Interviewee: Jonathan Barlow
Engineer at NASA on the Astrobee team
February 28, 2023 at my house

00:00:08:20 - 00:00:12:03
Speaker 1: Sabrina Barlow
OK. Will you please state your name and what you currently do for a living?

00:00:13:07 - 00:00:19:12
Speaker 2: Jonathan Barlow
My name is Jonathan Barlow and I am an engineer at NASA Ames Research Center.

00:00:20:15 - 00:00:23:24
Speaker 1: Sabrina Barlow
OK, can you give a brief history of your working with NASA?

00:00:24:21 - 00:01:02:06
Speaker 2: Jonathan Barlow
I started at NASA Ames as an intern back in 2009, I think. And I was working on airplane control systems and I was hired on uh shortly later that year, I think, and then I continue to work on aircraft controls and guidance. At one point there was a project called Spheres that needed some help that I thought that sounded like something cool to look at.

00:01:02:06 - 00:01:42:14
Speaker 2: Jonathan Barlow
So I started doing Spheres and I over time did more and more with Spheres and eventually got to work on. We worked with Spheres, we worked with a bunch of different users that did some really cool science. And then over time, this idea came about that, hey, maybe we should do an update to spheres. And so I got to work on the proposal and later on, the actual project that became Astrobee of doing an update to spheres that could do research with guest users and fly around inside the space station.

00:01:43:10 - 00:01:44:18
Speaker 2: Jonathan Barlow
And that's what I'm working on right now.

00:01:45:16 - 00:01:52:19
Speaker 1: Sabrina Barlow
Cool. OK, so and what you're working on right now is Astrobee. Can you describe Astrobee and like the Astrobee program?

00:01:54:02 - 00:02:20:14
Speaker 2: Jonathan Barlow

So Astrobee is a series of free flying robots they're about one foot cubed, a foot by foot by a foot, and they fly around inside the International Space Station they're robots, so they have cameras that help them to see the environment there. They use fan based propulsion. So you can think of it kind of like a quadcopter although they don't use the same propellers as a quadcopter.

00:02:20:14 - 00:02:50:12
Speaker 2: Jonathan Barlow
But, you know, Kwai Copter can kind of hover and move and up and down and in any direction. It's kind of a similar thing. They do use the air inside the space station for propulsion and they are able to run for a few hours at a time. They use natural features inside the International Space Station for localizing themselves, knowing where they are and for moving around there.

00:02:50:28 - 00:03:21:07
Speaker 2: Jonathan Barlow
They were made with three expansion bays. We call them payload bays where a guest user can plug in their hardware to be able to test their thing. So we have some users that want to do a variety of things. One, it's called SVGS. They're looking for doing a vision based guidance system. So SVGS stands for a smartphone video guidance system.

00:03:21:07 - 00:03:48:26
Speaker 2: Jonathan Barlow
So they want to use smartphone type cameras and processors, which actually coincidentally is what Astrobee uses to do vision based guidance systems for satellites. So they're using some of Astrobee's built in cameras, which was nice for them, but they also flew their own LED array, which they attach to Astrobee, and then they can use that to localize rather than using the natural features like Astrobee does.

00:03:50:00 - 00:04:14:13
Speaker 2: Jonathan Barlow
Astrobee's localization was designed specifically for inside the International Space Station, where there's lots of things to look at. SVGS is looking at, well, what if you're on on a satellite and all you have is like space around you? Like there's not a lot of natural features. I mean, they're stars, but there's not a lot of difference when for from one foot to the next foot, there's not a lot of difference there.

00:04:14:28 - 00:04:21:07
Speaker 2: Jonathan Barlow
So they they're generating their own LED array to be able to localize and navigate with that.

00:04:21:26 - 00:04:27:09
Speaker 1: Sabrina Barlow
And the the bays is where you can attach the.

00:04:27:09 - 00:04:59:22
Speaker 2: Jonathan Barlow
Yes. So the bays provide a physical attachment. They also provide power for the payloads that need power and data communications. Yeah. Some of our payload users are communicating data back and forth between the Astrobee and the payload so realm was another payload that we did do I remember that RFID enabled automated logistics management Realm. Everything's an acronym with NASA. I don't know what to say, but but they're one.

00:04:59:22 - 00:05:48:00
Speaker 2: Jonathan Barlow
They're a NASA. a NASA actual user. They're a team located at Johnson Space Center, JSC down in Houston, Texas. And they are doing RFID readers in hatch ways and in drawers for keeping track of all the stuff that's on on ISS on the International Space Station. RFID is a another acronym that stands for Radio Frequency Identification, and they're little tags. They're fairly common if you've gone to any store and and seen like if you peel off the labels and you see like a little spiral pattern of metal or sometimes they're little they're little rectangular packages like when you go through the, the doorways and the the alarm goes off because they forgot to disable one of the things.

00:05:48:12 - 00:05:51:04
Speaker 2: Jonathan Barlow
Those are RFID tags. They're just tracking.

00:05:51:04 - 00:05:51:27
Speaker 1: Sabrina Barlow
To help you find something that's lost.

00:05:52:07 - 00:06:13:19
Speaker 2: Jonathan Barlow
A reader. So they help with inventory management. They're used on the ground all the time. That's what they're like, hey, we can, you know, we can put tags on things on ISS and keep better track of things. But there's a lot of stuff on the ISS. And so they're trying to figure out they don't want to have astronauts have to go around and do inventory all the time.

00:06:13:19 - 00:06:41:27
Speaker 2: Jonathan Barlow
So they're trying to figure out, can we have robots do inventory management by robots? I don't necessarily mean things like Astrobee, but like they have these readers and they have readers in drawers and things like that. To be able to read the tags and know is everything put away properly or is it lost or what? And so one of the things so they had they'd have these different different types of readers, but one of the things they needed was a way to look for lost things.

00:06:42:21 - 00:07:05:03
Speaker 2: Jonathan Barlow

So they thought, we need a robot to be able to go around and look for lost things. And then they heard about Astrobee and they said, Hey, you know, we don't really need or want to design our own robot. You guys are already designing this robot. Let's just design a reader to put on Astrobee. So they put their reader on Astrobee and they're they have some software that runs on Astrobee that manages the communication back and forth.

00:07:05:03 - 00:07:19:22
Speaker 2: Jonathan Barlow
It basically says, Hey, reader, you know, did you find this? Or, you know, where do you think we should look next? And then it tells Astrobee, OK, turn here and go this way. And they have their reader running it so they can look for their lost things. So we did some demonstrations for them. That's really cool. So that's an example.

00:07:19:22 - 00:07:26:19
Speaker 2: Jonathan Barlow
Another example that uses, I think, a little bit more of the capabilities where they're actually doing power and data from from Astrobee.

00:07:27:08 - 00:07:36:18
Speaker 1: Sabrina Barlow
Cool. OK, what challenges did you face in creating Astrobee? Because I know you were part of the team that did the proposal.

00:07:37:07 - 00:08:03:12
Speaker 2: Jonathan Barlow
Yeah, well that was a learning experience for me. Being part of the team that had to figure out what it is that we where we thought we could do to put together the proposal come up with a plan in terms of people time. It would take money, it would take what sorts of what we, what we were going to build and so the proposal was, I would say pretty high level.

00:08:03:29 - 00:08:08:13
Speaker 2: Jonathan Barlow
And when we got approval to do that. We had to drill down into the details of, OK, what is this thing going to look like?

00:08:12:04 - 00:08:15:21
Speaker 2: Jonathan Barlow
And we had to go through various levels of review.

00:08:21:29 - 00:08:26:07
Speaker 1: Sabrina Barlow
OK, you were talking about the creating the proposal.

00:08:26:20 - 00:08:51:10

Speaker 2: Jonathan Barlow
Yeah. Going from you know, the proposal getting approved and kind of having high level general idea to having to drill down into the details. So that was a challenge. Sometimes it's good practice and that's what we did to go to the customer, which in this case were the people providing us the money to design and build Astrobee. NASA people.

00:08:51:10 - 00:09:07:07
Speaker 2: Jonathan Barlow
Yeah, I'd say, hey, you know, this is what we have so far. You know, we haven't gone very far, but this is what we're thinking. What do you think? And get their feedback on that. So it's really important and we early on got some really great feedback that sent us in a different direction so that was definitely a challenge.

