

Paul Thies: According to the 2020 US Census, the tiny farming community of Beaconsfield, Iowa boasts a population of just 15 people. The downtown area bustles with one commercial building – the original HyVee grocery store – and a United Methodist Church.

By all appearances, it seems as unlikely a launchpad for interstellar dreams if ever there was one.

Imagine growing up there in the 1960s and 70s, during NASA's golden age of exploration, when men first walked on the moon. For a young woman coming of age in this rural town, the then-male dominated profession of astronautics could have easily seemed completely out of reach.

Maybe so for most folks. But then, you need to meet Peggy Whitson, Beaconsfield's most famous daughter and the American who has spent more time in space than any other US astronaut. A role model for perseverance and daring do, Dr. Whitson enjoyed a legendary career as a NASA astronaut with such noteworthy achievements as twice being named the Commander of the International Space Station, as well as holding the position of Chief of the Astronaut Office and Chair of the Astronaut Selection Board.

Hello, I'm your host Paul Thies, and on this episode of *If/When*, Dr. Whitson joined me to discuss the future of human spaceflight. She currently serves as Axiom Space's Director of Human Spaceflight, following a career of 37 years as a NASA astronaut and scientist.

Before joining Axiom Space, she was the first female commander of the ISS and has flown three long-duration missions to the ISS, has conducted 10 spacewalks and has spent more cumulative time in space than any woman in the world. Upon joining Axiom Space, she commanded the Axiom-2 mission, becoming the first female commander of a private space mission.

It was a privilege to sit down with Dr. Whitson to learn firsthand about her amazing career and to get her thoughts on the future of spaceflight and the role that privatized, commercial endeavors will play to help us push the frontiers of human space exploration even further out.

Paul: Peggy, thank you so much for joining me. I'm really looking forward to learning about all the great work that's going on at Axiom Space and these exciting missions that you all are preparing for, as well as, you've got a storied career in space, and would love to unpack that, learn a little bit more. Just first off, thank you so much for joining me today.

Peggy: Oh, it's really great to join you guys. I know that Jacobs plays an important role in space and lots of other industries so it's very exciting to chat with you guys.

Paul: No, thank you so much. To start us off, and we'll go full circle here, but I want to start us off talking about like STEAM endeavors, STEAM education. There's a lot of push these days to try to help kids see themselves as astronauts and engineers,

and scientists, really embracing math and science and whatnot. Can you tell us a little bit about young Peggy Whitson? What inspired that dream to go to the stars and do all the hard work that is necessary to become an astronaut? Tell us a little bit about your own journey and why you pursued space?

Peggy: Well, that's a great question, Paul. My interest in space started probably with Star Trek [chuckles] but it became something real to me, something tangible when I watched the first guys walk on the moon. For me, that was a really pivotal moment. I thought, "Wow, cool job." I mean, even as a nine-year-old, I knew that was something very special and impressive that our country had done. I thought, "Wow, I'd like to do that too." I was an Iowa, rural Iowa farm kid, had no idea how to go about doing anything like that, and just assumed that that was probably not ever going to be something for me, but it's still in my head. I dreamed about being an astronaut, even wrote some poetry growing up about being an astronaut and going into space.

I think what really changed for me was the year I graduated from high school and NASA selected the first female astronauts. Among them were Shannon Lucid, who was a biochemist and Rhea Seddon, a doctor, and Ellen Baker, a doctor. I was interested in doing life sciences and I thought, "Wow, maybe I can become an astronaut. They picked some females and they are scientists in fields that I would like to pursue. At that point, it changed from being a dream to being a goal. I still say that looking back on my life, I'm probably lucky. I had no idea how hard that would be, [laughs] but it was an important step for me to make that transition, to make it a goal.

I applied, started applying to be an astronaut as soon as I finished my PhD in 1986. I applied for 10 years before I was lucky enough to be selected as an astronaut. During those 10 years, I still worked at NASA. I was a scientist, research scientist for NASA, and I was leading the US-Russian Joint Science Working Group and doing a lot of very interesting things, but at the time I was very impatient with the fact I was not an astronaut. I look back now, though, and I know that those experiences that I learned during that time leading people in harsh environments and with no plan having to come up with solutions on my own with this team, it was a very important time for me.

I developed a lot of leadership and teamwork skills that, in the end, I think, are what qualified me to be selected as the first female commander on the International Space Station and selected as first female chief and non-military chief of the astronaut office. I think those were things that I never even would have dreamed of, but with that experience, I was ready for those tasks when they were offered up as an option.

