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INTERVIEWED BY SANDRA JOHNSON
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JOHNSON: Today is August 26th, 2015. This oral history session is being conducted with Julie Robinson in Houston, Texas, as part of the International Space Station Program Oral History Project. The interviewer is Sandra Johnson. This is the second interview with Dr. Robinson, who's the Chief Scientist for ISS. I want to thank you for agreeing to talk to us again.

I want to talk about CASIS, the Center for Advancement of Science in Space. Until recently U.S. research space on board the ISS has been reserved mostly for government initiatives. But new opportunities for commercial and academic use of ISS are now available, and 50 percent is set aside for them and it's facilitated by CASIS. I want to talk about that relationship between NASA and CASIS and when the decision was made to look for that and how CASIS was chosen and anything you had to do with that decision.

ROBINSON: To go to the roots of where we are today on the Space Station, you have to go back to around 2003, 2004. Around that time NASA was really grappling with the fact that we needed to retire the Shuttle the minute that the Space Station was assembled. The NASA budget was all spent on different things and there was nothing available to start building whatever that new vehicle would be. As the Constellation Program stood up, the Agency also made a decision to focus its research on just exploration-related things rather than being the NSF [National

Science Foundation] of space if you will, managing all research that anybody might want to do on the Space Station.

It was really driven by budget realities. But up on the [Capitol] Hill among congressional staffers and especially among a very influential Senator Kay Bailey Hutchison from Texas, there was a lot of discussion about if the Agency cannot afford to fund all the research that should be done in space, who could take that place. Because everyone was concerned that after having made this great investment in the laboratory, the minute we were done assembling it, the support for the researchers would go away, and we wouldn't get all of those powerful things that that laboratory could do for the nation.

These were really strong space supporters, certain influential staffers, Kay Bailey Hutchison, others, that looked at this and were trying to think of some alternatives. One alternative that emerged, and it really came from earlier efforts that NASA had done to provide commercial access to spaceflight, things like the Space Product Development Division that at that time existed in OBPR, that's the Office of Biological and Physical Research, which was an equivalent of Mission Directorate at the time. In the 2005 NASA Authorization Act, it was really an effort to rethink the way that we use space and put it in a context of enablement even in the middle of the budget realities.

In that Authorization Act of 2005—and that was something that was really important to Senator Hutchison as I understand it, because that was an important legacy for her. At that time we hadn't had a new authorization act in a really long time. One of her goals for that year was to influence that authorization act. One of the things the act did is it declared the Space Station a National Laboratory. It didn't really define what a National Laboratory was. It said that the Space Station would become a National Laboratory when its assembly was complete, so really in

2010. But it set the stage saying, "Hey, coming up the Space Station is going to be a National Laboratory. It's not going to be just for NASA." Then it directed us to start Pathfinder projects to help define how we would use ISS as a National Laboratory.

We as an agency had to do a report in 2005, reporting back on what resources were available for commercial and other government agencies to use, and to start initiatives where we could start opening up the Space Station to that as a Pathfinder for when it would become officially a National Lab in 2010, which at that time was the assembly complete date.

That provided a really great opportunity within what's now the Human Exploration Mission Directorate to put some creativity in place and to try different things and to use different capacities that maybe wouldn't have been used in the traditional way that NASA had been doing research.

Of course we talked in our last interview about all of the reorganizations that happened as that research went away or as the funding for research was shifted in focus. Some of the exciting things that happened in what I'll call the Pathfinder period, from really 2005 to 2010. In the ISS Program we named a National Lab Manager. That was someone to work with all of these people that maybe had never worked on utilization before, maybe weren't even sure if there was commercial value to using ISS, but to help them get on board ISS, because they wouldn't be going through the same infrastructure that NASA had in place for the research it funded.

Mark Uhran, who was basically the Division Director for ISS at [NASA] Headquarters [Washington, DC], took that on, that Pathfinder aspect, as one of his major efforts. He emerged to really work at finding those Washington relationships with other government agencies for example. I was asked, because I could talk about everything that had been done in the past on

ISS and what had been learned, I could talk the science part of it. So I had the opportunity to be really involved in a lot of the different discussions.

What happened in that timeframe then is a lot of different companies started talking to NASA at different levels, and also Mark worked on a number of different MOUs [Memorandum of Understanding] with other government agencies. We had an MOU signed with the National Institutes of Health [NIH] for example, through a lot of contacts back and forth and a lot of meetings building relationships there. After that MOU was signed they actually had an announcement of opportunity where their research could apply to a specific grant program and propose to do their research in space.

What was really unique about that is they didn't set aside a space budget, they just let any of the institutes that wanted to participate if they thought it was of such merit that they'd rather fund that than other research, then they selected it. It competed head to head against all the other research those institutes could choose to fund. There were four projects selected under that Pathfinder.

Those are flying right now. They were five-year projects and most of them had their flight at the end of the project. We just finished flying the first of those. One of them wound up being canceled along the way, and we're in the process of getting ready to fly the others. Those things take time, but those are still bearing fruit today even.

We also had a lot of discussions with USDA [U.S. Department of Agriculture], discussions with National Science Foundation, and had a few different Pathfinders coming through different directions through all of those other government agencies.

