3 Takeaways Podcast Transcript
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Ep. 169: A City on Mars: Can We Settle Space, Should We Settle Space, And Have We Really Thought This Through?

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INTRO male voice: Welcome to the 3 Takeaways podcast, which features short, memorable conversations with the world's best thinkers, business leaders, writers, politicians, scientists, and other newsmakers. Each episode ends with the three key takeaways that person has learned over their lives and their careers. And now your host and board member of schools at Harvard, Princeton and Columbia. Lynn Thoman.

Lynn Thoman: Hi everyone, it's Lynn Thoman. Welcome to another 3 Takeaways episode. Elon Musk and Jeff Bezos have ignited interest in settling space with their space flights and their reusable rockets, but no one up until now has explored what space settlements and living in space would actually be like. Today, I'm excited to be with Kelly and Zach Weinersmith. Kelly is a professor at Rice University, and I'm excited to find out what living in space would be like. Their fascinating new book is, A City on Mars. Welcome and thanks so much for joining 3 Takeaways today.

Kelly Weinersmith: Thanks so much...

Zach Weinersmith: Thanks for having us.

KW: Yeah, we're excited to be here.

LT: I'm excited to talk more about what living in space is like. The opening of your book, A City on Mars, is wonderful. Would you read the first paragraph?

KW: Happily. Wherever you are on this planet, you've recently given some thought to leaving it. Space is looking more promising every day. There's no political corruption on Mars. No war on the Moon, no juvenile jokes on Uranus. Surely, space settlement presents the best chance since about 50,000 years BC to try out something completely new and leave all the bad stuff behind. After five decades of stagnation and human space fairing, we now have the technology, the capital, and the desire to go beyond the age of quick forays to the Moon and seize our destiny as a multi-planetary species. Well, maybe not.

LT: It sounds so wonderful. For a space settler, you believe the question is not where's the good place, but where's the survivable place? Can you explain?

ZW: Well, you can be really deceived by seeing pictures, even actual pictures from space. And you could certainly be deceived by movies into thinking the moon or Mars or even some of the much worse places are kind of like Arizona without air, but still somewhat inviting…if you could just work out a couple things.

KW: Air conditioning.

ZW: Yeah, get some air conditioning going, bring a little oxygen and you're good. And actually, the pictures won't tell you a bunch of stuff. Like for example, that the Moon is naked to radiation, that it's surface, that dust is actually regolith and if you put it under a microscope, a lot of it looks like tiny little knives because it's never been washed over by earth and air or little creatures. The day night cycle on the Moon, for example, is two weeks on, two weeks off, which means it gets extremely hot and extremely cold. So those are the good places. And so, when we say survivable, those are survivable, maybe. Everywhere else is extraordinarily worse. People talk about what's the next best option? And it's probably building a bespoke giant space wheel in outer space, which is an insanely complicated and still quite dangerous endeavor that we don't know how to do. Down from that, it's like Venus, which is like getting into a furnace made of sulfur - I guess more like a pressure oven filled with sulfur. Yeah. Not good. And everything else is down from there.

KW: It's not so nice out there.

LT: And you bring up other issues such as, for example, gravity. Can you explain?

KW: Sure. Yeah. So, we know very little that's relevant to space settlement about how gravity is likely to impact our bodies. So there have been hundreds of astronauts who have been in space for one to two years or less, usually much less. And they've been aboard the International Space Station, which is in constant free fall. So, their bodies are never getting the cues that our bodies get on earth from gravity. And these cues tell our body to keep our bones nice and strong. So, after they've been in space for just a couple months, they come back and already their bones are weaker and their muscles are weaker, and that's just after a couple months. But if you're building a settlement on Mars or the moon, you're going to have partial gravity. So not the 1 G that we have on earth, but something like 40% of the gravity we have on earth.

KW: And so, we don't know if you're spending an entire lifetime, or for example, if you're a teenager going through a growth spurt, we don't really know what that's going to do to bones as they develop. And so, it's possible, for example, if you grow up on the moon or Mars, maybe your bones will never be strong enough to be able to survive going back to earth, which makes it scary if we're sort of figuring out what life is going to be like in space and if it turns out it's not going to work, but all these people are stranded there, what are you going to do? And that, you know, we haven't even gotten to the question of reproduction. We don't know if a fetus when it develops requires gravitational cues that might get messed up in partial gravity.

LT: Can you elaborate on that? What do you mean about the fetus and reproduction?

ZW: There's been some research on the International Space Station where we've sent rodents up to look at how various aspects of reproduction work in a different gravity environment. We get mixed results and that's again, at essentially no gravity, which is different than what you get on Mars. So, we have next to zero data about what happens when a mammal is reproducing and carrying a fetus at partial gravity. And so, we don't know if development requires some gravitational cues. Or if it's particularly susceptible to the effects of radiation, which are totally different in space than what we encounter on Earth, you could end up with massive reproduction problems that to be honest, I think we know very little about. Maybe it will be fine, maybe it'll be totally fine. But ethically, I don't think we should be starting space settlements until we've done a lot more research. For example,

putting rodents on the moon in a research station and seeing that that's fine before we allow people to have babies in space.

