Women at Warp Episode 162: The Viability of Trek Tech

Female Speaker: You're listening to a Roddenberry podcast.

[Women at Warp theme]

Sue: Hi, and welcome to Women at Warp, a Roddenberry *Star Trek* Podcast. Join us on our continuing mission to explore intersectional diversity in infinite combinations. My name is Sue, and thanks for tuning in. We've got a problem with the warp core or the phase inducers or some other damn thing. But to help me fix it here today, I have crew members, Aliza.

Aliza: Hello.

Sue: And Sarah.

Sarah: Hello.

Sue: And our special guest, Dr. Erin MacDonald.

Erin: Yay. Hello.

Sue: Hi, Erin. I'm so glad to finally have you on the show.

Erin: I'm so excited to be here. It's a big deal for me. [laughter]

Aliza: It's a big deal for all of us.

Erin: Yay.

Sue: Right up front, I want to power through a little bit of housekeeping. Our show is made possible by our patrons on Patreon. We've revamped our patron tiers for the new year, bringing you some new rewards, exclusive Women at Warp merch. Our first merch item was just sent out to everybody and we love it so much. If you've ever thought about checking out our Patreon, now is the perfect time. We really appreciate the support. Find us *@patreon.com/womenatwarp.*

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So, today we are going to be talking about the viability of Trek Tech, and we have Erin here to help us do that. Erin, I think a lot of our audience is probably familiar with you, but would you introduce yourself a little bit, talk about what you do and your history and, I guess, present with *Star Trek*?

Erin: Yes. So, thank you again for having me. My name is Erin MacDonald and my background is in astrophysics. I did my PhD and postdoc research in general relativity and gravitational waves. And then, I left that to go into-- I did teaching and engineering for a while and a lot of science communication. And currently, I live in Los Angeles and I'm working as the science consultant for the entire *Star Trek Universe*. So however much your little shows want to use me, I am available to them and it is a dream job.

Sarah: Can I ask how that works? Do they just call you and ask, “Erin, would this work?” How do you science advise *Star Trek*?

Erin: It's a lot of all of the above. It starts out kind of a little bit more of a distant relationship until they start to get to know me and kind of trust my input. So, I'll get just generic scripts thrown my way as they go through the production cycle. But then, as the showrunners get to know me and if they like what I can bring to them, then it does start to become a, “Oh, hey, let's hop on the phone. I've got a quick question,” or a text message of, “We're recording AVR and we're in trouble. Please solve this for us in 30 seconds.” [laughter]

Aliza: Nice.

Sarah: That sounds so cool. But it sounds like you also have to keep a lot of spoilers secret.

Erin: Oh, my God. I have very stress dreams. That's all I can sum it up as. [laughter] Lots of stress dreams, it's fine. [laughter] Once they announced that Janeway would be in *Prodigy*, all the CBS people were like, “And now, we know that Erin can keep a secret. If she could sit on that, she can sit on anything.” [laughter]

Sue: Well, speaking of spoilers, I guess we should mention that we're probably going to be talking about some tech through season 3 of *Discovery*, just in case. I don't think it'll have much plot effect, but just in case. So, this was a patron-suggested topic from our patron, Ty, who wrote, “I'd love an episode focused on the plausibility of some of the science and technology. And really, how many times can recalibrating the whatever be considered effective?” Fair point. When going through all of this, at first, I was, “Oh, yeah, we'll talk about warp drive and holodecks and transporters,” but as I started making the list of *Trek* tech, it got longer and longer, and I wound up organizing it sort of by how close we are to it.

So, there's some *Trek* tech that we have already surpassed, there's some that we're kind of close to, and there's some that seems a far-off dream. So, I think that's how best to move through this and want to start with the stuff that seemed so futuristic at a time, but we've kind of passed it by already. Does anybody have a favorite on this list?

Erin: I have two. First of all, the pad, the tablets, I love the fact that you cannot argue with me that the original Kindle was not 100% designed as a *TNG* tablet. It is the exact same size, [laughter] exact same layout. It's just that's what it is.

Sue: And can hold so much more.

Erin: It's so true. And then, just the other one to throw out there. I love, love the transparent aluminum thing because part of my brain feels it is almost a time travel meta event. Like, would we have pushed ourselves to invent transparent aluminum if it weren't for the one with the whales? [laughs] How much did that actually influence the materials engineering? So, in a way, Scotty did implant the idea of transparent aluminum and I love that.

Sue: It blows my mind that we actually have it.

Sarah: Yeah.

Erin: It’s true.

Sue: For anyone who wasn't aware it's real. It's called aluminum oxynitride and it is four times harder than glass, used in bulletproof windows and armor, and can withstand temperatures up to 2100 ° C. So, it really is what *Star Trek* predicted it to be.

Sarah: In a lot of ways. I'm proud of us that we have developed beyond flip phones the *TOS* one. I mean, go us.

Sue: I'm still mad that nobody made a flip phone case that looked a *TOS* communicator. Come on, people.

Aliza: Total missed opportunity.

Sue: [laughs].

Aliza: Although we do have now iPad cases that look pads, so that's cool. And they're also easier and cheaper to just 3D print an iPad case to make it look like a pad.

Erin: That's true.

Aliza: I have a lot of favorites throughout this list we're going to talk about. But I guess in the already surpassed category, [sighs] man, I want to say my favorites are video conferencing. I think that's a big one and it's one that we totally take for granted now. But it was not a thing. It was such a special, unique form of tech that was just ingrained in the world of *Star Trek* from the beginning that it seemed so futuristic and now it's literally how we live our daily lives and how we see each other, especially during this pandemic. So, that's pretty amazing.

Erin: Yeah. And it seems so natural to just call someone on videochat now. I think FaceTime is so much like that, where it's like, “Oh, I'm getting a buzz and pop on the screen, okay.” That's what they promised.

Aliza: Yeah. Amazing.

Sue: I'm really blown away by Bluetooth and not only Uhura's earpiece, but I have a *Next Gen* communicator that is Bluetooth. I can answer a phone call by hitting my com badge and talking at it.

Aliza: That's so cool.

Sue: It blows my mind. That's one of those things where we had the technology and just made it *Star Trek*.

Erin: Totally.

Aliza: That's so cool.

Sue: It's very cool.

Aliza: Wait, so does it-- When you press the communicator, does it put your phone on speaker or does it actually route the call through the communicator or the badge?

Sue: The speaker is in the badge.

Aliza: What?

Sue: So, it’s like an earpiece, but you just wear it instead of have it in your ear.

Aliza: That is really cool. I didn't know that existed.

Sue: Yeah. And it rings with the communicator sound. It's bananas.

Aliza: [laughs] That is so cool.

Sue: And it's totally unnecessary, but I love it so much. [laughs]

Sarah: I love it too. I'm happy that you have one.

Sue: So, there are a few more things on this list. Another one I really love is that *Star Trek* sort of foretold our switch to touchscreen.

Erin: Ah, yeah, that's true.

Sue: Yeah. Because by *Next Gen*, everything was touchscreen. All those gumdrop buttons were gone.

Aliza: Mm-hmm, so true.

