INTERNATIONAL SPACE STATION PROGRAM
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EDITED ORAL HISTORY TRANSCRIPT

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INTERVIEWED BY REBECCA WRIGHT
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WRIGHT: Today is September 29, 2015. This interview is being conducted with Michael Suffredini in Houston, Texas at the NASA Johnson Space Center for the International Space Station Program Oral History Project. Interviewer is Rebecca Wright. We thank you for sharing your time with us today.

SUFFREDINI: It's my pleasure.

WRIGHT: For the last 10 years, you've served as manager of the International Space Station [ISS] Program, but prior to that you served in a number of positions for ISS. For instance, managing the Payloads Office, Vehicle Development, Operations Integration, as well as serving as a deputy manager of the program before you became manager in 2005. Even before that, you worked as the assistant manager of the Space Shuttle Program. If you would, share some of the valuable lessons that you learned during that time period that you took into your new role as program manager and have helped over the last 10 years?

SUFFREDINI: It's an interesting question. I always was drawn to the bigger picture, even as a design engineer I was drawn to the bigger picture. It was never really my calling to design a widget that was part of a bigger widget that was part of a system that would be part of an anything, including a spacecraft. When I came to NASA, that was the job that I was interested in.

When I first actually worked for NASA as a civil servant, I came in to an organization called the Orbiter Projects Office. I was what they referred to as a MER manager, Mission Evaluation Room. We still have them today. This is where the engineers sit and look at the real-time data and make recommendations to the ops [operations] teams when things are off-nominal. From that very moment, I started getting this feel of the bigger picture and working in the bigger picture.

Even from that job—and it was actually an assistant MER manager job that I was hired to go do; then the subsequent roles. I've always been operating at that level. When you're looking at the big picture, I think, and what I've learned over the years, is you tend to have this natural inclination to look at the strategy—the future—and where it's all going and how does it fit in the big picture. I learned early on, even when just working an anomaly in a system during a Shuttle flight, that you have to take that into the context of the bigger picture—what are you working on? How's it important in the near-term, how's it important in the long-term?—to allow you to get the focus.

That's one of the biggest things I learned in the Orbiter Project, which was part of the Shuttle Program. In fact, I've benefitted from it quite a lot when I moved into Station, where really it was about, "What's your goal? What is the overall strategy that you're trying to get to so that you can make your day-to-day decisions?" I've never been a sit-down-and-work-the-details of a specific thing. It's always been about strategy, direction, and keeping the team focused in a certain direction.

In the Shuttle Program, of course, that was one of the biggest things you had to do, because it was pretty tumultuous in the period that I was in the Shuttle Program. I have a wonderful experience in the Shuttle Program because Brewster [H.] Shaw was the program manager when he asked me to come over. He didn't have a deputy program manager. I was detailed over, out of the Orbiter Project, which Dan [Daniel M.] Germany was the head of at the time. Brewster didn't have a deputy, so I had this opportunity to work on a lot of things that normally a deputy would do.

Eventually he did get a deputy, and the job changed a little bit, but this was an up-close opportunity to see the kinds of things program mangers worry about, like how to lead your team through it even though things don't seem that great. The Shuttle went through a lot of changes, but this was the beginning of the change where we were thinking that Shuttle was going to be more and more specific. It wasn't back in the heyday where we thought Shuttles could do everything and we were going to fly them all the time. We were starting to become more focused, and talking about maybe we should manage it a little bit differently. This is the advent of the integrated ops contractor that was ultimately created that companies did, the last of which was USA [United Space Alliance].

I got to witness all that very close up, and it helped teach me that leadership was about understanding the strategy, pointing the team in that direction, giving the team the tools to get the job done, [and] helping them stay focused on a direction, particularly if it's not where you were heading in the first place, or if it was different than where the culture was taking you. Your job really was to keep talking about the direction, where you're going, what the strategy is. It's harder if you're changing the culture. It's a little easier if you're not changing the culture, you're just saying, "Hey, this is where we're all going and here's why."

When you're changing the culture, which I spent a lot of time doing in my last several years in the ISS Program, it is very, very difficult. It takes a lot of time and energy to know what the team is doing, and make sure in certain areas where they're losing focus, to put the focus back on. You have to do that sometimes in the face of some challenges, where people are challenging what you're doing and why. You have to a) explain it, and b) you've got to make sure you got the right support from your management, and then you need to spend a lot of time with the right folks to keep them pointed—help them with the strategy, help them understand, help them get pointed.

That's change; change is difficult. How to lead a team is one of the things I learned the most in going through this process, and it started with just I'd come to work every day to solve problems on orbit, to where I am today. You look back and you go, "Oh, look. Look what I learned along the way. What do I like to do? What do I think I'm pretty good at, and how do you get that done." That's kind of a long-winded answer to your question.

WRIGHT: No, it's a very good one, which I would like to follow with—is it still difficult after all these years to make sure that your vision and your strategy are communicated clearly to the people that you're leading?

SUFFREDINI: Technically how you communicate to your people is relatively easy to know and to do. Sometimes we don't do it so well, but it is relatively easy to do. The hard part is when you're doing something that's different than the norm, what people were brought up to do. There are a lot of areas where this was a big deal, but one of the biggest for the ISS Program is when we started to transition from, "Okay, we've finished assembling this thing," to, "Okay, now we have to utilize it." It was a different set of priorities.

With assembly, it was okay that the systems guys got everything they needed, and then the leftover crew time was allowed to be used for research. Now, where we are today, just because you have a system problem doesn't mean we stop everything we're doing. We identify a number of hours that the utilization guys are going to get, and then the ops team has to work within that. There are several days where there's things that have failed and they say, "Okay, I'm okay with it like this. I think I can get it done here. I'm still preserving the utilization time." That's their goal—preserve the utilization time, because that's what's most important. That's why we're in orbit.

