bumpy, rocky ride and it's going to change things in ways like none of us can even imagine right now. I don't know, maybe it happens in

five years, maybe it happens in 10 years, but I'm pretty sure it's going to happen. I don't know. I'm super excited to see what happens, and I'm supper excited to continue building these fields which I feel are going to definitely kind of have this kind of impact.

[0:55:16.3] JM: Yeah. Okay. I know we're nearing the end of our time. Have you started delegating anything? I know you've been a lone hacker on your earlier projects. One thing I have found — Software Engineering Daily, I started it just by myself, but same thing with Adforprize, the other product I work on. As I have brought on other people to work with, it has become so much more enjoyable. It's become so much easier. There are so many things I'm bad at that other people are better it.

Have you started to bring on other people or delegate?

[0:55:50.9] AS: Svrround is actually a four person team and this span of time. It was three of us who cofounded it and there's another person who's working with us fulltime. Luckily it's not a single person team. I definitely agree that you can't do everything yourself, and it's much better to let people who are experienced in something and also much more enjoyable to work in that fashion.

Peeqo, as of now — Till now, has been a completely single person project, but at the same time I have kind of open sourced everything, open sourced the hardware design, the software, all that kind of stuff. People have started contributing. People have been getting in touch. People have been trying to build their own version of Peeqo across the world.

I'm hoping that's how contribution starts coming in and additions in terms of features and skillsets start happening where people are creating something that they need and putting it into Peeqo and then sharing it with the community.

[0:56:47.1] JM: Right. We didn't even get into the Peeqo module. We didn't even get into the discussion of whether Peeqo is going to be the open source Amazon Alexa or Google Home. Certainly, it seems like —

[0:56:57.6] AS: I hope so.

[0:56:58.4] JM: It certainly seems like it has a reasonable chance of becoming one of those things. Anyway — All right. We're out of time. Abhisheck, really interesting stuff. I feel we're pretty likeminded on a lot of stuff. If you ever have any interest in coming back on, if you have any other — I'm sure you'll have a new project in another month or so, so feel free to come back on. I'd love to have another conversation with you.

[0:57:19.3] AS: I will definitely do that. Thanks so much. This is really fun.

[0:57:21.7] JM: Great. Okay. Agreed.

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[0:57:25.4] JM: Deep learning is at the forefront of evolving computing and promises to dramatically improve how our world works. In order to get us to that bright future, we need new kinds of hardware and new interfaces between this AI hardware and the higher level software. That's why Intel acquired Nervana Systems, a platform for deep learning.

Intel Nervana is hiring engineers to help develop this full stack for AI, from chip design to software frameworks. Go to softwareengineeringdaily.com/intel to apply for a job at Intel Nervana. If you don't know much about Intel Nervana, you can check out the interviews that I've conducted with engineers from Intel Nervana, and those are available at softwareengineering.com/intel as well.

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[END]