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Leaders

NanoRacks
Providing a Commercial Pathway for Research in Low Earth Orbit

Eva-Jane Lark interviews Jeffrey Manber of NanoRacks

Leading up to the de-commissioning of the space shuttles, there was much talk about the International Space Station (ISS) being de-orbited as early as 2017. That talk has receded. I wonder if NanoRacks' role in increasing the utilization of the ISS through your operations in the National Lab is one of the reasons?
When I left Mircorp, the industry began to change and it seemed very exciting with the COTS program involving SpaceX and Orbital Sciences. It also seemed to me that there has been a sea change in how NASA viewed its place in the international space community. When I began to focus on the community again, I heard over and over that the utilization of the station was not at the levels that they wanted. This was really disturbing to me because I had fought very hard to keep the Mir, the Russian space station, in orbit. It was very upsetting to me personally to learn that the utilization levels of Space Station (ISS) were not really gaining traction. Nor at the time did I believe that the station would be de-orbited. When we formed NanoRacks, we really took a gamble, because as you said, it was U.S. budgetary policy to de-commission Station in the near term. We went ahead anyway. We put in our own money and went forward with our proposal. Now it has been changed to 2020 and beyond. I happen to think that it will be quite some time before we see the Space Station coming down. Just as I fought to keep the Mir in orbit, I will fight as hard as I can to keep the ISS in orbit. You don't throw away perfectly good space hardware or our home in space. Having said that, I don't think we played a role at all in the decision to keep the station going. However we do expect to play a very positive role as Congress looks at the decision in a couple of years whether to extend Station beyond 2020. There I think that through the efforts of NanoRacks and the whole ecosystem that

Jeffrey Manber (right) with NanoRacks CTO Mike Johnson.
NANORACKS

is developing on utilization of the platform that, yes, we will have a voice and a role in that.

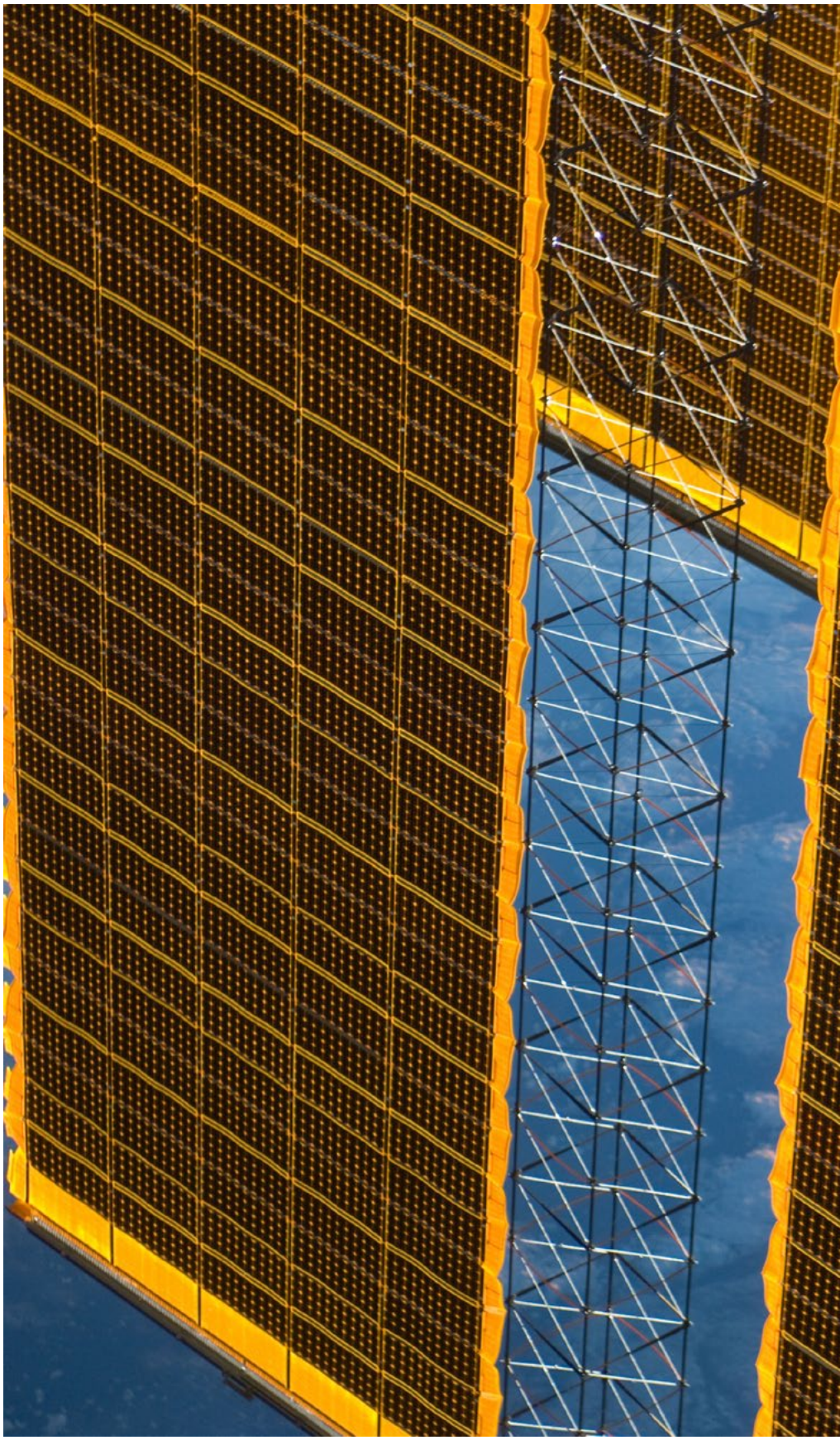
Can you tell us a little about NanoRacks; how and why it was formed and what were the initial goals you wanted to accomplish?