LT: Zach, you talked a little bit about the moon. The moon seems to be the easiest place, if not obviously the closest place. Can you talk more about what a settlement on the moon would entail?

ZW: The moon you might say, is positionally desirable, meaning whatever its resource load, it's close, it's close enough that you can send a signal in a little under one second. So, if there was an emergency, you could actually call home and have something like a live conversation. Also, because it's only about one sixth earth gravity, and has no atmosphere, in principle, if you could set up a rocket launch facility, they could launch mass to space much more easily. So, if you look at a rocket on earth going to space, like if you look at the big Saturn Vs that put two dudes on the moon for a tiny amount of time, those are about 1.5% cargo. And that's just the stuff that's going to space, not the stuff that's landing on the Moon. That's an even smaller bit. And the reason is because about 80% is propellant, just stuff that gets burned up on the way up.

ZW: The other major portion of mass is just the machine itself, the engine, the pumps, the exterior, et cetera. And so only a tiny fraction actually goes to space. You might say that it's barely possible to go to space from earth. Like if you twiddle the knobs a little, it'd be just practically impossible. On the other hand, on the moon, if you could launch from there, you could put a lot more [into space]. And so there was a futurist and engineer named Croft Erica, who said something like, if man was meant to go to space, God would've given him a moon. So that's what we mean by positionally valuable. The problem is, I mean in addition to all the stuff I said before, there's almost no carbon. Carbon is about 20% of the human body. All life as we know it is based on carbon. And if you don't remember physics 101 listeners, you cannot just get more carbon. It requires a star to generate more carbon. So, you have to bus it in. It's not like you can amend the soil, you have to bring the farm. And so having a permanent settlement on the moon is very difficult. It's why most people would rather do Mars. And if they see the moon as a possibility, it's as a stepping stone.

LT: Tell us more about Mars. Why is it the most commonly suggested place to settle in space?

KW: Mars has a little bit of an atmosphere about 1% of what we have on Earth. And that actually makes a huge difference. So first of all, you get a little bit less radiation. That atmosphere is also made of carbon dioxide. And so, as Zach mentioned, there's not a lot of carbon on the Moon, but you can extract carbon from the atmosphere in Mars. And so now that makes farming a lot easier. Also, that atmosphere makes the temperature swings less extreme, which is good for both humans and good for equipment. So, you know, a lot of the equipment on the moon, you're going to have to come up with crazy good lubricants that can survive essentially boiling to freezing temperatures. Whereas on Mars, a bunch of those engineering problems get much easier. Additionally, water is much more abundant and much easier to find on Mars, whereas on the moon, you only get water at the poles in these craters of eternal darkness.

ZW: So essentially, there are areas where you end up with a crater that has created a rim so that the sun can't get in there to melt and vaporize the water. And so, it's trapped like a super hard ice at the poles and there's just not that much of it. Whereas Mars has a lot more water. So, between carbon dioxide, milder temperatures, the availability of water, Mars is just much easier. But it also has some challenges. So, for example, it still has some sharp regolith like Zach was mentioning on the moon. It's a little bit easier to work with, but first of all, there are dust storms that can last weeks.

And so good luck with your solar power if you have these unanticipated dust storms where you can't get the power that you need. And additionally, that regolith, it's about 1% perchlorate, which is an endocrine disrupting hormone that binds to thyroids and messes up a bunch of hormones. And it can be removed, but we have kids.

ZW: And if somebody said to us like, yes, the farm that you're thinking of purchasing has endocrine disrupting stuff in the soil and you plan on gardening, but you can remove it, it'll be fine. That would not sell us knowing that you could remove it.

LT: And how about other issues on Mars? So far, it seems like they're one or two issues, but are there many more?

KW: There's some research on psychology in isolated and confined environments that, you know, these are very difficult environments, and even if they don't create levels of psychological problems that are higher than the baseline you get on Earth, you should still expect that there will be psychological problems on Mars and maybe they'll even be worse than here on Earth. But you can't just call home and have a live call with your psychiatrist if you're on Mars because the delay can be, I think, up to 22 minutes long when Mars is farthest away from Earth. So, if you have a problem with your equipment or you have a psychological problem, you just can't get the help that you need in terms of getting home quickly enough or getting conversational input from experts. So, you're kind of stuck out there on your own. And the regolith still is going to stick to stuff.

KW: And there's some concern that if the regolith gets into the habitat and it gets breathed in, you could end up with diseases like stone grinder's disease where essentially you end up with scarification of your lungs, which makes it hard to breathe. And so, people are working on solutions for how do you make sure that the dirt stays outside and doesn't get inside? And of course, you'd have to worry about radiation, but there's so many other things wrong with Mars. Maybe that's low on your list of concerns, but you can put the power source far enough away from the habitat that you can get reliable power without worrying too much about radiation if we develop this technology, which is not quite ready to go yet. And so, when people like Elon Musk talk about getting boots on the ground and starting settlements up in the next decade or so, we ask ourselves questions like, well what is the power source going to be? Are you really going to have thousands of people hoping that there's no dust storms that kill the power source if you're relying on solar panels? There's a lot of problems that still need to get solved.