00:09:09:24 - 00:09:13:14
Speaker 1: Sabrina Barlow
OK, can you elaborate on how the project changed over time?

00:09:14:13 - 00:09:47:27
Speaker 2: Jonathan Barlow
Yeah, so it's going back to that example I mentioned of our one of our main users. You know, we presented what we had so far, what we were thinking and pretty much an agreement on most things. But he really took exception with kind of the idea that we had initially of having a more quadcopter like thing that was kind of surrounded by a cage because, you know, we wanted to make it safe so that nobody's going to get hurt by a propeller blade spinning because, you know, quadcopter, you stick your hand in there, ow. right?

00:09:48:13 - 00:10:08:15
Speaker 2: Jonathan Barlow
We don't want that. The ISS people weren't going to want astronauts to potentially get whacked by something, right? So we thought, well, we could just always put a cage around it. I don't think we put a lot of thought into that, but it was a concept. And he really this one person in particular really took exception with that and said I don't think that's going to fly.

00:10:09:00 - 00:10:31:29
Speaker 2: Jonathan Barlow
I don't think you should do that. So we took him seriously and we went back and tried to find other ways of getting it done. And so that led us to the configuration we have now, which is two propulsion modules that are that kind of pull air into the into the propulsion module and then have louvers that open and close to that to direct the air.

00:10:31:29 - 00:10:33:03
Speaker 1: Sabrina Barlow
It had what that opened?

00:10:33:19 - 00:10:49:26
Speaker 2: Jonathan Barlow
Louvers, they're like flaps like veins on a on a pair of shutters or something like that. That kind of open and close. So when the louvers open, air flows through and the louvers close, it stops.

00:10:50:00 - 00:10:51:14
Speaker 1: Sabrina Barlow
And that helps go in the right direction.

00:10:52:16 - 00:11:07:11
Speaker 2: Jonathan Barlow
Well, if you open the ones that are behind you, it pushes you forward. If you open the ones that are on the front, it pushes you backwards so you can do rotations and up and down and side to side and all that stuff by opening and closing them at the right times.

00:11:08:07 - 00:11:17:05
Speaker 1: Sabrina Barlow
While I'm thinking of it, do you want to talk real quick about the way that Astrobee moves through the International Space Station.

00:11:18:00 - 00:12:08:27
Speaker 2: Jonathan Barlow
Sure. And I'll start by comparing it to Spheres. So Spheres was a battery powered satellite that had a CO2 tank. So carbon dioxide liquids, carbon dioxide tank. And so it had a little valves that it would open and little puffs of carbon dioxide, which people breathe out all the time. So it's fairly benign and that's how it would move around and with Astrobee, we wanted something that could be a little bit more self replenishing, not not in the sense of, you know, put out solar panels and get stuff from the sun, but something that a crew member didn't have to do so with spheres a crewmember would have to replace the CO2 tank, would have

00:12:08:27 - 00:12:43:06
Speaker 2: Jonathan Barlow
to replace the batteries. We wanted to get away from that. So crew didn't have to spend time doing like doing the actual like management of Astrobee, but could be something that could plug in and recharge itself. And so with the fan base propulsion we were able to use the, the ambient air for our for motion and we have rechargeable batteries so you asked you asked how to how Astrobee moves around.

00:12:44:13 - 00:13:11:03
Speaker 2: Jonathan Barlow
OK, so you're asking how Astrobee moves around. So I think I described this a little bit already, but maybe I'm repeating myself. It has a propulsion module which is about a third of each propulsion. There's two propulsion modules and together they're about maybe 50% of the volume of Astrobee. It's a big open space on the side you think of Astrobee like a hamburger.

00:13:12:06 - 00:13:41:28
Speaker 2: Jonathan Barlow
The two propulsion modules are the buns, and everything else of Astrobee is in the middle so you could also call them the bookends. There's the large round circular opening that air gets drawn into through that circular mesh we used mesh to prevent hair from getting tangled in there and getting yanked out. right? Air Gets drawn in through the mesh and a fan pushes it to the outside of that volume.

00:13:42:18 - 00:14:04:07
Speaker 2: Jonathan Barlow
Not very high pressure. It's a very low pressure system. But it's moving a lot of air. So just like when you blow on a feather or something, you can move the feather. Well, the air that you're blowing is is providing a lot of force of change to the feather, but it's also acting on you. But on Earth you don't feel that very much.

00:14:04:25 - 00:14:31:06
Speaker 2: Jonathan Barlow
But up in space that that really adds up. So that's basically all Astrobee is doing, just blowing strategically in the right direction. There's no gravity, so it kind of floats around. So unlike quadcopters on Earth where it has to be constantly blowing just to keep itself to fight against gravity in space it's called microgravity, basically. It doesn't fall to earth.

00:14:31:28 - 00:14:45:09
Speaker 2: Jonathan Barlow
It kind of floats around relative to the things around it. And so it's able to to move around with a lot less power, I would say. But but also it doesn't have to keep itself floating. It floats naturally in that environment.

00:14:45:18 - 00:14:58:27
Speaker 1: Sabrina Barlow
So it's just floating. And then the air is like navigation and did you have anything else to say about how it changed over time or were you done with that.

00:15:00:16 - 00:15:03:00
Speaker 2: Jonathan Barlow
Like anything else to say about I'm sorry, I missed part of the question.

00:15:03:00 - 00:15:09:18
Speaker 1: Sabrina Barlow
how the project changed over time, any any challenges or things. Anything else?

00:15:09:27 - 00:15:53:08
Speaker 2: Jonathan Barlow

I guess another challenge that I would point out is towards the end of the project, when you start to run out of time and money and you have deadlines that are coming and there were launches to be met, we still had to put things together and and test everything so I was involved. I was the integration and test lead, which means it was on my head to make sure the thing got put together and tested which was a lot of fun, but also a lot of work to get all the parts bought paid for and inspected, processed, and then have everything put together.

00:15:54:18 - 00:15:55:18
Speaker 1: Sabrina Barlow
Because there's a lot of.

00:15:57:00 - 00:16:18:25
Speaker 2: Jonathan Barlow
There's a lot of parts, thousands and thousands of parts. I mean, it's only a foot by a foot by a foot, but there's thousands of parts in that thing. And we didn't just build one so with spheres we had there were three spheres on orbit, which we thought was pretty good. We tended to use two. Two was the normal, but every once in a while something would go wrong with one.

00:16:18:25 - 00:16:43:01
Speaker 2: Jonathan Barlow
And so we had a backup. So there were three on orbit and there were a few experiments that used three. So we got three. Sounds like a good number we also found it very useful to have units down on the ground to be able to do to test out what we were going to do in space, on the ground so we thought, OK, three on orbit, three on the ground, and then we should probably have some spare parts of things.

00:16:43:01 - 00:17:12:00
Speaker 2: Jonathan Barlow
And until just in case things break so we we essentially planned for ten units worth of Astrobees. So again, that's three on orbit, three on the ground, that's six. And then spare parts gets you to almost another, almost another four units. Now the nice thing is when you're talking about building custom things, the first one is really expensive.

00:17:12:00 - 00:17:52:13
Speaker 2: Jonathan Barlow
If you do everything custom just for one, it's super expensive. To go to a few more isn't is still more still more expense. It's still more expense, but it's to go to go to ten was not much more money like we essentially were able to do ten for the same budget that we had budgeted for three because you're buying in bulk it's not a huge numbers but it's but it's the same thing like when you're already paying the machinist to set up the machine and, and cut out your custom part cutting one custom part, you're paying for all of that setup cost for that one guy doing ten parts.

00:17:52:13 - 00:18:31:13

Speaker 2: Jonathan Barlow
Well, you just spend a little bit more time on the machine so they don't charge you like ten times the cost. So it turned out to be pretty economical to do that me how much a spare parts. So we built our, our space units, our ground units. It was just a lot to manage that. I think it was a huge challenge managing all of the parts and pieces and trying to keep track of everything and keep everything straight and get all our documents in order because we still had to be able to to satisfy our our quality assurance people who are signing off on everything building being built as well as our the people who

00:18:31:13 - 00:18:51:07
Speaker 2: Jonathan Barlow
wanted our verifications for all the things that they said we needed to do. You know, we had people telling us, no, you have to you have to show that it's not going to hurt astronauts, that it's not going to, you know, do short out things or be a hazard in this way. Or have parts break off of it or any of that stuff.

