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COMMERCIAL CREW & CARGO PROGRAM OFFICE
ORAL HISTORY TRANSCRIPT

VALIN B. THORN
INTERVIEWED BY REBECCA HACKLER
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HACKLER: Today is December 17, 2012. This oral history interview is being conducted with Valin Thorn at the NASA Johnson Space Center in Houston, Texas for the Commercial Crew & Cargo Program Office History Project. Interviewer is Rebecca Hackler, assisted by Rebecca Wright.

Thank you so much for taking time out of your schedule today. We'd like to start by asking you if you could give us a brief overview of your background with NASA. We understand from talking to Alan [J.] Lindenmoyer [Commercial Crew and Cargo Program Manager] that you had a lot of experience with [International] Space Station integration that you could apply to the COTS [Commercial Orbital Transportation Services] program.

THORN: Sure. I have over 30 years of experience in the aerospace industry. I began out of school at Rockwell [International's] space division in Downey, California. Rockwell was the prime contractor for the Space Shuttle. The Space Shuttle had just flown its fourth operational flight [STS-4], but there was still a lot of work to do in finalizing development in some areas. I began on Space Shuttle entry performance and guidance analysis and enhancement.

I also worked Rockwell's advanced programs, a lot of the new business work they were trying to bring in, everything from the early Space Station work—and I also worked on the Strategic Defense Initiative, which at the time was nicknamed Star Wars, for ballistic missile

defense. Specifically the kinetic energy weapon program, which ended up becoming called Brilliant Pebbles. I started off working more atmospheric flight and Shuttle entry, but then I got very much into orbital mechanics and space mission analysis and design.

In 1986, after Rockwell won a consolidation contract for Space Shuttle operations—it was called the Rockwell Space Operations Contract—I was sent here [to JSC] from Los Angeles, which is where Downey is, to help get that going. In fact my wife came out too, she worked for Rockwell as well. I worked in flight design dynamics. In January of ’86 though we had the *Challenger* [STS 51-L] accident, and so the company had also hired a bunch of young new hires. Of course I’d been out of school four years, but I was a veteran compared to all the new hires being brought in. I taught them space mission analysis and design and orbital mechanics for much of that year, getting them all ready for when the Shuttle operations continued.

I went back to California again working ballistic missile defense for about a year, but then decided to come back. In late ’87 I came back to work Shuttle operations, because the Shuttle was flying again. I was a flight design manager, so I led a team that designed the missions and set what we call the I-loads, or initialization loads, to program the Shuttle software for the missions. I did that for about three years, then I went to work for Grumman Aerospace [Corporation].

Grumman Aerospace at the time had what we called the Level II engineering and integration contract on Space Station Freedom, the program-level integration and engineering work. The program office for Space Station Freedom then was in Reston, Virginia, and we had the Houston field office. Grumman was in charge of trying to bring the whole program together, integrate it all, but it was very difficult for a contractor to integrate all these different NASA Centers that all had pieces of the Space Station Freedom Program.

At that time I was working guidance, navigation, and control integration for Space Station Freedom, but recognizing, seeing the organizational problems that the program had as it restructured in 1993 and 1994—as part of that, the program leadership was moved to Houston, with JSC leading the program and then [The] Boeing [Company] taking over as the prime contractor. Grumman, which had about 1,200 people at the time, was cut down to 60 people.

I was fortunate enough to be in that 60 people that were not cut, but not long after that I was hired into NASA to work in integrated vehicle performance in the vehicle office for the new International Space Station [ISS]. That was basically a systems engineering and integration function, and in time I ended up managing that area. We had about 150 engineers total between the civil servants and our contract staff.

At the time we were called the VIPER team, for Vehicle Integrated Performance and Resources. The VIPER team still exists. And then I also led what was called at the time the SABER [Strategic Planning and Requirements] team, which is also an SE&I [Systems Engineering and Integration] team. We were really doing the same thing, but it was more up and out, higher level. We were responsible for the Space Station architecture and assembly sequence and the launch packages of the Shuttle.

So I was with Space Station for about 15 years. This was our flagship development program with a lot of people. It was international, working with the Russians and Europeans, so certainly very much an engineering and integration challenge, but it was also a challenge in one's patience for decision making and process.

I really could see how we could stand to see improvements in the way we do business. Our generation didn't create it; really we inherited some inefficient processes. Some of them were just a natural consequence of any government agency, given the controls and protections

you have so there's not abuse of power and waste of money. It also means you sometimes end up with some excessive bureaucratic processes.

