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SHAPING THE FUTURE OF AEROSPACE

Building space societies

When Jeff Bezos inspires us with visions of colonies in low-Earth orbit or Elon Musk tweets about terraforming Mars, the need to discuss the laws that would govern such off-world societies might not spring immediately to mind. But lawyer Caryn Schenewerk believes it's these "unsexy" discussions that will pave the way for humanity to expand beyond Earth. She participates in such discussions in her volunteer role at the Commercial Spaceflight Federation industry group. She views the situation today as similar to about a decade ago, when SpaceX proposed reusing rocket stages and discovered that FAA's licensing rules on the topic were written with suborbital vehicles in mind. Similarly, today's international laws, including the Outer Space Treaty of 1967, are inadequate, she believes. Among the many considerations are how to enforce laws in societies hundreds and thousands of kilometers from Earth and how to resolve disputes between residents hailing from perhaps dozens of different nations. I called Schenewerk to discuss these issues and more. — *Cat Hofacker*

CARYN SCHENEWERK

Positions: Since November, chair of the Commercial Spaceflight Federation executive committee board. Since July 2020, based in Washington, D.C., as vice president of regulatory and government affairs for rocket builder Relativity Space of Long Beach, California. She lobbies Congress for legislation favorable to the company. 2011-2020, senior counsel and senior director of spaceflight policy at SpaceX. 2009-2011, deputy to the associate director for legislative affairs at the Office of Management and Budget. 2007-2009, deputy chief of staff and policy director for U.S. Rep. Gabrielle Giffords, D-Ariz.

Notable: Participated in SpaceX's efforts to gain U.S. congressional approval and funding for the Commercial Crew Program in which NASA partially funded the development of privately owned capsules to carry astronauts to the International Space Station. Also at SpaceX, lobbied for updating FAA licensing to streamline launch and re-entry requirements, including allowing a single operator's license to cover multiple launch vehicles and sites, changes now largely reflected in the revised Part 450 rules released in late 2020.

Age: 45 — her birthday is July 20, so she's a self-proclaimed "moon baby."

Resides: Washington, D.C.

Education: Bachelor of Arts in literature, Austin College in Texas, 1999; juris doctorate, University of Texas School of Law, 2002.

Q: When you hear these grand visions of millions of people living in low-Earth orbit or establishing moon and Mars colonies, where does your mind go?

A: One of the things that's important about those kinds of challenges is taking the time to learn about what we've done in the past in analogous situations and what lessons we can learn from those. Of course, it won't be perfectly informative, but I think about, "What did it look like when we were pioneering the West of the United States or when we were settling other continents?" One big difference for space exploration is that we don't think at this point that there are people indigenous to Mars, but we will have to deal with multiple nations exploring simultaneously and think of what rules of law we will need to apply. The Outer Space Treaty and accompanying documents establish a framework for how we operate in space and on celestial bodies, but there are a lot of interpretations on that. I like to joke sometimes that if you have six lawyers, you can get 12 opinions. Some things are purposely not specifically defined in those treaties so as to be able to flex with the ages, so when multiple nations are exploring the same celestial body, we will have to figure out how those entities interact and what it looks like to set up rules of governance. In the United States, we have a system of laws that's very much tied to states — tort law, for example, is based on what state you're coming from. So for instance, are early explorers going to be more like members of the military? — You're deployed from a home state, so you're subject to and governed by the laws of that state; that's where you vote; that's where you pay taxes. What does that look like in early exploration versus in the distant future? If we have a more developed colony someday, might it have some autonomy and set up its own rules of governance, and then how does that interplay with our 50 states on Earth in our constitutional republic government?

Q: Might this be a scenario where even if it's technologically possible to create an in-space colony, the legal framework has to be in place before it can be established?

A: We're going to need to hit some milestones technologically and exploration-wise before we see significant thought and effort put into what it looks like to have governance of those activities, especially if there are diverse activities across the private and government sectors. People make terrible jokes all the time about bureaucracy, that you start with "no" and then you have to get to "yes." I actually think that the American spirit starts with "yes." So that means that when we start exploring, while we might get ahead of having any kind of specific laws to what people are doing on the books, we will be able to come up with requirements and policies that address that without having to pass statutes and regulations immediately. At the same time, we are working on regulations on Earth that could enable a space settlement. The U.S. Department of Commerce is working on overseeing novel or nontraditional activities; these are the kinds of activities that would fall within that potential future approval process for a space settlement. Then when it comes to governance, I think we'll see that those early space explorers will probably be governed in some form or fashion by what's happening in the U.S., but they're going to be very much governed by their ability to operate and survive in space. Think of the early pioneers; they weren't necessarily a full society. Then as those settlements grow, we're more likely to have the development of those kinds of rules.