00:18:51:07 - 00:19:10:04
Speaker 2: Jonathan Barlow
So we had to keep track of all of our testing data in order to be able to submit these documents to these people. To showing that that yeah it was going to be safe and not going to kill anybody. You laugh But yeah, that's you know, it's loss of of property you know, it's not going to de-orbit the space station.

00:19:10:04 - 00:19:17:12
Speaker 2: Jonathan Barlow
It's not going to kill astronauts. Those are like the main everything kind of ties back to that. It's not going to break anything. It's not going to hurt anyone.

00:19:18:09 - 00:19:23:03
Speaker 1: Sabrina Barlow
Yeah. OK, so and you got to build Astrobee right. You got to be kind of in charge of that.

00:19:23:14 - 00:19:33:22
Speaker 2: Jonathan Barlow
I got to turn some screws too. Yeah, it was great. That was the fun part. all the documents where that was a big, big chore. But we got through it.

00:19:34:18 - 00:19:38:12
Speaker 1: Sabrina Barlow
And then was there any, any stories of testing do you think.

00:19:41:13 - 00:19:53:13
Speaker 2: Jonathan Barlow

No. I mean, we we test to find problems and we found problems and we had to fix problems. But I don't think there's anything really worth sharing there.

00:19:53:14 - 00:20:04:12
Speaker 1: Sabrina Barlow
OK, would you like to quickly go over the like and the on ground situation you have set up and like the identical ones and how that helps?

00:20:06:25 - 00:20:14:26
Speaker 2: Jonathan Barlow
OK, so on the ground, a lot of stuff right now that's on the ground. So there's only three.

00:20:15:05 - 00:20:16:08
Speaker 1: Sabrina Barlow
And by on the ground

00:20:16:08 - 00:20:46:28
Speaker 2: Jonathan Barlow
Astrobees and one Dock in space. We have on ground in the lab, we have on ground operator workstations and other stuff on the ground that we do as well. So let me go bit by bit. So on the ground in the lab we have a lab that we call the Granite Lab because it has one big slab of granite in it, which is really cool because it's nice and flat and level and we can use what's, what are called air bearings kind of you can think of them as like a reverse air hockey table.

00:20:47:04 - 00:20:51:22
Speaker 2: Jonathan Barlow
The air comes out of the puck, it floats just like an air hockey puck would.

00:20:52:03 - 00:20:54:20
Speaker 1: Sabrina Barlow
To kind of recreate.

00:20:55:05 - 00:21:17:00
Speaker 2: Jonathan Barlow
To give a frictionless. Yeah, it gives it a frictionless motion on the on the table, just like with the air air hockey puck, you know, you hit the puck and it goes flying away, right? Very low friction. It's the same thing. Only these air bearings can hold a lot of weight because Astrobee is big and heavy, right? So we can put it on an air bearing, we can run it around.

00:21:17:00 - 00:21:39:23
Speaker 2: Jonathan Barlow
It has real physics in two dimensions, which means it can go forward and backward and rotate around and it obviously can't do all of the same rotations. And it can like fly doesn't have that

kind of power to hold its own weight in gravity. But we can do experiments on the table and we can have it move around to do a lot of the same things.

00:21:39:24 - 00:21:43:21
Speaker 2: Jonathan Barlow
We can rehearse what we would have to do on orbit. We could rehearse that in the lab.

00:21:43:25 - 00:21:45:21
Speaker 1: Sabrina Barlow
It like kind of mimics the anti-gravity.

00:21:46:21 - 00:21:55:07
Speaker 2: Jonathan Barlow
Well, it mimics the, the physics of having very low friction and being able to move with low friction. Just under the Astrobee propulsion systems.

00:21:55:13 - 00:21:57:11
Speaker 1: Sabrina Barlow
And that helps kind of prepare.

00:21:58:18 - 00:22:23:06
Speaker 2: Jonathan Barlow
Well, it helps us as, as the as the testers and users of the system. It helps us to be able to rehearse and prepare. So we might have a user come in and put their software on and, and try something out and we actually had this happen with realm that the one that I talked about, they came and they put their software on and and tested it looked fine in the lab.

00:22:23:23 - 00:22:47:13
Speaker 2: Jonathan Barlow
So this is an example of where we don't catch everything in the lab. But turns out that one of those rotations that we that we couldn't test in the lab had a sign error so when they thought they would rotate up, they actually rotated down it's always the sign error. Right. It's math. It's the way it goes. There was a sign error since that time we said, OK, now we really need to put it.

00:22:47:13 - 00:23:10:26
Speaker 2: Jonathan Barlow
So we designed a way to put be able to put Astrobee on its side so we can also do other rotations. We can't have it do all of them all at the same time, but we can put it on its side to do some of those others yeah. Because, you know, things like that happen and that's something that can be fixed in software, but you just need them to know that it exists in order to be able to fix it.

00:23:10:26 - 00:23:28:09
Speaker 2: Jonathan Barlow

So we do a lot of testing on the ground to save time for when it's in space, because when it's in space, that's when you're getting your really valuable stuff and you don't want to spend time with something that you could have fixed it's astronaut time. It's all the effort that went into it, all the people time that the ground people time that went into it.

00:23:28:12 - 00:23:47:07
Speaker 2: Jonathan Barlow
Like there's a lot of effort that goes into running one of these things in space and it's really worthwhile. But you don't want to be fixing something that you obviously could have fixed on the ground because then you're like, Oh, why did I waste why'd I waste the time doing this when I could have fixed that in the lab?

00:23:47:11 - 00:24:26:04
Speaker 2: Jonathan Barlow
Right. So we test a lot in the lab. We have a simulation that people can run, our users can run, which will do the full three dimensional rotation and motion in a in a simulated ISS so they can see what the behavior should be. All that stuff so that's the lab and the simulator. But then we also have a workstations, which is a piece of software that we developed as part of Astrobee to kind of do a 3D visualization of what Astrobee looks like, but also where it is relative to the International Space Station.

00:24:26:04 - 00:24:49:02
Speaker 2: Jonathan Barlow
So we have a rough geometric model of the space inside of the space station. And when Astrobee reports to the the workstation where it is, you know, X, Y, Z coordinate frame, it can put Astrobee there in the correct orientation so it can look so the user can see, oh, that's where Astrobee thinks it is, and we use that a lot.

00:24:49:29 - 00:25:32:10
Speaker 2: Jonathan Barlow
And compare that to the actual video feed that sometimes we get an external to Astrobee. and say, oh, Astrobee looks like it's there and it and it matches where it thinks it is. So okay. well yeah, the ground work is just a visual visualization tool. The, the localization algorithms that Astrobee is using is more like the GPS where it's figuring out where it is and then it's reporting that down to the ground and where and when that comes to the workstation, the workstation puts a little a little it's like, it's like on your Google Maps, right?

00:25:32:12 - 00:25:52:07
Speaker 2: Jonathan Barlow
It has a little dot that represents where you are, puts it on the map right. Or where somebody else is. If you have they've had if they have their location shared with you right now, it updates periodically. It's the same kind of thing, only this is a 3D representation and so you not only get where it is on a map, but you get OK, it's this high and facing this direction, right?

00:25:52:07 - 00:25:56:09
Speaker 2: Jonathan Barlow
So we give as much information to the user as we can.

00:25:57:07 - 00:26:10:11
Speaker 1: Sabrina Barlow
Cool. OK, is there any other cool examples of science that Astrobee is doing right now? I know you've given a lot, but is there any other that stand out

00:26:11:13 - 00:26:13:24
Speaker 2: Jonathan Barlow
yeah. I mean, you say I've given a lot. I've Given two.

00:26:13:25 - 00:26:14:15
Speaker 1: Sabrina Barlow
You've given a few.

