Sue Nelson

Hello, and welcome to the Create the Future podcast brought to you by the Queen Elizabeth Prize for Engineering.

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Shah Selbe is an explorer, an engineer, and conservation technologist who is normally - pandemic aside - found working all over the world. He studied Chemical Engineering at the University of California, as well as a master's in Systems Architecture and Engineering before working for Boeing as a Propulsion Engineer on satellite launches. But then he left Boeing in 2016, after 10 years, to become the founder of Conservify, which is based in Los Angeles. And this was to concentrate on technology that can help the environment. He's described these projects as 'wild engineering'. So Shah began by explaining to me what he meant by that rather wonderful term.

Shah Selbe

'Wild engineering' is when we're building technologies with the core user of that technology, being wildlife, being wilderness.

Sue Nelson

So, what sort of projects then because 'wildlife' and 'out in the wild', that covers a huge area?

Shah Selbe

The sort of projects vary greatly. We've done work on glaciers and in deserts and in rain forests at the ocean. And every time what that technology looks like is very dependent on what you're trying to understand or the questions that you're trying to answer. And so sometimes it's things like, how do we build a drone that can monitor a coastline? Or this project has a huge amount of photos that are taken through camera traps or tourists? And how do we take all that data and turn it into something that makes sense and allows us to understand how that place is changing over time. It really varies quite drastically. And the difference, I would say, between the type of work that I do, and the type of technology that's been used in field science in the past, is the way that we develop it, we're really kind of leaning very heavily into how technology is developed now in places like Silicon Valley, and trying to use those methodologies, product design and all that stuff, to build these solutions, as opposed to maybe using something that the military used to use.

Sue Nelson

So, give me an example of a couple of projects where we can see the different applications of technologies, say a rainforest compared to something that you've used technology in, an ocean or on a glacier?

Shah Selbe

One of the rainforest projects that we're working on currently is with an organisation called the Wildlife Conservation Society. And they have scientists from the countries that the study is taking place in, which is five of the countries that make up the Amazon basin. And one of the things that they're seeing is a change in the freshwater fisheries that indigenous communities are seeing. So, their fish catches changing over time. And so, they want to figure out how to understand how that's changing and why it's changing. And so, they came to us to develop sensor technology to measure that. So, we built water quality sensor stations, we built water level sensor stations. And we built them in a way that allowed the communities the indigenous groups that they're working with to be able to very easily use these tools and not feel overwhelmed by the technology. And they use that alongside an app that was developed by Cornell and some field programmes they've set up to look at the change in fisheries from a basin level, the ability to do that sort of work was very expensive in the past, these sensor systems that they would use for this stuff, costs $30,000, $50,000. They're quite pricey. And then we figured out ways to build the equivalent and then take them through calibration and all the stuff that we

have to do for $300 $400. And by doing that, you really create an ability to kind of monitor something on an ecosystem level that just wasn't possible even I would say five years ago.

Sue Nelson
Do you also have to take into account the environment? I just know from when I've given Zoo microphones to scientists who've worked in the Arctic and the Antarctic, and those that have worked in a rainforest to record audio diaries, for instance, the actual equipment can react very differently to extreme cold as opposed to maybe the real heat and humidity of a rainforest?

Shah Selbe
That's half of the work that we do. We're putting electronics in places where electronics doesn't like to be, you know, in the middle of a swamp or on a glacier. And when you do that, you have to protect it and think through, okay, if it's going to see really cold environments, then the battery life is going to be diminished. The other thing that we think about too is there's other environmental things that you have to consider. One is, if we're building these systems, and they're going, say, to the middle of a protected area, in the Congo Basin, if anything breaks on these, we have to engineer them in a way that they can be repaired locally, right. And so that makes you make a lot of decisions about the types of things that you're doing. One of the things that I'm really passionate about with these sorts of technologies is, our mission is to make sure these places stay pristine and protected. And so, when we put technology into these places, we have to make sure that if the technology were to fail, we understand how those failures happen and we make sure that it fails in a graceful way, it doesn't damage the environment, or disturb things or spill a bunch of toxic chemicals. So how do we create these systems to fail gracefully? And how do we make sure we really understand the entire life of these technologies from us creating prototypes in the lab all the way down to this technology is no longer useful because of X, Y, and Z. And that entire life goes into how we design these products.