That transition was a big transition for the team. You went from this NASA process—where just successfully getting a crew into orbit and back home safely was everything—to okay, so we have to keep the crew safe, surely, but we have a job to do. You talk about the means to an end—the end wasn't the assembly of ISS. Really, the end was utilization of ISS. It's about learning things that you can't learn on the ground, and it's about implementing things on orbit that you can't do on the ground and trying to do it as efficiently as you can.

That was a big, big change for us, emotionally, because safety wasn't taking a backseat, it was just more difficult to have the conversation, because before you'd say, "It's safer this way," and everybody did it. Now, "Is it safe enough?" and that's the conversation you have. How do you know? What is safe enough? What isn't safe enough? Making sure you're managing your risk while still getting the utilization job done. That's probably the harder part—where you're changing a mindset, or a culture it's called sometimes.

Communicating is very, very important, but sometimes communicating is not enough. People say, "Well, I hear you, but that's not the way I've always done it, so I'll sit over here and do it the way I've always done it." That's where you've got to go find the little factions where they don't quite get it, and help them, however you need to, to change them over to where they have to be in order for you to take the path you have to take. That's a big leadership challenge.

WRIGHT: Communicating with your team, along with communicating with the global partnership.

SUFFREDINI: Absolutely, yes.

WRIGHT: Talk some about how the multi-national relationships and partnerships evolved during your tenure. And then how you were able to do what you needed to do to make those relationships work as well as they do.

SUFFREDINI: When I saw your question, I started thinking about that. That's fascinating, too. You have 15 countries, all of them with governments and people who are deciding what they're going to do with their taxpayers' dollars. It wouldn't be surprising to hear that some countries have different ideas of what's most important. They put that on to their agencies, and those agencies turn around and apply that to ISS, because that's where they get their funding, and that's their responsibility.

Now, there's the communication like we do. The agencies typically are responsible for helping guide their future, so they know what ISS can do and what the plan was, and they communicate that back to their governments. But then their governments have to sell that to the people, and so there's that back-and-forth like we do here in this country. That's happening in 15 countries. Then they all have to come together and utilize the same vehicle.

In the early years we were very, very fortunate in that everybody was really focused on building these vehicles, building these platforms, getting them assembled on orbit, and flying safely, just like we were. Other than the challenges we had along the way—the big delays once we got the first two elements up, the big delay before the Service Module was ready—that was a two-year delay, give or take. Then of course, the big delay associated with the loss of the *Columbia* [STS-107, Space Shuttle disaster].

Everybody's focus was the same. "We have to go build this thing. We need to focus hard on that and get it done." Along the way, people, agencies were deciding, "Okay, here's what I originally planned to do." Those plans evolved, but it was always about building the Station, and that was the focus. Although that was very, very hard, we were all focused on the same thing.

Then as we evolved to utilization, that by itself was fairly well accepted as what we should be doing, but not all. We all agreed utilization was important, but it was less important to some of us than others, I'll say. That was a challenging period, although not too difficult, because the way we evolved the organization made sense. And since we were evolving ourselves, it was easy for the countries to come along with us.

Our Russian colleagues have always kind of been their own little area of research, although we're coordinating better and better with every year, and I'm very proud of that. Back then it was pretty much they were doing their thing, and USOS [U.S. Orbital Segment] was doing its thing. We were an integrated crew and all that, but research-wise, it wasn't necessarily important that they have an integrated effort with us.

On the USOS side, even though there are other elements—there's an ESA [European Space Agency] Columbus [laboratory] module, there's the JEM [Japanese Experiment] Module that the Japanese have—we're all tied together, we all have racks in each other's elements. It's a pretty integrated effort, and the research tends to be fairly integrated based on our history. With the Russian colleagues, we weren't as integrated as we should have been on the research side, and so that let them be a little bit different as we were evolving the USOS.

Again, everybody's goal was roughly the same, "Let's evolve." The big change for ISS where you started to notice it was this idea of commercial use, the National Lab [Laboratory] concept that the U.S. came up with. We all have a certain portion of utilization rights, based on percentage of total capability. The partners really don't care too much what you do with your utilization time, as long as you meet the requirements for crew safety and all these other things. When a partner like the U.S., which is such a big piece, starts down this road, everybody starts to watch. It's okay, but they kind of watch. We keep talking about why we're doing what we're doing. Why we're doing it is very, very important to get the commercial piece of this going.

It's interesting that now, as I leave—we've been talking to them—but now they're starting to actually ask, "How are you doing it? Why are you doing that?" Some of the commercial companies are starting to talk to the different countries, so it's kind of interesting to watch. Here's this evolution where we as a country did something—the rest of the partners were still standard research—but now they're starting to see that, "Wow, this commercial thing, maybe this is important," and so they evolve.

I think this will be the wave of the future as we go forward into cislunar space. The next step for our agencies, after ISS, will be cislunar space and human exploration. What the partners want to do will vary more dramatically than it does on ISS. Some partners want to land on the Moon. Some partners want to just do robotic-only research in the semi-near future. We have this idea about this ARM mission, Asteroid Redirect Mission.

As we evolve, we're learning that we need to build capabilities to support whatever the different governments want to do, knowing that what we all want to do is exploration well beyond cislunar space. We started with everybody having the very same goal—build successfully the Station and use it—to where we're headed in the future. You still have to accommodate what the governments need. The agencies still have to be able to meet the needs of their governments, and at the same time we all are trying to do a similar thing, so you have to figure out a way to that path, and that's what we're learning with ISS.

While the National Lab step's a pretty big deal, it was sort of take it or leave it for the partners. Now they're starting to understand the benefits and why we're trying to do it, and this will be a minor challenge. Going out here though, where some people want to land on the Moon and some people want to go to an asteroid—those are dramatically different things, but we can still build our systems to support multiple things.

