Getting Curious with Jonathan Van Ness & Kathy Sullivan

JVN [00:00:00] Welcome to Getting Curious. I'm Jonathan Van Ness and every week I sit down for a 40 minute conversation with a brilliant expert to learn all about something that makes me curious. On today's episode, I'm joined a triple threat: a geologist, astronaut, and oceanographer Kathy Sullivan, where I ask her: *What's It Like To Live On The Edge?* Welcome to "Getting Curious." This is Jonathan Van Ness. I'm so excited for this week's episode because we have a scientific triple threat. We have Kathy Sullivan. You are an oceanographer. You're a geologist. You're an astronaut. And also, if people don't know, you are the first person that ever has completed a spacewalk and gone to the deepest part of the ocean known to man. So the question for today is, what is it like to live on that edge? Kathy Sullivan, welcome.

KATHY SULLIVAN [00:00:50] Hey, Jonathan, great to be with you.

JVN [00:00:52] You are an, just an icon in those, in the three scientific fields that I just said. I mean, you are, you just have such an incredible storied career. I've spent the last few days watching some videos of you on, doing spacewalks, seeing you. I mean, I just have the chills. It is just so cool.

KATHY SULLIVAN [00:01:19] It's been a grand fun adventure, that's for sure.

JVN [00:01:20] I mean, I will say. So I kind of wanted to think about today's interview in kind of three chunks. I wanted to kind of cover space in the first bit, and then more of the ocean journey in the second bit, and then kind of zoom out and talk more about science a little bit more generally in the end. But it's interesting because you, from what I understand, you got your start in oceanography and then got recruited into NASA, right?

KATHY SULLIVAN [00:01:47] Yeah, I was, I was in grad school working on a PhD in basically deep sea floor geology when NASA started putting the advertisements out for the space shuttle program. So just really fortuitous timing.

JVN [00:02:02] So you get into NASA and you, you realize that you are going to go to space. What is that conversation and process like?

KATHY SULLIVAN [00:02:13] It's a very obscure and mysterious process, actually. So 35 of us joined NASA at the same time in the Group of '7-, 1978. I think they were about a dozen and a half astronauts who've been around since Apollo or earlier. So they were, you know,

the long timers. We joined them. And who got tapped for what flight and why? It was I mean, maybe somebody knew. But I've never talked to anyone who knew that. You could, you knew which big boss-boss would probably had the final say or made the main recommendation. But so you could kind of guesstimate the head of the astronaut office, the chief astronaut, clearly makes an input. The boss above that, head of flight crew operations, clearly has a decision factor. Maybe there's some back and forth with NASA headquarters. You know, here's what we're thinking.

But if what I just said bears any resemblance to what actually happened or not. I don't, I don't actually know. So you go about your business, your assigned different technical support roles. I always liken this to starting in the mailroom of a big company. You start doing, you start doing the building block work, the, the stuff that makes the space flight happen that you never see in public, that never gets any press or any fanfare. But it's the essential engineering and planning and testing and preparing. There's scads of that that lead up to every single spaceflight. And first, you become a member of several of those teams, you, and you learn your way. You learn how spaceflight comes together. You learn how the bits and pieces work by being in the trenches and doing them. And then at some point you get a phone call or a summons to go over to the big boss's office, often how it happened. And he would just inform you, you're going to be on this flight in that role. Oh, OK. You know?

JVN [00:04:06] So do you? I don't-. This is going to, prepare yourself, because this is going to be an interesting question to lead into the ultimate point. But have you seen the Netflix documentary "Cheer"?

KATHY SULLIVAN [00:04:15] I have not.

JVN [00:04:16] OK. Well, it's about this cheer squad in Texas, and there's this whole thing about like you want to "make mat" because that's the team that gets to actually go to the big national competition. And then, like the team that doesn't make mat, like doesn't get to compete. So it kind of makes me think of like, just because you get enrolled in NASA, does that necessarily mean that you're going to get to go to space?

KATHY SULLIVAN [00:04:36] The basic answer is yes. I mean, NASA does not recruit 100 people planning to winnow down to 30. They, they work harder on the front end to be very careful in their selection. So they, NASA selects with the intent to fly you. There might, something happen along the way that takes you out of play, yes, but it's not, it's not like the football squad or cheerleading tryouts where there's 100 of you trying out and 10 of you are gonna get to go. Unless something very odd happens, you've been chosen because it's clear and they're confident you got what it takes. You can fly, you'll be

successful and you could be in a car accident or have a physical problem that would take you out of contention. But it's not NASA's plan to winnow you out.

JVN [00:05:23] OK, then I have one more little baby question along these lines. So do you think, could you conjecture. that maybe like while you all are learning things and, like, your training together, do you think that, like, your boss and the boss's boss would be like, you know, I think Kathy and so-and-so would work well together because they're both, you know, like this? And maybe these two wouldn't be great on the same flight because of this and that? Or do you think because there's so much re-, like there's so much winnowing, like on the front end that they probably wouldn't even make it to those 78 people if you couldn't all work together?

KATHY SULLIVAN [00:05:54] Yeah, I think there's, in this selection process, there's definitely a judgment that you are the kind of character and personality. It's a blend of independence and confidence and collaboration or team capability. You need a chemistry like that. And clearly, there's been some assessment of that in the selection process. Definitely every, you know, observation is happening all the time. So how did you do on this technical assignment? Where did you seem to fit technically? Did you succeed? They're, they're watching you develop and, and do the work. And that's part of the ongoing assessment, I'm sure, of everybody. In the shuttle era, shuttle flights were fairly short, you know, maximum in the latter stages, program, maybe three weeks max. But in the early days when I was there, you know, a 10 day mission was a really long mission.

And so I think your point about who gets along, who really gets along well with someone else, I suspect was a very minor factor. You had a lot of things to do on a flight, let's say, 10 experiments or lots of satellites to deploy. And so it was more I need this skill set and that one and that one. So that's you three people. And it's a 10 day sprint. And there's a long list of things that have to get done and get done properly. And I sort of don't care if you guys really love each other, go get it done. And if you come back and you become, you've become best friends and you socialize forever, that's great. And if you come back and you don't talk to each other for, I don't really care. You know, go get it done. And if you want to go fly another time, it would be really wise of you to not let little silly personal stuff get in the way of getting the mission done properly. So you guys, you're grown ups, sort this out amongst yourselves, but get it done.

Nowadays with the space station crews, there's, you can't expect people to just blast through minor personality mismatches for six months or nine months. So there is more consideration for that. There's more evaluation of those factors in selection and there's more consideration of that as you're putting the crew together. And then there's also more the structure of the working day is and your life aboard is set up to recognize everybody's

going to need some downtime and everyone's going to need a little bit on their own chill time. So there's, there's room and time in the way the mission is run to be sure that the humans can stay human and have those relief valves.

JVN [00:08:21] But that wasn't really the case when the missions were like 10 days? Like that more became the case once they became much longer?