Paul: No, it's fantastic. I'm listening to you and I'm thinking the patience, perseverance that you had to cultivate during that while you're waiting for your time, and how important those skills are as a leader, especially in a harsh environment like space and all of the technology that goes into it. It's funny you say Iowa farm kid, and without getting into the Star Trek geeky world, Captain James T. Kirk was also an Iowa farm kid. Look where he went. I love your story because the importance of representation, right? You yourself saw other women who were becoming astronauts and getting into those roles and you yourself in your career **[unintelligible 00:05:24]** have been and are a role model for other women, who can see themselves like,

"Hey, I could be Peggy Whitson. I can aspire to do that kind of stuff. Kudos to you. It's just fantastic.

Peggy: I like to tell folks that your path to your goal isn't always a straight line. Mine certainly wasn't. It took a lot of years to get there, but I think it's so important to learn from all the opportunities that you're given. Sometimes you might fail but it's something you can still learn from. I think that's a really important lesson for anybody no matter what you're trying to do.

Paul: No, fantastic. Let's talk a little bit about Axiom Space and unpack that a little bit for people who may or may not have seen Axiom Space. Besides the fact that you all make like really cool-looking spacesuits and a lot of great technology, can you tell us a little bit about, for the uninitiated, who is Axiom Space? What do they do? How are y'all leading in the commercial space industry? Can you tell us a little bit about that?

Peggy: Yeah, sure. Axiom Space actually won a contract with NASA to put a module, an Axiom Space module on the International Space Station. That's important because that allows us to start developing things, developing our program a little bit sooner. In addition to that, the last two missions, the Axiom 1 and Axiom 2 missions that went to the International Space Station, we don't have our module up there yet, but we went up there and we're testing out our procedures and processes, the interfaces with NASA and how to make commercial space work as we develop that station up there.

As you know, in 2030 or thereabouts, the International Space Station is going to be decommissioned. Before that happens, Axiom Station will separate from it. We'll already have multiple years of experience and be a very viable replacement, a commercial replacement for the International Space Station. For me, personally, I'm really excited about what the future of Axiom Station can provide in the sense that Axiom Station is going to try and develop commercial and biomanufacturing in space and other types of commercial activities in space. Because of my background as a scientist, I get really excited about the fact that we're actually going to commercialize the lack of gravity as a tool to make things that we can use either here on Earth or we can learn to expand our reach in space. It's very exciting for me to be a part of that.

Paul: Your career is heavily involved in NASA and in the government, and then now, of course, you're in the commercial side with Axiom Space. That trajectory we're also seeing, I think, really play out, at least in the American space industry where it used to be NASA had a complete monopoly on everything. Now it's really opening up and so there's companies like Axiom Space who are starting to really make themselves felt and known in that industry.

With that experience, you've straddled, you've had a foot in the government world, and now you have a foot in the commercial world. Can you talk about what it's like to work with commercial astronauts, which is a relatively new field, I'm imagining. Can you talk about like what it's like to work with commercial astronauts as part of your role at Axiom Space?

Peggy: Sure. Well, Axiom's goal is to try and open up space to more and more people all over the Earth, and that can be private astronauts who are paying for a

position to go into do research in orbit, or it could be governments who are doing it, or it could be investigations that want to be flown on the International Space Station, and we provide an access earlier than they might normally get. A lot of entities that never had access before, because they weren't part of the international partnership that was developed 23 years ago or more, and they weren't part of that initial phase, and Axiom space and Axiom Station allows that capability not only in the future on Axiom Station but now even with the research that we're doing.

For instance, I had two government-represented astronauts from the Kingdom of Saudi Arabia and they were doing a lot of scientific research for their country, as well as-- John Shoffner was there. He's a private astronaut from Tennessee. He was also doing research onboard the station. We were doing a number of national lab research investigations. I was really excited about the capability of doing research on colorectal cancers and breast cancers. We were looking at a new therapy or potential for a therapy to be developed. The researchers are extremely excited about the results.

Microgravity is a great model for growing these cancers because they grow more like they do in your human body. They can actually test therapies and drugs in space and test ways to detect and, hopefully, prevent these cancers from forming. It's a really powerful tool platform to test drugs that will inhibit cancers and potentially ways to predict or detect cancers even earlier which will help in the prevention.

Paul: Wow, that's really interesting. I was going to ask you about that, some of the life science type of experiments on a space station and what that will tell us. Let's unpack this a little bit. Your vision for the research that's done on Axiom Station. Obviously, you've got an interest in the life sciences, but what are some of the other kinds of areas where you see commercial or maybe other government entities like Saudi Arabia that are non-traditional space players who are now having an access point where they didn't before? What kinds of research, projects, what are some of the opportunities that you see that Axiom Station is going to open up for people?

Peggy: I think it'll open up research in all different kinds of areas, physical sciences. A lot of research onboard the International Space Station has been done in combustion and fluid physics and just the characteristics of physical properties that get changed without convective forces or just the effects of being in space. I am excited, I think pharmaceutical companies are going to come up with some of the earliest uses for space research because I think they're going to find a platform where they can develop things more efficiently or effectively.