00:26:15:03 - 00:26:33:03
Speaker 2: Jonathan Barlow
I've given a few. There are. I think I personally think that the science that gets done using Astrobee is the really cool part. Like Astrobee is cool. I like it, but it's cool. I think it's mostly cool because you can do cool stuff with it, right?

00:26:36:12 - 00:27:08:02
Speaker 2: Jonathan Barlow
So we talked about realm doing the logistics, the RFID tags and finding RFID tags. I talked about the SVGS and doing localization. So we have two users. One that's that one that's actually the Japanese space agency, JAXA, and another one that's called Zero Robotics that run student programing competitions, and they're targeted as college students. And then I think like middle school and high school students that get to participate.

00:27:08:11 - 00:27:43:24
Speaker 2: Jonathan Barlow
Yeah. So JAXA does, I think I think it's college level for JAXA and then their robotics. I know it's middle school, high school targeted. And so students get to participate in early rounds of the competition. You know, they're writing their code and then they're running it on the simulation. I think early on they get graded based on their simulation results and then the final rounds are done on on the actual hardware in space, which is really cool to see and it's exciting for students to be able to do, you know, have their code run in space, which is super cool.

00:27:43:24 - 00:28:11:09
Speaker 2: Jonathan Barlow
And they often do a really good job. So that's really cool to see we do. We've done a couple of two different payloads that had gecko inspired adhesives. So geckos, you know, they can stick

to flat surfaces, they can walk up like glass panes of glass and things like that. And scientists figured out, you know, why they've done why they're able to do that.

00:28:11:22 - 00:28:33:14
Speaker 2: Jonathan Barlow
And other scientists have taken that research and said, Oh, well, can we make materials that will do that? And so they've come up with these materials that can actually act like a gecko foot and stick to flat surfaces. And so we've had some users who have changed out the gripper on Astrobee with a gripper that has this gecko adhesive.

00:28:33:14 - 00:28:36:03
Speaker 2: Jonathan Barlow
And so they can actually go and stick to a flat surface.

00:28:36:28 - 00:28:37:09
Speaker 1: Sabrina Barlow
What's its current Gripper.

00:28:38:12 - 00:29:03:24
Speaker 2: Jonathan Barlow
Its current gripper. So it Astrobee has a perching arm, which is part of the basic Astrobee system, which it fits in one of those payload bay that I described. It provides the connection and the power and the communication and then it can unfold its arm and grab on to a handrail and then it can turn off its propulsion and and just hang out there for a longer periods of time so it doesn't have to waste as much energy use and battery if it doesn't need to move around.

00:29:03:26 - 00:29:30:00
Speaker 2: Jonathan Barlow
It just needs to record for a while or, or something like that. So we've done that a little bit we did some demonstrations early on and getting Astrobee that was part of the development project was getting it to actually perch detect a handrail and perch on it on a handrail. So we were able to successfully do that. And we actually coincidentally, one of the astronauts had gotten lost earlier in the day.

00:29:30:00 - 00:30:19:25
Speaker 2: Jonathan Barlow
So we perched we were able to pan over and see the other Astrobee and like, oh, now we can get unstuck. And so we were able to get our own Astrobee unstuck using our our own perching arm, which is kind of a a fun moment to use one Astrobee to rescue the other. Astrobee in a sense, we've had another user that was called Sound See, that is, they just barely finished up and they were trying to use microphone arrays, trying to use microphone arrays to to detect anomalies with machinery and things like that and create a sound map inside the inside the ISS

00:30:19:25 - 00:30:48:29

Speaker 2: Jonathan Barlow
And so they were they were on they well, they had a microphone array, which is which is directional. So as Astrobee points in a certain direction, they can see that the sound is coming from directly in front of it or from off to the side. So they get angle information about where the sound is coming from. And then Astrobee can move to a new location or point in a different direction to get more information so they can kind of create a a grid map of all of the inside of the

00:30:48:29 - 00:30:49:22
Speaker 2: Jonathan Barlow
ISS and where the sound is coming from

00:30:49:23 - 00:30:50:21
Speaker 1: Sabrina Barlow
So they're recording different spots.

00:30:50:21 - 00:30:51:05
Speaker 2: Jonathan Barlow
Mhmm.

00:30:52:11 - 00:30:52:21
Speaker 1: Sabrina Barlow
OK.

00:30:54:29 - 00:31:18:23
Speaker 2: Jonathan Barlow
So yeah. So the theory there, there was two parts that one was like generating this heat map type thing where they can show where noisy spots were on an on, on and on, like a model of the inside of the ISS and the other one was yeah Could they detect changes or, you know, potential failures of machinery or things over time?

00:31:18:23 - 00:31:19:15
Speaker 1: Sabrina Barlow
Based on the sound?

00:31:20:01 - 00:31:21:08
Speaker 2: Jonathan Barlow
Based on the sound, yep.

00:31:26:03 - 00:31:30:18
Speaker 2: Jonathan Barlow
Yeah. So those are the ones that come to mind. I could probably think of more if you need to think of more, but

00:31:30:18 - 00:31:53:06
Speaker 1: Sabrina Barlow
No that's probably good. Thank you. Um, OK. Um, so we already reviewed the story of kind of the birth of Astrobee the proposal, the design and the assembly and then current Astrobee operations are how do those work other than like the science but like in general.

00:31:53:24 - 00:32:20:07
Speaker 2: Jonathan Barlow
Current Astrobee operations. So I talked a little bit about the, the workstation that we, the software that runs the workstation that shows us where the Astrobee is. It gives us the ability to turn the things on and off like the lights or start and stop programs on the Astrobee. We give it a series of points to move to they're called waypoints inside the inside of the space station.

00:32:20:07 - 00:32:22:15
Speaker 2: Jonathan Barlow
And it can move from one point to the next kind of thing.

00:32:24:27 - 00:32:52:17
Speaker 2: Jonathan Barlow
So that workstation can run on on any computer that we need it to. We just have to have the right log in to be able to log in and connect to the right systems. So when we do Astrobee operations because of COVID, we were not allowed to be in the same place at the same time. So we really had to we had already kind of designed the system because we wanted to give as much capabilities to the users as we could.

00:32:52:17 - 00:33:19:00
Speaker 2: Jonathan Barlow
We said they're the ones that are doing the science. Let's let them drive the thing if they want. So we had already put that in place. We ended up using that a lot more than that our users actually do. So we have the ability to, you know, open our computer, our laptops connect to the the VPN, the virtual private network, and talk to the robot from from home.

00:33:19:15 - 00:33:35:22
Speaker 2: Jonathan Barlow
And that's what we had to do all during the lockdowns and that where we couldn't we couldn't go in to work. Since they opened things back up, we've gone in a couple of times. We've kind of gotten in the habit of doing things remotely. So it's been nice at times.

00:33:37:24 - 00:34:08:27
Speaker 2: Jonathan Barlow
But yeah, our operations usually consist of one or two people that are kind of our voice, either with the crew member that's working with us or sometimes with the other people that are directing everything that's going on with the ISS. There's a whole team of people at Johnson

Space Center at Marshall Space, Space Flight Center, which are two centers in Texas and in or don't quote me on that, but I think it's Alabama.

00:34:10:00 - 00:34:31:27
Speaker 2: Jonathan Barlow
But anyway, I'd have to look that one up where Marshall is. I've never been there but there's a lot of people that are managing everything that the crew members are doing and all of the systems on ISS and making sure that that thing is running because they don't want stuff to break. And so there's a whole lot of people that are paying attention.

00:34:31:27 - 00:34:57:13
Speaker 2: Jonathan Barlow
And so we have to communicate with them and so there's two people on our team that are usually doing a lot of that, managing a lot of communication, talking, explaining to them what we're doing while the rest of us are focused on actually running the hardware. And there's usually we usually have a person who's running with that. That GUI that I described, the 3D visualization and giving direction to the robot.

00:34:57:27 - 00:35:23:12
Speaker 2: Jonathan Barlow
And then usually there's another person that's kind of their teammate that's doing kind of the behind the scenes. Just checking me making sure that we're good on battery and data, depending on what we're doing, one or the other of those two people might be starting and stopping things as we go and then if we're doing two Astrobees then we have double the number of, of operators doing it.