We approached NASA in 2009 with a unique proposition and that is: if we were to design and develop our own research hardware for on the Station, using our own funding—we asked NASA for no funding - and in return for that bargain, that agreement, could we go ahead and market that hardware commercially? And NASA agreed. It's an easy date to remember—on 09/09/09, September 9, 2009, we signed the Space Act Agreement with Mr. Gerstenmaier. By April of 2010, we had our first research platform ready to go. Everything at NanoRacks is about standardization, open source, miniaturization, ease of use, low-cost and finally putting to rest the question "if done correctly, is there a market for Station or Low Earth Orbit utilization?" We had never really proved this yet. We had never proven that you could get a community going outside of the NASA contractors to utilize micro-gravity. So we felt that if NASA permitted us, if we could create low cost, open source, standardized hardware; that we could answer that question. We went operational in August of 2010 and since that time, in two and a half years; we've flown over seventy-five payloads which we call "NanoLabs". Everything from the first high school to pay its own way, Valley Christian in San Jose that is doing a whole series of interesting experiments, to Fisher Institute of Israel that did stem cell and cancer research. We can now say, three years after forming the company, "Yes. There is a market for low earth orbit utilization, there is a wonderful service provided by the Space Station." Two months ago we became the first company to arrange for the deployment of a small satellite from Station. You can see that the role of the space station and our own strategic needs as a nation in the international community just keeps growing. It's a very exciting time. We are very pleased that we have what we consider the world's first commercial laboratory in space and it is mostly self-funded. It soon will be four platforms. Three are inside the Station and one external, two microscopes, a centrifuge with our partners at Astrium, a plate reader which is a sophisticated research device and there will be some other hardware sent off in the coming year. So we have the commercial pathway, commercial laboratory in space, multiple ways to get to that laboratory—we can fly four to six times a year on a variety of launch vehicles. All in all, we think we are in a very good place and we enjoy where we are at the moment.

Several tiny satellites are featured in this image photographed by an Expedition 33 crew member on the International Space Station. The satellites were released outside the Kibo laboratory using a Small Satellite Orbital Deployer attached to the Japanese module's robotic arm on Oct. 4, 2012. Japan Aerospace Exploration Agency astronaut Aki Hoshide, flight engineer, set up the satellite deployment gear inside

What can you tell us about the make-up of your customers? You mentioned high school and universities… What is the make-up in terms of type of organization, industry and geographical location? And do you have any Canadian customers yet?

Yes, we do have our first Canadian customer—it is a school in Manitoba. We've been surprised that the first group that really jumped at the NanoRacks opportunity was education. The last, and I think that is indicative of how long it takes them to move to take action, is government research programs. We are extremely proud that the first NASA NRA (NASA Research Announcement) has come out that includes the NanoRacks facility. There will be a dedicated announcement in a couple of months just for NanoRacks facilities for use by government researchers. We're thrilled by that. We are also gratified that we have flown through our educational partners over thirty-nine school districts in the States. We've flown about twelve individual schools. We have flown three Israeli schools. We have a multi-year agreement with the Kingdom of Saudi Arabia. We've flown a Vietnamese university and also one from Romania. We are delighted that in this difficult time in America, where we have to rely on Russia for transporting our astronauts to and from the station, that we can show leadership in another critical area such as utilization of that station. We are very grateful to NASA because we have NASA as a landlord, we have NASA as a service provider in transportation (they arrange for our flights to and from the station) and also as a customer! But they are not a competitor. They don't seek, as in the old days, to design hardware just like us. They understand that they may not be the best at marketing to the overall marketplace. So Congress and NASA have created the non-governmental organization (NGO) CASIS—the Center for the Advancement of Science in Space, and we work very closely with CASIS to increase utilization and we think that having a NGO/not for profit pathway and having a commercial pathway like NanoRacks is really a good model for moving forward beyond low earth orbit.



the lab and placed it in the Kibo airlock. The Japanese robotic arm then grappled the deployment system and its satellites from the airlock for deployment. A portion of the station's solar array panels and a blue and white part of Earth provide the backdrop for the scene. NASA