Then on the commercial side we did some different Pathfinder projects. There was a Space Act Agreement done with Astrogenetix, which was a company that was interested in

building on some of the results from some of the microbial experiments on the Space Station and seeing if they could find a shortcut to vaccine development. It was privately funded.

There were some other Space Act Agreements that were entered into, one with NanoRacks. We agreed that if they wanted to build a subdivided facility, basically be able to subdivide some of the space on ISS and facilitate users putting simple experiments in plug-and-play mode into that, we had that Space Act Agreement with them so that they could guarantee to their customers that if they paid them to do something they could fly it to ISS.

We really set up a lot of different structures. It was an opportunity to try things, see how things worked out, get lessons learned as we were heading towards 2010, when ISS would officially become a National Laboratory.

JOHNSON: It did become officially a National Laboratory and then in 2011 was completed. As you said, NanoRacks was already and some of those other things were working toward that. But then in 2011 then CASIS was selected to actually manage that 50 percent that was going to be dedicated to those other than government or NASA-related research. Talk about that decision.

ROBINSON: In 2010 actually the Authorization Act gave us notice that we should seek a nonprofit organization to manage the ISS National Laboratory. A lot of the thinking behind that was commercial companies routinely when they talk to different staffers, different consultants that have been engaged, they would say, "We don't trust NASA. We don't want to work with NASA. We don't want to work with the government." The idea emerged that if it was a nonprofit organization they could sign nondisclosure agreements and they could work together.

I had that experience myself. We had done a lot of work with a pharmaceutical company who was very interested in having a set of flight opportunities on ISS during that Pathfinder period. Before we went any further they wanted me to sign a nondisclosure agreement. NASA civil servants aren't allowed to sign nondisclosure agreements. There are criminal statutes that are actually more severe than a nondisclosure agreement that govern if we were to release any proprietary information like that that we gain as part of our duties. But that is so foreign, that's such a foreign concept that even though the NASA lawyer assures them that me not signing a nondisclosure agreement gives them more security, they just refused. They stopped the project, they said, "No, we're not going to do that."

There's some real basis for that idea that a nonprofit organization might be able to work more effectively, especially with commercial customers. There had been a consultant who had contacts with a number of members of Congress and staffers like Jeff [A.] Bingham. We had also competed a study to define what National Lab models would be. That report also was available by 2010. That report was out there and we had paid for it under a contract so we could put it out in the public domain.

It had a model for how one might operate a National Laboratory, and it was specifically struggling with who pays for which pieces. If commercial customers don't know they want to use ISS, why on Earth would they ever invest all that extra money and effort it takes to do something in spaceflight compared to just regular R&D [research and development] on the ground in the labs? It looked at some different models for that. We put that out in the public domain.

Then we had a cooperative agreement notice to compete different alternatives for institutions. They had to be nonprofits. They had to be nonprofits that weren't managing

anything else. They would have to be spun off from some other entity and exist independently so they had a level of independence. We did a solicitation and looked at what kinds of proposals came in. That was how NASA emerged to look for—with all the lessons learned along the way—how we looked for a cooperative partner. It would be a nonprofit organization that managed the National Lab. In the end after the procurement process went through, then CASIS was selected to be that management organization.

JOHNSON: When it was first selected how long was it before it actually started managing some of the research, and some of that actually started working, that relationship?

ROBINSON: The relationship itself took place almost instantly because the CEO [Chief Executive Officer], for example, of the new CASIS organization, who was Jeanne Becker, she had been an ISS PI [Principal Investigator]. She was well known to all of us. She knew Marybeth Edeen, who was the National Lab Manager. We immediately started working together, and we started transitioning a number of these Pathfinder projects to CASIS management. But, that said, because they couldn't be part of any other existing organization, they were a startup. They started with one employee, that Executive Director, Jeanne Becker. Then her first thing was to hire someone to help her hire other people. They had no staff. Even though people were smart and knew what was going on, there was going to be a lag phase as they sought talent.

One of the challenges I think they had is NASA had had a corner on space for so long. Civil servants that knew how things had worked in the past, some of those are going to be entrenched in the old way of doing things, and they were pretty resistant even to the idea of a National Laboratory. Others were really excited to help in any way they could, but they certainly

weren't willing to leave their 30-year civil service careers to go to this startup organization. It took a while for them to staff up, to find the right mix of people. They needed people who had existing contacts. They set up a board of directors.

I had the opportunity both to work with that board as it had its first members and then as it added additional members, as well as the staff. But it just took a lot of time. That startup phase I would say not surprisingly was about a three-year startup period. What we're really seeing today is the organization actually come into its own and be actively managing.

JOHNSON: I know it was forming, and as you said they were having to find the best people for the positions. She [Becker] ended up leaving and the management changed. Did that affect anything that was going on as far as the relationship with NASA and CASIS.

ROBINSON: No, it definitely didn't. Our relationship—I remember when we first heard that Jeanne had decided to leave CASIS. On the NASA side, our viewpoint has always been, "How do we help this partner be successful?" They're trying to be successful at doing something that is an absolutely innovative approach to research management in the U.S. government. This is not how any other organization ensures that we meet the government's mission for research and development, by managing things with nonprofits. Everywhere else, whether it's NIH or NSF—they might put out an institute every now and then. But mostly it's a matter of government funding then being passed out to the most meritorious scientist. This is so novel because it's saying, "Let's find out where the private sector thinks the research is meritorious, and let's let them do what they think is important, not what a government civil servant thinks is important. Let's have that financial support be how you measure whether or not it's important."