Heavy lift [launch vehicles] can support multiple things, the Orion [Multi-Purpose Crew] Vehicle can support multiple things. That's what we all have to do as a partnership, is to provide those capabilities, and then support each other. Even if they have varying goals, you're kind of in the same area. You're learning how to explore, because ultimately we all want to go to Mars.

That's another long-winded answer to the question of what are you learning as you go, and how do you do that multi-nationally. You have to accept that not all governments are trying to do exactly the same thing, and if you accept that, then it broadens your view of what your job is to keep us all together, and all productive, and happy. As happy as you can be.

WRIGHT: Other nations have provided cargo transportation to ISS through the years, and recently America has been able to do that with its Commercial Cargo Program. As with many things, this looks so seamless, that it was just no big deal, but could you share with us your thoughts when you first learned that this program was going to be initiated and how it was being developed? What were your concerns? And/or what you felt was going the biggest advantage with having an American-based commercial cargo transportation system? Then, how this will affect future crew transportation?

SUFFREDINI: Yes, I can talk about that. Of course, the partner vehicles were part of a barter arrangement. When we as a country reached those original agreements, this is what ESA and JAXA [Japan Aerospace Exploration Agency] owed the U.S. for what we called "common operations costs." It's part of the power, and data, and all the stuff that we provided to the partners as part of this big infrastructure, and the services of getting to low-Earth orbit and all those kinds of things. The partners owed us a certain amount for that. Both ESA and JAXA wanted to provide these vehicles.

From the U.S. perspective, we had the Shuttle, so these were good things, nice things, but they weren't critical to us. Then with the Shuttle going away, they became completely critical. I was a little disappointed we didn't get to keep [ESA] ATVs [Automated Transfer Vehicles] around. I'm a little disappointed that we're changing [JAXA] HTV [H-II Transfer Vehicle] because it's a reliable vehicle. But the partners have their needs, and so they want to build a more advanced spacecraft. ESA just didn't want to make that kind of investment into a spacecraft.

Both of them are very expensive to fly. They approach half a billion dollars for each flight, or something on that order, so they're very, very expensive to fly. Rightfully so, they want to do something different. ESA took a completely different tact—a good tact, but a completely different tact. JAXA wants to evolve their HTV. That's all good.

At the time that we made our decision about commercial cargo, it was part of this culture change. It was a mindset change. The idea was we need to let the commercial industry step in and learn how to do this, and perhaps do it more efficiently than NASA has. Just saying that sentence to any NASA person is enough to really make their hair stand on end. I was one of those. It would just irritate me. I'd say, "Oh, sure. If this is the way we want to operate, we can." But it is a culture change. I'll just tell you right now, in the culture today, we couldn't do it.

What we always said back then—the philosophy always was, "Let's do commercial cargo first." [NASA Administrator] Mike [Michael D.] Griffin was the big proponent of this, and we worked the requirements, which was a big part of it. Well, first Shuttle's going away. How are you going to replace Shuttle, still do what you want to do beyond Shuttle, and support Station? This idea was that commercial capability should be less expensive to get cargo to orbit than Shuttle, and this idea that you separate cargo from the crew was born.

The philosophy always was we would build the commercial cargo vehicles, and we would see how this idea of letting commercial companies provide a service would work. Then we'd say, okay, and if that worked and we figured that all out, well that would evolve to commercial crew. Perhaps we'd find a lower-cost way to get crews safely to ISS and back home. That was really the genesis of the whole thing. The whole idea was we'd learn with cargo, and if cargo supported it, we'd go try to do it with crew.

Of course, things don't ever work out the way you plan. One thing is we got a couple more Shuttle flights, so it helped us close the gap, because it always takes longer than anybody thinks it takes to get started. Then we hired ultimately these two companies, SpaceX [Space Exploration Technologies Corp.] and Orbital ATK [Inc.], to provide this service. We learned how to do requirements. As an agency we accept that the commercial companies want to be successful, or it hurts their business. We, of course, want them to be successful because we need the cargo, and we ultimately want them to be successful around the Space Station, because it's a safety issue.

We essentially said, "Okay, you're responsible for the launch and the ascent phase. We'll pay attention. You owe us some information, but we're not going to core drill and know everything about your design. But, when you get inside a two kilometer sphere of the International Space Station—when you do the burn that's supposed to put you in that area—then we go back to a requirements case. You've got to make us feel safe, you've got to prove to us that you're okay." That was our "give me," the launch up to that point. Then we did our normal—not normal, still we relieved requirements, but they were mission success requirements. We put mission success on the provider, and safety requirements we held on to.

That was successful. In fact, we learned a lot. We also—and this is not well known, I don't think, to many folks—we assumed, I certainly assumed, that we would have a failure. I never imagined we'd have three in eight or nine months, but what I learned after the failures is we probably almost had to have the failure so the companies really understood the pain of failure.

Orbital ATK and SpaceX now trying to recover from this, they have felt it. They've felt it on the budget side, they felt it with new customers. They felt it with existing customers and whether they want to stay flying or not. That's more SpaceX than Orbital ATK right now. It really does affect their bottom line, and so they almost had to have the failure to understand the impacts.

I would tell you *that* was part of a learning phase we had to go through. Also, it kind of teaches you. Every failure teaches you. I think we're doing exactly what we set off to go do. I would tell you, we're off to go do commercial crew now, and honestly, because of the failures, I think we're going to be better with commercial crew.

Even though Orbital ATK is not trying to do crew right now, they have aspirations for things in the future. [The] Boeing [Company] watching what's going on, of course is understanding the implications. SpaceX, of course, one of the commercial crew providers, is learning a ton about what you can and can't do. I think the whole philosophy is working. I have very high hopes for commercial crew, and I have pretty high hopes that the cost to gets crews to orbit and back will be reasonable, and certainly cheaper than flying Space Shuttle. That's a different beast altogether since it had such a cargo capability to go with the crew capability.