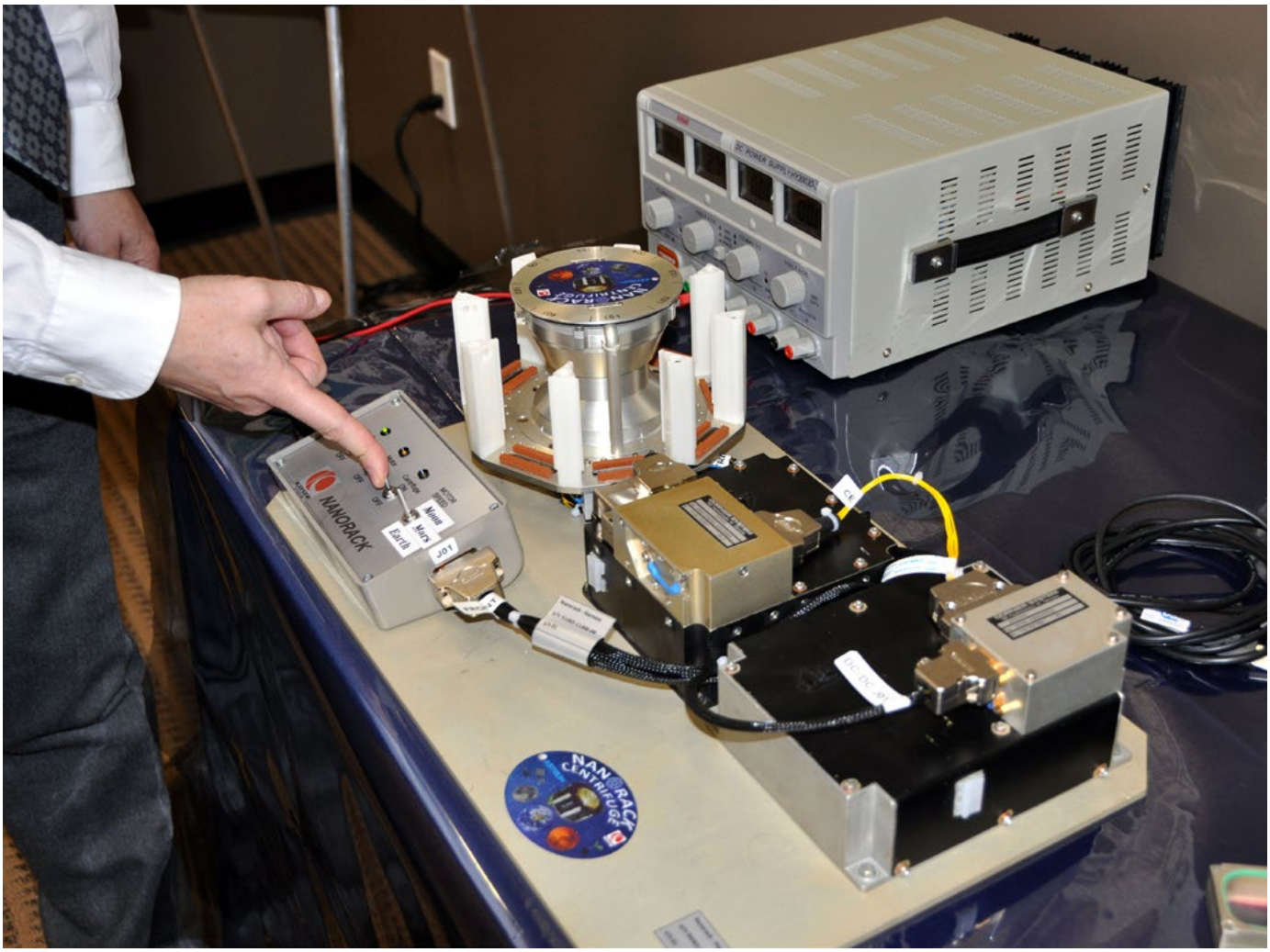
Are you aware of the content of all of the experiments? And of the goals the experimenters have for them and of the results that they achieve?
Our agreement with NASA basically says that we can market to whomever we wish as long as it upholds the honor and the integrity of the U.S. National Lab and we take that very seriously. We're very proud to be representing the U.S. National Lab and the first U.S. National Lab in space. So that means we don't do coffee mugs or that type of thing. Everything we do fly has to pass the NASA safety. We're very intimately involved in the development of the payloads, making sure that they are NASA and Space Station compliant. Yes, we know what their objectives are—to a degree. We sign confidentiality clauses and the IP of our customers is protected. We work with our customers to release information accordingly, as appropriate. That's sometimes frustrating for NASA. They are very eager of course, to get out good results. We've had two examples already where our customers don't wish those results to go out. And that what's called "commercial". Our customers in some cases are investing a lot of money. They want a competitive advantage etc. We have an agreement with NASA where we do have to publish some results, we do have to share but it is at a level that is appropriate and does not impact on the confidentiality of our commercial customers.

Are there any particularly innovative and exciting ones that you can tell us about?
We had a customer that has flown what seems to be one of the largest pharmaceutical crystals in space and that was one of our first customers to go to the Space Station. Our first two missions were on the last two shuttles. We had to convince him to fly to Station rather than to just do his work on the shuttle. So he went up on 134, the second to last shuttle, and his project stayed on the station and came back on 135. He got fantastic results and we are all very excited about that but he is not prepared to go public with it yet. We've also had the iPhone as a research test bed to see if off-the-shelf smartphones could really be used as research tools. They have accelerometers and gyroscopes inside of them. It really fit in with everything we're about at NanoRacks which is: don't reinvent the wheel. The consumer marketplace is growing very quickly and we don't think we need always to have space specific hardware on the Space Station. That was fun to do and I think there's a future for using smartphones and tablets in very interesting research ways in the U.S. National Lab. Also the schools have got some very interesting results flying electroplating in space. The Valley Christian program has grown from one high school to, I think, twelve schools now. And they are really doing very innovative work. NanoRacks is not an education company—we're a space company, we really like to say that we are really a concierge to help people get to space. We have educational partners, we have the National Center for Earth and Space Science Education (NCESSE) which has now flown over 30 school districts in the States. NASA has said it is the first time there has been a national space science, technology, engineering and mathematics (STEM) program with no NASA funding! We also have a program with the Conrad Foundation where you can use your American Express points. Parents and school districts can get together and either make individual donations of a little money or use their American Express points to lower the cost to get to space. So we are reaching out to educational partners throughout North America to lower the cost and make it as easy as possible for students to fly. We believe that in North America that by 2020, every school district will have had a chance to participate in a Space Station project, hopefully via NanoRacks.