Sue: And I also put automatic doors on this list. And at first, my brain was going, “Well, it's not really the same because, the ones in stores just open based on sensing that there's weight on them.” But then, I started thinking about my last trip to Disney World and the MagicBand and the RFID chip that they put in your MagicBand and, rides take pictures of you and because of your RFID chip, they just show up in your account. You wave your MagicBand in front of your door and it unlocks for you because of the RFID chip and your MagicBand.

Erin: Yeah.

Sue: And that really is *Star Trek* technology. The door opens for me because it knows who I am.

Aliza: Yeah. And they built into Galaxy's Edge, the fact that as you walk through it, you get certain story elements and voices and things as you walk through because of your band. So, yeah, you're right. It's not just automatic doors. That's several steps above just automatically sensing your presence. [laughter]

Sue: Of course, in *Star Trek* and even, I guess, you could say in Disney parks, we are held to the belief that this is benevolent. That nobody's going to use this for ill. But of course, this kind of tracking-- well, Disney is questionable. But of course, this kind of tracking scares a lot of people. So, there is that to consider that when you've got technology and information that knows where you are and what you're doing and everything about you all the time, it's a little scary.

Erin: Yeah.

Aliza: And you know what's interesting too is that *Star Trek*-- I mean, yes, we had the cautionary tales and the episodes where the ship takes over and it's going to kill us all because it's scared or it wants to protect us, so it’ll like kill all humans, we have those things that tapped into the fear of technology and AI in particular. But for the most part, you're right. It was presented in a way that was not only benevolent, but also kind of organic to us, and it complemented us. It was supportive of human life and productivity. So, I think that's interesting too that *Star Trek*, for the most part, set us up for a future to not be as afraid of these types of technological supports, extensions of our humanity.

Erin: Well, and I actually saw a really funny cartoon that was along those lines where it was saying in the 1950s, like, “Oh, be careful about the phone. You don't want to be wiretapped.” And then nowadays, it's, “Hey, wiretap, what's a good recipe for spaghetti sauce?” [laughter]

Aliza: Oh, my God. That's so accurate.

Sue: It's true.

Aliza: Hey, thing that's always listening to me. [laughs]

Sarah: Oh, my God.

Sue: I'll admit, I'm a little paranoid, and that's why I don't have one.

Aliza: Mm-hmm.

Sue: How many Trekkies have renamed their Alexa or Google Home Computer?

Erin: I have.

Sue: Like 99%, 100%?

Sarah: I talk to the computer every day. [laughter]

Erin: We set up a red alert function, turns all of our lights red. [laughter]

Aliza: Oh, my God. Okay, now y' all are giving me ideas. I'm like, “How do I do this in my home?”

Sarah: You know weirdly enough for me, I moved into a new place, there were no lights in my bedroom ceiling. The one plug that's connected to the switch was in not a convenient place. So actually, setting up voice commands was the most practical way to turn on the lights in that room. And then just once you do that, you have to call it Computer. So, *Star Trek* ended up just being the most practical solution for me.

Sue: Absolutely. As usual. [laughter]

Erin: So great.

Sue: I think the one other thing I have on this first list is-- I mean, we could argue whether it actually belongs on the surpassed list, but that is wearable smart glasses. And I'm thinking specifically of the medical ones that are worn during surgery in some early episodes of *TNG*. We have Google Glass, but it never really took off.

Aliza: Mm-hmm. Yeah.

Sue: So, maybe, maybe not. We'll give it another try sometime.

Aliza: I think it still counts as we have surpassed because the technology was out there. Just because it didn't gain popularity or marketability, it still exists and it was made and it was created. So, I think that still counts as have surpassed.

Sue: All right, well, let's get into some meatier stuff and some stuff that we might be kind of close to. The first thing I have on my list, because I'm obsessed with them, is the MRI being close to a medical tricorder. And the MRI was actually, according to everything I found, invented by a *Star Trek* fan because of *Star Trek: The Original Series*. MRI stands for magnetic resonance imaging. And the scanner visualizes the internal workings of your body by aligning the electrons a certain way, is the way I understand it. And it can diagnose brain, cardiovascular, oncological and musculoskeletal ailments.

Aliza: Pretty cool.

Erin: That's awesome.

Aliza: Yeah. I didn't know it was invented by Trekkie.

Erin: I didn't know that either. That's really neat. And then, they had the Qualcomm Prize, which was only a few years ago, that put out this contest for, I think it was a million dollars or something, for people to invent a tricorder that they had to diagnose 13 medical conditions and monitor five vital signs and be consumer friendly, I think was the criteria. And it got awarded. The technology is there. It's just not available from a cost-benefit perspective yet but.

Sue: And certainly not the size of a handheld device at this point.

Erin: Right.

Sarah: But I mean, these days, because of the pandemic, if you go to the doctor's office or something, they do point a handheld device at your head and take your temperature.

Aliza: Yeah, yeah, we're there in some ways. We can do some simple functions with a handheld device, but we still have a big bridge to cross to getting all the functionality into a small handheld device.

Sue: We did have a question from a patron, Ashira, who asked, “How would a medical tricorder work, one I assume typically that we would see on screen in *Star Trek*? Do we have any idea how that might work in real life if we could get it to?”

Erin: It would basically have to be a targeted radiation thing of some sort like an x-ray or an MRI or something that you're able to, from a handheld device have a high beam of radiation that penetrates the body and it reflects off the information that you want to know from it, which is-- That's how the-- you mentioned the touchless thermometers work. That's basically measuring infrared radiation that your body is emitting itself. And then, this would just be, you're hitting it with x-rays or magnetic fields or whatever, that then give you information on that. And so, it's all about sort of how these sensors work, whether it's emission or reflection, you have to be able to get enough data from that to get information.

Sue: Well, does anybody have another one they want to pull out and talk about?

Aliza: I'm really excited about holodecks becoming real, specifically because I do so much TTRPG, playing and running of games. Yeah, I want to LARP in a holodeck. Like, I want to run a TTRPG in VR. Like, “yeah, let's get that going.”

Erin: I've got an Oculus Quest, which is the wireless one that's fully internal in the headset. And that, for me, was where I felt like I'd crossed over because I was traveling so much when those first came out that I was like, “You mean, like, I can carry it in my backpack?” And then those long, lonely nights in these desperate hotels, Hilton walls, I can just put on my VR headset and suddenly be in a cabin watching Netflix, like, yes, please.

But there's a beautiful metaness to it as well, because one of my favorite things to play in the VR is the *Star Trek: Bridge Crew*, where you literally just sit at a station and play through scenarios on a *Star Trek* bridge. And it's like taking the complete opposite of what the *Star Trek: Bridge Crew* use the holodeck for. And I'm like, “No, I want to pretend I'm fighting the Borg.” [laughter]

Aliza: Right.

Sarah: I was going to ask if anyone did that Star Wars VR in Vegas?

Erin: Yes. Yeah, they had it in LA as well. I did it at-- They had a downtown Disney one where you-- You're talking about the one where you actually walk through with the backpack on?

Sarah: Yeah, that's the closest to holodeck we have, where you're actually moving around in a space.