KATHY SULLIVAN [00:08:28] That's right. Because, because the Skylab experience, there was earlier experience, submarine crews, Antarctic crews. You could look at analogs to long, long durations, missions with small groups of people in confinement. Submarines, Antarctic bases, spacecraft. And so there's some common lessons and insights about how people work in those environments that NASA has been very careful to study and now they're providing some of the data into that field.

JVN [00:08:57] What scientifically changed about the shuttles? So there's like the shuttle era and then is there like, what's the next era?

KATHY SULLIVAN [00:09:05] So I would break it down this way. There was the space shuttle era when that's, that's all you had the shuttle and its cargo bay. And NASA was still learning, you know, it was a brand new spacecraft. So you get better and better and you sharpen your pencil, learn how to do more with it as you get more experience with it. So the first flights were two, three, four days. By the latter part of what I would call the pure shuttle era. They were up to 10 and maybe 12 days. That was kind of learning how to stretch all the consumables. You could then say the next era was the space station assembly era, and that was still using the space shuttle. But a lot of the flights were station assembly flights. Go up with some new module lift it up with the robot arm, attach it to the station, do some number of spacewalks to connect all the fine wires and plumbing. And then the shuttle was retired in, you know, 11 years ago. And so now we've been in this space station era where launch and landing still have to be dealt with, but you've got two, two to four people who really are oriented towards living and working, doing engineering and science aboard the space station for typically six months at a time.

JVN [00:10:22] So how big is the space station up there? Is there more than one?

KATHY SULLIVAN [00:10:27] There's right now just the International Space Station, just Canada and Japan and the United States and Russia and the European Space Agency and other nations timesharing it, if you will. And how big is it? It's got, it's got a wingspan. These big girders that go out to the left and the right to hold the big solar arrays and radiators. Those are, those are longer than a football field from wingtip to wingtip. But that's just-.

JVN [00:10:58] Each? Or altogether?

KATHY SULLIVAN [00:10:59] Altogether, longer than a football field. That's just all open structure out in the vacuum of space. Nobody lives in that. The parts the modules in the center where, where the astronauts live and work. They've got about the same pressurized volume as the inside of a 747 or a, you know, kind of typical sized four bedroom house, probably not a McMansion kind of house. So it's a fair amount of square footage.

JVN [00:11:30] But is the house, like, stretched out like a tube or is it like, like up in space, like, is it like? Is it like? It's not like the shape of a house.

KATHY SULLIVAN [00:11:37] No.

JVN [00:11:37] Is it more like the shape of, it's more like a 747 shape.

KATHY SULLIVAN [00:11:41] It's not at all the shape of an actual house. It's a, it's a, it's a living and working area that's been assembled by connecting cylindrical building blocks. So, so think of a cylinder, usually 50-ish or so feet long, and then 15-ish feet out on the diameter on the outside. And then you connect them end-to-end and you make this, it's kind of a race track. So if you, they connect in an almost sort of a race track together.

JVN [00:12:11] Oooh. That's interesting to think about. So you join NASA in the first class that had women in the ranks, which is incredible. Which is in, that's in 1978? You said.

KATHY SULLIVAN [00:12:25] 1978. Yeah, the class of 35 people of our class, included six women and also the first people of color and minorities, three African-Americans and Asian-American.

JVN [00:12:37] Which is incredible. But when you also think about, like, 1978. That's literally only 9 years before I was born. Like so I think, just, it's a quick, important reminder that when you think about like Jim Crow and like all of these things, like "They ended like in 1964, it doesn't affect people now," like, actually, like, the effects of that leeched into science, it leeched into like so many different spaces that we--thank you for pointing that out. I think that's incredible. But so 1978 you join, and then you make your first walk in 1984, which was that on your first flight? The first spacewalk that you went on?

KATHY SULLIVAN [00:13:10] It was.

JVN [00:13:12] So what was that like?

KATHY SULLIVAN [00:13:15] It was great. Well, that was, you couldn't get a better first flight assignment. For for the time, it was a relatively long mission, eight days, and the orbit we were going to fly in was tilted 57 degrees to the equator, which meant we would see a lot of the Earth underneath us. Most shuttle flights stayed much closer to the equator. You would not see as much of North America or Asia, for example.

JVN [00:13:40] I need you to explain that to me one more time. I'm sorry.

KATHY SULLIVAN [00:13:43] Ah.

JVN [00:13:43] You just used a degree and stuff. So the Earth-.

KATHY SULLIVAN [00:13:47] Ok. So think of the Earth as a, close to a sphere, the equator through the middle of it. And when you, when you plan a space mission, one thing you decide is it's called the inclination. So where do I want the spacecraft to fly? Right, like, right over top of the equator? That's called geostationary. Then you do the mathematics and you can put the spacecraft there. For the shuttle, you usually just launched straight due east from the launch site in Florida. And that, that sits at a latitude of 28 and a half degrees. But you're letting the Earth help you launch, right? The Earth is rotating that way and you're letting the Earth help you launch.

JVN [00:14:32] Aaaaah.

KATHY SULLIVAN [00:14:33] "Due East" means you get more energy because the Earth is helping you a lot. But what that results in if you look at a map of what part of the Earth goes underneath your spacecraft while you're flying in that orbit, it'll be a little band between 28 and a half degrees north and 28 and a half degrees south because your orbit is tilted that much to the equator.

JVN [00:14:56] Right.

KATHY SULLIVAN [00:14:56] For some flights, like the, my first mission, a big objective, all the big objectives were Earth science-oriented. Geology and oceanography. So the scientist needed to see more of the Earth. So we sacrifice some of that energy boost instead of launching due east, you know, we steered a little more to the north. And if you plot, so our, our orbit was not in the equator and it was not like the launch site. It was like that. And as, as we went around the Earth and the Earth spins underneath us, we could see, we were over top of everything, all the land and all of the planet between 57 degrees north and 57 degrees south. So get, get your World Atlas out sometime and find those two

lines of latitude. And over the course of our eight days, we had hundreds of orbits to see all of those parts of the world.

JVN [00:15:52] That's incredible. So you had a number of orbits. So how many times did you go all the way around?

KATHY SULLIVAN [00:15:59] I'd have to go look at the stats for this. It was a, I've, I've done a total of 350 laps around the planet. And that was probably 142 or something like that.

JVN [00:16:13] Oh my God. So now when you got assigned to this mission, did you know you were going to have to do a spacewalk? Or was it more, like, "Gravity" situation when you got up there, they were like, Kathy, this thing came undone, honey, you're gonna-. I'm sure they wouldn't say, "honey," but did they, were they like, you're going to go fix this thing?

KATHY SULLIVAN [00:16:27] Yeah. You don't hear "honey" very much on air-to-ground.

JVN [00:16:30] Right. I just realized. Yeah.

KATHY SULLIVAN [00:16:31] No, ours, ours was a planned spacewalk. We were, we were going to demonstrate some specialized tools that had been built that would let you refuel a satellite on orbit, which is still not done to this day. So you put fuel in a satellite and you, you seal that fuel tank every which way from Sunday because you mainly don't want to lose any of the fuel because of leakage.