To me this is all great evolution. Meanwhile, the Agency hopefully will benefit from this by getting safe transportation, cheaper than we would have otherwise done it, and we can use some of the money that we have ultimately saved to build the capabilities to go do exploration. Even in cislunar space now, we're talking about, "Okay, what are the commercial companies going to do in cislunar space?" There's some things they can do. It's the right step.

We hadn't got to the point where we can completely take our hands off and say, "Okay, you meet these requirements. You can go fly whoever you want, however you want." That's partly because there's not anybody else that really needs to fly to low-Earth orbit that's willing to pay those costs, but it's also because we're still learning how to evolve ourselves from where we are today. How do you put requirements in place, that if they meet those requirements then they're good, and have those requirements not be set such that the only way to do this is with some sort big cost-plus contract with the Agency. That's what you're trying to avoid.

WRIGHT: Kind of back to research and development, aren't we?

SUFFREDINI: Yes.

WRIGHT: Speaking of commercial, SpaceX, I believe in one of its future launches is going to bring the Bigelow Aerospace BEAM [Bigelow Expandable Activity Module] to the ISS. The hope is that once it's attached to the Tranquility node, and all goes as planned, it's basically going to set a new path for the future. And, what I also find interesting about Bigelow, I learned years ago, that many people may not know, this was NASA technology that was done in the late 1990s, and then now it's licensed by them to use. Kind of an interesting type of partnership.

Share your thoughts about this whole evolution of past NASA technology, now being used by a commercial company, and how it will be impacting Space Station in the future?

SUFFREDINI: Well, first of all, that's what we're supposed to do, right? We're supposed to help evolve technology and capabilities to advance space travel, essentially. [Robert T.] Bigelow was a good example where he came in and said, "I like this technology, I want to further technology. I'd like to license this technology." We do this in a lot of areas, but as you said, this is a well-known one, given the capabilities of an inflatable module, if you will.

The idea behind the BEAM module, which flies on the next SpaceX launch, as you said, is to test the technology. The module's relatively small. It's got lots of instrumentation on it. The objective is to test how do you inflate modules like this? By the way, there's a lot of dynamics we're learning that we're making changes at the last minute to make sure the dynamics aren't such that it impacts the Station in a way that's negative. Then once we get it inflated, the object is to see how it does. As you go around the Earth, you get warm and cold, and warm and cold, and you have the normal vibrations and structural fatigue that's caused by that. It's going to be interesting to see how this structure holds up through a few years on orbit.

We didn't give requirements to the module such that it was going to house crew for long periods of time. That was not really the intention, but if it holds up well for a while, then I think that's also an opportunity to use it for storage and things like that if we want, before we ultimately dispose of it. What's interesting about that is not only did we hand over the technology, but then Bigelow came in and said, "Hey, I want to fly this small inflatable." We provided money up front with them, so it's really a group effort where we put money, they put money to build it because we wanted to test the technology. We're very interested in that as an Agency.

We invested money to help build the module so that we could get this structural data, look at inflations, and all these things that we wanted to study as well—MMOD [Micrometeoroid Orbital Debris] protection and things like that. This is one of those things where we handed off the technology, but there was still more for us to learn on orbit about how it worked. Bigelow's flown a couple of very small versions in orbit. We have very little information on those, and so this is a great opportunity for us—working together to test the technology that we ultimately gave to Bigelow so that he could build these things.

We're helping grow a capability for the future, and this is the next step that you would normally take. Now you've got to build a demonstration vehicle. You've got to instrument it like you do, and then get it on orbit and test it out. It's a next step to basically what our charter is. I think this is fascinating. It'll be fun to watch it and see how it does on orbit.

WRIGHT: At the end of last year, NASA held a [Commercial LEO (Low-Earth Orbit)] workshop, and its goal was "to start a dialogue about creating a thriving commercial marketplace in low-Earth orbit over the next decade." The other part was to move the leadership of the effort from government-led to significantly more private sector involvement. Why are these changes important to NASA to move it more to the commercial or the private-led?

SUFFREDINI: If this Agency and this government want to explore, we're going to have to do two things. One is we're going to have to do it together with other countries, and we're going to have to transition low-Earth orbit to a commercial entity so that the precious dollars we get as an Agency are available for us to use for exploration.

The Space Station, with all the cargo and stuff we do, is approaching a $4 billion per year effort. By the way, more than half of that is for the cargo and crew capability. We have to hand this over to an entity in order for us, NASA, to spend our money on exploration. In order to make that successful—and this is the advent of the National Lab—we have to first show everybody what is feasible and cost-effective enough to do in low-Earth orbit.

This is a very critical part of what's going on in Space Station today. We are evolving. We have the National Lab set up in about 2008. Today, in 2015, we're about at the point where we are starting to get people who don't traditionally use low-Earth orbit—big [pharmaceutical] companies like Novartis [International AG], Eli Lilly [and Company]—to orbit to do, in their cases rodent research, and learn from this what they can't learn in labs on the ground. The only way to get to do this is to drive the cost down low enough that they go test this. This is where Station really is critical for our future. We really have to build the demand for low-Earth orbit, and today the demand does not support the platform, or there would be one built today.

As a government, we need to continue down this path. We need to resist the urge to go make NASA pay a commercial company to build a platform. We need to keep pushing the manned case. We're just starting to do that today. In this increment coming up, we will now have 50 percent utilization by crew time of the National Lab, which is what we always strove for. The National Lab's supposed to get 50 percent of the U.S. capability onboard ISS, and so we're just now starting to do that.