> Everything at NanoRacks is about standardization, open source, miniaturization, ease of use, low-cost and finally putting to rest the question "if done correctly, is there a market for Station or Low Earth Orbit utilization?"

Have you had many repeat customers - where they have had interesting results from one experiment and wanted to fly more to tweak the experiment and run multiple variations?
We had a meeting at Johnson Space Center about two years ago and a woman from NASA stood up and said "You know, I have a hard time understanding your business model. I can't really track you. I don't really get it. What I'm going to look for is: if you have repeat business. If you have repeat business, I'll know you're doing something right." So every time we have repeat business, we send her an email. Valley Christian has flown with us three times now and their own program has grown from themselves to twelve schools. NCESSE has been on every mission we've done. We keep flying twice a year and growing, and growing. Fisher Institute has flown with us twice. So yes, we have repeat business and I am sure I am missing other examples. It is a wonderful time. With the comparative low cost, there is ample opportunity to get to the station. You don't have to spend years now trying to develop the perfect space project. You can send something up, see if it works, test something, push the envelope, and if it doesn't work or you get unexpected results, tinker with it and play with it, and next year send it up again. During the shuttle program, you'd be lucky to send something once every two years, once every five years, once every seven years. And now we have schools flying once a year and paying for it themselves.

This is a medium close-up view of a gravitational research centrifuge which Astrium Space Transportation handed over to NanoRacks LLC, during a ceremony on Feb. 14 at Astrium North America's Houston facility. Astrium ST and NanoRacks are working in cooperation with NASA to deliver the commercial centrifuge facility to the International Space Station.
NASA / COURTESY ASTRIUM NORTH AMERICA



Do you have the ability to scale up the experiments? As I understand it they are fairly small at this stage. Assuming for instance someone had excellent results with crystal formation and wanted to start manufacturing, could you scale to do that?

Yes we can. But we think that is years away. We think that what is possible today in miniaturization means that you can do very, very good science in a 4U, a four unit NanoLab or even in an express locker. You can do very serious science today in a small format. The U.S. Department of Defense is looking at 3U satellites, 4U satellites. A smaller size also has advantages as it can get manifest on to the cargo vehicles. That is one of the strengths of NanoRacks. We understand the limitations on getting stuff sent to and from the Station. So for the foreseeable future we are focused on the smaller payloads and maybe a happy day will come that we have a customer who has flown with us ten or fifteen times and is ready to go far bigger and we can deal with that when that moment happens.

Are all launches full occupied? Do you have a backlog?

We have in queue eighty-two payloads; inside, outside and satellite deployment. We've just signed three more satellites for deployment from the Station in 2013. So—yes, we have a multi-year customer pipeline. It's growing in sophistication. NASA gave us permission five months ago to develop a platform outside the station. This is our external platform program and we are working on it with Astrium of North America. They are manufacturing the platform and the principal customers are very sophisticated users of sensors and advanced electronics and next generation satellite systems. You can actually test in the harsh environment of space and bring it back down to see results before you commit to an operational program. Prices start about two million dollars for a 4U, so we are getting into an entirely different aspect of space utilization. That is going to be deployed in 2014.

Do you have any competitors, Jeff?

Yes. We have people who do payload integration on the Station, we have people who build hardware who are competing against NanoRacks, but on the concept of a commercial company that is not looking to NASA for funding of hardware and is freely marketing its own hardware on the Station, we are the first.

NanoRacks Research Plate Reader ready for launch. Now on the space station.
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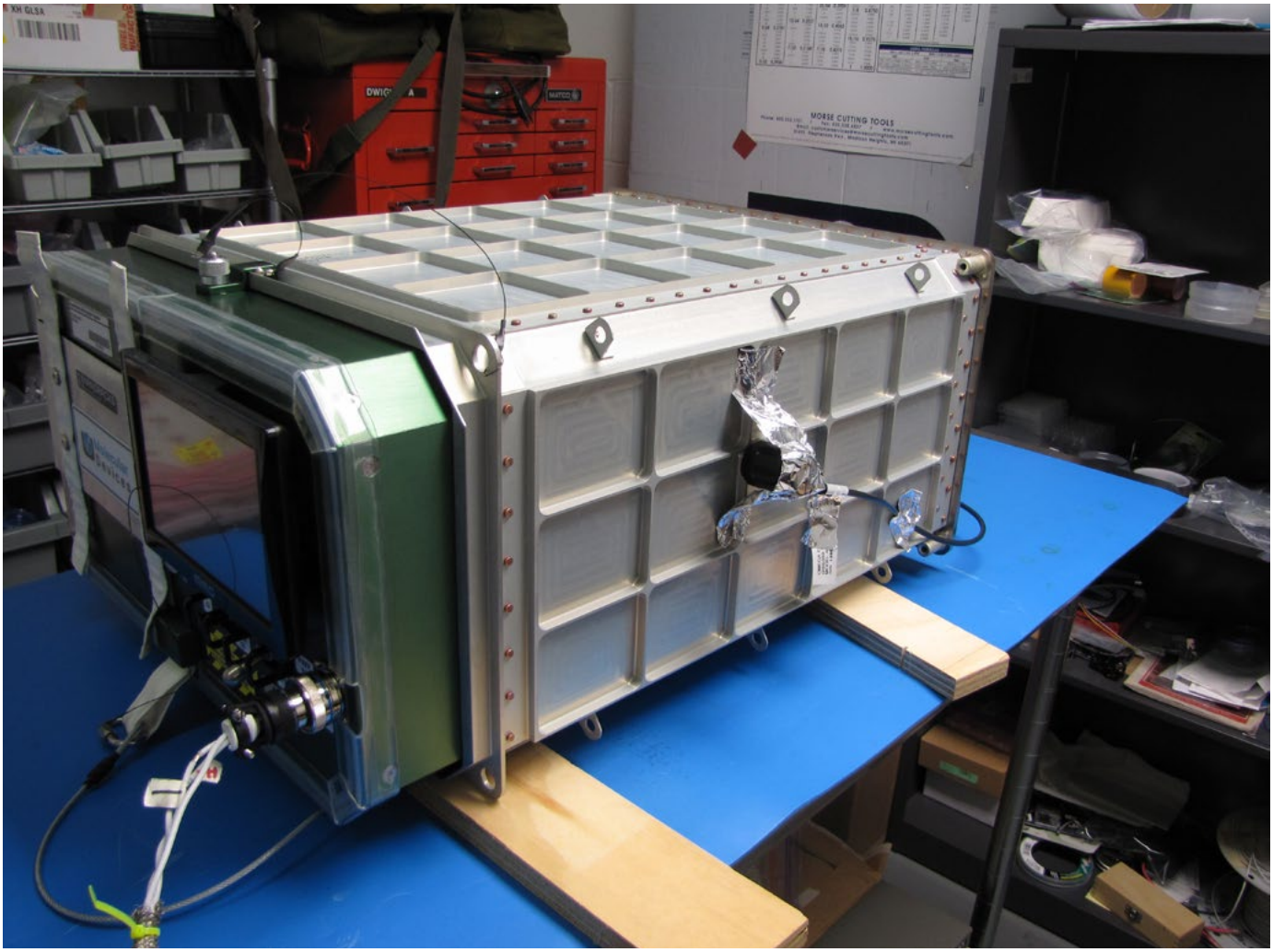