Sue Nelson
Now there is a connection with your former job, you worked at Boeing for 10 years as a spacecraft propulsion engineer, because I know that so many satellites are used to measure ice thickness or soil and moisture and salinity and they can look at crops so there's definitely a connection with the environment, but not as a propulsion engineer. I can't quite see the overlap there. So what was it that made you go from successful career at Boeing to then switching to obviously an equally successful career now, but to conservation in this conservation technology?

Shah Selbe
While I was at Boeing, I had the opportunity to work on GOES. It's a satellite that's developed by the National Oceanic and Atmospheric Administration around environmental monitoring. And I started thinking a lot about, okay, well, I've always been an environmentalist, I've always cared about these things. But previously, I saw like, that passion about what's happening in the environment is something completely separate to my job. Because, you know, I was an engineer, I was trained in engineering, and I didn't think engineers really had a place in that sort of thing. And while I was at Boeing, I went back to graduate school. And it was at that point where I just had the opportunity very randomly to work on a project around illegal fishing with the Center for Ocean Solutions, which is a non-profit think tank that was started at Stanford University. And we started thinking about what sort of solutions there could be to this massive problem of illegal unregulated and unreported fishing. And I just could not get out of my head, the technology solutions. I'm an engineer, so all I thought I was like technology, technology. And I started seeing things that were done in different industries, like what FedEx did in terms of tracking that maybe could be applied to that and started proposing ideas. And they really liked it so much that they asked me to come back as a research fellow there and work with them on it over a number of years. And that's where I started seeing this opportunity. This was back when I would propose to them the

idea of using drones for some of this ocean monitoring stuff. When people thought about drones, they just thought about wartime drones, they didn't think about this thing that people get for Christmas under the tree, it was just a different time back then. And I started seeing more and more opportunity. And for a couple years, I did both where I was doing a lot of consulting for NGOs, but still working in the satellite industry. And finally, in 2013, I became a National Geographic Explorer, and started working on a lot of projects with National Geographic, and at one point got some seed funding from that organisation to leave Boeing and create my own non-profit, which is what I did. But one thing I will say about satellite engineering, which is very closely related to the work that I do today is when you build a satellite, you're building a very sophisticated piece of technology that is going to go in one of the harshest environments that you can imagine, temperature fluctuations are vast between freezing and very, very hot, you have to deal with radiation and micrometeorites and all these things. And so, you had to think a lot about what the different failure mechanisms were behind that, and then how to protect them from an environmental place. The second thing is, when you build these systems, you put them on a rocket, you launch them into space, and they have to work perfectly for 15 years, nobody can touch it, no one could repair it. And I think that sort of engineering mindset really plays a lot into the types of systems that we create today. I think a lot about how do we create something that has those sorts of environmental protections, and can function without people really having to interface with it for a long period of time, because that's really important. If we want to study these environments, we can't just keep on sending people into them. Because that's going to change the study. We want these systems to be quiet monitors of what's going on in the environment. And so, I think that thinking about that so much in my early years really helped me later on in my career.

Sue Nelson
What do you prefer working or designing equipment for? Is it for something that's inanimate like a glacier, or is it something that might involve a creature like a gorilla?

Shah Selbe
I love wildlife. So, I've been very lucky in this work to have some truly remarkable experiences with things like gorillas. Me personally, that's what I love. But I think the most important thing in the type of work that we do is like, how do we think about getting information about how this world is changing? In the way that's gonna create the most impact? And that question always comes with the people we partner with for projects. You know, our projects are never Shah Selbe decides he wants to measure a glacier for X, Y, and Z. It's always somebody who's working in that area, or living in that area, has the scientific question about a glacier, and doesn't have enough resources to be able to buy the most cutting-edge equipment. And they come to us and we try and figure out okay, let's design a tool that answers your question. But when we do that, let's design it in a way that it's open source. So, if anybody else like you has that same question, they can download the designs off the internet and build their own version of it and be able to answer that question. And how do we do it at a price point that allows you to buy a bunch of them? And then ask a different type of question, the question that was not even possible before.

Sue Nelson
To do that, though, to be so altruistic and put your instructions so that other engineers can have a go at doing it themselves is wonderful. But that also requires a lot of capital from you to do it to effectively give it out for free. So how do you get the investment in order to do that?