00:35:23:29 - 00:35:51:03
Speaker 2: Jonathan Barlow
And then there's usually whoever is doing the investigation like that, the user usually has whoever they need to be there. And they're usually saying making decisions of, you know, do we, do we do that One again? do we do that run again or do we do, you know, do we go on to the next step? Because we we're usually following a procedure which we try to get fairly detailed down to, OK, do this, run this command, do this, do this, do this and that.

00:35:51:03 - 00:36:11:07
Speaker 2: Jonathan Barlow
And it lays out, you know, which of all the people are doing what at any given time so we can always refer back and say, you know, I'm in this step. You know, I just did this, OK, now it's your turn on this next step, those kinds of things. It makes communication a lot more fast, quick if you have a common reference of a procedure to go from.

00:36:11:16 - 00:36:20:25
Speaker 1: Sabrina Barlow

And so this is all virtual now. So and transitioning with covid must have been a challenge. How did that work for Astrobee?

00:36:22:19 - 00:36:51:27
Speaker 2: Jonathan Barlow
So Astrobee had already launched before covid happened, which I'm so glad because I don't know how we would have built the thing we had. We would have been delayed, I'm sure, but we had already built the hardware and sent it to space and we'd already done some operations. So there was there were a few months of learning how to work together as a team because we were used to being in the same room where we could talk to one another.

00:36:51:27 - 00:36:55:12
Speaker 2: Jonathan Barlow
We could look over our shoulder we could do things like that.

00:36:58:01 - 00:37:27:27
Speaker 2: Jonathan Barlow
And so we had to learn how to do that virtually, you know, through through things like Skype or, or teams is what NASA uses. And then what's the other one? I'm blanking on it. Anyway, there's other products out there, but, you know, screen sharing and voice sharing. So NASA has a way of doing all of that but when we need to talk over a problem.

00:37:29:11 - 00:37:41:25
Speaker 2: Jonathan Barlow
You know, we don't need to be told by others that we're talking too much on on the one channel because they assign us one channel to talk on, usually with that with through the NASA's system, which is fine, but we're kind of chatty

00:37:42:18 - 00:37:45:00
Speaker 1: Sabrina Barlow
Is that specifically during test sessions or

00:37:45:22 - 00:38:14:12
Speaker 2: Jonathan Barlow
Yeah, we get specifically assigned that's called the Science Channel that we're that we use for our communications, but that gets listened to by a lot of people. A lot of those people that I said are like monitoring a lot of things. They're also listening into what we're, we're talking about, which they're right to do. But if we're trying to troubleshoot and have a conversation, we don't need to, you know, have that in front of and try to figure out and so we move to

00:38:14:12 - 00:38:15:13
Speaker 1: Sabrina Barlow
And so you move to like a Zoom or whatever.

00:38:15:13 - 00:38:28:28
Speaker 2: Jonathan Barlow
Yeah. Well, so when we're doing that in person, we wouldn't do that over what's called the loops. We wouldn't do that. So everyone could hear. We'd have our own conversation and then we'd tell them over loops, OK, this is what's what we're going to do, what the plan is. We needed to figure out a way.

00:38:29:08 - 00:38:56:10
Speaker 2: Jonathan Barlow
Zoom was the other one thanks We needed to figure out a way to use Zoom or or teams, which is what we use. They're all just product names for the same thing to do that differently so that we can screen share and use our and so other people could see, you know, what we were doing or so. So everyone could see that the GDS, what the operator was doing, there were issues with that

00:38:57:09 - 00:39:12:09
Speaker 2: Jonathan Barlow
Because we weren't allowed to retransmit certain imagery that was coming down from our robot for astronaut privacy reasons. So we had that we had to make special accommodations and ways of operating so that we didn't accidentally do that.

00:39:14:24 - 00:39:19:13
Speaker 2: Jonathan Barlow
But yeah, just figuring out how to talk to each other and when we're not in the same room was, was a challenge.

00:39:19:16 - 00:39:26:10
Speaker 1: Sabrina Barlow
And so you, you've gotten to try it like drive robots from your house.

00:39:27:01 - 00:39:30:03
Speaker 2: Jonathan Barlow
Yeah, I've gotten to drive robots from my house.

00:39:33:19 - 00:39:55:05
Speaker 2: Jonathan Barlow
From a hotel room sometimes if I was on a, on a trip, but I had to, I had to do I had to work while I was on a trip I could do it from my bed if I wanted to, but I try not to do that, feels a little lazy. So I do try to get up, but I don't always have to get dressed if it's because our test sessions happen in the middle of the night.

00:39:56:03 - 00:40:17:04
Speaker 2: Jonathan Barlow

Astronauts are on Greenwich Mean Time, which is just like eight or 9 hours ahead of here. So in the beginning of their day, it's midnight here. So when they do, when they turn Astrobee on the first thing in the morning, that's us here at midnight getting started. And we usually get, get, get like to get here a little bit early.

00:40:17:04 - 00:40:31:26
Speaker 2: Jonathan Barlow
So we're set up and ready when that happens. And then we do our a few hours of set up time and then we run our experiment for a few hours. Then we have a day worth of downloading data and processing all the stuff afterwards. That has to happen too.

00:40:31:26 - 00:40:32:21
Speaker 1: Sabrina Barlow
So you just wake up early

00:40:33:04 - 00:40:37:01
Speaker 2: Jonathan Barlow
Wake up really early, and sometimes don't go to bed till really late that night.

00:40:39:07 - 00:40:55:28
Speaker 1: Sabrina Barlow
OK, um, does Astrobee have any current defined goals that it's working towards? Or undefined.

00:40:56:02 - 00:41:18:07
Speaker 2: Jonathan Barlow
Ooh. Goals. Like I said, Astrobee, the cool thing about Astrobee right now is not the robot itself because it's been around for what's it been four or five years now and not a lot has changed. We've we've made some improvements. We're definitely getting better at localizing and not getting lost was a big challenge at the beginning.

00:41:20:25 - 00:42:00:06
Speaker 2: Jonathan Barlow
But Astrobee itself hasn't undergone a lot of changes. Mostly it's been that the new things, the new users that we're supporting. So where our goals usually involve which users we're going to work with and the new things that we have to do to help them one of the new exciting things that's coming is we're going to try to help out with what's called the ISS safety video where they usually have a crew member with a video camera just kind of pan and go along all the all the walls and all the surfaces inside the ISS

00:42:00:06 - 00:42:19:05
Speaker 2: Jonathan Barlow
And then a team goes back through the video and reviews it all and checks for any issue, any safety concerns. So we're going to try and do that with Astrobee, do it a little bit more automated

save some crew time and maybe make it a little bit easier for the reviewers to go back over it. So that's the hope.

00:42:19:22 - 00:42:21:15
Speaker 1: Sabrina Barlow
Cool because astronauts time is.

00:42:22:26 - 00:42:53:14
Speaker 2: Jonathan Barlow
Astronaut time is valuable. Yep. Because they're up there to not just to live but to do a job, right? They're there to do science and and the more time they can spend doing science, the more the more we get out of all of the, the money and things that are go into having people in space. So it's a lot better that they spend their time doing science rather than fixing the toilet or fixing this or you know, running a camera along the walls.

00:42:53:18 - 00:42:59:08
Speaker 2: Jonathan Barlow
If they don't have to do that, they probably would choose not to because they can spend that time doing more valuable things.

00:43:01:02 - 00:43:11:03
Speaker 1: Sabrina Barlow
OK, are there any like original goals or that of Astrobee that haven't happened yet? that You still want to happen or that are something like that.

00:43:12:02 - 00:43:38:17
Speaker 2: Jonathan Barlow
Any goals of Astrobee that haven't happened that we still want to happen? Well, so this. Yeah. So Astrobee was designed with kind of three purposes. One was to do research, which we've been doing all along. Even before Astrobee was fully done, people were lining up and saying, we want to do research using Astrobee and they still are. Or we've we, we have more people wanting to use Astrobee than we have time.

00:43:38:20 - 00:44:16:08
Speaker 2: Jonathan Barlow
that we could actually do it. So the other two things, one was for it to be a mobile camera, which we haven't fully gotten to yet. And the other one was to do like a mobile sensor survey, which I think with this, this doing the safety video panorama thing would pretty much count for that. So a mobile camera would be more like if an astronaut's doing a task or somebody wants to go look at a particular piece of hardware because they want to see what the, what the display is reading out.