JVN [00:16:57] Right.

KATHY SULLIVAN [00:16:57] And the tools, the tools that we designed, basically said, but wait, I changed my mind. So I want to go up to one of those satellites that we see old every which way from Sunday. And I want to have tools that let me undo all of that and put a fuel line in and refill it. The trick is we're not talking gasoline like at your local gas station. We're talking really nasty, highly explosive and very toxic stuff. So I want you to get all those caps and seals off and put that fuel line in. But I want there to always be two physical barriers between you and that fuel while you're doing that. So wait. I'm going to get a fuel line in there, even though there's always two barriers? I mean, it sounds like it's going to take a magic trick to do that. But it, all it took was the magic of very clever engineering to come up with a set of tools that would let us do that. So that. So we knew we were going to do a spacewalk. It was planned. It had that purpose and it was built into the schedule. We, we did have one little thing go wrong with the shuttle's primary communications

antenna before we got to the spacewalk day. And so there was a little bit of oh, by the way, while you're out there. Kathy, go over to the other side of the shuttle and fix this thing for us.

JVN [00:18:19] So you, OK, OK. OK. So you're out there. So. So when you go out of this shuttle to fix something, what happens? And what are you wearing? Like do you have to wear, like, a special thing to leave?

KATHY SULLIVAN [00:18:35] Oh yes.

JVN [00:18:36] I think you would.

KATHY SULLIVAN [00:18:37] Yeah. So the inside the space shuttle, the environment is just like it is in the rooms where we're speaking. Same amount and composition of air temperature dial. You can control the temperature. Outside. There's no air at all and you're exposed to the full radiation of the sun. So if you, if you're out in sunlight, stark sunlight, no atmosphere scattering things around, it'll start to heat you up like crazy. But. But you're going around the Earth every hour and a half. So half, 45 minutes, you're in the sunlight on the daylight, daytime side of the Earth. The next 45 minutes you're flying over all the parts of the Earth where it's currently night. You're in the Earth's shadow. So you're always going like every 45 minutes from pizza oven hot to Antarctic cold and back again. So you can't survive outside the spacecraft unless you put on a space, space suit. And, and the space suit is, it's a spaceship in its own right. It's just happened to be shaped like your body instead of like a capsule or an airplane. And it's, it's, you have a backpack on the back of it that has the same, the same pumps and fans and motors and oxygen and things in miniature that that let the shuttle keep you alive. That's your life support backpack.

So you're flying your own body shaped spaceship. When you go out on a spacewalk. You're always, like a mountaineer, you always hook onto something. So you're tethered. In case you've made a mistake or slipped or, or bumped something, you won't come loose from the spacecraft. We call it a spacewalk. But in the, in the zero gravity environment around the space shuttle, you're not actually walking, you're, you're moving hand over hand. I mean, think of, watch little kids in a playground when they're playing on the jungle gym. It's, it's like monkey, monkey bars kind of stuff to move around. But, you know, fingertip forces are all it takes. The thing is, your bulky, you know, you, think sort of sumo wrestler suit 'cause the space suit is bulky, it makes you very bulky and on Earth it weighs over, well over 300 pounds. So you get, you have to get used to moving. And it's a little bit of a skill. How much force do I need to use with my arm, for example, to move the mass of my body plus the mass of the spacesuit, but stay smooth and stay controlled. You don't

want to be you, you don't, you don't want to be the Sandra Bullock spacewalker. Sort of. You know.

JVN [00:21:12] I want to get into, no, I want to get into "Gravity." I'm really curious about "Gravity." We have to talk about it in a second. So keep telling me about your spacewalk. So. So you're in the 350-, the, the thing. And then what happens?

KATHY SULLIVAN [00:21:23] Yeah. So it's, it's, you don't just toss this on and hop out. It takes you about four hours to get everything ready. And you need to spend a little time getting your body physiologically ready because the spacesuit contains pure oxygen. So all the nitrogen we have in our body from normal breathing of normal air, you need to let some of that purge out. And that needs to go slow or you'll get, you'll have what's called the bends. So it takes about four hours. You're finally buttoned up in your suit and ready to go and open the hatch and you sort of swim out, hook into your tether and start moving hand-over-hand to wherever you're going to do your work on the shuttle. A lot of these routes have been preplanned and they're special handrails. Look at any spacewalk picture. Any time you see a yellow bar that's, yellow means that's the handhold I put there specifically for a spacewalker to grab onto and use. So a lot of, a lot of preplanning to be sure you can get to all the parts of the shuttle you would need to get to.

And so I was doing this spacewalk with a crew mate named David Leestma. So Dave and I got out and went to the little tool box that was right by the airlock hatch, loaded up the gear we needed and headed, headed back to where this, this model, this mockup of a real satellite was. And that's what we were going, I mean it was complete exact replica of an actual real satellite's fueling system. And that was our task. Go ope-, we sealed it up on the ground really well, open it back up and refill the fuel tank with these special tools.

JVN [00:23:05] And you did that in space?

KATHY SULLIVAN [00:23:08] And we did that in space.

JVN [00:23:10] And that. OK, wait. So did? But since you guys did that and it worked. Did they just realized later that, like, 'cause, did you say that they haven't really done it since?

KATHY SULLIVAN [00:23:18] Yeah. It still really hasn't been done. And it, it's a set of factors. One thing is a lot of the satellites, a lot of satellites that might make the most economic sense to do that on are, and orbits the space shuttle, can't get to and couldn't get to. And then another thing is, it's business calculation. Let's say, you own, let's say you own one of the big communication satellites and that's, it is, they will be in orbit, the shuttle can't get to. But suppose you migrated it down and took it back out. You calculate

the cost of doing all of that and the speed with which the technology advances. It tended to make better economic sense to just replace a satellite rather than refuel and extend its life. And then the shuttle itself turned out to not be anything like as economical or frequent to fly as the early rosy projections had suggested. So, you know, if the shuttle had turned out to be the super, super cheap and super efficient thing it was imagined to possibly be. Maybe the story would have come out different.

JVN [00:24:26] But it's still probably a really important skill because I was thinking about maybe like space debris. So it could be eventually that we really need to be refueling stuff because like, you can't be creating, like those economics could shift.

KATHY SULLIVAN [00:24:38] The economics definitely can shift. And the number of objects in orbit continues to grow and become more and more of a concern. And so, you know, the refueling did not happen via shuttle in the space shuttle era. But you're exactly right. The idea is not gone on orbit repair and servicing, refueling. The idea is not gone. And the engineering knowledge gained through our work and others, you know, it stays in the toolkit. And there are now private sector companies that are creating, designing and creating repair satellites. The tow truck of space, for example, that could fly up to your communications satellite and, you know, maybe remove and replace something that's broken down or maybe repair, refuel it or raise or lower its orbit, things like that. That's, that's maybe starting to come around.