In terms of executing your operations, are there any particular challenges or issues you face that you wish someone would create a solution for, to complement your activities?
We struggle every day with the NASA safety requirements in the NASA system. It was not set up for efficiency nor has it evolved to be an efficient system. It has evolved to be a safe system. They have yet to make the transition in their procedures from operating the fragile shuttle program which suffered two misfortunes to operating equipment onboard the ISS. Having said that, at the Johnson and Marshall Space Centers, NASA has been extremely accommodating. When we first approach NASA with a new customer, we are already late in the NASA system. We are averaging from contract signing to launch—nine months. This is extremely fast in the NASA system. It's painful for us, it's uncomfortable for them. And we'd like it to be six months. So we struggle every day with the NASA system—duplication of requests, uncertain lines of authority over our payloads. At the same time we know they mean well and are trying to streamline their process. I like to think that NanoRacks has played a role in showing them that the commercial sector needs certain things that a NASA, government or academic researcher does not.

They may not need them but perhaps they too would appreciate them…
NASA has been averaging roughly three years to get a payload through the system. We're averaging nine months. So we just think to assure the Station is part of the solution to competitiveness and research and development, it's got to routinely be six to nine months. I have seven full-time people now in Houston who do nothing but work with their colleagues at Johnson Space Center on these issues of getting a payload through the system. When we see a problem, we are very vocal. And when we see a tool that can solve it, we don't ask for help. We're developing a software program which is now in beta testing, called the Payload Tracker, and it allows everybody who is responsible at NASA and at NanoRacks for a particular payload to track every step. We've broken down the NASA steps to seventeen distinct steps to get a payload through their system and now we can track it.

So we have self-funded this. We will be licensing it now to other users and NASA I hope, but we developed it because we needed it. So when we need something that we think is important, we behave as a commercial company behaves and we self-fund.

Another example of a challenge has been that when we fly a customer that is not from