Erin: That blew my mind that. You're absolutely right. I completely forgot about that. That is 100% the holodeck. [laughter]

Aliza: And so just to clarify, this is-- So, you're not wearing a headset, you're actually in a room that is projecting holographic image?

Erin: What they do is they basically rig you up. It feels like you're about to go into a laser tag arena, and you put a vest on, and it's got a backpack on it, and then it does have a full VR headset. But you're able to walk around it, and you're with a group of people. And then, they essentially are like-- At least I did the *Star Wars* one, they're like, “Okay, put the headset on, and then look at your hands and look at the people around you. And if you're all Stormtroopers, give me a thumbs-up.”

And you do that, and you give the thumbs-up, and the trippiest moment for me was like, when you get into it, and they're like, “Okay, we're at our destination. Open the blast door and grab your rifles,” and you physically reach out, and there's actually a door handle. And then you actually pick up a blaster rifle. And I'm sure you're walking around the space that's like maybe 30 square feet. It's not that big, you're probably just walking in a circle, but it's playing a video as if you're going from room to room to room. And it projects heat, and it makes you feel it-- And it vibrates, like, your chest vibrates if you get hit with stuff. My partner got so stressed out when we were fighting Darth Vader, and Darth Vader reached out and collapsed our rifles, so they bent, and you couldn't use them anymore. And then, he started coming at us, and he literally flipped the blaster and was ready to baseball bat Darth Vader. [laughter] But it was-- I'm so glad you remember that, because that was absolutely like the holodeck.

Aliza: Was the headset comfortable or-- Because here's the thing, I've tried the Oculus or one version of the Oculus, and I don't know, I have migraines, and I have a lot of head issues, headache issues. And I just didn't feel really physically comfortable doing it, and I started getting a headache, and my eyes felt strained. So, I think, I don't know, for me, the next step in getting closer to a holodeck would be something that doesn't need a headset or at least maybe it's a very slender, comfortable, light thing so that a lot of people can use it and physically feel comfortable in it.

Sarah: Some of our listeners might have done the *Star Trek* ride that they had at the last Star Trek Las Vegas, which you can find in Dave and Buster's around the country. I found it in Portland. And you don't walk around, and you just wear a headset, and you sit in the ride and the ride moves, and it's like you're flying through space and you shoot a gun. You're wearing the headset. That was a lot of fun. And you can like turn around and even look behind you.

Aliza: Mm-hmm. That reminds me-- You couldn't look behind you really, but that reminds me of-- I grew up in Jersey and at Six Flags Great Adventure, that was our local Six Flags Great

Adventure. We had the *Mission: Impossible* ride. And it was like giant video screen that you're fairly close to or it feels like you're close to it and then you're in seats that move. That was like my favorite ride. It was the simplest thing. [laughter]

Sue: The old school motion simulator.

Aliza: Yes, exactly. It was like there was no-- It wasn't 4D. You weren't in the room. It was just a screen. But I ate that up. [laughter]

Sue: It was the 1990s holodeck.

Aliza: 13-year-old Aliza was for that. I was super into that. [laughter]

Sue: The other thing I was thinking about with the holodecks is what-- I feel like news channels, and I guess some award shows have tried to do and have holographic performances and like reconstruct a person and have them perform and it's just light?

Aliza: Yeah. Remember when Coachella did that with Tupac? For me, that was the first time I remember hearing about that done publicly and it was controversial because he did. It's a little disturbing. And I guess the next step of it would be something like with Data having that little device where he pressed the button and Tasha Yar's message, I would be down for that. If we started having little holographic messages we could send each other. That would be so cool.

Sue: On this list, I've also got our universal translator. I feel like that's something that is being worked on by a lot of companies. But I did find out that Microsoft Translator currently supports 65 languages as of January 2020, which is kind of neat. We've got the hypospray. Believe it or not, this one surprised me. There is something that we have called a jet injector that was created at MIT around 2012 and they've been working on improvements, but it is not widespread. But it is essentially an air pressure hydraulic, by my understanding, way to give a vaccine, interesting. Artificial hearts are real things. Voice interface computers, as we talked about, are real things.

So, here are the two where it's the biggest kind of deflector shields. And I know we have some magnetic shielding for some of our extraplanetary missions that have gone out, but it's not quite Enterprise level.

Erin: Basically, the idea is that you want to deflect mostly radiation for us. Right now, the biggest threat that we have in space exploration isn't the Borg, thankfully, [laughs] but it is radiation from the sun. We're protected here on Earth from solar wind and high-energy solar radiation because of our atmosphere. And the reason our atmosphere is protected from all of that is because of Earth's magnetic field. The fact that we have a molten core and that we have compasses that point north, that magnetic field really does act like a deflector shield. And when the solar wind hits our planet, it gets deflected around it.

And now, some of those particles do get trapped in the magnetic field and then they go and hit the poles, they hit the atmosphere at the poles and that's what makes the aurora, the northern and southern lights. And so, that same principle can be used to extend to other space missions that you have to figure out how to protect yourself from high-energy radiation.

Things like cosmic rays as well can be very dangerous. Now, the International Space Station is technically in low earth orbit, so they're still a little bit within that protective field, but they are still exposed enough compared to us that they have regions of the space station that are shielded with water. So, they have like a foot-thick water in the walls that goes around that

protects from the radiation. But that's certainly something that we're going to need to figure out.

And one of the big things people ask about, like the opportunity of us to go and terraform Mars, biggest issue is that Mars doesn't have that molten core, and that's one of the reasons we think that all that water that used to be on the surface of Mars evaporated was because that molten core solidified, the magnetic field disappeared and then the atmosphere disappeared, which meant that the water boiled away. So, that's the main reason for us in space exploration now to have deflector shields is to protect us from radiation.

But going into things like torpedoes [laughs] and debris, now those are like more physical shields. You talk about those being kinetic weapons and we don't necessarily have technology that can deflect those at this time. That was a bit of a fire hose of information, but yeah. [laughter]

Sue: So, the last one that I have on this part of the list is replicators.

Erin: Yes. Yes.

Sue: I mean, 3D printers have changed the game, right?

Erin: Yeah.

Sue: And especially in cosplay. Well, I can't say especially, it's just in my experience then for *Star Wars* cosplayers, right? You can just-- All the stuff that was hard to find or you had to mold or make out of resin or find somebody to make, you can just download a file and print. And they're lighter and they're more accurate and they're cleaner, and it's fascinating. But we can also-- Some places have started 3D printing food.

Erin: Yeah. The technology is there. It's crazy. That was my partner's Christmas present to me, was a 3D-printed Leia lightsaber, and he just was able to print all of the components and glue it together. We got a resin printer for ourselves. It is still magical to me, it's still magical. I'm like, “Ah, that's weird. I can just print that.” [laughter] Instead of having to carve it out of digging stuff out of the recycle bin, I can just print this now.

But the food thing, it's really the idea because they have all these different 3D printers, and you have the resin prints that sort of layer up this resin as you go. And then, you have the-- One of the first 3D printers that everyone got were the pens that are laying down plastic in layers as you went. And those are kind of different styles. But I think the food ones that I've seen, it's really just laying down the material in a way that resembles nutrients. If you can get nutritional food printed in some form and figure out the science of flavor, I think that's a big area. We're not far off from that.