Q: This reminds of the moon colony in Andy Weir's "Artemis" where the residents retain their Earth citizenship of whatever nation they came from. Is that a realistic starting point for a multination space settlement, or might we someday have an independent moon colony, for instance?

A: I love the idea that anything is possible here, and I would love to think that whatever the governance structure is, it's a result of peaceful decisions and

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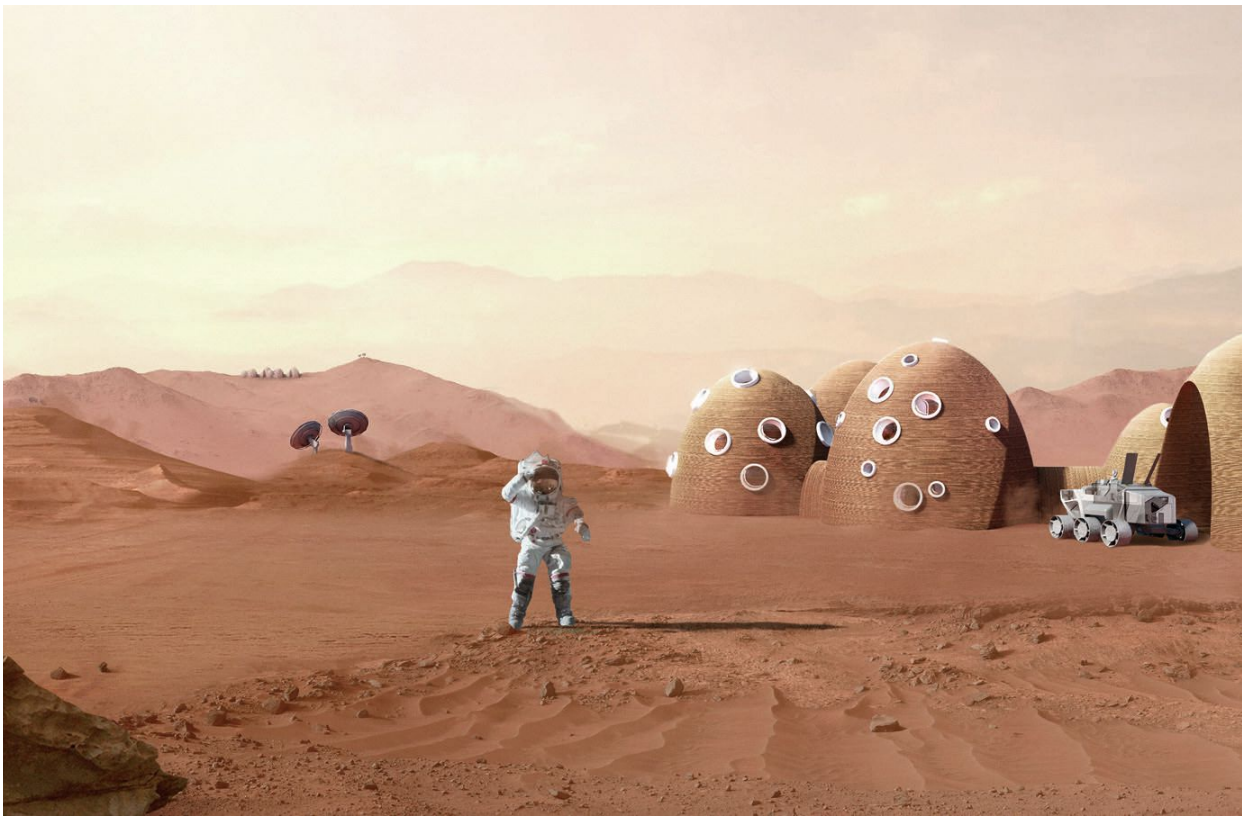


▲ This illustration of a Mars habitat was among the submissions for NASA's 3D-Printed Habitat Challenge. The multiphase competition required entrants to 3D print structural components for deep space habitats, an essential skill for a future self-sufficient space colony.