NanoRacks 3RD Platform prior to leaving the shop with the traditional signatures.
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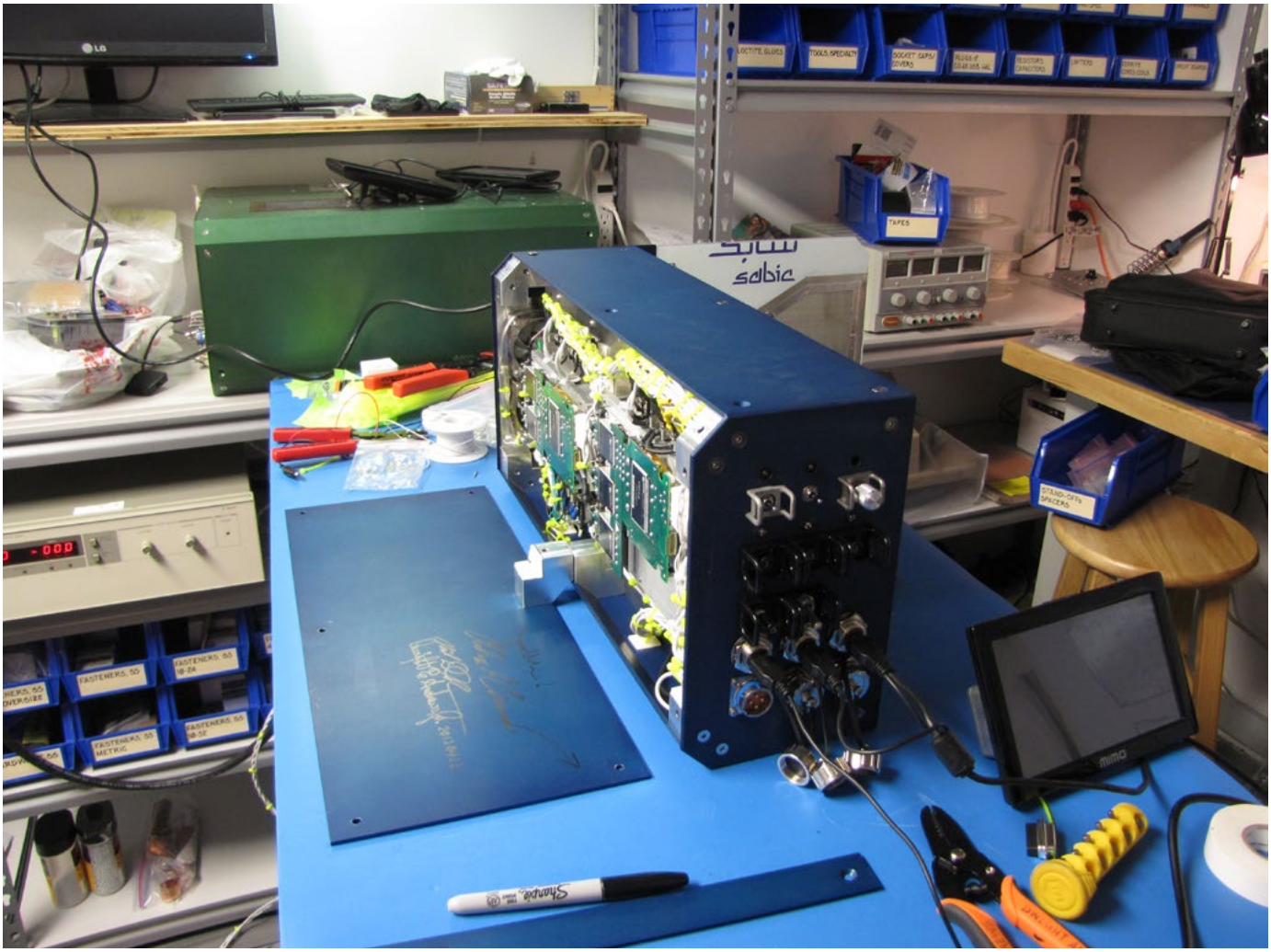

an ISS partner member nation, we need the written permission of every one of those partners. We didn't know if they would give us permission. As it turns out, we've gone with NASA three times to the International Space Station partners and they have kindly given us and quickly (within a matter of days) written permission to fly our non ISS partner customers. So now everyone, internationally, in the space operational community is learning about NanoRacks.

Are you planning for other platforms than inside and now outside the ISS? For instance, long duration Dragon spaceflight missions, Bigelow modules or on some of the suborbital vehicles?

We were very, very gratified when Virgin Galactic selected NanoRacks to design, develop and build their research hardware on SpaceShip Two. What's so exciting for the industry about that is it creates a standard—from the leading suborbital platform to the U.S. National Lab. A researcher, once SpaceShip Two is flying, can fly multiple missions on suborbital and the hardware will be the exact same hardware that will then be used to go via NanoRacks to the U.S. National Lab. You've reduced the cost of a dynamic aggressive multi-step research project because the researcher focuses on his or her payload and not on the hardware. We're currently engaged with Virgin Galactic on the suborbital, and for LEO, we are completely hardware or vehicle agnostic. We're excited about the opportunities to work with Bigelow. We fly everybody now. We've flown the only commercial cargo that was flown on all the SpaceX missions. We believe we are the only company in the world (which is amazing for a three year old company…) to fly payloads on shuttle, Progress, SpaceX, ATV, HTV, and Soyuz up and Soyuz down. So we take full advantage of the wonderful situation we have today in low earth orbit, we take full advantage of the international agreements that NASA put in place and yes, we are certainly excited about moving into the other platforms as they become available. At NanoRacks we are starting to look at moving beyond low earth orbit. We believe that the systems we put into place, the cost efficiencies, the standardization, the miniaturization and all the things we've used to build the business case for Station utilization would work just the same beyond low earth orbit.

So that will be interesting… to see how results would differ in other parts of space?

What I mean by that is that the United States and other nations are beginning to look at L2 and the other Lagrange points. They are beginning to look at Mars and returning to the Moon. We believe that there must be a standardization across all the programs. I think you start small using NanoLab type

hardware and the first few forays out, let's say to L2, there is no reason why it shouldn't be in the cubesat form factor. How do you use low earth orbit for assembly? Start small. Start with standardization. Use commercial practices. I think we will get there far faster, and it will be more robust and safer than if we follow the traditional process of times past.

You have mentioned a few times, that unlike many space ventures NanoRacks is self-financed and does not operate on a cost-plus basis. Can you talk more about this business model and expand on what "self-financed" means in your case—Personal Funds? Friends and Family? Angels? Venture Capital?

When we started the company we liked to say that the first investors were Visa and MasterCard… I have been in the business a long time now. I shudder to say this but I have been in for three decades. I didn't want to approach anyone with "I will…" in the future tense. I'm past that point now. If you believe in it, you do it. We self-financed, out of our pockets to put up the first few research platforms. At that point we did our first round. We haven't disclosed the amount—it was an adequate amount. We didn't go to friends, we went directly to angel investors and we worked with Near Earth LLC which raises funds for satellite and other space ventures. And sometimes when we first approached the angel investors, we'd say we were looking for *x* amount to do a round and they'd say, "Oh you can't get into space for that money" and we'd reply, "No, we are already in space. We are permanently on the Space Station. We already have customers. We're looking for these funds to grow and to operate." It was still difficult to close the round. I'm bemused when I see people getting up and saying "I have an idea for a space project and I'm going to raise five million dollars". Space does not have a good reputation in the investment community because it has yet to show strong and adequate returns. So even though we closed our first round when we were already permanently on the station, it was difficult. We used that first round to grow, to build equipment, to keep the team together. Now we are going out to do a second round. Far more significant. This will be with Venture Capitalists. These funds will be used to build the external platform. We have revenue and yet it will still not be the easiest thing in the world because it is space. But I am very confident that we'll do fine on our second round of financing.