CASIS [Center for the Advancement of Science in Space], as the National Lab company, needs to start choosing research based on best value. This is going to get hard for them. We have companies that are interested. Part of that challenge is not only that, but then figure out how do you make obligations to companies that want to fly to low-Earth orbit such that they can have a reliable capability to plan for? Today, we don't tell anybody that we'll give you 200 kilograms every six months to ISS. That's exactly what a company needs to know how their business case is going to work, and whether or not they can utilize it.

More companies are starting to fly to ISS to figure out whether it's viable for what they want to do. We need to increase that ten to a hundred-fold in order to really get people in there, because some will work and some won't.

Even manufacturing. We need to pick up on the manufacturing. There are some manufacturing capabilities we can do in low-Earth orbit that would be very valuable on the ground. We need to get a lot of customers in to find out what will be commercially viable in low-Earth orbit, that somebody's got to have data to make a business case. It's going to be about what does it cost to do it, and what's the payback? We need to learn about the payback. That's part of growing demand.

Then the other thing we need to learn is now how do we deal with commercial companies with the asset that we have today? How do you get them to go, "Oh, I can use Station, because I can count on this kind of capability every six months to low-Earth orbit, and I can tell them late in the flow, and the requirements aren't ridiculous, and the cost is reasonable." That's part of what we're going to learn along the way. This is so, so very critical to building the demand and the how-to, and we have to do that before Station goes away. That's mandatory.

As soon as we build the demand, somebody out there's going to, with their little piece of paper, go, "Oh, if I do this, it looks like they're going to get this out of this, and so I can make it cost only this much, and so they'll make this much, and I can make that much, so now I'm going to go build a platform." The government then can go from a platform operator, to just utilizing the platform.

When we're exploring, we've still got to be in low-Earth orbit. We need to test our critical technologies, especially our fluid systems. You can't test them on the ground like you can test them in low-Earth orbit. You need to do it close to Earth. We'll still be doing research that you want to do close to the Earth, so if the crews have any problems or anything, you can get them home quickly.

We're going to have a need for a low-Earth orbit platform, but we can't afford to operate a low-Earth orbit platform. Station is so very, very critical to this capability, because if we don't get out of low-Earth orbit, we will never explore. There's just never going to be enough money to do both.

WRIGHT: I'm sure as soon as the ISS was designed, someone was designing the end of life for it, because there's always a beginning and an end. Those dates, fortunately, have been pushed out, and again are being considered to be pushed out. What do you believe that, during your tenure, you were able to do to give Station extended life? Where would you like for it to be before it is actually put out of business?

SUFFREDINI: First, I wish I could take credit for anything that was done in the original design that allowed us to get to where we are today. I'm the one who asked the team to assess 30 years. The team did all the work, and given what they had to work with, and given what we've done in flight, we are finding that we can last pretty long. The reason why that is, is because the original Space Station was designed for 30 years of life, and each element was designed to fly twice to orbit.

We assumed that it was possible we'd get to—because none of these elements saw their mate on the ground, physically. We assumed that we'd get to orbit and that we might have some problems, so each element was designed to fly twice to orbit. The ascent phase, of course, really takes structural life out of your structure. None of them had to do that, so that was a big plus. They only had one flight.

A lot of the structure was originally designed to 30 years, and when we went to 15 years, it was more costly to change the design than just keep going with what we had. A lot of them already had a 30-year design life.

What we have found is that given that, I just asked the team to assume 1998 for Node 1, and when the rest of the vehicles flew, how far do you think we can go? Since Node 1 was 1998, let's go look at 2028. That's how we got 30 years. Today, all of the oldest elements have already been certified to 2028. We've got to do the rest of the elements, and we feel pretty good that 2028's doable.

Encouraging to me is that quite a bit of the structure that's certified to 2028 had eight years of life left. We require four years of life, so we have margin even on 2028. When you find particular points where you have challenges—and in fact, we did have that on P6 [Truss]. There was one area where we had a challenge, and after doing some more detailed analysis, we decided it was okay. But when you find a point on a structure, for instance, that needs some attention, there's all kinds of things you can do.

The other piece of that, of course, is the ORU [Orbital Replacement Unit]. All of the systems are replaceable, at least on the USOS. As long as we keep the spare train going, those systems will be fine. You look at structure, you look at wiring, you look at seals, and all these things. They all look like they'll be good until at least 2028.

I would like Station to stay on orbit long enough for it to build the demand so that a commercial company can come and provide this capability so that we continue to have access to low-Earth orbit for the things that the Agency needs, and the things that companies on the ground need. And when that day comes, then we can safely be over at the ISS and go spend our money on going beyond low-Earth orbit.

WRIGHT: As we move into the last part of this conversation, I would like to ask you more about your reflections. I know that you were quoted recently saying that, "You can't do great things without great challenges." Would you describe for us some of the most significant challenges you faced while you were serving as program manager and how you were able to overcome them?

SUFFREDINI: There have been a few in this program. I wasn't even in the program when we faced once of our biggest challenges. In the summer of 1993, remember Congress had their famous vote? That was back when we actually passed budgets before the fiscal year came. It was one vote [to continue the Space Station program]. I think it was 215 to 216 or something like that. I was in Shuttle and that caught my attention. All my friends in Station were, "Wow." Politically, that was a really big deal.

When I became program manager, we were just trying to get back to flying after the *Columbia* accident. I've had a lot of challenges along the way, and so I won't list every one of them, but before I became program manager, we dealt with some pretty fascinating challenges. I'll try not to spend all day on this.

I was asked to create the Payloads Office, which is now called Research Integration. It didn't exist. Randy [Randolph H.] Brinkley and George [W. S.] Abbey said we need one. There was a budget called the Science and Technology [SAT] budget or something like that. It was a hefty budget for a five-year program. I think it was about $3.5 billion dollar budget. It was farmed out to different [NASA] Centers doing different things. The designs were more advanced than we even knew the lab interfaces were. They were ahead, because they weren't managed together.