Sue: Yeah. And of course, we're not talking about building it from the molecule up, but creating things from not elements, but base materials that you need and are useful. And I kind of joke that it changed the game for cosplay, but it changed the game for everybody. You can get parts that you can't find anymore. You can make things that haven't been made in years as long as you have a file.

Sarah: And they use it on the space station, right, to make tools?

Erin: Mm-hmm. Yeah, because actually, one of the really interesting things is when you print stuff on the space station, you don't have to worry about gravity. And so, we have a lot of stuff that we've built and designed here on Earth to withstand that constant gravitational pull, but they don't have to worry about that on the space station. So, they can design materials

and components slightly differently to be fully just printed and used in zero-G environments that use less material and have different structures.

Sue: I love it. 3D technology or 3D print technology is so exciting.

Erin: Still magic. [laughter]

Aliza: Really, really is.

Erin: And I think too, it's important to note that one of the limitations we have right now isn't just that you can do it, but it does take some serious time. It's you're not hitting a button and getting a burger. That burger would take, if you could do it, like four hours to print, at which point you've moved on to the chips in your cupboard. [laughter]

Sue: Speaking of technology, I want to talk for a minute about TextExpander. Work smarter, not harder with TextExpander. TextExpander helps you work faster and smarter so you can focus your time on your most important work. With just a few keystrokes, TextExpander keeps you consistent, accurate and working efficiently. TextExpander has time-saving power. Use their powerful shortcuts and abbreviations to streamline and speed up everything you type. Speed through emails, expand forms with fill-in-the-blank fields using a quick abbreviation and expand content that corrects your spelling and keeps your language consistent with just a few keystrokes. Get your message right every time. Listeners to the show get 20% off their first year. *Visit textexpander.com/podcast* to learn more about TextExpander.

Well, why don't we get to some of these large, large topics and of “is it even possible?” And the first of which is faster than light travel.

Erin: Yes.

Sue: There are so many different examples that we see of this in *Star Trek*. There are ways beyond *Star Trek* that people have talked about how it might be possible. But I want to start with the Federation, our matter-antimatter reaction controlled by a dilithium matrix that bends spacetime in order to essentially jump from one place to another, create a shorter passageway, is my understanding of warp drive.

Erin: Yeah, essentially the way warp drive works and the technology behind it is the idea that nothing on the surface of spacetime-- So, if you think about our four-dimensional space time like a fabric, you put something on it's going to dip it down like a bowling ball and trampoline. And it's limited to how fast it can move within that. The lighter it is, the less it dips down. And then when it has zero mass, it just coasts on the surface in a straight line and that's light, so that's the speed of light because light doesn't have any mass.

And so, because of that anything in normal spacetime can't go faster than the speed of light because having no mass is essentially as light as you can get. But the idea behind warp drive is that nothing in those rules says that spacetime itself can't go faster than the speed of light. So, that's like you build a bubble around your bowling ball on the trampoline, and that bubble of trampoline pushes your bowling ball faster than the speed of light. So, it's not moving itself. It's the fact that the spacetime around it moves faster than the speed of light.

And you mentioned the matter-antimatter reactions. It's essentially like if you want to bend spacetime, you need mass, you need that bowling ball. But if you don't have that, you can use the concept of energy mass equivalence or $E=MC^2$ to have enough energy to bend space time an equivalent amount. And so that's where the matter antimatter reactions come in, because those generate a lot of energy. And that gets regulated by the dilithium. And then

that energy gets channeled into building this bubble of space time around the ship. And then if you want to go even faster than one, then you build another bubble around that bubble, and that's your warp factor 2 and then warp factor 3. And so, you exponentially increase your speed as you go. That's my high-level explanation of warp drive.

Sue: That's my favorite thing.

Erin: [laughs] Mine too. The thing to note is that mathematically it can work. There's been lots of research in this, like the Alcubierre drive. There's been some recent papers that have come out recently as well that have talked about the type of energy needed, whether you need negative energy, which we haven't really found, but again can theoretically exist. Figuring out how much energy and to what extent you need to build those warp bubbles but mathematically, the idea of a warp drive is completely sound. We just need the engineers to figure it out. I've done the math. [laughter]

Sue: So then, okay, the Federation uses a matter-antimatter reaction. The Romulans use a singularity to power their warp drive. Is that just a different way to get the energy needed to create that warp bubble, or are they using a different kind of warp drive?

Erin: I kind of picture it in a little bit of a goofy way. But if you think of a singularity, that's essentially a black hole, right? It's a point where spacetime has warped so much, take a pinch of that trampoline and pull it all the way down so it's incredibly steep. And it's almost like they're dangling a black hole in front of their engine. And it's like a carrot, that you're just like that's what's-- You're always falling into a black hole. And once you start to get to those dynamics, then the physics changes a lot.

Now, you could talk about the fact that they might still need dilithium to power that singularity, to actually build it in the first place because you still need energy to create and sustain that singularity, but then what you do with that is different compared to the warp drive. But yeah, it's like your ship is just like chasing this black hole. I just love that image. It's very like not Romulan. [laughter]

Sarah: These just sound like very dangerous in completely opposite ways. Like, the Federation one is going to blow you up and the Romulans are going to implode you.

Erin: [laughs] Well, that's my joke, is like that's why Zefram Cochrane drinks as much as he does, [laughter] because it's terrifying.

Sue: So, a couple more FTL options I guess that we have seen on *Star Trek* are Borg conduits, our quantum slipstream and our spore drive.

Erin: Yes. So, the Borg conduits and quantum slipstream, those are kind of similar that you think of those more as like artificial wormholes. They're wormholes that have been created to have like point to point. So, especially the Borg network, those are like point-to-point transport. They've basically stapled two points in spacetime together that you can constantly jump between those.

And then, quantum slipstream is like you're generating a wormhole as you're traveling. It's kind of like a hyperdrive in *Star Wars* works the same way, that you're able to-- I'm making some wild gestures that nobody can see, [laughter] but I promise it helps my explanation. [laughter] It's like you start to pop out of spacetime and then you build this tunnel that's actually a shorter path as you're traveling and then you come into normal spacetime again. So, they're both wormhole types. It's point-to-point travel, if that makes sense.

And then, spore drive, which is kind of similar as well. I interpret the spore drive as not literal mushrooms in our universe because mushrooms can't survive in space. But if you think about it like a network that lives in almost like subspace, you can think about it the same way that it's this network that already exists that allows for point-to-point travel.

Aliza: Yeah, I'm doing my first full watch of *Voyager* right now and *DS9*, complete front to back, which I've never done. And I just watched an episode in season 5 of *Voyager*. A few of them get stuck in their shuttle in a gravity well that contained a whole mini solar system. So, yeah, just like-- And I think the idea-- And actually, there was another recent episode of *Voyager* that I watched where they get stuck in subspace, like a subspace sandbar is how they described it.

Erin: [laughs] Oh, yeah.

Aliza: Do you remember that?