And how long until you will be profitable? Or are you already?

I don't anticipate that we will be profitable for some time as we spend 30 plus percent of our revenue on investments. And that's what you do as a commercial company. We are embarking on something now that is terribly exciting. I told you we have three platforms now. Platforms 1 and 2 went up in 2010. We are now investing in rebuilding new platforms to replace 1 and 2; given what we've learned, given advances on the station, we are making an investment that the station is going to grow and we want to be more sophisticated for our customers. There are other people still clinging to shuttle hardware. Commercial companies keep investing to make sure their services to

their customer are at the cutting edge. We will be the first company or organization ever to have second generation space station hardware. To our knowledge, no one has yet put hardware on the station, used it, have customers use it, get feedback, figure out ways you can do it better and take advantages of advances that are taking place on the station as it moves into the utilization era and finance a second generation of that hardware. This is the speed that commercial companies move at. We don't need to wait for NASA funding, we don't need to wait for an RFP, we can say "Huh! Our customers have told us A,B,C, and D." Now is it worth it to take our money and rip out platforms 1 and 2 and put up new ones? We've made the decision that the answer is yes.

Disruptive and self-disruptive innovations are often the most valuable types of innovation… and being self-disruptive is preferable to having a competitor creating the disruption.

Right. We just did something that I am so proud of… we just announced a winner in a contest we held to have another company offer, open source, low cost NanoLabs. We announced that Infinity Aerospace has been awarded for their product that they are coming out with, ArduLabs, for likely (I don't know yet) under $2000. That's $2000 for the NanoLab and then you have to pay for the space side through Nanoracks. First of all, why didn't NanoRacks develop this themselves? The reason is, we believe passionately that you have to develop an ecosystem. We don't have all the answers. I want someone else waking up in the morning, thinking about products that can be used with NanoRacks. And the more people thinking about it, the better.

This seems similar to the business model that Apple and other smartphone or tablet manufacturers have used with their app development…

That's how we see it as well. We are seeding Infinity Aerospace with a two thousand dollar investment and customers right now can use them on the NanoRacks platform on the U.S. National Lab, and you'll soon be able to use the ArduLab on Virgin Galactic's SpaceShip Two—then you can see a market for one to two hundred of these a year and then you have a whole community out there making NanoLabs better and better. I can envision in a few years that you'll be able to do ten sophisticated experiments inside a single NanoLab. That means we keep lowering the cost, we keep driving the innovation.

> We take full advantage of the international agreements that NASA put in place and yes, we are certainly excited about moving into the other platforms as they become available.

The more the nature and results of these experiments is communicated, the more likely that is to spur innovation and creativity and encourage people to think of what else they can do?

That's exactly right. We believe at NanoRacks that the creativity comes lower down the pyramid. It's not just people with PhDs who have the ideas. Like the software marketplace, like the internet business, the first great breakthrough in space research may happen from a college drop-out. It may be somebody whose parents buy a gift of flying a payload with NanoRacks, and they come up with something. There's no reason why the breakthroughs and applications in the internet may not be duplicated in space research.

Here's a basic difference between NanoRacks and a lot of folks in the space business: most folks in the space business from the big guys to the little guys, make profit on hardware development. They build something. Government uses it. NanoRacks makes our profit on utilization. Our goal is to make something as inexpensively and as quickly, as safely as possible so a consumer base can develop.

Utilization is the big issue isn't it? If you have something that doesn't do anything, provides no value in people's minds, then what is the point in doing it, in having it?

That is the accepted model in this community where the government funds people to build hardware, it takes years to do and the end product is simply the hardware. We keep people skilled, we keep the knowledge base in place and the results that come out may be very good but they are very long in coming. I find it fascinating that we in our business even have a special word for when the hardware is used: we call it "utilization". In any other business that is called a customer.

We don't say "Boy you should see how those Fords are utilized" or "you should see how my iPhone is utilized". It's so unique and rare in our business that we use a special word. At NanoRacks, we try and get away from that. We're trying to get away from being in the hardware business. We're in the services business. I was at a meeting at Johnson Space Center and somebody said "the chief goal of the U.S. National Lab is to produce good science". I said "May I say it a different way? The way we look at it at NanoRacks—our chief goal at NanoRacks is to have a happy customer. It could be that their project fails to get results. But they are happy and satisfied that they learned something from that failure".

As Thomas Edison said "I have not failed. I've just found 10,000 ways that won't work"...

Exactly. So we are customer driven. If there are some ways that NanoRacks is unique, first is our profit does not come from hardware development, it comes from customer use. The second way we

are unique is that we are solely focused on keeping our customers happy and that is why we get repeat business.