That's really really innovative. Nobody knows how to do that. There was no organization out there, CASIS or any other competitors, that had experience in doing that. There was basically a white paper out there that said, "Here's a model that might work." That was not required for any of the people who applied to the cooperative agreement. It was just an idea of how you might make it work.

This has really been an innovative experiment in public-private partnerships. Because of that I think people like myself or Bill [William H.] Gerstenmaier or Mark Uhran, we all recognize that this is really cutting-edge stuff, and it's not going to be easy. It's real simple for people who are maybe entrenched or even don't understand this new concept in the way that research could be supported, and it's real easy for them to take potshots at CASIS saying, "Why aren't they doing this, that or the other?" But it's such a novel approach. So much of what CASIS does doesn't really show up in the public record because these are relationships. They're agreements to exchange proprietary data. They're discoveries that may not show up until a drug is approved for the market. It's been something that when they've had difficulties, like any time an executive director leaves suddenly that's going to be difficult for an organization, when they've had those difficulties, we've just always tried to do what we could to provide stable cooperation so that those things wouldn't affect their ability to achieve their mission.

JOHNSON: NanoRacks for example, one of the things that they advertise is they can get things up within I think it's nine months. They can get through all that paperwork quickly, and that's one of the ways they're attracting people to do those contracts with. But does any of that—not just them, but specifically the CASIS side—does any of that take away from what might be

happening on the NASA side instead? Or is NASA focusing mainly on the Human Research Program [HRP] to go forward from here to go to Mars or beyond low-Earth orbit?

ROBINSON: You got to separate the ISS mission, the NASA civil servants in the ISS Program. Our job is to execute the research that comes to us under the strategies that we're given. Things like shortening the integration time so things could fly quickly, that was really a joint objective that we had with commercial innovators like Jeff Manber from NanoRacks. But also working with CASIS as they stood up. Even during the Pathfinder phase we found a way to do these placeholders. We knew what type of thing was going to fly but we didn't have to have selected the investigator yet. If you know you're going to fly a facility that can grow plants and you're going to put something in it, you can actually then select that PI much later in the flow. That benefited both NASA-funded researchers as well as National Lab researchers as we made that a different standard, rather than having to have everything in line and then get approved, to use that placeholder process.

Those are examples of innovations that came in the way we plan and operate that just wouldn't have come if we had behaved like the same old plan, overplan, replan, and then do something mode, which was the mode that had developed during the Shuttle Program, when you had five years to plan a mission like a Neurolab mission. You'd plan it for five years and then do it for two weeks and you were done.

JOHNSON: You work with the ISS Program Science Control Board.

ROBINSON: Right.

JOHNSON: Can you talk about that and just talk about what that board does and then what your role is with that board?

ROBINSON: The Program Science Control Board is a relatively recent way of codifying the way that the ISS Program has worked with its commercial customers really since 2005. The reason we had to codify it more recently is just because the resources have become much more limited. Going back to 2005, we were asked to write a report to Congress about the possibilities of making ISS a National Laboratory. They particularly asked us how many resources—how much isn't going to be used by NASA for exploration that could be used for other purposes.

As we looked at that, we found that 50 percent of what I'll call the real estate, space in the racks, lab bench space, would be available to other users. We specifically said, "There'll be no crew time available. Anything National Lab is going to do is going to have to be very light on crew time because human research is the most crew time-intensive thing that we do." If I remember right, at that time I think they were using maybe three-fourths of the crew time on ISS at the time. We knew that that would go up when we got to six crew, but we also knew we could project ahead and see that we were never going to have that much crew time, because human research is by its nature so crew time intensive, and because human research is a big part of NASA's exploration objectives.

But in spite of that, in the Authorization [Act] of 2010 and then again in 2011, Congress specified when we selected this National Lab management organization that we'd get 50 percent of all the resources, including the crew time. I've talked to folks like Jeff Bingham about it later and said, "What were you thinking there?" Because we've been in I would say a resource crisis

for the last couple of years because National Lab grew really quickly and then all of a sudden there's not enough crew time to do what NASA was planning and what National Lab was planning. We have a law saying we have to give National Lab 50 percent of the crew time. Yet we also have another law saying we have to be done with our exploration research by the time ISS is complete. You can't do that.

He said to me, and I think it's probably true, that he never in his wildest dreams thought National Lab could grow its use of ISS that quickly. But of course the reason he didn't imagine that is because nobody thought about rodent research.

The other thing that we did, because so many commercial users seemed to be interested in doing research using mice or rats as models, and because that had been very successfully done by Amgen during ISS assembly in some rodent flights that they flew during that period, then we reinstated the rodent research capability to support the National Lab. If you have rodent research and you're having crew members do actually on-orbit dissections, on-orbit sample collection, all of a sudden you can need a lot of crew time really quickly. That's really why National Lab grew so rapidly. We just didn't think about that particular discipline because that wasn't something—on a short Shuttle flight you couldn't even open the cages. They just flew up and came home and you didn't need to worry about it. But if you're going to launch them on a SpaceX you're not going to keep them on orbit necessarily till the next SpaceX comes home.