Shah Selbe
We've been very fortunate, the timing that we've started to do this work is kind of the perfect time to do this, right. So, I started this research just about when smartphones came out, smartphones created the miniaturisation of a lot of technologies. And so many people were buying these things that the parts inside of

them became very cheap. And that allowed us to then take those parts and create new systems based off of them. The other timing thing that's worked very much, I think, in our favour is the fact that a lot of the tech founders, places like Microsoft, and Google and all these places, they made a huge fortune on the technology that they created, and then created foundations that have then turned around and started to work on environmental issues. So, we came up in this time where there's a lot of these foundations, that know technology, and they're interested in the environment. So, when you come to them and talk to them about conservation technology, it feels like something that's very much in their wheelhouse. And so we've had really, really great partnerships that allow us to do that. Knowing that, you know, I want to be able to bring on engineers, onto the staff of my non-profit, develop these sophisticated tools, and then give out that knowledge for free. And they're supportive of that sort of configuration. And I think part of it is because if we look at conservation today, we're losing wildlife faster than any other point in history. We seem to be losing the battle against trying to protect this planet and the traditional methods of trying to create a new technology, patent it and sell it to people isn't causing us to work as fast as we really need to stop some of this decline. And so they see that capacity building of being able to create these technologies by making all this open source as a real differentiator I think in that in that area.

Sue Nelson
I did wonder if you ever got disheartened by that, with this constant uphill battle, to ensure that any development, for instance, is sustainable or to prevent species from dying out or stop the ice caps from melting?

Shah Selbe
Me personally, I am eternally an optimist. I get very excited about new opportunities of collaboration and enabling the really important work that's happening on the ground by conservationists and environmentalists, all over the world. And so that's something that I get continuously excited about, I think, if I was a pessimist, conservation is the wrong industry to be in if you're a pessimist. So that's one of the things I fall back on is I always think that there's hope.

Sue Nelson
And has there been a project where it success has exceeded your expectations, where maybe a local community have taken what they've seen you do, and it's empowered local engineers to get involved?

Shah Selbe
One of the projects we're most focused on right now is something that's called FieldKit. So basically we're creating a lot of ideas around how to create open source sensors for basic environmental monitoring for all these different partners that we had. And we decided a couple years ago, what happens if we just take a few steps back and design this as an open source product. So basically, pretend we're a start-up and not a non-profit and create something that anybody can use. And that was quite a learning experience for us. And so we, we ended up designing FieldKit as this tool. And I think the people who we've had reach out to us about FieldKit, who are using FieldKit, it's just constantly a surprise. We built this thing for field scientists and we have educators all over the place that are now using it for teaching students about how the planets changing, we've had archaeologists reach out to us about creating systems that allow them to monitor the environment around their digs in ways that's a lot more finite than the way that they're able to do that, right now. We've kicked off projects in in the Yucatan, and all these different places, that are basically just indigenous communities that are coming up around this idea and saying, "Hey, now we could use these tools, because these tools are now freely available". And the exciting thing about it for me is like now it's no longer just my team developing it. There's teams at universities that are now building their own versions of FieldKit, or sensors that plug into the FieldKit ecosystem. And over the course of the next year, we're going to be developing an educational curriculum

around that, and putting it out into the world with organisations like Hackaday. And that should fuel that even further. And then earlier this year, we kicked off a project with Smithsonian Institution around taking our FieldKit sensors and using them in a marine environment, because marine sensors tend to be incredibly expensive. And that project is going to be focused around coral resilience. So how do we understand the environmental parameters around corals that are going to last in a warming ocean in places with lots of up swelling?

Sue Nelson
What sorts of things can these sensors actually measure?

Shah Selbe
Right now, we have a weather station, and we have a bunch of water quality sensors. And we have water level. So, determining the flood. So, water quality and water level are being used in the Amazon, weather stations are being used in the American prairie reserve and work that we're doing in Cameroon with UCLA. We've also just recently started a project with the City of New York to do water level sensing in the parts of the Greater New York City area that flood quite often. And they're going to be taking that sensor data and using it in community engagement meetings and trying to understand basically how to look at these low-lying areas of New York, as the sea levels rise as climate changes and things start to adapt to moving into the future. And then we have other sensor types that we're working on at the moment around air quality measurements, soil, moisture, all sorts of different parameters. And some of those things are being built by people outside of my organisation that just really want to build those sorts of things. Over the next year or two, we're just going to see some really phenomenal things come out of it.

