Microgravity at Scale: Turning Insight into Impact

Twyman Clements: What I've titled is microgravity at scale. What we've heard about in terms of these use cases are insights of how zero gravity affects mostly biological systems. How do we take that to the next scale so that we can really commercialize on these great space stations that we just saw? I'm going to talk a little bit about how we got here.

You've got this floating cube. That is a real photo. One interesting thing that the Space Station group will know, if you take just a nice camera and take an image on the space station, because you're still under the GPS satellites, there's still geotag wherever they took the photo. You can actually watch the sequence of photos as they're transiting a country or something else like that. We found that out a couple of years ago. It's really cool.

I talked about an ecosystem. There's really three parts to commercialize space in the part that we're talking about in the biomedical space. There's infrastructure, which is how do I get to, where do I go, and how do I get back from space? On the other side, there's use cases. Where does zero gravity actually affect it? Then middleware, as it sounds, is in the middle. They take terrestrial processes, terrestrial supply chains, and operate them in a space flight environment. That's where we fit. There are others that do that. But we'll show you a little bit about some of the work that we've done with the Sanford Institute, the IC Corps, and UCSD as a whole.

I put this in just about every talk I do because we talk about space and zero gravity, which are interrelated but different concepts. You can go to space. You can just go straight up and be in space, but gravity is still pulling on you. You actually have to orbit a celestial body to remove gravity for anything longer than a few seconds. You can do drop towers, you can do the vomit comet, which is how they shot Apollo 13. But anything long duration, you do have to orbit a celestial body. But once you're there, you have this base layer of differences. You don't have convective heat flow, you don't have hydrostatic pressure, you don't have sedimentation. Then that affects a level further down that can advance or increase the aging rate of certain biological systems. It can change the cell signaling, all different types of things that you've heard about here today.

A little bit about where we fit in this. Space Tango has done just about every mission since 2017, and I'll tie it back to Peggy. She didn't know this was coming, but you actually installed our first experiments in 2017, and we've been flying since then. But we mostly do them in these boxes that you can see some of our employees and customers holding in these photos. We basically take these ideas, we shrink them down into these boxes. Now, this is what's in some of these boxes. Some of these are Cat's work, some of these are Dr. Motri's work, and what Eleni talked about, you've got tissue chips. You've got some bacterial studies. You've got all different types in there. But we basically shrink those down into these labs.

They go up and down. That's where when we to get to is where we're going is right now, we're flying a lot of metal, we're flying a of circuit boards to and from space, and we're getting these insights, but that's not scale. Because ultimately, the unit cost to the customers are a little too high right now. Now we've got to go to the next step with these commercial stations. To gain more insight and more production value that makes it more economically feasible.

I love just showing these photos. Again, it shows some of Cat's work. But what I love about the bubble study, so I'm going to go into the physical science space real quick. These are some bubble studies that we did. While you can't quite see them with this resolution, they are perfect spheres, which is very cool. Actually, in the top right one, you can actually see the optic system looking back at you through the sphere. It's a very MC Escher image of these perfect spheres, and that's actually a boiling experiment that you see there. We always love to show a little bit of the art that comes from some of the work.

You heard a little bit about today. It's just a coincidence that actually SpaceX 33 returned just a few days ago. We had a different team, and actually, Paul Gamble, our project manager, is here, who's been here with the other teams who were doing the deintegration. Both Cat and Allison talked about that a little bit. But I at least wanted to show that we did that. They're obviously doing the samples, processing the samples, and everything right now. Sheldon, I'm sorry you're texting in that photo, but I did ask Cat earlier if I could use it.

Now we've got to where we're going. We do have the space station. It's been a great asset. It does have a few years left, but we have both commercial space stations like VAST and AXIOM and some others, as well as some potential reentry capsules that are now going to allow some of this insight move into scale into different architectures. It's very exciting to imagine how these supply chains are going to work.

I'll end with how do you solve that? One of these, a solution that we've really been working with, that I think a lot of the industry is going to move to something that's much more robotic. That has more of the sampling on orbit, where you can actually come up with experiments, put together different components on orbit. Gain insight, not have to fly the samples down, things like that. This is a concept that we have. You've got a robotic arm with a microscope on it. You've got these sleds there that actually have culture bags in them, and this is something that we're really working on to look at this next generation of infrastructure opportunities.

The last thing I'll show, we've talked a lot about drug discovery and how to put drug screening. How do you actually now take that application, implement it in an architecture like this? I go back to as I've made these sales pitches over the last decade, how do you bring down the cost? How do you increase the throughput to answer these questions much more rapidly than we have been so far?