CERAMIC TECH CHAT

Episode 35

Title – "Space, the new frontier for business: Jonathan Volk (E35)"

INTRO

De Guire: "I'm Eileen De Guire, and this is Ceramic Tech Chat.

> On February 12, 1962, almost exactly 61 years ago, American astronaut John Glenn became the first human in space when he orbited the Earth three times before returning. He was part of a government-driven race to send a man to the moon.
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> The United States National Aeronautics and Space Administration, NASA, and similar space agencies around the world still drive much, if not most, space exploration. But today new entrepreneurs see opportunity to create space-based businesses, adding a new element of commercial incentive to current-day space activities."

Volk: "There's so much areas where space can be utilized. Again, space for habitation, exploration, but also space to improve life on Earth. So, you look on the biology side, the pharma side, the materials side, the fluid side, the combustion side, the earth science side. All those areas have a benefit to utilizing the space environment, the microgravity environment, etc. And then those types of scientific disciplines, those research areas translate directly into terrestrial markets. So, your textiles, your pharma as I mentioned earlier, chemicals, energy, food and beverage, consumer products."

De Guire: "That's Jonathan Volk, senior manager of in-space manufacturing and advanced materials at the commercial space company Sierra Space, which is headquartered in Colorado. In today's episode, Jonathan will talk about Sierra Space's vision for commercializing space and the broader impacts of making space a more accessible destination."

(music)

SECTION 1

De Guire: "Please tell us a little bit about how Sierra Space got started and what its vision is for space activities."

Volk: "Sure. So, Sierra Space, it officially formulated in June 2021. It spun out as basically the old space division of Sierra Nevada Corporation, but now we're an independent company. So, we've been around, I guess, now for almost two years. We've grown very rapidly. I'm approaching my one-year anniversary with the company. When I joined, we just crossed

over the 1,000-person mark, and now we're over the 2,000-person mark. So, we've really grown in a short period of time.

Our general mission is to really build a platform in space to improve life on Earth. We're really focused on commercial, low-Earth orbit. That's the altitude where the International Space Station orbits, where a lot of satellites are. So, it's really we think a new and growing marketplace to do things that, as our mission says, benefits life on Earth. So, we're really focused on developing vehicles, platforms, and capabilities that can really make an impact utilizing space to benefit humanity and a lot of different industries and markets here on the ground."

De Guire: "I didn't realize the company was so young. That's pretty interesting. Can you tell us a little bit about some of these vehicles, platforms, and capabilities that Sierra Space is working on and when you're targeting them to be deployed?"

Volk: "Sure. So, the near-term one is called the Dream Chaser. So, that's our spaceplane. That's going to be doing several cargo resupply missions with NASA over the next few years. And actually, the first one is going to be later this year. So, we're very excited about that. We're doing a lot of final prep getting that ready. So, it's going to be a big day, not only for Sierra Space but the space industry as a whole. Really kind of resurrect kind of what was along the lines of the shuttle program, which has obviously ceased for about the last 10 plus years, to be able to launch.

And then the key thing is to return Dream Chaser on a runway that any kind of regular airplane, passenger aircraft could land on is going to be a really great opportunity for us. Because right now, as we return things from space currently, we use the capsules that either crash into the desert or in the ocean. And that can be a little challenging, especially if you're thinking about science research experiments coming back, etc. So, being able to have that nice, smooth, low-g landing is going to be very beneficial in a lot of different ways. So, that's really a big near-term focus for us.

But a next part will be what we're teaming with Blue Origin on. Blue Origin is our main partner in our commercial space station called Orbital Reef. And that's going to be able to support research, manufacturing, tourism, etc. And not only Blue Origin and Sierra Space. We also have other teammates really helping us build this infrastructure.

One of the main components of Orbital Reef that Sierra Space is focused on is the LIFE Habitat, which stands for a 'large, integrated, flexible environment.' And it's obviously, it's an inflatable. We've had several successful burst tests, which have been highly publicized. We're very proud of how well those have done. That really kind of shows we're really well on the road to making this reality. And that'll be a key component, which could house some of that science capability, manufacturing, that crew quarters, etc. So, that's going to be one of our main contributions. We'll have several other components, but the LIFE Habitat's a big one that we're focused on contributing to the Orbital Reef space station.