JVN [00:25:31] So, like, so you're in the shuttle. And then when you put on the spacewalk suit, don't you need to, like, go into like another module where like that backdoor closes and then like the hatch opens, because if that backdoor didn't close, wouldn't everything, like, get sucked out or something? Or just like float out?

KATHY SULLIVAN [00:25:51] Yeah, no, that's exactly right. If you're going to, if you design a spacecraft knowing you want to do spacewalks, you build into it an airlock and, think of it like the vestibule or the, you know, the, the outer foyer of a house, if you live anywhere that's got a serious winter. There's an outer front door and then there's an inner front door that's basically same thing as an airlock. So you, you put on the space suit. The inside door is open to the cabin. You get your space suit on, get in the airlock, you close the inside door, make sure everything's working on your suit. Then you start dumping the air out. You don't open the outside door all at once because there's a lot of air in there. It would be explosive. You open a smaller valve and you let the air bleed out. And when there's no air in the airlock, it's the, equal to the outside in outer space. Then you open the outside door and you got into the cargo bay. And when you want to come back in, it's the reverse. You come into the airlock. It's full of vacuum at that point. You close the outside door. You bleed some of the space shuttle's air back into the airlock. So it fills up to the same

pressure as the cabin and then you can open the inside hatch and come back into your crewmates and have your dinner.

JVN [00:27:02] Now then in your big 350 pounds suit, like, where did the tools go? Because I would assume you need like, this thing and that thing to do the job out there. So is there like a pouch or is there like a purse or something in there?

KATHY SULLIVAN [00:27:15] Yeah. Pouches and purses are not really great because your hands are so bulky with the gloves. So what we, what we had were two sockets on the front of the suit and we created, created a little gizmo that kind of looked like a metal H. And you would put, so think of the letter H, turn it on its side and two prongs at the bottom of that would attach in the sockets on the suit. The-.

JVN [00:27:43] Oooh.

KATHY SULLIVAN [00:27:43] Cross, crossbar of the H lifted the the other side, the H up to where you could reach it. And on that top part of the H, the bracket or sockets and places you could attach the tethers for tools. So you would put your tools on this bracket that was mounted to the front of your spacesuit. That way you can see it. It's right in front of you. You could, you could tilt it a bit away from the space suit if you needed to see something more clearly. Or you could tuck it right up against the side of spacesuit if you didn't want to be so bulky. But if you look at, take a look at a YouTube video of the space station spacewalks or even a still photo. You'll be amazed how much stuff is dangling off the spacewalkers. Just like you said you're going on. The space station might be going far, far away. So you're going to load up with lots of tools. And so you'll see the space, spacewalkers' arms are, it almost looks like they're hugging a trash can. The whole space in front of them is full of tools and equipment all around the front of them.

JVN [00:28:48] How many tools, like, did you have? What's like the most tools that you can have on your belt at once?

KATHY SULLIVAN [00:28:55] Oh, boy. There's, there's clever ways to stack and sub-stack things. So when, when I did my spacewalk, the gadget I was talking about, the little workstation gadget had four, four sockets you could stick something into. But sometimes what you put in one of those sockets was a Velcro pouch that held five tools in its own. So a little caddy that carried five other tools. So if you put four Tool caddys in there and if each of those caddys had five tools, you can have 20 tools. So it just depends on what you were trying to do.

JVN [00:29:33] So now, before you go up there, like, do they put you in a pool with, like a mock space shuttle so you can practice the spacewalk like a million times on Earth?

KATHY SULLIVAN [00:29:45] That's exactly how you trained for spacewalks, in very large water tanks. You get an, you get in a space suit. It's a real space suit, but one that's been earmarked to only ever use in the pool. It's never going to fly in space, but it's the real deal. They take that big bulky backpack and the computer off because you don't need the electronics in the water. And they put a shape there. They want, they want you to get, you need to get used to how big and bulky you're going to be. So you've got the same shapes on your back and on the chest. But they're, those are fake. And you get in the water tank and SCUBA divers put the slivers of lead weight around the suit so that you, you're neutrally buoyant. And the SCUBA divers let you go. You're not going to sink and you're not going to pop to the surface. You're going to stay right there. And that's like being weightless, right? If you stop, if you just stop moving, you will just stay right where you are. And then, yes, there's a very faithful good fidelity mockups in our case of the shuttle cargo bay with a, with an airlock hatch, with the handrails, sort of everything quite, all the, all the spacewalk stuff very faithfully replicated. And you go through the motions and you discover bits that don't work. You discover, you make a mistake. You learn a way to do something better. You even start that way developing the tools.

One of the things I think people don't appreciate very much, but really to me it was part of the joy of being an astronaut was if, you know, if you watched Dave and I do that spacewalk, you might have said, oh, these guys are just so disciplined. I mean, it's step one. Step two. Did you follow the checklist? And how, how boring to just sort of go do a checklist all the time. But what that misses is we wrote the checklist. I mean, we started with blank sheets of paper and a group of engineers. And you basically sit down together and say, well, OK. So no one's ever done this before. How do you think we would do this? And you sort of sketch out. Well, you know, we'd, we'd start in the airlock and you open the hatch and we, tools, whatever tools, OK, we need, we'd go there. Right?

And then we'd, Dave would go down the side. Kathy would go down this-. And you, you sort of rough out that choreography and you get in the water tank and you try that rough choreography and you'll find little details you didn't think about when you were just talking it through. And so you modify that plan, you make it more and more refined by doing and testing and trying and learning together. So when it comes to the spaceflight, I didn't feel like some, some robot, or some drone. Just, you know, mechanically going through steps. I felt more like. I mean, I imagine being the composer of a symphony who now gets to conduct it on a grand stage. I wrote this. I imagined it. I wrote it. I refined it. I tweaked it. I worked it with all the musicians so it, we all know how to this right. Now we get to perform this on the grand stage. It's a crazy fun experience.

JVN [00:32:47] It's incredible to think about, just in the, the instances where I watched it. I was so nervous and didn't at all feel I mean, I was like, I feel like it was like such high stakes. But I did feel that you were very disciplined. So I have a question about the practicing for it. So as you're kind of going through these rough choreographies in the pool like 'cause can't you get like the bends thing in the pool? Like in your space suit like don't they have to bring you up with care? And like, I mean if you're down there practicing for like two hours, they, like the SCUBA people can't just come down there and, like, bring you up to the surface real quick, like a lot of time and effort goes into even the practicing, right?

KATHY SULLIVAN [00:33:24] Yeah. Oh, absolutely. And there are a lot of SCUBA divers in the tank with you, a couple of them just watching your suit to make sure nothing's leaking and others helping deliver tools or just work logistics. They all need to watch their time under water, just like any SCUBA diver, and be careful and slow about coming up and down. You're inside the spacesuit and there's some air pressure on you and you're breathing at a pretty normal mix of things. So there's a, yes, you do still have to be careful, but it's a little bit cushioned for the spacewalkers. But you're, you've got the flight surgeons or doctors always there watching times and paying attention and making sure that people don't get so absorbed in the work they stay too long or they surface too quickly. Yeah, you have to keep an eye on the safety factors all the time.