Erin: Yeah. [laughs]

Aliza: I love the idea of-- Because you described the fabric of spacetime as like an actual fabric in the bowling-- I love that image and the trampoline that really, works well for my brain. And then, to me, adding the subspace and the quantum slipstream and the spore drive even are just kind of adding, either layers to the fabric or texture to the fabric or ways to, like you said, pinch the fabric and fold it in different ways. So, that whole-- I feel like the fabric spacetime analogy is one of the best science analogies because you can layer all these other theoretical scientific things on top of it and it still works.

Erin: That's good. Yeah, I think personally, for me too, it really works, which is why I go to it. But I appreciate if it doesn't work for everyone. But then, thinking like you said of those eddies, they hit gravitational eddies and little pockets of subspace you can think of that as being just those little distortions or folds or bubbles or things that have popped out that are above or below the trampoline that kind of exists slightly out of our realm of physics. It works very well for *Star Trek*. So, I'm glad that helps.

Aliza: And it's like, I imagine the spore drive as, threading on the fabric. So, there's just this threading of mycelial matter that threads through the fabric, and that's what you can travel through. Is that kind of-- Do you think that works for the analogy?

Erin: Totally, yeah. And if you think about it's like we exist within the normal webbing, I guess, of that spacetime. But then if you think about this mycelial thread that's almost woven throughout that, that removes you from the normal fabric, but yet is still tied to it, I think, really makes a good analogy for that, definitely.

Sarah: So, Dr. Mae Jemison, who is the first African-American female astronaut and was also on *Star Trek*, is leading a project called 100 Year Starship. And what they're trying to do is encourage the development of one of these kinds of drives or something else we haven't even thought of yet within 100 years that will get us to another star because, rockets basically aren't going to do it unless you do generation ships or something. So, they want to kind of make this jump to the next big thing and do it within the next 100 years. And this started a while ago, so it's by 2112, I think. And I think that's just fascinating that people are thinking that long range, “Within 100 years, let's build this.”

Erin: Yeah, that's awesome. And just speaking of those deep space generation starships, it's important to note as well, and I didn't catch this one, but I just thought of it, is the solar sail that we saw in *Deep Space Nine* is also a thing that we have right now. So, they had the Bajoran solar sail was a way that the ancient Bajorans did deep space travel. And that's

actually one of the ways that we here are looking at doing deep space travel. And we actually have a functioning solar sail that is orbiting Earth at this moment. It's called the LightSail 2. And so that technology does work and is being used, which is awesome.

Aliza: Yeah. And funded by The Planetary Society and their supporters.

Erin: Yep. Of which Bob Picardo, our good friend, The Doctor, is on the board of the Planetary Society.

Sarah: So, someday we might be the ancient space sailors.

Aliza: Oh, I love that.

Sarah: [laughs]

Erin: Just got to look out for those tachyon eddies. [laughter]

Aliza: Yeah.

Erin: I mentioned the artificial wormholes, but *Star Trek* has naturally occurring wormholes as well that allows you to travel faster than the speed of light. Mostly seen in *Voyager*, where they're trying to find ways to get home. *Eye of the Needle*, I think, is a season 1 *Eye of the Needle Voyager* episode where they talk about the Harry Kim wormhole. And that's again, a naturally occurring point to point shortcut through space time. And then of course, *Deep Space Nine* is entirely based on a wormhole. [laughs] So, yeah, those naturally occurring wormholes exist as well, that theoretically, again, can exist, but we've never actually detected any. But there's nothing in the math and our understanding of our universe that says that those cannot exist, so that's kind of cool.

Sue: And Aliza, you made a note about the EmDrive.

Aliza: Oh, yeah, yeah. I kind of got obsessed with the EmDrive a few years ago, several years ago, I guess, but I know that now there's nothing that proves it works. But Erin, can you give us a quick description of it and why it hasn't been proven to work yet?

Erin: Yeah, this was sort of a conceptual thing that some engineers had thought of was to be able to use essentially a radio frequency cavity. So, you build this chamber that allows microwaves or electromagnetic, that's kind of where it comes from, is Em, E-M-Drive electromagnetic radiation to push your ship forward. That you can use it almost as a way that if you can reflect this electromagnetic radiation inside this chamber, it will push your ship forward, but you have to generate that.

And so even though conceptually, it's really interesting, it does violate some laws of physics, which is normally not a great thing, particularly the conservation of momentum. And it's essentially-- it's almost a perpetual motion device. You need to get that energy from somewhere. Even if it's converted into forward thrust, you're still paying for that somewhere else. So, they haven't quite cracked that conceptually. It is very interesting and I agree, Aliza, it is a rabbit hole that you can go down. [laughs] But as of yet, there's no way that we can say that can work, unfortunately.

Aliza: Yeah, and I know I'm a science fan, not a scientist, obviously. The engine that powers remotely, not crude space missions right now, is kind of like is a very simplistic version of what the EmDrive wants to be, except it actually works. And it's very slow, but it also has been very effective and efficient, power wise. Can you just give us a little bit of the scientific info on how robotic missions are powered right now? Their engines?

Erin: Yeah, for the most part, we use a lot of ion propulsion for deep space missions. Is that kind of what you were referring to?

Aliza: Yeah, because to me, the EmDrive sounds cool because it feels like it's just a robust version of the ion propulsion, but it's just not really working yet.

Erin: Right. Essentially, what it is with ion propulsion is that you have some sort of radiation, some source of radiation, whether it's electromagnetic or it's like actual radiation particles that are being emitted from, for example, a nuclear-- If we talk about uranium is giving off radiation, that's particles that are leaving that. And so, you can have this source of radiation within your ship. And as it spits out radiation out one end, particularly ions, those radiated particles, we have the Newton's law, action-reaction. So, it'll go off in one end and it'll push the ship forward in the opposite direction.

But the difference between ion engines and the EmDrive is the fact that those ions leave, these particles leave, they push the ship forward a little bit every time they do. And like you said, it's very slow. It's very minuscule effects. But in space, there's nothing to slow you down. No one can hear you scream. [laughter] So, there's nothing to slow it down. So, those little, little effects do start to build up over time because it's a force. And so, we have this acceleration and then that acceleration holds. Nothing slows that down.

But with the EmDrive, it's almost like you're trapping that within this chamber, so you're not letting that radiation escape anywhere to push it forward. And I'm being a little bit simplistic with it because there's various nuances to the concept, so you can send me emails. [laughter] But the general description is that you're bouncing that radiation around the EmDrive chamber as opposed to an ion propulsion, which spits them out, never to be seen again, but doing that pushes your ship forward. And spitting them out is that price you pay for the propulsion that you're getting out of it, is that you don't get those back again. And that's where the EmDrive starts to violate that, is it kind of traps those and reuses them, and that's the perpetual motion aspect that violates the laws of physics.

Aliza: Mmm. There it is. Thank you for that explanation. Great.

Erin: I hope that helped. [laughter]

Aliza: It helped me.

Erin: Good.

Sue: Well, my next section of this is what I'm calling shipboard features, which is artificial gravity, long range scanners, subspace communication, cloaking devices, phasers and energy weapons, interactive optical displays, turbolifts and detached nacelles.