Sue Nelson
What started first. When you were younger, as a child, was it wanting to be travelling, do adventures? Was it wanting to solve problems, like lots of engineers do and you know, obsessed with LEGO or building things? Or was it the fact that it was animals and that you loved wildlife? Or maybe it was all three.

Shah Selbe
I have always wanted to be an engineer. That's just what I wanted to do. I was that little kid that would take apart my Dad's expensive stereo equipment. And to credit my Dad, instead of getting angry at me about it, he would sit down next to me and help me put it all back together. And I think that put this little engineering bug in me at a very early age. And I I've also been very much a scuba diver and environmentalist I've always loved animals. But as with most people, I saw that as like something that I just do on the side, I watched documentaries, I go hiking, and I really enjoy that stuff. But it's not directly tied to the job. And I think one interesting thing that I've noticed with this work and just in general is that there's a lot of opportunities for people to take the skills that they have, and apply it to problems that they care about, which is the environment for me and it doesn't have to be engineering in the environment. It could be you know, maybe you're a great artist or a great writer. Whatever your skills are, there's people in the environmental space that would love to have about sort of support and help. And I think there's a lot of opportunity to bridge those two worlds in much of the same way that I did.

Sue Nelson
And did you find it easy to bridge those two worlds?

Shah Selbe
No, no, it was not easy initially. I mean, there was a lot of pushback in the early years, I think there's a lot of scepticism around the value of technology. I remember sitting in a room full of environmental lawyers and

biologists trying to talk about these solutions. And there was very heavy opinions being said about, "I know what I know what I'm doing here, technology's not going to help, we just need people on the ground doing this sort of work". But that's changed, that's changed quite a lot. I mean, now technology is so popular, everybody wants to be able to kind of use these sorts of tools, it's almost swung too far in the other direction. Whereas now, like, when we talk to a new partner about a project, they typically come in saying, I 100% need a drone for this. And what I do in those early discussions is we walk it back a little bit, we say, "Okay, I understand that the drone technology is a very cool technology. But let's talk about what your actual problem is and let's understand what the capabilities are, where you're working and then from then we can reach a technology that makes a lot of sense". So, you know, I've had field programmes where we were working in the Caribbean, and they thought they needed a drone for something, they took me up to the area that needed monitoring, they showed me where the problem was. And in that problem, in that instance, the solution was actually just a person with a pair of binoculars that was going to solve more problems than actually having a drone and that sort of thing. And so, thinking about what technology is actually useful in those sorts of situations.

Sue Nelson
And not necessarily just for the sake of it.

Shah Selbe
Yeah, because that's damaging. We've seen, especially with drones, we've seen a lot of that you've seen people use them on projects where they weren't helpful, it didn't solve any problems, and then that changes their opinion on drones forever.

Sue Nelson
Now, bearing in mind, often your work involves so much travel, and the nature of environmental projects means that you go to various locations and places and worldwide, the pandemic must have affected quite a bit of your work, then I assume.

Shah Selbe
Yeah, hugely, we had expeditions planned all over the world. And basically, everything's been on hold. And it's still on hold. You know, even though now I'm fortunate to be vaccinated. I know a lot of people in the world aren't fortunate to be vaccinated, we also don't know how the vaccine behaves amongst COVID, and the variants and all that stuff. So, we've used this opportunity to step back and look at the work that we're doing and trying to perfect it on a level that maybe makes it more useful for broader swaths of people. And now, we're trying to set up more partnerships with organisations outside that can take some of the tools that we've created, make it their own, and, and end up deploying those themselves. So, you know, we'll see where things go, I would love to get to the point where we are travelling once again. But I think that this has allowed us to really think a lot about if we open sourced our technology, we put it all on the internet, that's something completely different than if we open-source technology, and then work with communities all over the world, to build that stuff from the ground up. It's much more engaging in a different way. And I think that's important. So I'm quite excited about our opportunity to kind of think about things in that aspect, as opposed to just flying around all the time to deploy these projects.

Sue Nelson
You studied chemical engineering. Do you ever look back and think, "Oh, I wish they'd had a degree that combined engineering and the environment"? Because I'm sure there must be a demand for it.