JVN [00:34:15] And then what about like, I would, I was just imagining, like, on all the practices where you're, like doing the rough sketches of, you know, the outline of how you think it's going to work. And then you're down in this pool and you've been like mathematizing and mathematizing and like doing it and figuring it out and then you get down there, what happens when you realize that, like, I need this other tool or like, this didn't go right? Would you ever be, like, dang it, like now we have to go up and rework this because this didn't work and I forgot the thing? And like, would you get frustrated, like if something didn't go right? Because, like, I would imagine it's really frustrating.

KATHY SULLIVAN [00:34:46] Well, but that's the whole purpose of the tank work, is that's where you want to find that thing out. And so, yeah, let's follow your scenario. You get all the way back to where you're supposed to work and then you realize, oh, I, I brought a socket wrench with the 8 inch extension and this thing's further away. I need a 24 inch. In the water tank, you would say, ah, my bad, I should have brought the 24 inch extension, one of the utility dry-, divers bring it to me and someone on SCUBA would bring it in, so you could, you could carry on and someone in the, on the tech, on the engineering console who's tracking and monitoring all this, which would include the engineers that are helping train you. They would note down. They're following through the checklist and they would

make the note and then, oh right, needs to be 24, not 8. And when the test is done, everyone sits down together and goes through. What did we learn? What did we miss? I didn't think this would happen, so I was surprised when I got there. And so and so. Well, OK, let's make a note in the checklists and remind ourselves about that so that when we get into orbit and we're doing it for real. I don't want to be surprised by things that can prevent us getting the job done. There's gonna be wonderful things to be surprised about and enjoy. That would be novel and exciting, but you don't want to find some surprise that means you're stuck and you can't get the job done. Because there's no utility divers once you're doing the real spacewalk. If you forgot it, if it doesn't fit, end of mission. And you know that, you just don't want that to happen.

JVN [00:36:24] Has that ever happened? Or another thing I wondered is like has anyone ever like that in the middle of a, like when you were, like, going to unclip something to then, then use it, like has a tool ever slipped out of someone's hand and then you're just watching it float away like, please don't hit a, like please don't hit the thing, like don't hit the thing! And then it's, like, and then is Houston going like, oh my God, it's go-? Has that ever happened? Or they would never say, oh my God? Like when you're up there.

KATHY SULLIVAN [00:36:47] Yeah. They're probably more cool and composed than that. But it has happened, there have been a couple of incidents. There was one space station spacewalk that, remember I talked about a tool caddy that might carry several tools and takes one clip, but it carries several tools. One of those got away from an astronaut. I don't know quite what was going on, but lost track of it or it wasn't clipped in. And then they noticed it drifting away and it was partway through a very complex spacewalk on the space station. Happily, the way that spacewalk has been designed and the choreography, the cooperation between the two spacewalkers, between them, they had still enough tools to get the whole job done. So one small batch of tools went drifting away. Some engineers are going to start tracking that right away, to be sure, you know, if it's becoming a hazard and might bump into the station. But the spacewalkers, they don't worry about that. They can't do anything about it. They just focus on, well, we need three wrenches to continue and get this done. Between us do we have the right three wrenches? And happily, the answer in that case was yes. And so it did not end up affecting the success of the spacewalk.

JVN [00:38:00] And then what would happen if that box of tools like floating around, like does NASA get, like with the, back to the space debris thing, like is there like a list of like high risk satellites or like high risk stuff that's threatening our satellites or something? Or do you don't have to worry about something that small?

KATHY SULLIVAN [00:38:16] Oh, you need to worry about something that small. You need to worry about, you know, something the size of a blueberry in orbit is doing 17,500 miles an hour. If you got hit by a blueberry in orbit, you would feel like someone dropped an anvil on you. I mean, it's it's a lot of energy. So, yeah, something the size of, even a single tool could be a real problem. And there's a, there's a, the United States has a group that tracks probably 16 or 20,000 known objects that are in space. And they're different radars around the planet that can measure those, goin-, those pieces and satellites going through and calculate what orbit they're in. And so you, you can know where those 16 or 20,000 objects are. And you can calculate whether their orbit is going to come too close to you. And so that's, I'm sure what happened with that tool bag is they, NASA would have alerted that group that does the tracking. You know, keep an eye on this, let us know, send us the math data so we can check and see if it's likely to recontact the space station. And if you calculated that it might recontact the space station, you would make a slight adjustment in the altitude of the station to widen out that miss distance.

JVN [00:39:30] How many flights did you end up going on?

KATHY SULLIVAN [00:39:42] I did three shuttle flights.

JVN [00:39:44] That is a lot of flights. And so coming back, what is that like? Like I mean, like what's the descent?

KATHY SULLIVAN [00:39:53] Yeah. So, you know, it it takes 8 and a half minutes to get into orbit, which are explosive, intense, you know, rocket, rocket engine intense. And that's what accelerates you to 17,500 miles an hour. So obviously, coming home boils down to slow down. On the space shuttle, and one of the, but one of the tricks of orbits is if I want to land here at this point on the Earth, the place I want to slow down is halfway around the Earth away from that. That's just how orbits work. I want to. I'm going to slow down, that means I'm going to lower the height of my orbit. I'm going to lower it so that it-.

JVN [00:40:38] So you have to stop half the orbit 40-, like 45 minutes before.

KATHY SULLIVAN [00:40:42] Like 45 minutes. That's right. You have, you have to do your slow down, your de-orbit burn, halfway around the world from where you want to land.

JVN [00:40:50] Wow.

KATHY SULLIVAN [00:40:51] So and for much of that 45 minutes or so you're still, from an astronaut point of view, you're still in zero gravity, you're still in freefall. You're just falling towards the atmosphere. Now you're falling at an angle that's going to put you in the

atmosphere. And so you've got, I don't know, much of that time, it's just still freefall. Then you start to feel the drag of the atmosphere affecting the cabin. I remember feeling that because the atmosphere is acting on the outside of the shuttle. My seat is bolted to the shuttle. I'm strapped to my seat. And so all of that. That's how all that slowdown gets transmitted. But oddly, you know, my eyes were the last thing to realize that we were going to slow down. I remember feeling just dimly aware of my eyes pressing against the inside of the eye socket because my skeleton is slowing down all the soft organs in my body. And that was one of the most interesting sensations, was realizing my eyeballs were the last things to slow down.

JVN [00:41:56] Wait, so you're in, you're in the shuttle and it's how many of you are up on that one?

KATHY SULLIVAN [00:42:01] My flights were, two of my flights had 7 people aboard and one had 5.

JVN [00:42:07] So is this the first one that you're coming back into that you're talking about?

KATHY SULLIVAN [00:42:11] Yeah.

JVN [00:42:11] And that's the one where you did the walk. You did your walk on your first one.

KATHY SULLIVAN [00:42:15] Yeah.