00:44:16:21 - 00:44:45:19
Speaker 2: Jonathan Barlow

They could call crew member to go do it, but Astrobee could also go do it right. And maybe Astrobee could sit there for a while and watch the, the numbers so that the, you know, has a camera that could then be fed down to whoever actually owns the hardware. And they can be reading, seeing the readouts and understanding what's going on with their hardware rather than having a crew member look at it and like try to talk over the phone what's going on or spend the time to go grab a camera and set up a camera to do that same that same job.

00:44:47:11 - 00:45:08:24
Speaker 2: Jonathan Barlow
So that that I don't think has gotten quite to that point. But where I think we're approaching the point where we might be asked to do things like this, this third task of doing sensor surveys with just a camera right now, but to be able to go around and do that as a useful task, a useful job for Astrobee I think is pretty exciting.

00:45:09:13 - 00:45:13:07
Speaker 1: Sabrina Barlow
So and so that's kind of the future goals of like Astrobee

00:45:13:19 - 00:45:13:25
Speaker 2: Jonathan Barlow
Yeah.

00:45:17:04 - 00:45:31:04
Speaker 1: Sabrina Barlow
How do you personally think Astrobee will or should be important in the future that can be used in the next year, in the next several years, or in the next? The new technology that's coming.

00:45:32:15 - 00:46:04:05
Speaker 2: Jonathan Barlow
I think Astrobee will always be important in the sense that people are always going to want to test their things in space. And having a way to test them in space is is critical for that. You got to have a way to test it. And I think people like having the ability to not have to design and build their own thing, build something else just to test their thing.

00:46:04:15 - 00:46:21:23
Speaker 2: Jonathan Barlow
They want to build their thing and test their thing and the rest of it they don't really care so much about, which is great for them. That we can provide that to them. We can provide a way to move their thing around and they can focus on their thing and test their thing. So I think that's a very important capability now.

00:46:21:28 - 00:46:44:21
Speaker 2: Jonathan Barlow

Does it have to be Astrobee? No, There's other ways to do that with robots. There is no current robot on space station that can do what Astrobee can do, which is to accept pretty much any user and put have them attach their hardware to it and provide them with a way to move around and get power and data to their hardware.

00:46:46:17 - 00:46:56:27
Speaker 2: Jonathan Barlow
There are other other user, other what would you call facilities, other groups Nanoracks is what comes to mind, that.

00:46:57:05 - 00:46:57:16
Speaker 1: Sabrina Barlow
Is that.

00:46:57:19 - 00:47:32:08
Speaker 2: Jonathan Barlow
The Nanoracks is a group I was about to describe that they are they're a group that provides power data. It's like, it's like having a spot on a shelf with a plug and a Ethernet jack where you can put your, your thing and you could plug in and it can have a place to sit and you can, you can talk to your hardware and you can run your experiments and things on it, which, which is very similar to what Astrobee provides.

00:47:32:08 - 00:48:05:03
Speaker 2: Jonathan Barlow
But they're stationary they don't get to move around and do those kinds of things. So I think that's a unique capability that Astrobee can provide. For ISS That's probably the most that it will be able to provide. I don't know. I guess we'll see if there's, if people can come up with other ways to use it. It I think it's going to be in the near future a very important way to test potential technologies for future NASA space stations like Gateway.

00:48:05:03 - 00:48:29:01
Speaker 2: Jonathan Barlow
Gateway is one that you may have heard of. I probably mentioned it to you at one point. Gateway is a planned NASA space station in orbit around the moon, which is farther away. So right now, rockets are going up to the ISS every I don't know I don't even know what to say once a week, once a month, something like that.

00:48:29:01 - 00:48:48:15
Speaker 2: Jonathan Barlow
But a fairly regular pace there are crew members on there. 24, seven. There's always a human there. Gateway is not planned to operate in that same way, at least not at the beginning. They're planning on it being unmanned, which means nobody on it for months at a time.

00:48:51:08 - 00:49:16:27

Speaker 2: Jonathan Barlow
And the ideas that are currently circulating is, you know, it would be nice if we could, you know, launch a launch a rocket there and have it unloaded and stowed and all of that. The supplies and things put away or or stowed somehow and the rocket could come back or do whatever else it needs to do if you don't have humans there to do it, then you need robots to be able to do that.

00:49:17:11 - 00:49:32:22
Speaker 2: Jonathan Barlow
Right. And so if you if you rely on humans to do that, then you have to wait till the humans get there and then send up all of the supplies. Whereas if you could have robots, you could set up the supplies first. That can be all clear and then the humans could come and do the science that they need to do.

00:49:34:02 - 00:49:53:28
Speaker 2: Jonathan Barlow
So that's that's a planned NASA space station that that would really benefit from having robots and Astrobee is a great way to test that because we have the ISS, we know how to run it. We know how to test how to do all this. How to how to run those tests in that environment. So it's good. It's a good way to do it.

00:49:55:15 - 00:50:09:08
Speaker 1: Sabrina Barlow
OK, well, yeah, in some of my research, I found the ISS is going to be retired in 2030. So like what are your thoughts on this? What do you think the future of humans in space is going to be?

00:50:10:28 - 00:50:16:16
Speaker 2: Jonathan Barlow
I applaud you for doing your research. I that number has changed.

00:50:17:06 - 00:50:18:23
Speaker 1: Sabrina Barlow
Oh, has it.

00:50:18:23 - 00:50:38:23
Speaker 2: Jonathan Barlow
Is it Every year? when we first launched Astrobee, it was like 2022 and then it was 2024. And now you say 2030. It doesn't surprise me they want to get a lot of money and time and, and work went into launching the ISS and they're going to get everything they can out of it. They want to get as much science as they can.

00:50:39:19 - 00:50:58:14
Speaker 2: Jonathan Barlow

They're trying to, you know, make things run as smoothly as they can, as long as they can so they can get as much value out of the ISS as they can. So it would not surprise me that the ISS lasts until 2030. It would not surprise me that, that a few years from now we read that it's 2035 or 2040.

00:50:59:27 - 00:51:24:23
Speaker 2: Jonathan Barlow
I think there are a lot of people trying to predict and figure out how long things are going to last, how much work we're going to have to do to maintain it. Is it worth continuing to maintain or do we, you know, scrap the ISS and start over? I don't know. It's been a great facility. It's been a great collaboration between a lot of countries.

00:51:24:23 - 00:51:50:12
Speaker 2: Jonathan Barlow
I hope that if they do decide to replace it, whatever replaces it is the same has that same spirit of cooperation and trying to include as many countries as they can. I think that sounds great. Is is Gateway going to replace ISS? I don't think so. They might be able to learn new things at Gateway that they can't learn at ISS.

00:51:50:18 - 00:52:10:19
Speaker 2: Jonathan Barlow
So would be gateway be valuable. Yeah. Would be valuable to have both probably. Would we see other commercial companies that could do an ISS like thing where instead of it being run by governments, it's run by companies. Yeah, I think that's a real possibility. I think companies are already talking about doing that.

00:52:12:25 - 00:52:33:05
Speaker 2: Jonathan Barlow
We'll see when that happens. Probably when that starts to happen, the government will probably say, you know, maybe it's time to stop putting money into the ISS and we'll just, you know, rent some space on this other space station. So who would who knows

00:52:33:16 - 00:52:40:25
Speaker 1: Sabrina Barlow
OK. Anything else about the future of humans in space after or as the ISS is kind of being phased out.

00:52:41:25 - 00:53:06:05
Speaker 2: Jonathan Barlow
Oh, the futures of humans in space, I, there is so much speculation that goes on about what humans are going to do, whether it's go to Mars, go to other planets, go out of the solar system. I don't like to speculate NASA has a plan of going back to the moon with Gateway there are plans of going to Mars.

00:53:07:03 - 00:53:35:21
Speaker 2: Jonathan Barlow
There are plans for a lot of different things. I think that we that there are a lot of challenges and by by facing the challenges, we push ourselves to learn more and do more and try harder for new things. And I think that benefits us as humans because we are stretching our capabilities and having to design new things and learn new things.