Erin: Nice.

Sue: There's a lot here.

Aliza: Yeah.

Sue: My favorite of this part of the list is cloaking devices. I remember sitting in an astronomy class because I started college as an astronomy major. I did not finish college as an astronomy major. [laughter] I remember learning about gravitational lensing in this astronomy class at some point in college and thinking, “Is that how cloaking devices work?” Because of course I did.

Erin: Nice.

Sue: So, that's how they work in my brain. But I want to talk in real life about cloaking devices.

Erin: I mean, you're not far off. The idea that gravitational lensing is where light gets bent around an intervening gravitational presence, and so, the light that was behind that got bent appears to be somewhere else than where it actually is. Again, I'm giving some very helpful hand gestures. [laughter] But the attempts that we've made to do-- Because the point is if you want to cloak your ship, when we detect things in space, we detect stuff from light that's being emitted from them or light that's being reflected off of them. And you can cloak your signature. We use a lot of that for military exercises. Here is how to cloak ships so they can't be seen. But the big thing is to mask any reflection. That's really, really hard to do. And one of the ways that I know some researchers, particularly in optics, have looked at that is how to define reflect light rays around an object so you can't see what's actually there. And currently, the biggest issue with that is that you have to be positioned just right in order for that to work. So, you can't tell the Romulans, “Just move one click to the west and then we can see you or then we'll disappear.” That's kind of where that technology is right now.

Sarah: I was really excited about the big reveal about turbolifts in *Discovery*.

Aliza: What's the big reveal?

Sarah: So basically, this whole time, they've been pretending like they're elevators or something in tubes, and it turns out they're little driverless shuttles that go around this big space inside the ship.

Aliza: Oh, right, right.

Erin: I did get a lot of messages about the turbolifts in season 3 of *Discovery*.

Sue: People got mad. Surprise. [laughs]

Erin: I'll take the heat, that's fine. But there was nothing in the dialogue describing that. So, the level that I'm at, it's an interpretation of how that kind of story-- But honestly, for me, it was a good action scene. And sometimes, we're still telling a story, first and foremost. And *Discovery* is kind of big. And so, however you interpret the internal mechanisms of the ship is up to you. But I thoroughly enjoyed it. I agree, the concept that it's not an elevator shaft. It's like, no, you get in this pod and the pod will take you where you've told it to go. And there is a lot of space in between that if it's not being taken up with elevator shafts. [laughter]

Sarah: And that would be a really handy technology to have if you've got a huge building and someone has some kind of disability, even if your elevator goes to all the floors, you still have to travel all the way across the floor to get to where you're going.

Aliza: Yeah, right.

Erin: Right.

Sue: And who knows if that wasn't part of their 32nd century upgrade?

Erin: Exactly. Thank you.

Aliza: Yeah, I'd love to talk about artificial gravity because that in so many other sci-fi shows, *Star Trek, Star Wars*, *The Expanse*, there's so many versions of artificial gravity and then even movies like-- What's the one with Matthew McConaughey, farmer?

Sarah: *Interstellar*.

Aliza: Thank you, thank you. Yeah, *Interstellar* using the centrifugal-- not space station, but that station that they had that used centrifugal force to create artificial gravity. What do you think is the closest we have right now to making artificial gravity?

Erin: So, the rotational one that you mentioned from *Interstellar* and we saw it in *The Martian* and as far back as *2001: A Space Odyssey*, that scientifically again works. That's how we train space pilots, is we'll increase the gravitational forces on them by putting them in a centrifuge essentially. And it relies on your inertial body to try to stay going straight, and then you get something that forces you around a corner constantly that creates this artificial force. That rotational artificial gravity, the science there is absolutely plausible.

The reason we don't have rotating space stations right now purely comes down to the fact that a rotating space station that has gravity that is comparable to Earth's is going to be either small and rotating fast or large and rotating slowly. The small and rotating fast means that your feet to head is going to be a significant part of the radius of that space station and that will give you bonkers vertigo. Every time you move, you're experiencing Coriolis forces that are going to do not great things because your head and your stomach are all going to be kind of pulled in different directions. And anytime you move opposite to the rotation, not happiness happens.

Aliza: Oh, yeah, I didn't even think of that.

Erin: That starts to remove that larger the radius of the space station gets. The more that you start to make up a smaller percentage of that, the less that happens. And then, we talk about the limitation really comes down to just how expensive it is to launch things and how much risk there still is to our technology that we just aren't at a place where we can feasibly and get that cost-benefit risk analysis out of building a large rotating space station around Earth. We can do it, but it's not necessarily something that we're capable of doing right now.

And then, *Star Trek* just kind of has a gravity generator. [laughs] And the thing I love the most about it is this is one of those great examples of actually dating the science fiction to when it was written. Because the original technical diagrams for *TNG* when they tried to give some components to the gravity generator reference superconductors. And superconductivity was huge in the 1980s and 1990s. It’s like this amazing technology that was going to take us leaps forward. And they weren't wrong, but that's kind of disappeared from the public imagination. And so, at the time that was on the forefront of everyone is like, “Superconductors are going to do all this cool stuff, include be a major component of the gravity generator on the 1701 D.” [laughs] So, I I love that fact. But we don't necessarily have a lot of science behind the gravity generator in *Star Trek*, unfortunately.

Aliza: When you were talking about the big hurdle that we have to actually build these types of things like the centrifugal one, that made me think of shipyards. That's something that we see in *Star Trek* and other sci-fi that we don't do that yet. We don’t build things in space so that's another thing that we're not there yet. But I'm guessing that is also plausible. Is it plausible to build a ship in space?

Erin: Yeah. And I think that's probably something I would say we'll see in our lifetime, I really feel like. The launch capabilities are getting much better and much cheaper and much more widespread. And the idea that we can, if not in orbit, build a shipyard on the moon, that's not

out of the realm of possibility, to make it more efficient to go to Mars and to replenish research stations and all that. That's really just dependent on public funding and interest.

Sue: So, I want to talk about long-range scanners and maybe my gut tells me subspace communication is related, but I could be very wrong. But Peter on Patreon asked, “How do long range scanners work? I sort of get how warp drive allows for faster-than-light travel. But how does a starship crew know what's going on light years away before that information could physically have reached them?”

Erin: I think you hit it that it's essentially what they've set up as subspace communication in *Star Trek*. And the way that I think about that, because they talk about their subspace buoys that are sort of positioned throughout or long range, these anchor points that they have. I view those as they have the technology to punch through that trampoline that we talked about. And they sort of sit as buoys. If you picture buoys on the surface of the water, they stick above. If you think about that on the surface of spacetime, those buoys will stick above spacetime and then the electronic transmission between those would not be limited by that faster-than-light limitation because they're not communicating on the surface of spacetime. You have this sort of point-to-point network that sticks above the sheet that can be faster than the speed of light. So, that's kind of how I picture those. I know that doesn't have a ton of scientific backing behind it. But again, once you get into subspace, then you can kind of play with it a lot.