JVN [00:42:15] And so you're in the thing and you're strapped to your chair, which is strapped to-, did you get hot? Was it hot?

KATHY SULLIVAN [00:42:21] No.

JVN [00:42:20] Is it like Apollo-? Where it gets all hot.

KATHY SULLIVAN [00:42:23] It's, it's blast furnace hot outside, but it's not blast furnace hot inside. There are steps you take to make sure the shuttle is very, very cold before you come back. And the shuttle sheds a lot of that heat. So a lot of heat never even tries to get in. And then you've made the inside super cold.

JVN [00:42:44] And so your, does it feel like you're descending on a plane or does it feel like you're-? What does it feel, like when you say that you could feel your eye socket, your

eyes pressing into your eye sockets, what did the rest of your body feel like on the soft, like what? Can you explain that again? In a different way? Because I want to understand it more.

KATHY SULLIVAN [00:43:04] Yeah. So you're, you're sitting in the shuttle, you're sitting in something that resembles an airline seat until the experience is a bit like descending in an airliner. It's pointy end is going forward, all, all those good things. And when you, when the vehicle starts to hit the atmosphere, you know, the atmosphere is slowing the airplane down, like, it's like a rock hitting the water. So the atmosphere acting on the outside of the shuttle. And your seat is bolted to the shuttle. So your seat will slow down and you're strapped into your seat. So your body is slowing down. But I had this interesting experience on my first flight of kind of realizing my seat belt actually is holding my skeleton in place. You can feel the straps, shoulder straps, on your rib cage for, and shoulder blades. And the soft, soft organs of my body are going to be restrained by the skeleton. And I became aware that because I could feel just a little bit of pressure where my eye, the soft eyeball was still going slightly faster than the skeleton. And I, I, you just never feel, whoever feels pressure of their eyes trying to sort of outward? And it was not big and it was not like, oh, my God, my eyes are going to pop out. But it was sort of, when are you ever aware of pressure around the rim of your eye? Outward pressure. And it was just a fascinating sensation.

JVN [00:44:35] Was there turbulence?

KATHY SULLIVAN [00:44:37] There's virtually no turbulence in a shuttle landing. It's just a progressive deceleration, slowly you feel the force of gravity, but first you feel the fact, what you feel first is the deceleration, is the slowing down. Just like in a car. If you, someone hits the brake, you go forward like that a little bit into your seat belt. Well, your body is still trying to go forward while the seatbelt is holding you back with the shuttle. With the shuttle decelerating. There, around Mach 12, 12 times the speed of sound. The shuttle would hit a little region of the atmosphere where you'd have just a burst of turbulence. It felt kind of like going over a railroad crossing, just bump, very short, very stiff. And then it was just back into a glide, smooth glide.

JVN [00:45:32] Then a parachute comes out, right?

KATHY SULLIVAN [00:45:35] With the shuttle in my era, the shuttle just came in like a, like an airplane.

JVN [00:45:40] It did, oh yeah.

KATHY SULLIVAN [00:45:41] Yeah. Much steeper and much faster than a jetliner. But basically like an airplane. And it was a glider. So you've got to be precise on making the runway because you don't have engines to add some power and adjusting. So you're a big chunky glider and it would land, you know, just land on the back two wheels and slowly let the nose down and roll out on the runway. Later on, but none of this, this didn't come about while I was still flying, but NASA did later add a drag chute. So once the shuttle had landed like an airplane, you pop a parachute out the back tail just like a drag racer when it's trying to slow down. And that would just help slow the shuttle down, save some wear and tear on the brakes. Things like that.

JVN [00:46:29] And then, but in this, like, what Apollo was it in the movie? What, I can't re-, what.

KATHY SULLIVAN [00:46:36] Apollo 13.

JVN [00:46:36] Yes, um, so those ones, they, that little capsule came out in the ocean, doesn't it?

KATHY SULLIVAN [00:46:41] Yeah, the Mercury, Gemini, and Apollo did, well, their reentry process was the same. You have to slow down halfway around the Earth from where you want to land. They came in a bit, a little bit steeper. And when they got to, well, they got through all the hot part of the atmosphere and sort of down into the normal place where airplanes fly, then they pop three parachutes out the top of the capsule. Capsules now suspended like a teardrop underneath the parachute. And they would land in the ocean and the dragon capsule that took Doug Hurley and Bob Behnken up to the space station back in May. That's going to come back to Earth. They're going to leave the station tomorrow and come back to Earth. And they are, that's also going to be a water landing. So that's going to look like the Apollo landings.

JVN [00:47:32] Wow. Interest. OK, wait, one more question about, well, ok, two more. I accidentally, like, talked through all of the ocean part, but we're going to get there really quick. But I have so many questions about space, I can't help it. You said that the fuel was like, really toxic, highly-. So is it like, so it's not. Is it like a literal different chemical than gasoline as we know it? It's like a whole other thing?

KATHY SULLIVAN [00:47:52] It's a whole other thing than gasoline, as we know, it is called hydrazine, monomethylhydrazine. And it's just, it's virtue for the rock, for rocket fuel. In that it's got a lot of explosive umph in small quantities, but it's also very toxic, very poisonous. So tiny bits of it.

JVN [00:48:13] What does it look like in a jug? Is it clear?

KATHY SULLIVAN [00:48:17] It would look like a red liquid.

JVN [00:48:20] Red liquid. Interesting. So was there ever a point where you just like, really nervous, like before the spacewalk, like before the landing is there ever? Like this one time I was flying from Perth to Sydney and there was the biggest drop in, like, altitude I've ever felt in my life. There's like a good 15 minutes where I was, like, holy shit. Like I really, it was like the scariest flight I've ever been on. Which apparently is, like, common for that weather pattern down there. I never knew. But like, were you ever super nervous on any of your three? Was there? Or just the most nervous?

KATHY SULLIVAN [00:48:52] I mean, not nervous, like, I really thought, we're losing it and this is all going very bad. You know, certainly a mix-, odd mixture of-. When I was I think going into spacewalk is an interesting mix of super focus and mildly anxious because now you're doing it for real. Now it's not the water tank and it's like, you know, it's on stage. This is the, this is the final take. And you care about getting the work done. The engineers that put all that work into it, the purpose, the reason, the money. That's all in your hands now. So do right by that and your own reputation, your opportunity to fly again. You want it, you know, you want to do well. Or I'm certainly wired that way. Probably all astronauts are wired that way. But very familiar, that's a pretty familiar thing for me by the time I get there, I mean, I've been, I've been out at sea on research ships. The stakes are not going to be, they don't evolve as rapidly as they do flying around the Earth in a spaceship. But, you know, same kind of thing. It's, you're there. You're responsible for something. There's a purpose involved that's important to you and to your own future. And a lot is in your hands, a lot of responsibility. And you feel that. I didn't. But I didn't feel that in a hands ringing, oh, my goodness, oh, my gosh way. I felt that in sort of a focus and let's go way.