So, timeline for Orbital Reef, by the end of the decade, we're hoping it to be up and running. And again, we're really looking forward to that, too. And what's going to be nice is between Dream Chaser and obviously LIFE Habitat being part of Orbital Reef, Dream Chaser will be able to get you there and get you back, and you'll have obviously the Orbital Reef space station. So, Sierra Space is very excited about really having a complete solution all the way through. Some organizations, some companies just might have the station; they might not have transport. The fact that we're going to have both is going to be I think very key for us, and something we're very pleased to be able to offer here in the near term."

De Guire: "Well, it sounds pretty exciting. But in a lot of ways, the Orbital Reef, which is envisioned as a mixed-use kind of space station, has a lot of similarities to the existing International Space Station. So, how do you differentiate between how the Orbital Reef will function and what kind of activities will happen there versus what's going on at the International Space Station?"

Volk: "Sue. So, I think the key thing is, especially as it relates to materials and manufacturing, is that the ISS was never really designed to manufacture products. It holds obviously a half dozen astronauts or so, but the science facilities are a little more smaller focused. As we think about space, I'm sure we'll get into this here in a little bit, about being able to manufacture materials in space, the ISS doesn't really have the hardware currently or the space to actually do that. It's not totally the proper environment to do that.

So, we're really kind of scaling toward that. So, the big addition that we hope Orbital Reef will be able to achieve is to be able to manufacture all types of materials, especially glass and ceramics, but a lot of other things, such as pharmaceuticals, metals, semiconductors, etc. So, a wide range of opportunities to manufacture things, and also do more updated science.

Obviously, the International Space Station was assembled right around the turn of the century. So a lot of the lab equipment up there, it is what it is. So to be able to offer more opportunities, more capabilities to do different types of materials research and other types of scientific research and analytical tools, etc., is going to be I think a big bonus and a big advantage for potential users from all types of organizations."

De Guire: "So it sounds like the vision for the Orbital Reef is very industrial. Really the vision is to actually do some manufacturing there."

Volk: "That's a key focus, yes. There's a couple key sectors, but obviously, and especially in my world, I'm very focused, as you can tell, on the industry and manufacturing side. But in general, yes, manufacturing is a very key focus of utilization of Orbital Reef."

(music)

SECTION 2

De Guire: “Of course, the obvious thing that you eliminate by working in space is gravity. But there are other factors, especially as we’re talking about really, really sensitive instruments, like vibration or humidity or barometric pressure. Some of those things that when you’re doing investigations on angstrom-level instruments really come into play. So, are we able to eliminate some of those factors by working in space? Or, conversely, are we introducing new factors by working in space?”

Volk: “I think a general question is, yes, you’re concerned about the environment. You obviously want to eliminate things like g-jitter [gravity jitters], especially if you’re doing very sensitive studies. So having that appropriate infrastructure to mitigate that is obviously very important.

But I think also too there are, and this kind of is general across all types of manufacturing, there are certain parts of a manufacturing process that benefit from microgravity because it’s a stage where if you eliminate those gravitational forces, the defects at that stage of the process could be mitigated.

So, for example, the semiconductor manufacturing process. Obviously, you grow a semiconductor crystal initially, and that gets cut into wafers, and then you do your hundreds and hundreds of steps to make your pattern and your etching, and you eventually make a chip. But if you can start out and crystallize a better raw semiconductor material, you’re starting off at a much better spot. So, that’s something where even if we just did that crystallization stage in microgravity and then do our processing on the ground, we might be able to end up with a much better semiconductor that has fewer defects, it could be made smaller, more powerful, uses less energy, etc.

And people can kind of start to think, ‘Well, hey, if we can’—and this is a very generic term—‘if we can make a product that’s 3x better than what’s on the ground, that could create a lot more price demand,’ or being able to sell it at a much better price or a price that meets the demand. And then that obviously could potentially offset a certain cost that you’d have to do to launch a product up and return it. Now, that’s obviously a big factor, and our industry’s trying to have launch cost mitigated and make it worthwhile, where there’s a viable economic model.

But, again, it might not be the entire process. It might be a key step or two, where you can potentially do that step in a microgravity environment. And then, obviously, you’ll be in a much better state than you would be had you done that step on the ground. And then to potentially continue that process on the ground, and then end up with a much better product having done those one or two critical steps in a microgravity environment.”

De Guire: “Interesting. Are there any materials challenges that you can point to, especially for ceramic and glass materials? The example I think of is a lot of ceramic processing is, they’re high-temperature processes. So, what kind of challenges does that present to manufacturing in space?”