Sue: I just want to mention that there was a prototype for a non-lethal laser dazzler developed by the U.S. Air Force. It's no longer in development, but it was titled the “Personnel Halting and Stimulation Response Rifle,” or phaser, and its purpose was to temporarily disorient or blind a target using a two-wavelength laser. So, that's interesting. I feel like that's about as far as energy weapons have gotten and that development isn't happening that we know of anyway. Would that be accurate?

Erin: Yeah. At least, I appreciate that someone tried to get that acronym for phaser into development at the DOD. Mad respect. I've been in those rooms where we've come up with acronyms, and the fact that they got that far at all is impressive. [laughs]

Sue: There's another great one coming that is definitely my favorite, but we're not there yet. Also, interactive optical displays. I feel like that's sort of along the same lines as the holodeck. Where we might be able to display something with light, but we can't quite interact with it yet. The closest I've seen are those light-projected keyboards that the interruption of the light is how it knows you're hitting a key. Do you know what I'm talking about?

Erin: Yeah. And there actually has been some really good advances in eye tracking movement in part of the VR development, where they can see where your eyeballs are pointing and react accordingly. But again, that's not really at the consumer level yet. But the technology is getting there. I played with one once and it blew my little tiny mind. [laughter]

Sue: And then detached nacelles, which I think we were told were held to the ship with magnetic forces. Would that withstand warp drive? Like, what, what? [laughs]

Erin: Yeah, so really what the nacelles do is that they're there to sustain that warp bubble. You have that warp engine that really builds the bubble around the ship, and then the nacelles sustain that. And so, including the nacelles, your starship is essentially, in normal physics space. Remember, it's that bubble itself that's pushing you faster than the speed of light.

Sue: It's like being on a moving train.

Erin: Yeah, exactly. And so, the fact that if you can attach these nacelles through-- Have magnetic forces be what's holding them to the rest of the ship, as long as they're inside that warp bubble, then that does actually work fine, no problem. The technology is a long way off, but magnetic fields are weird and useful. [laughs] And I think, a lot of us kind of don't realize how much we interact with magnetic forces in our everyday life. Magnetic fields can be weird and very useful, but the fact that the ship is within this warp bubble, lets us play a lot with it. So, I'd give it a little bit of a pass.

Sue: That's amazing. My next section is medical tech. And I've got on here, ocular implants, our visor, the kidney pill, which is my favorite thing in the one with the whales, and scanning for life signs. But the visor is where my favorite acronym on this list comes in. So, there has been in development a headset that is designed for people with low vision called the Joint Optical Reflective Display, or JORDI.

Erin: That's so good. [laughter]

Sue: Isn't it great? And it's portable and bulky, and it's essentially goggles that will magnify objects up to 50 times, and the user can adjust contrast and brightness and different display modes. But when we get to what Geordi's actual visor is, it's not in necessarily the visible light range. He's getting infrared readings or other types of readings that are connected directly to his brain for interpretation. And I would guess that we're pretty far off from something like that.

Erin: Yeah, I think that's fair. It's always been interesting, they've skirted around a lot what exactly the visor does, but like you said, the times that they've gone into it, it's a little bit different than correcting vision, as it were. It's interpreting it slightly differently. But that's really cool. That's fascinating.

Sarah: So, I was doing a *Star Trek* panel here in Portland, and this came up, and someone in the audience raised their hand. They said, “My parents are blind, and we used to watch *Star Trek* together. And I would explain to them what was going on the screen.” And then, their parents ended up being beta testers for this.

Sue: Oh, wow, that's awesome.

Sarah: Yeah.

Aliza: That's very cool.

Sarah: I think the scanning for life signs would be super useful in terms of, “Hey, are there still people alive under that building that collapsed over there?” Or, where is this person that's lost on the mountain?

Erin: Yeah, and we do kind of have some of that technology with-- As long as you have satellites in orbit. We do have a lot of, especially planetary scanning that they do in *Star Trek*, I think that's very similar to what our weather satellites have been used to. And our weather satellites have been used-- To use infrared to look at wildfires to try to find bodies based on how good the technology is. And obviously, we're still a ways off from being able to use that on a regular basis. But I'm sure too, there's just a lot of technology in there with satellites that you can “scan” for life signs. But I think your example of sort of finding bodies in rubble, I think we're still a little ways off from that, but we're skirting the edge of that.

Sue: All right, so I think that brings us to our bigger *Star Trek* Universe, 23rd century and beyond stuff. So, I've got on here, transporters, programmable matter, and androids. These are the big ones, right? [laughter]

Aliza: Mm-hmm.

Erin: I'll just jump in the transporter thing because it's my favorite example of science in science fiction, particularly because-- So, transporters can't exist based on our physics understanding because of something called the Heisenberg principle.

Sue: Well, they compensate for that.

Erin: We do. And that's the brilliant part. [laughter] So, Heisenberg's Uncertainty Principle basically states that you can never know exactly where subatomic particles are. You can never know exactly where something is. Everyone's had that moment when they were a kid and had that mind blowing thing of, “Yeah, the ruler's this long. But now, I've learned about atoms and at what point is it exactly 1 foot?” That's essentially Heisenberg's uncertainty principle. And if you want to be able to break a body down and transport it and rebuild it, you do want to know exactly where all those particles are.

But like you said, Heisenberg compensator. [laughter] We don't need to know how it works in the *Star Trek* universe, we just say it works very well, thank you for asking [laughter] and leave it at that. But yeah, I love that because that is such a perfect example of science fiction acknowledging they're breaking the laws of physics without needing to come up with a way to do that.

Aliza: Mm-hmm.

Sue: Well, and that's even before you get into the ethical philosophical question of are you dying or not? Is that person really you?

Aliza: Yeah, ship of Theseus type of thing. Is this the person that we transported or is it a new person every time?

Erin: Yeah.

Sue: Now, wasn't there something though recently about-- Oh I'm not going to remember the type of particle, but there was a particle that the scientists thought they could transport?

Erin: So, it was a little bit of a misleading way of phrasing it. What they were doing is that they were able to entangle two particles so they could have them behave as the other one was, which was in a way that transporting. It's like ending up with two Rikers. If you think about the transporter as creating another copy somewhere else, that's kind of what they were able to do with these particles, is that they were entangled so they were behaving in the same way, but they weren't literally picking it up and it appearing somewhere else, if that makes sense.

Aliza: Yes, got it.

Sue: All right. Programmable matter. This was some of the coolest stuff on *Disco*, I’ve got to tell you.

Erin: I mean, for me I just see that as an extension of replicators. It's like technology continues to advance and 900 years later, we've gone from replicators to programmable matter. And I love when he's-- It was like episode 2 of season 3 where he's drawing the component that they need with the pens, because we have 3D printer pens now and so I feel like that's just an extension of that.

Sue: That's a fair point. I didn't think of it that way, but yeah, it's just constantly replicating whatever you need. So, androids. [laughs]

Aliza: Androids. I love androids.

Sue: I think we're very far off from Data or Lal or Soji, but I know there have been some attempts at human-like robots, but I don't think we're close to androids.