JVN [00:50:21] So the movie "Gravity." How accurate was all that? Like especially the part when that one astronaut, like, got out of the space station and it was like the part where I had to turn my head away because I feel like there had just turned into like a hole or something. It was like a very intense-, that wouldn't really happen? Or would it?

KATHY SULLIVAN [00:50:37] I don't remember that exact scene, but let me say this about "Gravity." The visuals were great. I mean, pretty, pretty nicely done. None of the physics was right. So you remember the scene where she's trying to reel Clooney back in, and like fingertip apart, and suddenly he sort of drifts. Suddenly he starts moving away. She could have reeled him in with one fiber of human hair.

JVN [00:51:09] Oh. Because of gravi-, like-.

KATHY SULLIVAN [00:51:11] Because they're both weightless. And there was not anything propelling him away. So just slowly, gently, literally on one fiber of human hair. Could have pulled him back in. If he really wanted to disappear and leave her, he would have to push off and propel himself away. You know, it starts at working on the Hubble, then they pop over to the International Space Station, then they pop over to the Chinese space station. Those are all in such different orbits. It's, it's not poetic license. It's just flat physically impossible to do that. And if I said, if I said to you, I took my boat out on San Francisco Bay and it began to sink, so I walked to the moon. That sentence is just as feasible as that scenario in "Gravity." It's impossible.

JVN [00:52:03] I'm obsessed with you. I mean, I already was. But I love that little thing. OK, we're going to take a really quick break, and then we'll be right back with more Kathy Sullivan after this. Welcome back to "Getting Curious," this is Jonathan Van Ness. We have Kathy Sullivan. So you come back from your last flying mission and at what point do you get the opportunity to just casually go to the deepest part of the ocean known to man?

KATHY SULLIVAN [00:52:28] Yeah, that was a delightful surprise. I had been following Victor Vescovo, who built the world's first reusable, repeatable, go anywhere in the ocean submersible. And I watched him, or followed the work as he did his five deep expedition in 2019. Pretty cool stuff. And then out, totally out of the blue, in late 2019, I get an email from him. He's planned expeditions for 2020, he's going to go back to the Challenger Deep in the Mariana Trench and he's decided that one thing he'd like to do on the 2020 expeditions is take the first woman down to the Challenger Deep. It's time. You know, this is crazy. I mean, there's only been 7, 7 people down there at, at the point that he's e-mailing me, and he thinks it's time and he thinks that should be me. He says he talked to a lot of people as he was considering, you know, who, who would you invite if you were going to do that? And my name kept coming up. So evidently, that's how that happened. And needless to say, I said yes.

JVN [00:53:33] So just if anyone doesn't know the Challenger Deep is?

KATHY SULLIVAN [00:53:38] So the Challenger Deep is in what's called the Ring of Fire, which is these, these sort of festoon of super deep trenches that ring the Pacific Ocean from off the coast of Peru and Chile, off Cal-, Central America, Washington, Oregon, the Aleutians, Japan, all the way around and down to the Philippines. This is, the Mariana Trench lies east of Guam. That's the big island in the Marianas. And the Challenger Deep, and these are all arc shaped. So they're curved. And the Challenger Deep is at the sort of bottom southwest tip of the Mariana Trench. And it's just this extra deep part of the

trench. What do I mean when I say extra deep? The hole, I mean, 11 kilometers. I mean, essentially 36,000 feet deep.

JVN [00:54:31] That's like as high as most flights. That's higher than most flights fly.

KATHY SULLIVAN [00:54:36] Yeah.

JVN [00:54:38] It's like the same height-ish.

KATHY SULLIVAN [00:54:38] It's the same height-ish. If you're on a transcontinental flight across the U.S. or, you know, Tokyo to Chicago or something, you're probably flying around 35, between 35-37,000 feet.

JVN [00:54:51] So is the Challenger Deep like, is it always down there?

KATHY SULLIVAN [00:54:55] So it's, it's a trench. So think of it as a slit in the ocean floor, a curved shaped slit in the ocean floor. So it has, it has sidewalls. It's, it's very, it's a pretty narrow zone that, that is that deep.

JVN [00:55:10] But it's not manmade? It's not like a manmade like, you know, like-.

KATHY SULLIVAN [00:55:15] No.

JVN [00:55:15] International space station in the ocean. No, it's just an area.

KATHY SULLIVAN [00:55:17] No. It's a, it's a big geological feature. And why does it exist? It exists because the, the floor of the Pacific Ocean is moving west, northwest and it's getting pushed under the Asian plate. So where those two plates collide, they buckle down. And that makes the deep, like the crease of a fold. So it's always there. It's a big geological feature and it's super deep.

JVN [00:55:45] So in 2020, you got to go to the deepest place on Earth?

KATHY SULLIVAN [00:55:50] I did. I got in a little two person submersible called "Limiting Factor" with the owner and pilot Victor Vescovo. It's kind of a cozy little cabin, a sort of think, think economy, economy airline seat with the seatbelt sign on all the time. But, you know, no obnoxious person in the row in front of you leaning their seat back. Getting down there is a four hour elevator ride. It's very smooth. It's very calm. We just chit-chatted and monitored the submarine systems and checked in with the surface on a regular basis. Our plan was to spend four hours on the bottom, basically doing a mapping survey, running a

transect and measuring the depths. We had an electrical problem come up about an hour and a half into that, so we surfaced sooner than we had planned. And it's another four hour elevator ride back up to the surface.

JVN [00:56:44] Were you nervous about the electrical problem?

KATHY SULLIVAN [00:56:47] No, it was, it was pretty clear what it was. You know, you've got a lot of pressure trying to help every little molecule of seawater get into all the electronics. So it's, it, it's common on submersible's going this deep that you'll have little gremlins in the electrical system if there's the least bit of water getting in there. And the system's designed with fuses and circuit breakers. So they're going to stop something becoming a big problem.

JVN [00:57:14] What's the shape of it? The shape of the thing that took you down.

KATHY SULLIVAN [00:57:17] The shape, the shape that matters in a submersible like Limiting Factor is a sphere because that's the part you care most about. It's the pressure sphere. And ours was about five foot diameter titanium sphere with a wall thickness of about three and a half inches. So that's the shape it takes to resist all the pressure of the deep sea. You're going to be inside that shape. The next question is, well, then what do you put around that shape in the case of Limiting Factor, it's basically a rectangular shape and that's thick, it's a little thicker than the sphere is wide. So it's about 6 feet thick. And from 10, 10 or 12 feet, horizontal and vertical, and that carries the elect-, the electrical stuff, the brackets for the weights that hold you down. Batteries, the compe-, the computing stuff and a lot of it, a lot of that is what's called syntactic foam. It's the buoyancy that's going to bring you back up to the surface. We think of Styrofoam as being buoyant. But Styrofoam is basically a little plastic and a lot of air. And if you took that down to depth, it would just get crushed and it would lose all the buoyancy, not be able to bring you back up. Syntactic foam is, the simpl-, the simple way to think about it is sort of the super strong glass version of Styrofoam, that does not lose its buoyancy. So you can take it down. The pressure at the bottom of the Mariana Trench is 1200 times the pressure that we're under here at sea level. It's 16,000 pounds per square inch.