Volk: “A lot of that obviously has to do with one having equipment available that does that and is certified for flight. But this goes back to your earlier question about how Orbital Reef will be different than the ISS, or at least our platform. So, in some cases, at least on the ISS, it’s continuously habited, so there’s some safety restrictions that you have to be concerned with. But in some cases, for example, on our platform, if they are unmanned or at least unmanned for a period of time, you might be able to have equipment that generates that temperature that you need to manufacture glass and ceramic materials. Obviously still very safely, but the fact that you can mitigate the risk of not having it being crewed, it’s uncrewed, so that could make things a little easier and more likely to be able to do that.”

De Guire: “Interesting. Here on Earth, a lot of high technologies are bumping up against the intrinsic physical limits of the materials, and the example I think of often is optical fibers. You know, as you pump more and more data, which is in the form of light, down the optical fiber, you’re bumping into various dispersions and scatterings that are just really physical limits of the materials. So do you think that would be an example of a kind of material that you might be able to do an end run around the intrinsic limits by being able to make them in space?”

Volk: “Well, you’ve definitely done your homework. There’s actually quite a few companies right now that are exploring that. So, there’s actually kind of even a competitive marketplace for that type of optical fiber, ZBLAN fiber, for example. The thought is, as you want to incorporate these into long fibers used in, you know, large telecommunication networks, etc., going back to the overall kind of physical principles, being able to pull long fibers is more difficult because if you get defects, it really attenuates the signal. So, trying to be able to pull those fibers in a more pristine environment could be very beneficial.

So, you could make those meters and kilometers length worth of fiber that are used in these large networks that have those very little defects. So you can really get little if no signal attenuation and obviously make your network much more effective. So, there are multiple companies that are looking into that. There’s definitely a focus in that area, for manufacturing that type of optical fiber in the low-Earth orbit.”

De Guire: “Well, it sounds like a very exciting future for the next evolution of materials science and manufacturing.”

Volk: “We refer to it as the Orbital Age. So, it’s the next Industrial Revolution. So, that’s a term we use around Sierra Space quite a bit.”

De Guire: “I like that. I like that. How about yourself? Do you think you’ll ever get a chance to visit space?”

Volk: “I would say about me, the one thing I think I can definitely say is that the people who visit space, hopefully sooner than later, they don’t have to be rigorously trained astronauts. They may have to do a little bit of training, but not nearly the months and years of sweat that the NASA astronauts and the commercial astronauts go through right now. And also, I

don't think you'll have to have a ton of money to do it. So, it's going to make it more, hopefully more available for the general researcher or the general scientist."

(music)

BREAK

De Guire: "ACerS online courses provide instruction in ceramic and glass science and technology. These courses are available in formats that make it both easy for individuals to learn and cost-effective for companies to train their employees. View available courses and learn about ACerS Learning Center Certificate Program at www.ceramics.org/onlinecourses."

SECTION 3

De Guire: "How about you yourself? How did you get interested in space technology?

Volk: "When I got my Ph.D. at the University of Florida, my advisor had a, still to this day, has a very big microgravity research portfolio. So, I sort of got indoctrinated into that in my time there. My research in grad school was funded through a NASA fellowship, so it was focused on enhancing heat transfer for closed environments. So for space habitats, etc. So for ecosystems and the like. Try to find a better way to more effectively manipulate heat through a system. So that sort of, I guess, planted the seed.

Once I left grad school, I wasn't in that industry for a few years, but I came back to it when I worked at the ISS National Lab, or CASIS [Center for the Advancement of Science in Space, Inc.] is the organization that manages the national lab. And at the time, they were really focused on that commercialization of space. So really working with innovative companies, in addition to academic researchers, etc., to really want to grow that, we call that commercial low-Earth orbit, or LEO, marketplace.

So that's where we started getting those innovative companies involved. And then, it's followed me through my time at Space Commerce Matters and now at Sierra Space. So, really kind of driving that commercial innovation. And I shouldn't just say large companies, but all types of companies. We've done a lot of work with startups, etc., as well. So we're really, like I said, growing that commercial marketplace in low-Earth orbit."

De Guire: "Sierra Space is a Sapphire Corporate Partner of The American Ceramic Society. So, how does being an ACerS member help you and your business?"