Erin: I think space exploration is going to push us there. Not from walking around, but more from a HAL ship's computer perspective that we're going to need. Because especially if we're able to start sending humans to Mars, we are going to need a significant amount of machine learning. And this is something that is being researched to have machine learning to help problem-solve emergencies when you have so much of a time delay with the rest of the Earth.

When you have a 12-minute communication delay, you want to be able to have as many resources you can to help you solve problems when they arise, and there's been a lot of effort into-- I forget the exact thing it's called, but it's essentially mission operations machine learning that you take all of that problem solving that you normally have this hive mind of people who are working in mission operations, instead be an AI that's able to respond to incidents and, say, “Well, one protocol says this, one protocol says this, I'm taking in all of this information and this is what you need to do to solve this problem.” That's what I think is going to push us closer to having some form of artificial intelligence in space travel.

Aliza: In the way that so many NASA innovations have become a part of our daily lives, that feels like something that can and will and would be marketable just for everyday life. A problem-solving AI for your home, for your kids, for your scheduling even. I wonder if that's the path that it's going to take too.

Erin: And then, once we figure out that uncanny valley of having a human-looking thing walking around with that inside them, then that'll be a quick port over. [laughs]

Sarah: I feel like those headless police robot dogs are kind of a step towards androids, and that kind of terrifies me.

Erin: That's the last sound you hear before you die, for sure. [laughter]

Aliza: You know what's interesting? For me, Sophia and those headless robot dogs, they kind of are evolving in different directions, it feels like. The robot dogs are getting really good at physical movement and moving objects and just navigating through space. Whereas Sophia is becoming this intellectual, this evolution. She's not Data, obviously, but she has a Twitter. She tweets. She's on Instagram, she creates content. And she has citizenship. So, it feels like we don't have an all-in-one package yet, but we do have different projects and entities that are kind of getting really good at one little area of being android or being an AI.

Erin: Yeah.

Sarah: I do think we need to course-correct from this trend of Sophia and Siri and Cortana all being female. All of our robot servants are female.

Sue: Fair point.

Aliza: Yeah. I mean, and there's also-- Oh, goodness, there's a lot to be said about slavery and the idea of creating entities that will be in servitude to other entities and individuals. And of course, we have that amazing *TNG* episode where Guinan points that out, T*he Measure*

of a Man, where Data goes on trial for his individuality, for his autonomy. And then, of course, so many episodes of *Voyager* deal with the same, with The Doctor as a holographic individual, what are his rights? So, I think, if you all ever dip into Afrofuturism, there are some really cool stories being told about the correlations between androids and slavery and that correlation.

So, my personal hope, one of my own personal missions is as a writer, as an artist, is also to get more people of color working in AI and in machine learning and in all of these areas because we have a historical and generational knowledge of how these things can go wrong, of using an individual for your own purposes. So, yeah.

Erin: I hope people are aware or can become aware of the current ongoing crisis at Google about AI ethics, where they fired a prominent woman of color, Dr. Gebru, from their AI program because she was bringing up some very serious ethical issues and is a really amazing person. And anyone who's tried to stand up to Google against that has ended up just being fired. And so, I think we still have a long ways to go. So, thank you for bringing that up.

Sue: I would like to hope that, down the line, when we get there, when we have human-like androids, or as close as we may get, that having had the introduction to those ideas in *Star Trek* with characters like Data and The Doctor will influence our society to not be terrible about it. Maybe that's too much of a hope. But we've already in a way developed sort of a cultural empathy towards characters like this. So, hopefully we will-- If it comes to that point, I would like to believe that these beings will be granted rights and citizenship and autonomy.

Sarah: I actually think we're going to be okay because, I mean, look at how emotionally people get about Curiosity and the Mars Rovers singing happy birthday over on Mars. I think we're going to treat our robots okay.

Aliza: I hope so. I do a lot of research on AI and machine learning and ethics because I'm writing a pilot about it. And we already have some really scary things that are happening, even just in machine learning, which is literally just feeding an algorithm data so it can learn to make decisions and recognize pictures and things. There's already huge issues with the data it's being fed not being reflective of our society. And we have people-- Sorry, I can go-- Actually, we are going to do another episode about AI and machine learning. So, I will save it for that episode. [laughter]

Erin: I look forward to listening to it. Yeah, I'd love to hear your thoughts on that. It's fascinating.

Aliza: Yeah, it's really fascinating.

Sue: Well, not to change the subject entirely, [laughter] but was there any piece of tech anybody wanted to talk about that we didn't talk about at this point?

Sarah: Self-sealing stem bolts. [laughter]

Aliza: Thank you for that.

Erin: Yeah, brilliant. Oh, you can't beat that. Yeah, [laughter] best currency on *Deep Space Nine*.

Sue: We talked about a lot of stuff today.

Aliza: Ooh, yeah.

Sue: As I was going through this, I was thinking about retrofuturism, which I think is fascinating going back and looking what people in the past thought the futurism would be like. And when you look at the 1940s and 1950s and 1960s, a lot of the assumptions were that the coming advances would be made in travel and transportation, personal jetpacks, flying cars, high-speed rail. But what we actually saw was the advancement in computing and especially with microprocessors, which has led to advancements in things like medicine and gene mapping and communication. So, my question, I guess, from all of that is that, is there a field that we're expecting a breakthrough in or are there predictions that we're making about what our next advancement would be that is different from what we thought it would be 10, 20, 30 years ago?

Erin: Well, I think *Star Trek* has inspired so many generations and continues to inspire so many generations of scientists and engineers and inventors that they're already-- The people who are inventing that stuff and doing the research have *Star Trek* on their mind. But I think the greater social needs, particularly right now in medicine and the advances that are being made, I think are going to push us closer to the medical advancements that we see in *Star Trek*. Particularly with how much we've gone to virtual care right now, that I think if they're able to get better technology to diagnose stuff virtually, it saves everyone time to be able to just call over a viewscreen. And if you're able to have technology that can have the doctor read your symptoms, we're so close to improving that I think that's going to drive us much further. So, I think the big medical *Star Trek* stuff, we're going to see sooner rather than others.

Aliza: Yay.

Sue: I like that. I think that's about all the time we have for today. We've got to go reverse the polarity of a neutron flow. Erin, where can people find you on the internet?

Erin: I am mostly on Twitter @*drerinmac*. And that's the same handle for my Twitch account. So, you can find me streaming video games on Twitch, occasionally *Star Trek Online*. And then you can search for me on YouTube as well to find all my old videos. And I've got some videos on *startrek.com* about *Star Trek* technology so feel free to check those out as well.

Sue: Awesome, and, Aliza?

Aliza: I'm @*alizapearl* on Twitter and Instagram. And then I also occasionally stream on Twitch @*apizaliza*.

Sue: Sarah?

Sarah: You can find me on Twitter @*sarahmiyoko*. And you can find my fanzine, *Star Trek Quarterly*, on Facebook.

Sue: Awesome. And I'm Sue, you can find me on Twitter @*spaltor.* You can find our show on Facebook, Twitter and Instagram @*womenatwarp*. Or send us an email *at crew@womenatwarp.com.* And for more Roddenberry podcasts, visit *podcasts.roddenberry.com.* Thanks so much for joining.

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