LT: And how long would it take for people to get from Earth to Mars?

ZW: Using modern technology, about six months inbound. In principle, in the future, maybe we'll have nuclear fission or maybe one day fusion reactors or other exotica to get you there faster. But right now, it's about six months.

LT: How about other planets and other places to potentially settle? Can you describe some of them?

KW: We came across some proposals that are a little bit wacky. So, Mercury is closest to the sun. It gets extremely hot. We read one proposal that suggested that you could live at the interface of where the sun and the dark part of mercury are. So, what is it called? The penumbra?

ZW: Penumbra, yeah, the Penumbra.

KW: The temperature there is survivable and Mercury rotates slowly, so you could move your entire civilization and track that. But that sounds complicated. There is a part of the Venusian atmosphere that is sort of earth-like and if you could create habitats that were floating around in the atmosphere, that could be doable. But the problem is, you're living above sulfuric acid clouds. And if you fall down to Venus, you get crushed by pressure that's just, how many times is it?

ZW: It's close to 100. Yeah, I don't know that you'd make it down.

KW: Probably the next most promising option is these rotating space stations, and they're going to be difficult to make. There's still a lot of problems that we need to solve to make them a reality, but they're an exciting idea. And if it does turn out that partial gravity is just not enough to allow the development of babies that needs to happen or is not enough to keep our bones and our muscles healthy, then we might have to use these rotating space stations.

LT: What are Jeff Bezos's and Elon Musk's vision of space travel and how do they differ?

KW: They both grew up as sci-fi [science fiction] fans and have had these dreams of space stations for a really long time, since they were kids. For Elon Musk, he wants to make the species multi-planetary by setting up a settlement on Mars that could survive the destruction of earth. And so, a backup for humanity, essentially. He thinks that we can have boots on the ground in the next couple years. And in a couple decades, we can be self-sustaining. We think those numbers are wildly optimistic, even from Musk. And Jeff Bezos, he is in the camp of the rotating space station. So, he thinks if we could move people to rotating space stations, we can reduce the pressure on earth and we can move a lot of our heavy pollution industries out to space so that the pollution is no longer impacting earth. His phrase is something like, we need to move to space to save Earth...

ZW: I think so, yeah, yeah.

KW: Yeah. Something like that. And so, it’s a beautiful idea and I love the idea of saving Earth, but the numbers just don't work out when you start thinking about it in more detail. So, on earth we put on something like 200,000 additional people every day. So, try to imagine the number of people you would need to move to space to make a dent in the impact that humans are having on earth, it just isn't feasible, especially because we do not have this technology yet. We don't have any rotating space stations that people can inhabit. So, it doesn't seem to us like it's going to come soon enough to save us from the global climate change issues that are coming at us fast right now. I still think it's a cool idea to pursue, but I don't think it's going to solve the problems that Earth is dealing with right now, like Bezos suggest it might be able to one day.

LT: So, what are three things that would surprise people about living in space or space travel?

KW: I think the three things that would surprise people are three areas where we know much less than you might expect, and that's space medicine which we talked about. Secondly, the current state of space law. So, for example, are you allowed to use resources on the moon and sell them? That's being debated by the international community right now. And also, a bunch of the technology still needs to be worked out, like creating closed loop ecosystems that could sustain hundreds, thousands, millions of people for years at a time without input from earth. Those are all very

fascinating questions that need more work and I think people would be surprised to know how much work still needs to be done.

LT: Wow. Before I ask for the three takeaways you'd like to leave the audience with today, is there anything else you'd like to mention that you have not already talked about? What should I have asked you that I have not?

ZW: In addition to all the science stuff, there are also sort of scary geopolitical aspects of a sort of rush into a space race. Like the '60s space race is at least a kind of battle over stunts, like who can do the awesomest thing in space. Plausibly, a modern space race ends up looking something like a scramble for turf. And that's much scarier, and it is not talked about. It's talked about a lot by nerdy legal scholars, but it doesn't get talked about a lot in discourse about space, which we think is unfortunate.

LT: Fascinating. What are the three takeaways you'd like to leave the audience with today?

KW: One, a lot of the international space law came about because we were testing nuclear weapons in space, and it made the international community very nervous and willing to create treaties to try to curtail that. Space is a global commons and part of that came out of those United Nations treaties. Two, space is much worse than you might guess from reading books or watching movies or even seeing pictures of space. Best place is Mars where the soil is made of poison and the poison storms blot out the skies. Everywhere is worse. And three, astronauts lie a lot and they're lying about their mental health and how their bodies are feeling 'cause they know that if they have a problem and they admit it to the doctors, then they're not going to be able to go up to space again. And so, biographies are filled with stories of astronauts lying to the people who are going to subsequently write scientific papers.

ZW: So, the takeaway is astronauts are liars.

LT: So, we should expect the same from settlers essentially?

ZW: Oh yes.

LT: Thank you so much. I really enjoyed your book, A City on Mars. Thank you.

KW: Thanks for having us.

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