Shah Selbe

I do. I mean, I think about that all the time I and I've worked with universities to try and kind of establish some of those things. So, I'm a fellow at the University of Wisconsin Madison, working very closely with how you create a curriculum around conservation technology. I've worked with Duke University and a bunch of other universities around the same thing. I think there is a lot of excitement within that, and the first step that some of these universities have done that they set up these conservation technology clubs, where they can work on these sorts of ideas within the framework of mechanical engineering, electrical engineering, and in those sorts of fields. I think if this opportunity was around, when I was in school, I would 100% have done it. I studied chemical engineering and did a lot of work with Engineers Without Borders at the time. So, we were doing kind of water treatment and sanitation systems for communities. There wasn't really an opportunity to do this sort of thing. And I think that's going to change which is pretty exciting.

Sue Nelson
So what would your advice be then to engineers or budding engineers, who, like you have got a real interest in the environment, conservation? Would you say to them, stick with your degree and do volunteering in the same way that you did with projects, what would you say to them?

Shah Selbe
There is the opportunity to do a lot of volunteering. And I think that's important. I learned a huge amount through volunteering in my time. I think sticking with engineering, a really important part of it, it's really essential to get those fundamentals down. If anybody who's listening wants to take some of the stuff we've developed and hack on it and create their own, like, we're always happy to help as much as we can around that. And I think that there's been communities that have opened up around conservation technology, where you could really start to understand more about what things are out there. And so, there's this group called WildLabs.net, where you can go and it's a community forum and a bunch of other opportunities around conservation technology. And you can read up about the different types of technology and what's happening like, say, and AI and conservation technology, or drones and conservation technology. And there's another organisation that that's called 'Conservation X Labs', which is kind of like a sister organisation to my non-profit that's focused around, they've created a digital makerspace. So, like they're trying to create a place online where people can develop these projects and help write some code or do some designs to be able to kind of foster these projects moving forward. So, I think checking into what's happening in those spaces is, it's a good first start. But again, if anyone has any questions, or is curious about this, I'm always happy to answer any questions. So, you can always reach out to me as well. And I can kind of connect to people.

Sue Nelson
Is there any particular animal or part of the world that you could do? What would it be? What do you really want to save? What is your sort of Holy Grail?

Shah Selbe
Yeah, that's, that's a really hard question for me to answer because I am very passionate about a lot of them. I think I keep on coming back to what's happening in our rainforests, and how quickly things are happening there. We're losing giant swaths of rainforests every single day and being a part of a lot of scientific expeditions that have gone out to rainforests in the Amazon, in the Congo Basin. There's just so much we do not know about these places, in terms of biodiversity, what's out there, and we're losing most of this stuff before we even have the chance to understand that it's there. And I think that's hugely tragic. And I think that me personally, seeing what's happening with indigenous communities in those regions breaks my heart. If I could focus on something, I would focus entirely on that. And right now I'm the advisor to the Rainforest XPrize, which is looking at fuelling some of this innovation in that space. So, I think that's an opportunity to we'll see what happens over the couple years with that work. But I hope more people can get into this. And we can start

understanding these ecosystems in a way that stops some of the industrial development and deforestation that's happening in those regions.

Sue Nelson
Well, best of luck with it. And I just wondered, where would be the first place you'd like to go once all our restrictions and travel is back on the agenda again, is there a project that you're chomping at the bit to get back to that's maybe either not quite finished, or maybe it's about to start?

Shah Selbe
Yeah, we actually, right before the pandemic hit, we were in southern Cameroon, at this protected area called the Dja Faunal Reserve. And for that project, what we did was we deployed some FieldKits. And we also set up a radio network, an open-source radio network, so that anybody who's doing any kind of scientific studies in that area can upload their data live and get it through the web to wherever they need it to go. And so towards the end of that expedition, we got some pretty heavy rains. And we had to stop. And I had planned to go back in April of 2020. And we all know what happened to the world then. And so I'm actually very eager to get back into there and finish the deployments that we are doing and work with some of the universities and non-profits that are working in that region. And it's just it's a very fun expedition, because, you know, you have to carry everything on your back and hike 30 kilometres deep into the middle of nowhere to be able to do a lot of this sort of work. And so, I'm really excited to get back into nature back into these wild places.

Sue Nelson
And it sounds like the absolute ideal job for you doesn't.

Shah Selbe
Yeah, it's perfect. I love it. I'm very lucky to have found my dream job and I hope that I'll be able to do this for the rest of my life.

Sue Nelson
Well, Shah Selbe, thank you very much for coming on the Create the Future podcast.

Shah Selbe
Thank you. It's my pleasure.