They managed to get the SAT budget back as part of the big program budget to manage, and they came to me and said, "We want you to create this office. Pull these factions together, figure out how to manage it so that you get in sync with where the system guys are. We've got to slow down. We've got to get more focused, and we need to get our schedules in sync with where we are with the lab that you're actually going in." And, they needed money, so that was probably the biggest reason why they did that.

That was a huge challenge for me personally, and it was quite fascinating. Payloads was its own program inside a program. It had the payload ops organization. We were designing hardware, we were deciding what integration requirements were, design requirements. All those things. We had our little program inside a program, and then we went out to all these different Centers and all these different organizations, doing all these things, and understood what they were doing, how they were doing it, why they were doing it.

Then we helped evolve them—sometimes not something they wanted to do because we were slowing them down—but we involved them such that we got them synced up on a plan that we could afford, that was going to get the research done we needed to do, on a schedule that was in sync with when the Station was going to fly. We saved money in the early years, which we gave to the development guys in ISS, and we got every dime back when we needed it for research. That was a major challenge in my career.

The next part of my career, before I became program manager, was in the Vehicle Office. That was the time when we were building all these elements to go fly—the lab and its challenges when we first turned it on on the ground. One I remember very clearly was P6, before it was going to roll out to be on the [Assembly Mission] 4A [STS-97] flight, we called it. We discovered a problem with a component inside a box called a DC [Direct Current] Switching Unit.

These were big boxes and had great big covers on them. They were installed inside this module, and we found a component through testing that was in question. We were just about to roll out to go launch. I like to tell people when I was in the program that we never delayed a Shuttle launch for readiness of hardware, and I'm very proud of that coming out of the Vehicle Office. That was one that was very, very close, and right before it rolled out.

The normal thing to do, go back into the rack. Pull the box out, fix the box, test the box, put it back in, re-test everything. Go through all that and get ready to go fly again. What we ultimately did was figured out a way to take the lid off the box in place, change this component, put the lid back on, do some minor testing, roll out to the pad, and go fly. That was just part of the nature of the beast.

When I became program manager, we had one or two technical challenges along the way. One, there was a flight—I think this was 10A—where we were trying to move P6 out to the outboard truss. After some struggle, we finally got the [solar] arrays retracted. We put it out there and we were ready to deploy those arrays, and at the same time, on the starboard side, we had installed the starboard truss, and we were rotating it. We were noticing some problems with the alpha joint.

We ripped an array trying to deploy it, which we had no spare for and no plans. That wasn't a problem we'd ever planned for. That was a major moment. I can remember thinking that my job is to be cool, calm. "This is just a problem. We'll sort it out, we'll move on." Meanwhile, we had this limp array out there that we couldn't maneuver. We couldn't do anything because it was in the state it was in. We couldn't stiffen it because of the rip.

That happened, and then about the same time we did an EVA [Extravehicular Activity]. I don't remember if the EVA was before or after the ripped array, but we did this EVA to go look at this alpha joint whose signature was kind of strange. We found out the whole array had just been basically chewed up. This is the big alpha joint. We got through both of those, but it was quite the challenging part of my job as a program manager.

It's one of the first times I got challenged by the press, because I decided almost immediately that we couldn't work two structures problems. We could work one structures problem at a time, and the Shuttle was docked. I remember them saying, "Why don't you split up the team? You go work on this, you go work on that." I said, "Nope. As a team, we're going to focus on the solar array. That's the most important thing. I can live with the alpha joint for now, we're going to be fine. This has got to get worked now."

I can remember getting, "Don't you normally have a bunch of people that—" Yes, normally, but this is what we're going to do, because we had to focus everybody. Because all these systems were new, it wasn't like you had a lot of experience with them. We were learning how to operate them. We knew the alpha joint was going to be okay. It was okay up to this point. We could not rotate it if we didn't want to, but the solar array, we had to get that one fixed.

What an ingenious effort. I had nothing to do with the repair—we let the teams off. We said, "This is what you've got on orbit. What are we going to do?" Folks came up with a design, and my job was to say, "Yes, I think that's a good design. You guys have figured it out. Go do it." That's what the team did. That was fascinating to be a part of. That was early as a program manager one of the challenges that I got to deal with.

I think we talked earlier about probably one of the biggest challenges as a manager, and this is this idea of evolving the culture. We have spent years trying to convince people that we've got to drive the cost down. One of the big ways to drive the cost down is to use commercial off-the-shelf technology. We at NASA would say, "Hey, we have COTS," commercial off-the-shelf technology. We'd say, "Fine. That's going to save us a lot of money."

Then the engineers come in and say, "Okay, I used this COTS product, and it's going to cost you only $43 million."

I go, "My God. A hundred bucks buys the COTS product, where did the $43 million come from?" By the time we buy the COTS product, and do all the things we do around it to make it what we wanted it to be, we had cost $43 million. That's a huge exaggeration, but that was basically it.

We used laptops on orbit, and we even found a laptop that met the radiation requirement. I walk into a lab one day, just to see how we're processing our laptops. Every laptop gets completely torn open. Every card gets conformal coated, we put in special clips for the adapter, we get rid of the adapter and we put a different power supply on it. Then we put it all back together, and we take the $2,000 laptop and turn it into a $10,000, $12,000, $14,000 laptop.

One of the big challenges we've had as a program is to try to get comfortable with commercial off-the-shelf technology. One of the things I did that was a huge challenge for the safety community was we built AC [alternating current] adapters, 110 volt just like you have in your wall. The adapters look just the ones you could probably find one in here somewhere. We have that on orbit now.

Now when I buy laptops, we don't make mods [modifications] to them. They get no mods. We tested the laptops for radiation susceptibility, and if they're sensitive, then we just don't use them. We find a brand that's not sensitive. We buy them from the store, online. This last batch we bought online. We just put in our specifications, "These are the systems we want," they deliver the laptops to us.