You're going to have to decide when that experiment ends and what things you're going to collect. Long duration spaceflight for rodents really changed the crew time picture in a way we didn't imagine at the time, because at the time we did the 2005 report, there was no rodent capability. That had all been canceled by NASA and we couldn't imagine that it would come back at that point.

JOHNSON: I was reading—[September 21,] 2014, is that when the first SpaceX, the rodent model animals went up? Was it then or was it before then?

ROBINSON: The first SpaceX that flew rodents was SpaceX-[4, CRS-4], which was just in the last year.

JOHNSON: They took the mice up.

ROBINSON: Right. But that's not the first mice that have flown to the Space Station. That's the first mice in this new Rodent Research [Facility] system that we built because of the National Lab demand. Also then there were a bunch of NASA users who then said, "If we can build this we'll use it too." Everybody suddenly wanted this.

The Italians [Italian Space Agency, ASI] flew an experiment called Mice Drawer System to the ISS. That actually had the record for how long mice have been in space. I'd have to look back to see exactly which flight that went up [STS-128, August 28, 2009] and back on [STS-129, November 27, 2009]. I think it was right before assembly complete if I remember right. I could be off.

Then during assembly we had three times when Shuttle assembly flights to ISS did carry the legacy animal habitat research system. Two of those three times were completely commercial flights at the time. The first of those was joint commercial and noncommercial. In those cases the Shuttle docked to ISS. The whole mission wouldn't have happened without ISS, so I think of them as part of the ISS legacy. But they really were in the Shuttle, and they never

crossed them over. The air was shared, but the mice never went on board, I guess, they never came aboard.

JOHNSON: It's an interesting addition though to have now.

Also part of your position and your work with the Program Control Board, I was reading you're the first avenue if an organization wants to appeal an ISS priority decision by that board. Is that something that happens often? How do you negotiate those appeals or work with that?

ROBINSON: That's always been a role of the Program Scientist or the Chief Scientist. But over the years who gets precedence and what the rules are for determining that change over time. My role has often been to try and get consensus on things or get people to understand why it might be best for the Agency to do things in a certain order. These aren't what I call capital P priorities. These aren't should the Agency ever do this. These are for this particular next six months on orbit what things should we put together to make a plan and what things do we have to wait on.

Early in 2004, 2005 it was all about deciding which was the most important thing for exploration and postponing or delaying things that weren't exploration-related. Then as the portfolios got reshuffled it really was very focused on human research. That was pretty much using all our resources. Then when ISS assembly was complete and we started getting more and more crew time, about that time we also set up the Space Life and Physical Sciences [Research and Applications Division] at Headquarters. They started getting more money to fund research. Then it started being a little bit about balancing and trying to help each user get their most important research done in every six-month period.

But when ISS assembly was complete and CASIS started having research that couldn't fit in the plan and we had to meet the 50 percent, then these prioritization discussions became much much more difficult, because we started getting to a point where since CASIS can use their 50 percent then if HRP does what they were planning, there's no crew time left. That would mean there's no crew time for other technology demonstration, which really is part of the Agency's exploration mission, or also that there's no crew time for fundamental research that might have been funded by NASA Space Life and Physical Sciences organization, thinking that there were plenty of resources, so they went ahead and funded PIs, and then all of a sudden CASIS brings in a bunch of new PIs and there's not enough crew time to go around.

In this most recent era we had over the last couple years two really difficult priority appeals to deal with. The first one we were able to resolve successfully by really coming to the Program Manager level. I had always been able to resolve the appeals on my own before. We had an appeal process. It on paper could have been appealed all the way to Mr. Gerstenmaier, but we were always able to find a consensus before that. But what happened about two years ago is Space Life and Physical Sciences wanted to fly their own rodent experiments, CASIS had customers who wanted to fly their own rodent experiments, and you couldn't do both.

That became a very difficult prioritization challenge, and there really aren't clear guidelines in the law other than the 50 percent crew time piece. So that I didn't get beaten to a bloody pulp by people fighting over crew time while I tried to do what the law says and what Mr. Gerstenmaier wanted, Mike [Michael T.] Suffredini decided it would be really good if I had Program Manager backing. He controls money too, and that helps him. He doesn't have to find consensus with people, because he controls the budget.

We formalized that in making this Program Science Control Board charter. We also took that consensus forum that I had always operated over the years, formalized that in something we call the Program Science Forum-U.S. Now we've had my Deputy operate that forum, so that there's still an opportunity to get as much consensus as you can. But if you have an organization like Space Life and Physical Sciences coming in and being told they don't get to do any research this expedition, that makes them very angry for obvious reasons. So you really needed a little more formal structure to hear those questions and handle those questions. Congress has put us in a tough position. Until we have commercial crew and we have a seventh crew member it's going to stay tough on the crew time.

JOHNSON: I was going to ask you as far as crew time, I've heard as much as it'll double the amount of time with just the addition of the seventh crew member. Do you see that happening?