Logan Architecture

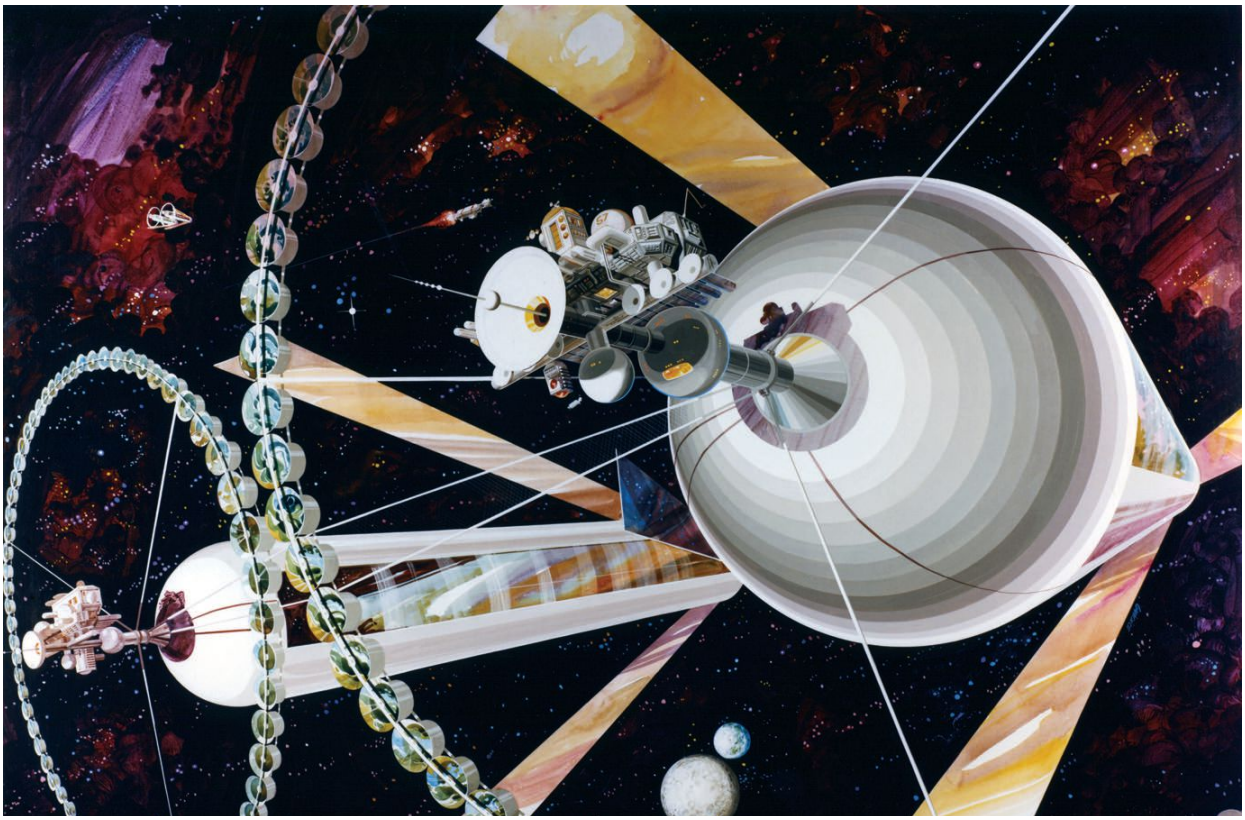
thoughtful people coming together — hopefully in a democratic way — to determine how they want to be governed. The idea that you'll have multiple people coming together from multiple places is absolutely one of the many options for how this could occur, and that you would carry your citizenship with you to this new place. There will be some need for engagement around how they interact with each other and what a system of justice looks like to resolve conflicts between them. Let's just keep it to contractual conflicts — is it an international dispute that needs to be resolved on Earth? Or is it a dispute that we have a means to resolve at the settlement based on some agreed set of principles? My pure guess is that it's an evolution; we're going to start one place and end up somewhere else. Another scenario is that this is an international exploration activity from the start, in which case something like the International Space Station Intergovernmental Agreements that apply to the individuals on the space station and how conflicts are resolved between them could be a good starting point.