Another area that, because I'm life sciences background, I have a lot more examples in life sciences, but the protein crystallization because of there's lack of sedimentation, some crystals form even better in space. They form more perfectly. The researchers on the ground can then use the spectroscopy and look at detail down to the molecule level of the three-dimensional structure and figure out ways to develop new antibodies or antigens to detect or to prevent disease progression. It's really exciting, the potential that exists out there. There's other biomanufacturing things that we are testing out. We did a few tests of those on orbit, on this mission as well. It's exciting.

Paul: I've got to imagine the data pool that y'all generate too and then you couple it with something like artificial intelligence or whatnot, and then you can start doing some modeling. I just got to assume that there's complimentary technologies that will just exponentially allow you to just grow and learn even more and more. This is like a new platform for learning or getting data. We've had the space stations for a while, of course, but now it's like more people can be involved, more projects can be involved. It just seems like it really opens up the panorama of what we can learn.

Peggy: For sure.

Paul: Now, You've been an astronaut for quite some time. This might be an unfair question to go back to the greatest hits package here but can you share with us an interesting event or obstacle in space in your career and what you learned from it?

Peggy: Over the years there's just been lots of different events. I have always felt like NASA does an amazing job at solving problems. At one point during one of my missions, it was when I was the commander on Expedition 16, we were moving a solar array. They're 115 feet long that had been repackaged down into its blanket box. Then we moved it to another location on station. As we redeployed it, there'd been a problem getting it to collapse, and as we redeployed it, it tore.

The team on the ground and the team, I was with the Pam Melroy shuttle crew and my crew, and we had to come up with a fix. The ground team came up with some ideas and then we had to actually physically cut metal and shape things and add wire and tape and come up with a fix on orbit because you can't just go to Lowe's or Home Depot or buy something.

[laughter]

Peggy: We had to come up with the solution but it was just an amazing effort by the ground team and the team on orbit coming up with a fix to this problem. That, to me, demonstrates how important teamwork is and how important listening to everyone is. As it turns out, it was a very young engineer that came in with the idea about, "How about we just make like cuff lengths to span the tear and put it in these little integral holes on either side of the tear like putting sutures on it. It was a great idea and the one they made work. It's just really spectacular.

During this last mission for Axiom Space. One of the important things that I've become to realize, I've done a lot of training over the years, training crew members for long-duration missions and what's the best type of training. We've evolved the training at NASA over those years to optimize for long-duration crew members. Now working with Axiom, I've got short-duration crew members. It's interesting because now I'm taking folks back to train more like we did when we were training on shuttles [laughs] because it's a short mission. It's very defined. We have to get our specific objectives done in a very short period of time. Now we're evolving our training, Axiom Spaces training is taking what NASA can help us with but then evolving it and making it more focused on what our mission needs are. I'm thrilled to be able to help out and be a part of that.

Paul: Do you think with Space Station living, are you going to see the training windows lengthen where it's as we get more and more mature technologically with

life in space, and you read stories like Christina Koch was in space almost a full year and stuff like that, are you seeing like the training is changing to where we're really focusing more on getting people used to the idea of being up there longer? Like Axiom Station, I'm assuming, it's trying to get up there and get back down, like you said, it's not like just going down the street to Lowe's or whatever. It takes an effort to leave the earth's gravity. How would you think the training focus, I mean, are we working more towards trying to prepare people for longer-term life and space-type missions?

Peggy: Well, I think what Axiom is offering is that we're going to tailor our training flow to fit what the mission objectives are if it happens to be a short mission versus a long mission. I think over the 23 years that we've been flying the International Space Station, NASA has tweaked and modified their training to optimize for the longer-duration missions. I've had a lot of experience with that so I can help with our training flows for longer-duration missions in the future for Axiom Station. This in-between timeframe, it's really important to adapt in order to optimize our mission success for these shorter missions, at least these initial shorter missions.

Paul: My last question for you, any final words of advice or words of inspiration for our next generation of explorers? We have the Artemis Mission coming up and we're going to Mars at some point soon. Any words for the next batch of explorers to get out there?

Peggy: Well, I think the most important advice I can give anyone is you need to live a little bit outside your comfort zone. Be willing to accept that you might fail at something because if you challenge yourself to do even more than you think you can, you're going to find out you're way more capable than you might have ever dreamed of or even imagined. By learning from the times when it doesn't go exactly the way you would've liked it, it prepares you even more for the next step. I challenge young people to don't do what's just easy. Don't do what you just know you can do. Do more than you think you can. Challenge yourself and live outside your comfort zone.

Paul: Excellent. Well, words to live by. Well, Dr. Peggy Whitson of Axiom Space, thank you so much for joining me today and talking about the future of human space flight. We'll be watching Axiom, learn more news about the Axiom Station, and just really exciting work. Thank you so much. I really appreciate your time.

Peggy: Yes, thank you. It was great. Great discussion, Paul.