ROBINSON: Yes. Our projection is that when we add a seventh crew member we'll get about 33.5 to 35 hours per week out of them, because it doesn't take a lot more effort to maintain the life support systems and keep the Space Station clean. But you have a whole other person's hands to do all kinds of work. Right now the Space Station was designed for with 6 crew 70 hours a week, 35 Russian, 35 U.S. We typically get about 40, 42 hours a week. We push our system pretty hard, because we know we're limited. The more we can get the crew to do, the more research we accomplish. There's this urgency we have to get as much research done and have people wait as little as possible so that those results can be built on and the next experiment can fly too. That's where you get that doubling number. If you have 35 in the U.S. Operating Segment [USOS] and you double it with another 35, that's roughly where it comes from.

But 35 hours a week, it's a goofy number. It was in those old experiment designs. It's a horrible misleading number. I've had people scream at me about how offended they are that all their tax dollars go in and all we get out of those three crew members is not even a week's worth of work. I remember talking to a guy in business at the National Academies [of Sciences]. He had drawn a crowd because he was just screaming about how offended he was about that.

I'm standing there, I had no idea, because I had just presented some of these numbers and showed them how much more we were getting with assembly complete. Because before assembly complete we were getting six hours a week sometimes. I was using it as a sign of our progress. He was just screaming at me how awful that was. "I don't employ anyone that doesn't work 60 hours a week. Businesses can't be innovative and they can't be profitable if you do that. You guys should be shut down."

I finally looked at him and I said, "I recognize you have really good employees. But I think our astronauts are pretty good too. Tell me. Do they recycle their own urine? Do they clean their own bathrooms? Do they make their own furniture?" It defused it because everybody laughed and the conversation was over. It's a bad number because people compare it to what we work here in terms of your business hours. It really is just the hard scheduled time that we book them to do a task. Not all the time. Just like you and I check our e-mails and we plan our day at home on our own time and the astronauts do the same thing. It's a very misleading number, but it is the number we have. It's what we use.

JOHNSON: You've got to use what you have. Let's talk about some of the international work as far as working with our international partners. As part of the ISS Program Science Forum you're

the chair of that forum. You work with senior scientists from all the other partner countries. Let's talk about that relationship and how that works.

ROBINSON: There was a really neat evolution in our relationships with our partners as each of the modules came on board. As we were getting towards the 1E [assembly] flight when *Columbus* [Module, European Laboratory, European Space Agency] was getting ready to launch, all the European systems stood up and they had a bunch of experiments. We had been operating a Space Station and planning our little bit of research in the corners and suddenly they were coming in and they had a right to 8.25 percent of that little bit of crew time. They were trying to get research done. They made a lot of promises to their community.

Then the same process happened as the *Kibo* [Japanese Experiment] Module got ready to launch [2008-2009]. We had to really create processes for working with our partners. That had to happen in engineering and operations and in safety and in all those different areas. But it also had to happen in terms of our science management, we realized in a number of the different meetings we had been having. The main meeting we had had was called the User Operations Panel [UOP]. It was very focused on projecting the future ISS resources and how they'd be divided up by the partners and comparing them to what everybody was planning to do.

It still continues today. It's an important thing you've got to do. I was the NASA representative to that forum. It's a consensus forum with all the partners equal, all five partners treated equally. But NASA does the executive function. I had been named as the representative to that forum. One of the things that we were finding, especially as we were getting closer to 2015 and everybody was talking about how to get ISS life extended, and what we found is that all of the partners were really struggling with how to synergize, be more efficient with their

experiments, how to communicate about the accomplishments better. We started having all these extra conversations at our UOP meetings and we saw even amongst ourselves people were fighting over crew time when we would have these UOP discussions saying, "I got only 86.2 hours and I deserve 86.45 hours." These sorts of discussions happen when you're dealing with accounting.

Then the next day when we would have our set of topics about research collaboration, the meeting would be completely different, and it would be collaborative and it would be brainstorming and we especially got some tasks as we were doing National Lab Pathfinders. What do Nobel Prize winners think today about ISS? Now that we have this early data from during assembly, do they feel as negative about it as some of them were publicly negative about it when the go/no-go decision was made in Congress about the Space Station Program? We wound up chartering what we called the Program Science Forum.

By that point I'd built really great relationships with my counterparts. Also we realized that it wasn't always the same people. Sometimes you had a policy-type person or an integration-type person that was maybe representing that partner at the UOP. But yet the science people who I also was working with at our other two working groups, the ISLSWG and the MSPG, the International Space Life Sciences Working Group and the International Space Microgravity Planning Group, so some agencies had different reps [representatives] on those different forums.

We realized we really needed a place for the ISS chief scientists or their equivalents to get together. In particular we had been reaching out to our Russian colleagues and we felt that the UOP tended to function as a USOS-only forum. The Russians were officially included but

they never came. Things were just divided differently there. We really wanted to start working with our Russian colleagues on that as well.

We worked with the [ISS] Program and worked with the Program Manager, who was Mike Suffredini by then. We put together a charter. We really built on this idea of we needed to get Nobel Prize winners together. We wanted to get together and have a workshop and get some feedback from the scientific community about what they saw as the potential of ISS today.

We wanted to start working on benefits for humanity so that we had those all written down in a way that JAXA [Japanese Aerospace Exploration Agency] could use to bring that forward to their government officials, especially those at MEXT [Ministry of Education, Culture, Sports, Science, and Technology].