Q: As you've said, the Outer Space Treaty provides many basic principles for exploration, but there's disagreement about whether it actually allows for a settlement on another celestial body. Which camp are you in?

A: I am in the camp that I don't think it explicitly prohibits the idea that people would create settlements and undertake exploration in an organized fashion. Maybe a rough comparison is if you pitch a tent on a piece of land, you would then have some expectation of being able to sleep in your tent for some number of days without being disturbed. The OST should be used to influence the idea that we should be collaborating and that we should be communicating and that we should not be declaring exclusive use or ownership versus disallowing, as you said, any kind of settlement or exploration.

Q: That gets tricky very quickly. If everyone has the right to colonize the moon, for instance, does that mean every nation is entitled to the same size piece of land? Is a new treaty required to address questions like that?

A: One can argue that: Are we appropriating orbits, or are we appropriating space on the moon or Mars? Anything in space in theory is subject to the concept of equal ownership in this framework, but by virtue of physics, we can't all be in the same place at exactly the same time. We're going to have to, in some way, divide access or grant access and address this concern, but I don't necessarily see us coming internationally together to change or develop a whole new Outer Space Treaty. I think we are more likely to see



▲ Blue Origin founder Jeff Bezos has championed the idea of millions of people living in habitats in low-Earth orbit. This illustration is one example of the concept, called O'Neill cylinders after the late Princeton physicist Gerard O'Neill. He concluded these habitats allowed for better conditions than the surface of other planetary bodies including Mars.

NASA Ames Research Center/Rick Guidice

interpretations of the treaty through things like NASA's Artemis Accords, agreements that started off bilateral and then built out to be multilateral. The ISS IGA [Intergovernmental Agreement] is another example of where some number of countries that developed the technical ability to pursue an exploration objective came together and came to some form of agreement about how that space hardware would be used. On Earth, we also have things like codes of conduct and sustainability guidelines, so we've come together to answer the same questions in other aspects and behaviors with regard to hardware in space and private interests. That will provide some precedent for whatever kind of question you're asking, whether it's about undertaking science or harvesting rare earth metals. It could even be something intangible like the position of some piece of hardware with regard to the sun, and therefore the best place to gather solar energy to power other activities in space. Also, increasing technological capabilities ahead of us will make some of these questions a little bit different — and in some cases easier to answer, in some cases harder to answer. For example, with additive manufacturing, do we need to set up a huge manufacturing plant on the moon or Mars that would take up a lot of space and take up a lot of energy and effort to transport goods there and fix tooling? Or could we put something like a robotic arm with the materials it needs to print in this location and then over there in that location? That would spread it out in ways that it benefits various entities that need access to it but also has a much smaller footprint than a huge manufacturing facility.

Q: Shifting gears a bit: there's governance and then there's enforcement. Let's say labor laws on the moon allow for 10-hour shifts because of the lack of gravity, but Company X works their employees 14 hours and has no incentive to stop because the United Nations committee or whoever enforces those laws is all the way back on Earth. So how do we not create a space society where some people have more rights than others?

A: That's a great question and one that is answered in a couple of different ways in my mind. It's probably a different answer in the near term, the next 50 years, than in 200, 300, 400 years from now. In the near term, I come back to the idea that we have precedent for how we maintain visibility and responsibility for all kinds of people and entities today who are operating remotely and are subject to the laws of the countries that they're based in. Under the Outer Space Treaty as it is today, a U.S. company is subject to U.S. law and has been authorized by the U.S. government to go to this place — to the moon or Mars — to undertake this activity, and so it would seem to me that companies should be planning for the idea that they are still

"I don't necessarily see us coming internationally together to change or develop a whole new Outer Space Treaty."

subject to U.S. law and regulation with regard to labor practices. For any of these activities, a key aspect of success will be the ability to communicate back and forth. Right now, it's at least six months to get to Mars — at the point where we have industrial activities on Mars, is it still six months to get there, or have we somehow managed to get that time down significantly so it's a couple of days? Quite a few of those technological solutions are going to also address some of the concerns you bring up so people can communicate in the same way they can communicate today on Earth when they're concerned about the level of work that they're being asked to undertake and communicate with their employer. In the near term, I think we're likely to see that the long arm of the law applies, where you would be subject to your national jurisdiction. Now, different countries have different labor laws, and we already have a situation where some countries are flags of convenience for various activities. So can people take advantage? Unfortunately. That's true here on Earth, and it could be true on another planet. That said, the opportunities are there for the long arm of the law to apply and be applicable to those kinds of issues, particularly when the authorized entity is coming from a country like the U.S. that has a sophisticated legal regime.