We can either use the adapters we already have on orbit, or we can just plug them in like you do at home and plug it in to one of our power strips and you're good to go. This idea of trying to really use commercial off-the-shelf capabilities to really save money is a big, big challenge. Part of that was the safety associated with it. This is one of those things I was telling you about, "What's safe enough?" We go through a lot of that. That was a big challenge.

Probably the one I'm most known for is this idea of evolving to this commercial capability and pushing us. We've already spent a lot of time on that, but it's my belief that as an Agency, if we're going to explore, we have to build the demand in low-Earth orbit. We have to be focused on that like it's the difference between us getting to explore or not, because I really feel strongly. That's been one of my bigger challenges, and it's still a work in progress.

WRIGHT: You have two ISS residents up there for a year. Share your thoughts about that [Year in Space program], and about doing things now that will help to explore further in the future.

SUFFREDINI: Yes. That's a whole dissertation almost. I won't get into the details of the dissertation, but really our Russian colleagues came and said, "Hey, we think we ought to do a year in space." They really wanted it as a follow-up to their Mars500 [psychosocial isolation] study. They were really trying to get interest from the population about exploring beyond low-Earth orbit. They said we need to do something that people can look at and say, "Oh yes. ISS is doing exploration."

We had always kind of been in the mindset that we're going to do six-month missions, and eventually we'd evolve to longer missions. If you asked the research and medical guys when that was, it wasn't now. It was years in the future. That's how it kind of started. When the Russians sat down and said we really would like to do this, we went and sat down with our research community. We started looking at it and going, "We can do this. We can make this work."

One of the aspects of that was to use it to help force more integrated research between the NASA partners and Russian partners. This started off as kind of a "pulling the interest in" on why you do ISS. Not so much for the research we were going to get, but people needed to be interested in ISS and understand that it's connected to future exploration, to now we have the two one-year gentlemen flying on orbit—Mischa [Mikhail B. Kornienko] and Scott [J. Kelly]. They're doing great, by the way. We have an integrated research program now. Probably the most integrated research program we've had for human research for these two guys.

In the midst of all that, the twins study came up. Once we selected Scott, one of the researchers got the bright idea that, hey, we have this ground truth in his twin brother [astronaut Mark E. Kelly]. This has really evolved to be a very productive effort, and we've gone from our

Russian colleagues suggesting it and really wanting to do it for the reasons that they stated, to now our research guys keep saying to us, "When's the next one-year study? "

We're trying to work with our Russian colleagues to figure out when we can make the next one happen. It's an interesting study in how you get to do something that you've always thought you needed to do, and how does it end up happening when it actually happens? It's been fascinating. The research is unprecedented. Even though it's only two subjects, because of how we're doing it, it will be meaningful. Two data points is not anything you can kind of draw a line through, but because of what we're looking for, and the comparison to six-month astronauts, we can get some meaningful data out of it.

Of course, the most meaningful data is, we can do a few more of these, which the research guys have asked us if we can do about 10 or 12 more subjects. This is the beginning of a longer-term effort, which, as you said, is connected to exploration. It is part of what we've got to do to be able to explore. By the way, that's why we have got to extend ISS, because we can't possibly get that all done.

WRIGHT: Of course, that's for exploration, but there's also the other parts that are already benefitting humanity here on Earth. You've been so involved in that through these last years. What are some [benefits] that you believe that have come from the work on the Station that have certainly proved to help those on Earth?

SUFFREDINI: That's always a struggle. You think, "Okay, I've been at it 10 years." Most of the time they tell you there's this 10-year lead time from the time things are learned in a lab to the time that they're applied on the ground. That's true in a medicine, in particular. Any sort of bio [biology] thing that turns out to be a sort of treatment for humans, which is very, very important. It's not true for technologies.

There are technologies that have been advanced as a result of the regen [regenerative] system that today is allowing us to provide safe drinking water to folks in devastated areas where they don't have power or anything. You get gravity-fed water through this system. Same filters we use on ISS for potable water. We're saving lives today. Technology-wise, there are advances. Again, it's just stuff we've learned on Station.

Ultrasound is on orbit today. A lot of the other systems that normally you use for treatment you can't really get to orbit, although we're making progress there, too. One of the big things about ultrasound now is we're learning how to utilize ultrasound for a long-distance treatment or assessment of patients. In northern areas, very, very rural areas where they can't get access to medical treatment, there are cases now today where they have small clinics that just have ultrasound. They even show mothers how to ultrasound themselves, and then a doctor somewhere in New York or wherever can take a look at the ultrasound and give recommendations for treatment.

This kind of stuff just was never even thought of, but it's what we do every day on ISS. We have the crews ultrasound themselves. The docs [doctors] look at it and make an assessment. If there's anything that we have to do, then we're able to do that. These kinds of areas, there's probably hundreds of examples where this is the case.

On the medical side—the rodent research, protein—it takes a lot longer to get to market. I'm very proud of one that we've been following along. It's called microencapsulation. What we learned is you can take a drug and encapsulate it in a membrane, and that membrane can only be absorbed by the specific cancer that you're trying to treat. If you can imagine, today, chemotherapy just attacks the whole body. If you can put treatments in a membrane that means once it gets only to the cancer does it get absorbed, and otherwise the body doesn't consume it. That's just a fascinating application.

That's work that was done in low-Earth orbit, and that's work that we've helped take to the next step a little bit. Now we're starting to get to the point where we start doing a testing on the ground. That's still a ways away, but it's making great progress. That's one area where I've always said, "We know we're successful when we've cured the common cold and cured cancer." That's just one step towards cancer, so we'll see how we go.

I know great things will come from this particularly as we involve more and more users—medical companies and all these folks that know what the challenges are on the ground, and if they could figure out a treatment, they could really make some money. This is where, I think, the pharmaceutical companies can really benefit. When you take gravity out of the equation, we learn quite a bit about what the other major forcing functions are.