They wanted something to bring to their MEXT officials that really weren't paying attention to space at all. We had a number of products we really needed to make. Those products took us all putting our scientific thoughts together. The other thing, Bill Gerstenmaier had asked me, because at these international meetings we would be there and you'd see a presentation from every partner. Each one would get up and present their statistics about what they've been doing on ISS. We were at one meeting one time and three partners in a row said, "See, we're doing more on ISS than any other partner."

I'm sitting there doing the face-plant, throwing my hand against my forehead next to Bill. He's like, "Can you fix that?"

I said, "I'll try." We thought well, let's at least count everything the same and show our collaboration and not just try to brag up against each other. That was crazy. I used the relationships that I'd built with the UOP and we decided to charter this as a separate forum. First they were going to meet together. But then over time because we got the UOP working really

well we actually handed that off to integration people. The Program Science Forum continues on its own and has been a stand-alone since then.

That's been how we've worked with all of our partners. So now we have a database that has all the experiments that have ever been done all validated by everyone. We have the ability to represent all the collaborations when experiments were done by multiple partners. All the partners have worked together to put in a single database all the results so that we can actually do analyses of all the results, even the publications in Russian. Everything is in one place. There's a record there. And we all count our experiments the same, for that matter.

What's been most important about it is having a place to think strategically to find synergies, so we're not doing as many duplicative experiments. We can try to put them together a little quicker. The huge dividend that's come from it is that our Russian colleagues have participated fully. From my career experience, that was when I started getting the opportunity to build relationships with my Russian colleagues. That has led to where we are today where we're really doing significant and growing collaboration with them on a daily basis.

JOHNSON: As you said that collaboration has grown. Do some of the shifting political problems between the two countries, does that ever affect the work that's being done on the science on ISS?

ROBINSON: Honestly it never does. Science is international. Russian scientists and U.S. scientists both have the same goal, seeking knowledge. Even at the more practical level, when they're trying to seek funding, so they can go seek knowledge, they're still interested in the same kinds of questions.

As long as we can find ways to remove the institutional barriers, the scientists want to work together. They really do. We and Roscosmos [Russian Federal Space Agency] want to remove those institutional barriers because we both want to get as much as possible out of the Space Station, as much knowledge. When you think about it, even in exploration-related research, we'll be going as a species to that new destination, so we'll be in rough shape if the Europeans have one belief about bone loss and the Americans have another belief and the Russians have a third belief. We really need that state of the science to converge onto a set of truths that everyone gets comfortable with so that all the international crew that go to that next exploration destination have the right medical support.

That shared goal really helps as well. You read the quotes and you just roll your eyes, because it has nothing to do with the way working together is on a day-to-day basis.

JOHNSON: NanoRacks has announced that they're going to be working with the Chinese too. It seems like it's even more global. Some of the work on ISS can surpass some of the political problems.

ROBINSON: One of the really innovative things about ISS as a National Laboratory is if you have a commercial user coming into ISS, providing different value-added goods and services, it doesn't really matter the home country of that particular piece of research. If people are willing to pay to do it in space, that's the beginning of that commercial demand for low-Earth orbit as a marketplace, low-Earth orbit as a place to do research. Just like there's a commercial marketplace for deep ocean research, and there are companies that provide the ability to do deep ocean dives and collect data. Someday low-Earth orbit will be like that as well.

JOHNSON: The ISS is the opportunity and these experiments can go up and do different things.

ROBINSON: It's very true. That's really true especially in our Earth sciences experiments. They don't care about microgravity, which is the science platform that we built ISS for. But if you got a place with good power and data and a really nice low altitude, and somebody else is going to keep it there for you, it's a great place to do Earth observations. Early on when ISS was still being assembled Earth sciences didn't want to touch it, because if you were going to spend money they didn't want their money to go to ISS. They wanted it to go to free fliers that they could put at exactly the orbit that they wanted. But now that ISS is built and it's got all this great capacity, now the trade is well, do I want to build a new satellite, or should I just use this that's there. There are a lot of cases where that makes good sense.

There's been this wonderful maturing of our relationship with Earth sciences and with the Science Mission Directorate in general as those opportunities have made sense and we have astrophysics experiments going up, because it's a win-win.

It helps them get more done in a time of really constrained budgets, and they can achieve decadal survey goals that otherwise would have been postponed years down the road, just by taking advantage of the fact that ISS is there.

JOHNSON: In the decadal survey, the model animals, that was part of the requirements for the last one, or that capability was recommended.

ROBINSON: Yes, it was a big part in the decadal survey.

JOHNSON: Were there other things that were recommended? Anything come to mind that has been implemented? Or something that maybe still needs to be implemented?

ROBINSON: Yes. One thing that was really recommended is moving forward towards more modern analysis techniques and open data. That's really a trend in science as a whole that I would say NASA was behind on. Marshall Porterfield, who's currently the Director of Space Life and Physical Sciences, when he came into NASA as an IPA [Intergovernmental Personnel Act], that was for him open data, having these data archives that people could analyze rather than having PIs hold the data for themselves, was something that was really important.

Especially as related to omics data, that's the studies of the different levels of genetics and how those influence all the way through physiology and looking at genes and proteins and RNA [ribonucleic acid]. That became a real hallmark of his strategic objectives for Space Life and Physical Sciences. But at the same time, OSTP [Office of Science and Technology Policy] has had a really strong emphasis under President [Barack] Obama over the last four years especially for federal agencies putting all their data out in ways that it could be analyzed and used by the scientific public but also by even the general public as a whole. I think there's a trend in our society that's been converging there as well.