00:53:35:21 - 00:54:03:24
Speaker 2: Jonathan Barlow
And it benefits in a lot of ways. I hope that continues. I think it's a benefit to for us to work together towards a common goal. If we didn't have space exploration as a common goal, I don't know what would fill that gap. Certainly there are problems on Earth that require attention, and some people might say that money is better spent on Earth doing that.

00:54:03:25 - 00:54:25:22
Speaker 2: Jonathan Barlow
I, I don't argue that point. I think we need to fix our problems on Earth, but I think that humans in space is inspiring and it's a great goal to work towards and it pushes us to, to learn more and try harder and do more I say why Not do it all. do both not do it all. You can't do it all.

00:54:25:22 - 00:54:31:28
Speaker 2: Jonathan Barlow
But why not? Why not fix our problem, our problems on earth and still explore space?

00:54:32:27 - 00:54:37:24
Speaker 1: Sabrina Barlow
Yeah. OK. Do you want to give a really quick description of Gateway since you've been talking a lot about that?

00:54:37:28 - 00:55:07:11
Speaker 2: Jonathan Barlow
I don't have a lot that I can describe about Gateway I don't. All I know about it is a an orbiting a space station that orbits the moon. I think there was discussion of being able to have something that goes from Gateway down to the moon for, you know, transferring down, down to the surface. I don't know much about that at all.

00:55:09:15 - 00:55:30:16
Speaker 2: Jonathan Barlow
I know that it's currently in development and parts of it might start to launch in the next five years or so, but I don't have a whole lot of information other than I've heard talk of it that they're strongly considering robotics as an important part of Gateway

00:55:30:16 - 00:55:30:28
Speaker 1: Sabrina Barlow

And so Astrobee is really

00:55:31:12 - 00:55:58:05
Speaker 2: Jonathan Barlow
And so Astrobee would be a good way to test. So, you know, people have asked, well, could you take Astrobee and put it on Gateway? Well, yeah, you could. Could you do a better job of designing Astrobee specifically for Gateway? Yeah. If the Gateway has a slightly different environment, you might be better off redesigning and that's just a trade off, you know, do you take something you already have and put it in a new environment and just accept the performance that you get?

00:55:58:27 - 00:56:14:06
Speaker 2: Jonathan Barlow
Or do you spend the time and effort to redesign it for that specific environment and try to get a better get a better performance Out of it, that there will be people that will make that decision that won't be me

00:56:15:07 - 00:56:22:23
Speaker 1: Sabrina Barlow
Okay. So Isaac, I know, is very strongly connected with Astrobee. You want to give a brief description of Isaac and.

00:56:23:02 - 00:57:05:24
Speaker 2: Jonathan Barlow
Yeah, I don't even remember what the Isaac acronym stands for. I'm sure it stands for something, but it is a project that uses Astrobee, one I haven't talked about yet, hey. it's a project that uses Astrobee that is trying to take information that is produced by normal. ISS life support like systems and information that is available on Astrobee or other robots and try to use those together to both detect problems and and fix problems.

00:57:06:18 - 00:57:41:06
Speaker 2: Jonathan Barlow
So one example, a demonstration that we did is if a theoretical sock got sucked onto a vent, and was blocking the air. You know, the environmental system might notice the drop in pressure and say, hey, there's something blocking this vent, but has no way currently of figuring out what that is or doing anything about it. So that kind of in that scenario, the system there, their Isaac software is kind of the glue that says, oh, this this system is reporting an anomaly here.

00:57:41:06 - 00:58:03:06
Speaker 2: Jonathan Barlow
Let's send Astrobee to go look at it and inspect it. Oh, it's a sock on the on the intake vent. OK, let's go send a robot at the time that they were talking about Robonaut, I don't know if they're still talking about Robonaut but at the time it was Robonaut. So they said, let's send Robonaut over to go and pick up the sock and clear that vent.

00:58:03:21 - 00:58:27:20
Speaker 2: Jonathan Barlow
Right. So that that's an example scenario of a way to detect and diagnose and respond to a problem. You know, it could be something as simple as that it could be, oh, we had a meteorite strike and now there's a pinhole in a module and, you know, there's a drop in cabin pressure. You know, what's, what's going on in this module?

00:58:27:26 - 00:58:49:24
Speaker 2: Jonathan Barlow
Why is there a drop in cabin pressure? You know, the pressure systems as look drop in pressure. So it's increasing its output to try to keep the pressure. But hey, it's something's leaking. and So how do you how do you detect that? How you. Well, the system might say that there's something going on, OK, so we could send Astrobee over to try and locate it.

00:58:50:16 - 00:59:16:11
Speaker 2: Jonathan Barlow
And Robonaut to go over and try and patch it, which, you know, is, I would think, a higher priority because you're you're losing air on the system and you're losing resources as you're as it's with all the leaking and the power going on. And if you don't have humans there in person to do that repair, then you either have to shut down the whole module, which you might lose science if you had plants growing or something like that.

00:59:17:06 - 00:59:35:04
Speaker 2: Jonathan Barlow
Or you have to have some way of responding to it without a human. But you could think, you could think tele-op. But when you start to go to the moon, you know, it's not right to ISS it's a second or two delay. So, you know, it's a little bit back and forth. You wait for the response and that kind of thing.

00:59:36:10 - 00:59:55:24
Speaker 2: Jonathan Barlow
But you get to the moon, it's much farther. So it's it's a longer delay. And it gets hard to do tele-op things that things just take longer so it's nicer tele-op uh tele-operation so operating something from a long way away, right? So just gets harder. The longer the delays are, the harder it is for a person to manage.

00:59:55:24 - 01:00:14:00
Speaker 2: Jonathan Barlow
And I mean, you can do it, but it just takes longer to do so. It's nice to have a robot or a system that can respond to those things. At a, at a quick way without having a person have to give every step of the way, have a command of every step and exact positions, those sorts of things.

01:00:14:19 - 01:00:24:03

Speaker 1: Sabrina Barlow
So Isaac is the kind of the middle man it helps, or it's the software that helps Astrobee like kind of diagnose. And then another robot comes over

01:00:24:03 - 01:00:54:18
Speaker 2: Jonathan Barlow
Yeah, I like the middle man. It's the yeah, it's the it's, it's an attempt to join a lot of these systems that are currently very separate systems. The robots on ISS that are there are very separate. They don't talk to each other very much. I mean, Astrobees talk to to other Astrobees, but there are other free fliers on ISS that we don't have a way right now of communicating and coordinating with them to do a common task like this.

01:00:54:23 - 01:01:18:12
Speaker 2: Jonathan Barlow
Like with Robonaut, before Isaac, there was no way for those two things to work together. There's environmental monitoring and systems that monitor, you know, the gas levels and the pressure levels and all and the power levels and all these things but there was no way for those systems to coordinate with the robots and say, hey, we need, you know, can you go fix this?

01:01:18:23 - 01:01:39:05
Speaker 2: Jonathan Barlow
Right. There's there was always there were always humans in between there. So there's the guys, there's the systems that are providing the data. And then there's somebody that's sitting there reading the readouts and saying, oh, there's a there's a problem, right? And then they go talk to the robot guys and say, hey, there's a problem here. Can you drive with your robots over it?

01:01:39:06 - 01:01:58:15
Speaker 2: Jonathan Barlow
So there's people on the ground, but when the time delay gets larger, the response time just takes a lot longer. And doing that, the repair takes a lot longer. And it just yeah, it's a lot more involved when you have people involved

01:01:58:15 - 01:02:12:12
Speaker 1: Sabrina Barlow
Yeah. And then so and I, I actually my question was is, is Isaac a system on Astrobee itself or is it more of like a system that's using Astrobee?

01:02:13:17 - 01:02:38:00
Speaker 2: Jonathan Barlow
I would like to think of it as the second. Isaac is not just Astrobee. They do use Astrobee as part of what they've done and a lot of the demonstrations That they've been able to do were on Astrobee because other things just weren't set up to be able to support, a guest user coming in

just using their hardware like Astrobee was, because Astrobee was designed that way from the beginning.