Q: How do you think international disputes or sanctions might play out? Take the Russian anti-satellite test last November. There's always a lot of condemnation around those activities, but the sanctions don't always take the most direct forms.

A: The honest answer is that these are challenges that we still face terrestrially, and the more work we do to figure them out within the orbit of this planet, the better we will be situated for exploration in the future of the moon, Mars and beyond. These kinds of challenges aren't going to go away. I think that the answer is that the same mechanisms that we have today are probably extrapolated to the questions that you're asking with regard to planetary exploration in the future, in that there are only so many tools in a diplomat's toolbox. A country's toolbox has sanctions all the way up to escalations of armed conflict, and there's been thankfully more and more interest in finding solutions that do not involve armed conflict. And an international body like the United Nations, it is limited. In some cases, we have courts of justice within the U.N. that have been established, but there are parts of that process that some countries have not signed on to. But we do have other avenues like the World Trade Organization, where we resolve conflicts and nations represent each other and the activities that they represent. We come together and we actually have a forum where a decision is made and a ruling is made on a particular issue, so it is possible that we could come up with some dispute settlement mechanism for space that doesn't necessarily exist today. I understand that it's not always the most satisfying answer, but it's really amazing all the ways we have found to interact — companies

▲ California startup Relativity Space's goal of 3D printing entire rockets is an example of the technologies that will help make in-space settlements a reality, says Caryn Schenewerk, the company's vice president for regulatory and government affairs. The company is printing the majority of components for its Terran rockets out of a proprietary metal alloy via the Stargate printers pictured here. The first Terran is scheduled to launch later this year from Cape Canaveral, Florida.

Relativity Space

interact with other private companies, how countries interact with other countries — and resolve conflicts on a minute-by-minute basis on this planet. There are a lot of positive aspects of that, and in some cases, humans created these mechanisms in response to other issues. Maybe I'm a bit optimistic, but we've made progress — sometimes two steps forward, one step back, maybe — in ways that I think are indicative of a hopeful situation for planetary exploration.

Q: What makes you hopeful we can find consensus in space when it's been so difficult to do on Earth?

A: I'm going to come back to two key aspects of how international law is developed: opinion and practice. Anti-satellite testing is a great example of this. When a country takes an action and that country's ASAT test purposely doesn't hit a target, that action might be met with a level of opinion: "OK, we're not excited that you're developing this activity, but it's not so bad because you didn't create a huge debris cloud that's going to spread and be up there for decades." Compare that to the response when a country undertakes an ASAT test and actually blows something up. We've seen an increased level of opinion specifically saying, "That's unacceptable." After the Russian test in November, there's been an escalation of opinion leading up to the U.S. declaration to not undertake this activity anymore and positive opinion around that declaration. So we see people taking actions and then how we respond to those actions as an international community is part of how the law develops. That approach is also indicative of how this would be extrapolated to activities on other planets.

Q: Where do you think the first in-space settlement will be created: LEO, the moon or Mars?

A: I leave these questions up to the technical experts. I stand ready to help figure out what the framework looks like and how we achieve that, changes in law or compliance with the law. I do see a lot of progress happening with regard to commercial LEO capabilities and habitats, and that's really exciting. That's a step that needs to happen in the direction of further exploration. The activities that we see happening with regard to the moon and Mars right now do seem to be NASA-led, which I think is right and likely to continue to be true. NASA just put forward its 50 objectives for moon to Mars and what does it look like to be able to support activities and take advantage of private capabilities and engage internationally for going from the moon to Mars. So if somebody asked, "Caryn, how are you prioritizing legal issues that need to be solved?," my inclination would be tackling the things that need to happen to make sure that we're able to do that LEO commercial activity and then moon and then Mars beyond that. I see a natural progression where you start solving some of those problems and they start extrapolating out to serve the benefit of all those exploration needs. ★