JOHNSON: One of the things I was reading, in 2013 you were asked to come up with a top 10 list of research results for the ISS. Is that top 10 list still about the same? Or has anything been shifted around on that list?

ROBINSON: People keep asking me to update it. Unfortunately it doesn't change that fast, because science moves slowly. There's a couple things I'd probably bump up. There's a few things where the story has gotten better. But they're still in the top 10. There are a lot of things I'm still watching, waiting to see if they change. Unfortunately, politicians, they want new results every year. Especially if you're in the House of Representatives, every two years you feel like you've got to declare victory. A lot of our scientists take longer than that to publish the first paper. From the time we send them data from space until that first paper comes out is often two years or more. Things do move slowly, and I think there's some really neat things in that top 10 list as well.

One of the things that I've joked with people about is eventually we're going to need different top 10 lists because there's the top 10 benefits to health on Earth. You can do the top 10 surprising discoveries. You can cut it a lot of different ways because it's such a broad research portfolio.

JOHNSON: Top 10 things that are going to get us to Mars instead of benefit life on Earth.

ROBINSON: Exactly.

JOHNSON: Speaking of the time limits or how long it takes to do research as far as ISS, it's being extended now to 2024. You mentioned earlier that part of what we have to do on the NASA side is do what's required of us in the time period that's allowed for ISS. Do you feel like that's going to give enough time to do what you're being asked to do at this point?

ROBINSON: I get feedback on that both from our Human Research Program, who has a risk-based approach where they look at the different risks and they guess we'll probably need to do two experiments to measure things and then maybe we'll have to test a drug, so they guess. As they look across all the risks they have for the human body in space and behavioral health and performance, they're not done in 2024. It's maybe 2028. It's not as heavy as it is now, and there are a lot of assumptions in there. Human research will not be fully ready.

Right now our colleagues in technology demonstration are doing the same thing. They're trying to figure out what all things do we need to prove out on ISS. If we need to show that a life support system is good for three years, then you've got to back that off. You got to operate it for three years on ISS, then you got to back that off. You got to design and build the system. It's really not that long. Nine years is not that far between now and 2024.

I do not think NASA will be done with everything it needs to do in 2024. Of course we know that the ISS itself should last 2028 or beyond, maybe 2030 or even longer. Its design life was 30 years, which would be 2028. I think that the Administration wants to keep us challenged. They don't want us to sit back and just slow down our use because we can. There's a desire to keep pushing the Agency to wrap it up so that budget can be deferred to other programs in the future. But also the new set of inputs are going to come from these National Lab users. NASA is an anchor tenant.

As we have more and more commercial users doing experiments they want to follow up on, as we have more and more Earth sciences instruments—we have Earth sciences instruments right now that are helping model hurricane strengthening. Those are operational products that NOAA [National Oceanic and Atmospheric Administration] is using. All of a sudden just retiring it in 2024 you start having to think about all those different values and data and the

different research that people are planning to do. I think the goal is really by 2024 the cost-benefit will be swinging towards National Lab success. Then we'll look at sustaining it maybe in a modified model, maybe where the commercial sector is taking more responsibility and the government is taking less. But government still is an anchor tenant for a little while longer.

That's my hope, that we'll go there. Then at some point of course the ISS will be worn out and it will just have to go in the ocean. But at that point the hope is that the research demand will be high enough and the cost will have come down enough that maybe it's SpaceX operating a DragonLab but those commercial users can keep using low-Earth orbit, and they can keep having access to it. Even though it won't be the International Space Station anymore.

If we do that, that's that final mission of ISS, to really open up low-Earth orbit as a place that's accessible and where you can do business forever.

JOHNSON: Do you feel that adding the commercial side and now having more, with CASIS the 50 percent on that side, they can help as far as funding with Congress? Where NASA doesn't have to be the only one asking for funding? Maybe these commercial entities, now they have a reason to keep ISS flying, and they can also put pressure.

ROBINSON: I think that there will be some of that certainly. It won't be so much—it won't be them wanting money to support their research. But it will be them saying, "If you take this infrastructure away, we'll have nothing, and we really need to follow through on these things that are really going to help the economy." We at NASA can talk till we're blue in the face telling everyone how good we are for the economy. We can look back at the economic

assessments of what Apollo accomplished, and everyone knows it was just this amazing jump-starter. The economic data is there to back it up, but you can't do that till it's all over.

In the middle of that budget decision you can't prove that it's going to pay off economically. The big difference is if you have people who are businesspeople saying, "I can make a real contribution to developing a new market or doing something that's going to have a long term impact on the economy if you just keep this asset in place."

JOHNSON: If you were looking back at your work with ISS, what would you consider to be your most significant contribution?

ROBINSON: Oh gosh.

JOHNSON: That's always a difficult question for people.

ROBINSON: I would say it's probably in changing the way that we function from an inward-looking organization to one that is responsible to outside users. Whether that's getting the program to realize building ISS isn't the goal, it's really getting the science done that's the goal, or if it's working with our international partners to help our politicians understand what we're accomplishing.