JVN [00:58:57] Oof!

KATHY SULLIVAN [00:58:58] It's 8 tons per square inch. An elephant per square inch.

JVN [00:59:03] So is there a window? Like or was there cameras that you were watching outside the-?

KATHY SULLIVAN [00:59:08] Yeah, there are both cameras and windows. So this, this subversal has three view ports. They look sort of out and down. And lots of cameras on the outside. Several high definition cameras and even one 4K camera. First time a 4K camera has gone to that depth.

JVN [00:59:25] Did you see any crazy animals on your way down? Or like, what was the coolest thing you saw down there?

KATHY SULLIVAN [00:59:30] Yeah, we were, we were not pausing on the way down to look for animals, and we didn't want to spend our battery power on lights on the way down. So we just went straight down because our goal was mapping, not biology. We went straight down and we were sort of cruising above the bottom, 4 to 6 feet off the bottom. So I saw plenty of signs of critters, you know, tracks on the bottom, and little pockmarks and little mounds, almost like you would see at a sea shore that tell you there's critters living in the upper few inches of the sediment and feed-, hiding and feeding on that stuff. And there, there's one kind of critter that we see down there that just lives on the sea floor called the sea cucumber. A little guy, sort of large potato size, I would say. And we saw a number of those scattered along the bottom. There are not fish or octopus, the kind of normal critters we think about in the ocean. They don't come anywhere near this deep. We were, we were several kilometers, probably a mile, at least a mile deeper than they would be.

JVN [01:00:33] Were the rocks just like rocky colored or was there any interesting colored rocks?

KATHY SULLIVAN [01:00:38] So we didn't get to any rocks on my dive, but the two dives later, they worked along the edge of the trench where you see some of the wall structure and they were a little bit drizzled with sediment. Dark colored, drizzled with sediment. Clearly, I'm a geologist, too, so clearly it was the salt, the salted kinds of rocks. You can tell that from some of the shapes. And in some cases they saw this interesting golden, orange crustacean on it, which is probably signs of some chemosynthetic life. So some sort of algae or bacterium that doesn't get its energy by converting sunlight into energy. It works off of chemical reactions in the deep, dark, cold.

JVN [01:01:23] I'm going to have to have you on to get to talk about, if I could ever get more of your time, to talk about ocean stuff and talk about rocks 'cause it's interesting. I mean, we only have a few minutes left. And one of the things I wanted to ask in the third part of the interview before I accidentally spent 55 minutes talking about space because it was so interesting, I couldn't get it together, is some of the research that I got to do on you before, is I learned that your dad was an aerospace engineer.

And I have this annoying habit where I compare everything to gymnastics and figure skating, because I don't know what's wrong with me. But I do. And one thing that I've noticed in that sport is that like so many people that get to that elite level either had a parent who was willing to like, that already knew about the sport a little bit or knew what it took for that child to go that distance. And I feel like the distances that you've gone in your profession are extreme. They are the highs of the highs and even the lows of the lows or the highs of the highs. So, I mean, you are, you're a boundary breaker. You are a trailblazer. And so for young women and also specifically young women of color, people that have not had the opportunities that you have had with what you've learned to get to where you've gone, if there is any young people who are interested in science or are interested in space, interested in geology, oceanography, what do they need to know?

KATHY SULLIVAN [01:02:38] I think what's powered me through all of that have been, I would say, three things. An endless, wide ranging curiosity. And a spirit of adventure. I'm someone who, ooh, I want to try that. Ooh I want, you know, ooh, I wondered and sort of lean in. And sort of an active wondering, which is kind of what adventure is in a sense. And then, you know, hard, hard work and stick-to-itiveness. Some grit. Like I definitely, I mean, neither my parents went kind of route that I went. But what they did to enable and, and set me up to be able to do that is always fed my curiosity. Never put any stereotype boundaries on me. As a very little girl was interested in all sorts of things that quote unquote, "normal" little girls or little girls typically don't do. Never once got a signal from either of my parents of “you should be doing something else.”

Both, both of my parents were equally invested in both me and my brother. So I would get alone time and adventure time with my dad and he would get it with my mom and vice versa. And, you know. They also never bonded us by them, so I'd never heard, if I came home from school with a bad grade in something, which I was too eager and keen, that rarely happened. But if I did, I never got like, oh, don't worry, dear. Mommy wasn't any good at math either. I never got the sort of permission to bail out. In our family, it was recognized. We all have, or the ethos was yes, we all have some innate talents and abilities that we're, we're, we're better at more easily. But other skills and attributes are actually muscles you can build and grow. They're not, it's not like you either got it or you don't. You can grow these things. And so we sort of build on your strengths, shore up your weaknesses, make those muscles stronger and also, and don't let anybody edit what you're interested in. No one gets to tell you what you're interested in or that you shouldn't be interested in.

And then the final thing that my parents did is, and again, I can see this as I look back to very, very early ages. They let us be part of all sorts of decisions in small and modest ways,

but ways that were showing us and letting us learn and feel, this is how you figure out something you didn't expect. This is how you deal with something you've never encountered before. It doesn't have to be run to mom and it doesn't have to be just stop. Well, let's think about this. Well, I bet we can figure this out. So it was this, well, come on, we can figure this out. And you'd build an answer to it. And they let us be a part of that and, and take responsibility for pieces of it at a very early age when, you know, small scale, low stakes. But we felt very big. It felt like a big thing to get to do that. And that's, I think, how we learned, how I learned, A, learned how to do it and gained confidence that I know how to figure, I can figure something out. OK, I'll try it. And that confidence, if you let it build, was smaller to bigger to bigger to bigger experiences. That's, you know, that's been an essential element of my success and my ability to take on these fun challenges.

JVN [01:06:10] Kathy Sullivan, I'm so grateful to you and for your time and for coming on the show, you wrote a book, "Handprints on Hubble," so if anyone can get out there and order that book, order it, read it. I'm just so grateful for you and for sharing your time and your expertise with us. And I really want to have you back to talk about more ocean floor stuff and geology stuff.

KATHY SULLIVAN [01:06:31] Oh, I'd love that, Jonathan. It's been great fun talking to you.

JVN [01:06:34] You've been listening to Getting Curious with me, Jonathan Van Ness. My guest this week was geologist, astronaut, and oceanographer Kathy Sullivan. You'll find links to her work in the episode description of whatever you're listening to the show on. Our theme music is "Freak" by Quiñ - thanks to her for letting us use it. If you enjoyed our show, introduce a friend - show them how to subscribe. Follow us on Instagram & Twitter @CuriousWithJVN. Our socials are run and curated by Emily Bossak. Getting Curious is produced by me, Erica Getto, Emily Bossak, Rae Ellis, Chelsea Jacobson, and Colin Anderson, with associate production by Alex Murfey.