Volk: "I think the important thing for us is the organization and the community that ACerS brings in for us. At least, again in my role, being more focused on those nontraditional space sectors, it's really important for us to understand what are the needs of the industry, of the research community in these areas. So, we obviously go, Sierra Space as a whole goes to a lot of space conferences, but customers for in-space manufacturing, especially

for terrestrial benefit, aren't going to necessarily be there. So it's important for us to engage with ceramic and glass, the major companies in the industry, researchers, academics, etc. We're really at the forefront of, 'Hey, what are your challenges? How could potentially microgravity or the space environment handle that?'

So with all the events you guys are involved in and you sponsor, you were nice enough to have us host a webinar last fall. So it really helps us engage and get the message out, get people thinking about maybe research and manufacturing in a much different way. And again, it's the people we want to engage with because we think these are the next generation of customers that might want to utilize a low-Earth orbit platform, and hopefully one that Sierra Space operates."

De Guire: "Yeah. Is there anything about working in the space industry that has surprised you?"

Volk: "I would say, on the commercial space side, how it's a very tight-knit community. We've all worked in different places, and we all know each other. And obviously there's other commercial space stations that are competitors to us, but we know the people there and even across kind of the entire supply chain, especially on the commercial side. So, I think it's a very tight-knit community. And there's a general, I think, we want to see the industry thrive. Obviously, we want Sierra Space's vehicles and platforms to be the best and the most utilized and the most successful, but I think the space community as a whole just wants to see these marketplaces grow. And lately, obviously, we want to see us get back to the moon, go to Mars, have all the NASA programs, the Artemis program, etc., be as successful as it can be. So I think there's a shared mission.

And one thing too that's also very nice about this, it's a very apolitical environment. I mean, space is something that brings people together, even across different nations. Obviously we're seeing, still cohabitating the ISS with Russia, Japan, the European Space Agency. So, it's definitely a unifying-type sector, and that's obviously very good.

De Guire: "Yeah, for sure, for sure. So, what would you say to a young person who was contemplating a career working with materials for space?"

Volk: "I think for us, or at least for me, I obviously did a Ph.D. I did a kind of combination of experimental and theoretical research. I enjoyed it. But as time went on, I enjoyed kind of the business side. Utilizing my technical skills to really grow a market. In my role now, I'm much more focused on the business development, kind of economic side of things.

I would say for someone who wants to get involved, you want to have the training on both sides. You want to have that technical knowledge. But really think about, 'Hey, can I…do I want to go that technical ladder? Do I want to go that business ladder?' But obviously still be strong enough on both sides.

And I think it's also, too, and this is more of a general kind of comment, is really being able to, if you do the high-intensity, nitty gritty research in the lab. Really being able to kind of understand it. It's very important. I was taught this in grad school, and it's been a

very beneficial thing to learn or to have, is to really be able to explain what you do technically to a nontechnical audience. That's so important. And, again especially in my role because being more on the business development side, I may be talking with people who don't have a strong technical background. They might know some. But a lot of times we see going to talks and stuff, and it obviously depends on the audience, but really being able to articulate what you do in a very kind of simple and straightforward way. Because we have to do that in our role to get people thinking about utilizing space to manufacture and do materials research.

So I would say for people that are obviously at a younger age, be involved in as many programs as you can, start early, and if you have a passion for it, get involved in research. I did undergraduate research. That really kind of inspired me to want to go to grad school because you're working on something that in theory no one's ever worked on before but which is kind of neat. But I would really say try to be very well rounded. Have a nice suite of skills, so you can really interact.

We think of engineers as staying in their lab, not engaging with people. But you really will, and you want to be able to do it very effectively. So I think that's a great piece of advice and a great skill I kind of learned in my education."

De Guire: "Yeah, I think you're absolutely right. That ability to communicate what you're doing is critical, regardless of which track you take. You have to be able to help people know what you're doing and why it matters. And I always think of the Thanksgiving model. Can you tell the relatives around the table what you're doing, and why this is important to them. And if you can tell your relatives, you'll be all right."

(music)

CONCLUSION

De Guire: "With the increasing engagement of private companies in the space sector, there is now space for more people to get involved with in-space research and manufacturing—which opens up a new world of benefits to life on Earth.

I'm Eileen De Guire, and this is Ceramic Tech Chat."

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Until next time, I'm Eileen De Guire, and thank you for joining us."