I think that I was in a place to have the opportunity—as the Space Station grew up I had the opportunity to be the one that was there and saying, "Hey. These things happen differently when your purpose is research. Think about this or think about that." I had the opportunity to be in that place.

Sometimes that's difficult or sometimes it's easy. Right now there's just a momentum behind things. Things like RISE [Revolutionize ISS for Science and Exploration] are just roaring forward. That's really exciting to see those changes happening over time. But at its core, I think the big contribution that I've made is seeing that big picture strategy without being biased towards any one particular discipline. My goal hasn't been just to help astrophysics be successful on ISS. It's been to help everybody be successful.

When they have a conflict, if they're fighting over crew time, I'm still trying to help each of them get what they need within the constraints of the law.

JOHNSON: You mentioned RISE. Are you working with that group?

ROBINSON: I would say that group came after the influence that I had. I definitely meet with them and insert my two cents, but what's beautiful about that is it's got a momentum of its own. People are really changing the way that they're thinking on their own. Engineering organizations are removing their own requirements. That's the beauty of RISE, is that you've got change generated from within.

JOHNSON: What would you consider your most significant challenge?

ROBINSON: I think the biggest challenge is that because we do have decentralized science selection we've got a lot of different scientific management organizations that are in control of their world except they're not in control of ISS. We have a lot of people who are used to being

in charge of their sphere and then they come into ISS and they're wanting the same thing that somebody else is wanting.

I'm trying to do the right thing for the Agency, but I can get caught between the politics of different organizations that have their own demands and their own schedules and their own desires. That can be ugly sometimes.

JOHNSON: I can imagine it would be. What do you think, based on your experiences, are the lessons learned for your work with ISS and in your position?

ROBINSON: I always think the most important lesson learned was not to peak too soon. We set up a science management organization that was going to be the NSF of space to be fully funded with 1,000 scientists and an $800 million budget all targeted at being ready when ISS assembly was complete based on the original ISS assembly complete date. Then that just made science this huge vulnerable honeypot. When people needed to find budget for Constellation, it was this big organ, ISS wasn't done.

By having those things out of sync on time, it made the research budget really really vulnerable. That's always going to be a challenge for our Agency I think. The same thing would happen if we had a Mars mission and we said we were going to get there in 2023 and so then we would start standing up a bigger geological organization to decide what Mars samples you were going to take while you were there and how you were going to bring them home. We'd start hiring curators. Then that mission really winds up being 2030. We just get excited about it and we start building all of that, and we build it too soon.

JOHNSON: Looking at ISS as far as—as you mentioned a lot of the benefits aren't going to be known for years for some of the science that's being done on there. But what do you think the legacy of ISS will be once it's all said and done and it's over with, and it's in the ocean as you put it?

ROBINSON: I think the legacy really will be at its core scientific legacy. Right now I mostly talk about the benefits for humanity, because that's what you have to talk about at this stage in the program. If we can point to people whose lives have been saved because they had brain surgery from a technology developed from ISS, that really helps put the story together for someone who's questioning the value of ISS. But over the long term, I think the legacy is actually going to be much more fundamental than that.

It is going to be a set of discoveries that you could not have made if you couldn't have removed gravity from the equation. Eventually we'll be able to trace little bits of information. Sometimes it's a one-sentence conclusion that sent a discipline off in a different direction. I'm actually working with some colleagues to try and find ways to capture those. In the science of science they'll talk about knowledge bursts. A lot of people are aware of a knowledge burst about nanomaterials, because you never heard of anything and then all of a sudden everyone was talking about nanomaterials, because there was this knowledge burst as people realized you could organize things at a molecular level if you were smart and actually make a material that worked better. That led to this huge burst of knowledge and publications. I think the legacy of ISS, someday we'll be able to find knowledge bursts that happened because we could do a key experiment in a certain way, and we measured a property or we understood something else.

What you'll see are that there are all these little knowledge bursts where science wound up in a different place because we had access to the Space Station.

JOHNSON: Is there anything we haven't talked about as far as your work with ISS that you wanted to mention before we close?

ROBINSON: I guess the one thing I would mention is that I think NASA as an agency, we're really an engineering agency. Scientists in the Agency are always a little bit alien. The simplest way I'll put it sometimes is that an engineer says, "Write down your science requirements." A scientist when asked to do that sits there and they scratch their head a little bit. Eventually they write a hypothesis. The hypothesis is not a requirement.

Then down the road some 20 months later, something doesn't work on orbit. The scientist says, "Well, can we try it this other way?"

The engineer says, "It's not in your requirements. No." That little silly dialogue, it happens thousands of times a day all around this Agency because we have an engineering culture and yet we're trying to do what is inherently not.

If you look behind me on the shelf it says, "If we knew what we were doing it wouldn't be called research." Engineers never do things they don't know what they're doing. They plan it all. We're always under tension to give scientists the room to make the discoveries and have the eureka moments and not have the engineers completely squelch that creativity with requirements and paperwork and plans.

We're just always in that tension. The neat thing about the Space Station is that because we're 24/7/365 we have a chance to get it right or try again. We never had that before. That makes it a really exciting platform, but it doesn't make those tensions go away.

JOHNSON: Thank you for adding that. I guess if there's nothing else we'll let you go for the day. Thank you.

ROBINSON: Great. Thanks.

[End of interview]