I really think that we will be discovering fascinating things with ISS. Over the years, we'll look back and go, "Wow." Then when ISS is gone, we'll still be doing, "Wow," because the last things we do before we dispose of it will be 10 years before it turns into something that you can look at and go, "Wow, that's fascinating." I think there's a lot that we're going to learn, and find that we've benefitted humanity quite a bit from the ISS.

WRIGHT: You've been in this field for over 26 years. There has been continual presence in space with crewmembers since 2000. How do you explain to people, why is it so hard to live and work and get to space? Of all the advances that you've made and all the technology that you've worked on, how do you explain to people why? Why is it so difficult to be there? Why is it so difficult to keep them safe while they're there?

SUFFREDINI: That's about where technology is relative to what it takes. Today, the best way to get off the planet is with chemical propulsion systems. By their very nature, they operate at extreme temperatures, and pressures, and fluid flow, and all sorts of things. Propulsion engines are still a challenging system to operate. We evolve the technologies as we go.

We learn how to do things better and we take benefit from those, but still it's a challenging business, to overcome gravity to get into the microgravity environment. Then when you get into low-Earth orbit, we have this big challenge of debris, both manmade and that that's just part of the environment. The manmade debris is by far the most challenging, and you just can't build a spacecraft today that's strong enough to withstand the size of debris that we can't track, and still get it to low-Earth orbit. It would be a very, very heavy spacecraft. That's part of this risk balance.

Also, radiation is pretty high in low-Earth orbit, although generally speaking we can manage the crew's time on orbit to be safe. We've learned a lot about the systems that allow you to breathe. Of course, the microgravity environment in space is not conducive to human life, so you have to protect human life. I think we've learned those systems and those technologies. We know how to operate. You never hear us talk about, "Oh, goodness gracious, we might have to bring the crew home because the CO_2 [carbon dioxide] removal system's not working." We've started to figure out redundancies and how you have to do that.

Still challenging technology, still very expensive to build, but as a community we're starting to learn more and more about those, so you don't hear as much about that. But the challenges, the things we can't do a whole lot about, are the chemical propulsion systems that are necessary to get to low-Earth orbit. And the microgravity environment that we fly in, around Earth's orbit is just a challenging place to live in.

WRIGHT: The other half of that question is, if it's so difficult, why do we keep wanting to go? What is in humans, do you believe, that makes us want to explore and see what's there beyond low-Earth orbit?

SUFFREDINI: Well, because it's in our genes, right? We've never sat still ever, so we think we've checked out the big ball we're on, and we want to go see what's next. I think that's very important. Not to get too deep, but I think it's engrained in all of us somewhere that we need to protect the species. The way to protect the species is to make sure that you have alternate locations to live in. This is just part of that.

We need to figure out how to live off this planet, so if someday our planet can't sustain us, we have a place to go. I don't know where—we're born with it—but it's certainly in our genome somewhere, that drives us to want to make sure our species is going to survive. I think that drives us all to want to, "What's over there? What's over there? What's over there?" We don't know why we always want to know what's over there, but we do. We are, at all costs, willing to do that.

People talk about the risks of flying in low-Earth orbit. There's a big risk in that, but explorers took risks for as long as history records. Every time somebody went off and did something, generally speaking, going somewhere new, people lost lives in ships. Thousands of lives were lost in ships trying to explore the world. If you know anything about the Lewis and Clark [Corps of Discovery] Expedition, that was no picnic. This is just part of the human system, to want to explore.

We'll keep wanting to explore, and I think that's very important for us, like I said, to preserve the species. Because the species is the same on this whole big planet Earth, this whole species together should go explore beyond this planet Earth. It's not something any one government should do, not that they can afford it, but it's just not the right way to go do it. We ought to go explore together as a species. Hopefully we'll do that here in the near future.

WRIGHT: I would like to close out the session by just asking you a couple questions. One, what do you believe the legacy of the ISS will be?

SUFFREDINI: The legacy of ISS will be that we created an environment that allowed us to permanently have humans in low-Earth orbit. That, by its very nature, will mean that the ISS helped us do exploration, because we have the capability permanently in low-Earth orbit to do the things we need to do to safely travel beyond low-Earth orbit, and the fact that ISS allowed us to create the demand so that the commercial entities would take over, allowing us to have the budget to do exploration.

That's not a concise legacy, but really to me the legacy—and it has implications to exploration—the legacy when ISS is gone will be at that point: we've always had humans in low-Earth orbit, and we will continue to have humans in low-Earth orbit. That's what I believe.

WRIGHT: As we close, in the next couple of days you'll be starting a new adventure, not associated with NASA as part of its employee force, but doing related work. Share with us what you feel is you legacy, or your lessons; what you would like people to think of when they think, "Mike

Suffredini was program manager of the ISS and this is what we've learned from him to go forward"?

SUFFREDINI: I hope it's that we'll look back together and go, "We built a Space Station that by any measure was wildly more successful than we could have imagined, and that we did the right thing, after we built it, to transition ourselves for what it was supposed to do for mankind." If people look back and go, "Mike helped us do that," then I'd feel really good.

WRIGHT: Thank you. Is there anything that you'd like to add, or a moment, or an event that you'd like to share with us before we close?

SUFFREDINI: I say this to people all the time. The team of folks that built and operate the ISS has no peer, and while leadership is important, it's the individuals that every day do their part to make it successful, that's made the International Space Station the success it is. I just want to recognize that while I got a front row seat for 10 years—the best seat in the house for most events—my part was small when in comparison to what the 7,000-plus people have done to make Space Station successful. I'm looking forward to watching them be successful for the next 15 years or so.

WRIGHT: Thank you. Thank you again for taking time today.

SUFFREDINI: Thank you very much.

[End of interview]