01:02:39:20 - 01:03:07:02
Speaker 2: Jonathan Barlow
So it has that advantage but if Astrobee was replaced by something else, they would use something else equally and they would not do only Astrobee they would do, they would, they would. Their whole concept doesn't really work. If it's just Astrobee, it needs a lot more information from other systems in order to be able to function the way they have envisioned it.

01:03:07:26 - 01:03:13:05
Speaker 1: Sabrina Barlow
Astrobee is like a model for this model. I guess.

01:03:16:10 - 01:03:37:08
Speaker 2: Jonathan Barlow
Astrobee is one part of their of their capabilities there. That one part of the whole just like with realm, like I described, they have hatch readers they have drawer readers. and They have something that needs to go find stuff right because hatch readers can tell them, Hey, somebody just moved a bunch of stuff from this, this module to that module

01:03:38:08 - 01:03:41:16
Speaker 2: Jonathan Barlow
And the drawer readers can say, Hey, you know, these things are in this drawer.

01:03:45:09 - 01:04:03:02
Speaker 2: Jonathan Barlow
And then the thing to go find lost things is like, Hey, we haven't seen it at a Hatch reader. It's not in a drawer. We don't know where it is. We need something to go look for it. Right? So it's it's three different parts, and having just this one part might be useful, but it's more useful when you have all the parts together.

01:04:03:02 - 01:04:03:27
Speaker 1: Sabrina Barlow
working together.

01:04:04:22 - 01:04:36:24
Speaker 2: Jonathan Barlow
Yeah. I would say the same thing with, with Isaac, like, yeah, it's useful to be able to tell Astrobee to go look at inspect something, but the real value I think in Isaac and this is just from an outsider perspective, but I think the real value in Isaac is for it to be able to detect and respond to problems that that need to be responded to and do that without having a large, you know, time delay of, OK, now somebody has to go plan yeah.

01:04:36:27 - 01:04:56:02
Speaker 2: Jonathan Barlow
If they can if they can shorten the time between, hey, something's going wrong here to getting information about what's wrong. I mean, that right there is a win. And, and then if you could shorten the time from getting information about it to be able to take action and fix it that would be great.

01:04:58:03 - 01:05:04:17
Speaker 1: Sabrina Barlow
OK, and then where does NASA hope to go with this technology? We already started talking about that with like kind of just.

01:05:05:10 - 01:05:06:25
Speaker 2: Jonathan Barlow
You talk about Astrobee or Isaac.

01:05:07:09 - 01:05:25:20
Speaker 1: Sabrina Barlow
Um, well, the combination kind of just the model of working together of

01:05:26:05 - 01:05:54:20
Speaker 2: Jonathan Barlow
So I I don't know that the question makes as much sense with Astrobee I don't think there's a lot of plans of like, oh, Astrobee needs to go here and do this. I think we are still learning with Astrobee what, what what it will be useful for these panoramas did I mention the word panoramas, this, this replacement of the safety video where an astronaut is kind of panning along with the with a video camera.

01:05:54:20 - 01:06:09:08
Speaker 2: Jonathan Barlow
We have a different way of doing it, which is a lot more like Google Street View where you can like go to a point and like use your mouse or whatever drag and look all around up and down at all around.

01:06:09:10 - 01:06:10:16
Speaker 1: Sabrina Barlow
It's like a big panorama

01:06:11:17 - 01:06:43:16
Speaker 2: Jonathan Barlow
Yeah a big panorama. That's that's the kind of product that we would produce. Not a video. It's not the exact same thing. So it's not a direct replacement but I think it will be very useful and people are already saying that lots of people will find lots of uses for that particular product

when Astrobee produces it. There may be other things that people come up with, but I don't think we I don't think NASA has like a roadmap for Astrobee at this point in time.

01:06:43:17 - 01:07:28:07
Speaker 2: Jonathan Barlow
Of where we expect Astrobee to go. Right now. The plan is use Astrobee for science to learn like we have goals and things of how we're going to support our users and how we're going to improve our system and those sorts of improvement goals and I certainly think we want to get as much use out of the time and effort that went into designing and flying Astrobee as we can as long as it makes sense to do that and as long as we have users that want to use it and we're providing value to users or to for the safety banner or whatever, whatever tasks that are providing value that Astrobee can do,

01:07:29:16 - 01:07:55:28
Speaker 2: Jonathan Barlow
I think it makes sense to keep doing it, but it's also very useful as a testbed for testing, like I said, for testing technologies and things that people want to put on Gateway for example, if somebody thinking like I mentioned, you know, you watch a rocket to Gateway or you want to offload all the cargo, well, you got to have robots that are going to be able to do that.

01:07:57:22 - 01:08:47:11
Speaker 2: Jonathan Barlow
From where those robots are going to look like are they going to look like astronauts that are like robotnaut where it's like a humanoid type thing or are they going to look like Astrobee? Well, we can test that with Astrobee on ISS now so that that can inform those decisions. So as a testbed, I think Astrobee's very useful as far as where NASA's going with Isaac, I think that the hope is that Isaac will be a a part of gateway, that it can become a way of operating the space station, whether it's the international space station or Gateway or whatever it is a way of operating so that again, I would say it's it's kind of

01:08:47:11 - 01:08:56:22
Speaker 2: Jonathan Barlow
an optimizing crew time so that more time so that problems and anomalies can be responded to quickly without having to involve humans all the time.

01:08:58:26 - 01:09:00:29
Speaker 1: Sabrina Barlow
Yeah, OK.

01:09:03:02 - 01:09:24:26
Speaker 1: Sabrina Barlow
I what it. So we haven't talked about robotic caretaking, but so I know the I think is the term for what you've been talking about kind of doing things without humans. So called robotic caretaking.

01:09:24:26 - 01:09:47:10
Speaker 2: Jonathan Barlow
Yeah. Yeah. So you mentioned that term robotic caretaking is just. Yeah, robots making sure things stay ready without, you know, without a human around, you know, making sure things that are broken get fixed or that things are still running smoothly, even though there's not a person around to do it.

01:09:48:11 - 01:10:10:04
Speaker 1: Sabrina Barlow
And Astrobee's job as you said, what isn't necessarily to do that in the future necessarily, but kind of as like a springboard or like a learning experience to help us do that in the future. Right? Yeah. OK, so as our last question. What's your favorite part about working with Astrobee?

01:10:11:03 - 01:10:12:15
Speaker 2: Jonathan Barlow
Oh, boy. That is a loaded question.

01:10:12:15 - 01:10:14:21
Speaker 1: Sabrina Barlow
or being on this team. you can

01:10:14:27 - 01:10:36:26
Speaker 2: Jonathan Barlow
Oh, being on the team so I can answer that one's really easy. My favorite part about being on the Astrobee team is the people. I work with some really awesome people and that is my favorite part like I enjoy I honestly enjoy working with the people that I work with. I enjoy the work that I do. It's interesting, it's fun, it's challenging.

01:10:37:15 - 01:11:04:16
Speaker 2: Jonathan Barlow
It sometimes makes me want to bang my head against the wall. I try not to do that. it Hurts. but it it is so the people that I work with are so awesome. They're humble, they're smart, they're hardworking, they're dependable. We've all got our things. Everyone's got, you know, their own quirks and we but we laugh together. We do stuff together.

01:11:05:10 - 01:11:17:15
Speaker 2: Jonathan Barlow
I honestly just enjoy working with the people that I work with. So hands down, working on this team that is my favorite thing, the people. So what do I enjoy most about Astrobee?

01:11:19:29 - 01:11:53:19
Speaker 2: Jonathan Barlow

Other than the people it's all the cool science that we get to see. We like kind of be on the in the background helping to make happen like there are so many things that people are using Astrobee for that is more than we would be capable of doing on our own. We get to help make it happen and we get to kind of be on the inside like seeing, Oh, this is how they're going to do that this is how they're going to do that and just helping people to, to do really cool science is a lot of fun.

01:11:55:20 - 01:11:57:00
Speaker 1: Sabrina Barlow
Thank you so much for your time.

01:11:57:16 - 01:11:59:12
Speaker 2: Jonathan Barlow
You're welcome. Thank you.