Various competitors in this summer's NewSpace Business Plan competition mentioned NanoRacks in their plans… does NanoRacks have interests in or collaborations with other companies?
Yes. One of the most exciting things happening is the development of this ecosystem. We had a meeting several months ago where a company has a new concept "sticky boom" for cubesat deployment and in their proposal they showed us, they are dependent on our external platform. And I said "Gentleman, you are going forward with your program based on our success with the external platform"?! And they said "Yes. We believe in you." And there are others - both startups; like the winner of the competition, Space Amalgam LLC, and others including some big companies we are partnering with. We see this ecosystem developing in the commercial sector and we are seeding this now. And people are making their plans now, second generation based on NanoRacks. It's a great feeling of satisfaction and tells us we are on the right pathway.

You have had unique experiences in dealing with space stations and commercialization. You've even written a book about it *Selling Peace*. Are there lessons you learned in Russia and with Mir and Mircorp that have given you unusual insight to the issues facing the ISS today?
Everything that I have learned from working with Energia, the Russian space company and with the Mir space station is what I am applying at NanoRacks. I think I am the only business man to have marketed two space stations. The toughest, toughest hurdle to overcome is the demanding requirement of the space operations versus the philosophy in the commercial world of "the customer is always right". So when NBC wanted us during the Mir era to guarantee for a television program that the launch of the Soyuz would be on Halloween, you had the two worlds coming together. The entertainment business was saying this is what we want, this is what we demand. And you had the complexity of a launch, of a manned launch. The idea in the space business of changing that launch schedule by one second to accommodate a commercial customer is ludicrous. To the commercial sector, the idea of the vendor not listening to you fully is also ludicrous. So I have learned a number of things. First I have learned there is nothing wrong with profit in space. I've learned that providing commercial goods and services in space works just the same as it does on the Earth. I've learned it is not our God-given right for America to be the leader in space: we have to earn it every day. I'm very proud of what NASA is doing today: I had thought they were in danger of losing their way in the 1990s. We in America rely very much on our friends in Russia now and I am very proud of the time I worked with Russia. I thought it was very important at that moment where Russia stepped up on Space Station. The Russians in the 1990s reminded NASA how to do long missions. NASA used to clock, down to the second, the astronauts' time and it really took the Russians to say "wait a

second… these astronauts are up there for months, you can't do that anymore". NASA knew that from their Apollo missions and Skylab, but they had forgotten it. My unique experience has taught me that capitalism works in zero-gravity just as well as in gravity. The free markets have taken over the planet, from China to Vietnam to Russia. Capitalism exists in different variants and models. Open markets are better for innovation, for providing services than are closed, centralized markets and that is true for space as well. That's what we are showing the space community, I'm hoping, with NanoRacks.

I was also involved with PanAmSat. I was very fortunate when I was younger to work with René Anselmo. René Anselmo may be forgotten today but he busted up the Intelsat monopoly. Up until the early 1990s, in Europe you had to go into the PTT, a phone booth, to make an overseas phone call because of the monopoly on satellites sending signals between countries: they had to all belong to Intelsat. Then, a call to London cost twelve bucks. René wanted to send soap operas between Mexico and America and he found out he wasn't allowed to because it violated the Intelsat agreement. He fought and fought and the first country to allow PanAmSat to function was West Germany, then Margaret Thatcher's UK and finally (to my utter embarrassment) was the U.S. (first Bush Administration). Overnight, the ability to allow the private sector to transmit satellite data and images from one nation to another, collapsed the artificial price structure of Intelsat. That's why we have CNN, that's why we have Skype, and cheap phones around the world. The entire world, as we know it today with instantaneous communications came about because of René Anselmo. What I took away from that was it was not a change in the satellite technology that changed the world as we know it. It wasn't a change in how you launch or operate satellites. It was allowing the free markets to play a role in international satellite communications. Eventually PanAmSat went public for a billion dollars, then Intelsat itself was privatized and later Intelsat bought PanAmSat. What I take away from my career is that it is not technology that is always the driving force; it's making sure we hit the sweet spot between government intervention (safety and regulations) and providing goods and services.

Looking to the foreseeable future, Jeff, what do you see as the big opportunities and challenges for space exploration, now that we seem to be getting closer to having reliable access?

The challenge is today. We're in an extraordinary period where many things that I dreamt about we have today. We have a stable policy and permanent facility in low earth orbit. We have multiple ways to reach the station. We have a government that's behaving like a commercial customer. So this is the moment to prove that the private sector can contribute to space exploration in low earth orbit and beyond. Also the idea that the NanoRacks model for commercial space only works in LEO is absurd. To me, it is like being a little bit pregnant. Once you allow the free markets into LEO, which is what is happening, they are not going to stop two hundred miles up. They will go beyond. When we go to the Moon, Mars or L2; unless we want to repeat the delays in the program and cost overruns it better be as a free market. There is something else driving me (and I am speaking here as an American who spent much of my career overseas)… Who gets to space first, who operates the first colonies, who gets to the Moon - these things matter. Our whole culture in the U.S. is based on Anglo Saxon law because of the British settlements (with some residual Napoleonic code influence in Louisiana). So who gets there first matters for hundreds and hundreds of years. So when we talk about whether to go to Mars, to me it's not about planting the flag, it is about the values that we hold in our society that become the norms as we venture out into the solar system. I think we should take the IGA, the intergovernmental agreement for Station as the founding document for moving beyond low earth orbit, back to the Moon and on to Mars. You have a functioning legal document that has all the spacefaring nations of the world (except for India and China) as signatories. It works. It's good. It's been in use for over ten years now on the Space Station. But it is time to start moving out, as nations and as companies, beyond LEO.

Thank you very much Jeffrey for a fascinating discussion! We wish much success to you, NanoRacks, and free markets in space.