I was really disappointed with all the energy it took on Space Station to get some of the simplest decisions made. I very much could see that we needed to move as much of what we were doing to the private sector as possible. I had that firsthand experience where that had consumed all my patience, though I'm very proud of what we did with Space Station.

Around the 2005 timeframe we had an initiative underway called the ISS Commercial Cargo Services [ICCS] where we were looking at providing commercial cargo services to the Space Station. At the time it was very much about flying an Atlas launch vehicle with a new cargo vehicle. With the Space Shuttle flying and when you looked at our logistics we didn't have the need for any extra support, because the Space Shuttle was doing everything we needed and we had our International Partner vehicles as well. In January 2004 NASA announced the Vision for Space Exploration, partly in response to the Shuttle *Columbia* accident [STS-107] in February 2003, and a strategic plan had come together that showed the Shuttle retiring in 2010. This created a need to replace the Shuttle significant cargo logistics support for the ISS.

There was political support for this kind of concept, to try to move more of what we were doing to the private sector and lower the cost. But in time, one of the things I've learned in this business—I know when I was younger I believed that NASA came up with all the ideas, and then it was just top down. NASA has these ideas, and everybody executes them.

In reality, the way things work in a democracy is really more of a circle. You have people and industry influencing policies and our legislators in Washington [DC], including the executive branch, and building support for different initiatives and projects. Of course NASA is an agency of the executive branch, and so we're responsible for executing policy. We certainly

interact in the process, but things don't always start off top-down just from NASA's thinking. It's really a much more homogeneous back and forth with NASA and industry influencing policy and NASA executing policy.

I bring that up because of this ISS Commercial Cargo Services Program, which had gotten some political support and some funding set aside. The other thing that happened around the 2005 timeframe was that there was a prize called the Ansari X Prize, which was to create an incentive for anyone, some organization to achieve a human-crewed suborbital flight.

There were a number of teams working on it, but the one that was successful was Scaled Composites [LLC], which was [Elbert L.] "Burt" Rutan and his effort at Mojave [Air & Space Port] in California. His effort was backed by Paul [G.] Allen, one of the Microsoft [Corporation] founders. For about $20 million they were able to build a new suborbital transportation system that won the Ansari X Prize.

Before that happened though, the idea that anything other than government multi-billion dollar programs could actually do human spaceflight was just a joke. It was never taken seriously. This NewSpace community was advocating to give them a chance, that NASA has had a de facto monopoly on human spaceflight. There's not much of a market of course, and then governments are providing the transportation for whatever kind of a need there might be. It was very expensive the way governments work and operate, and if we're ever going to make progress on that, the private sector needed to get engaged to help improve efficiency and lower cost.

There'd been this NewSpace community pleading for a chance at human spaceflight. Maybe it's too strong a word to say hijacked, but I'm happy they did. They had this political

support, which I would say was probably mostly drummed up by Lockheed Martin, who made the boosters that'd probably be used for this logistic support—this is my viewpoint.

The NewSpace community had that momentum, and with the Ansari X Prize having been achieved from Scaled Composites, it got everyone very excited about the possibility that really small teams could pull off a human spaceflight effort without it costing billions and billions of dollars. Everybody understood clearly that suborbital flight was very much different than orbital flight, but most people saw it as really an epoch in time. It was really a turning point in people's perception of what was possible.

That was the trigger, I think, for the political support needed to get a private sector effort under way. But it was going to need government help because the markets were unclear. Whatever markets did exist were small, and were probably mostly national governments wanting to fly people to space for national prestige reasons—as well as tourism, which would begin with the wealthiest people who can afford to take a flight to space.

They wanted a chance, and now they had political support for ISS Commercial Cargo Services, and then they had the Ansari X Prize having been pulled off. That created all this excitement, and they were able to basically reshape this initiative into what it ultimately ended up being called, the COTS effort, the Commercial Orbital Transportation Services effort. That was in the 2005, 2006 timeframe when [NASA Administrator] Michael [D.] Griffin had come in. The advocates for this initiative were talking to congressmen, they were talking to Griffin.

Griffin was a supporter. In fact, he'd had periods of time where he was involved with the NewSpace effort. One of those in particular was AMROC [American Rocket Company], which was a company that was really trying to lower the cost of launch vehicles using hybrid

propulsion. He'd had a period of time that he was there. So he supported the effort, he wanted to give it a chance.

There was agreement to go ahead and set aside about $500 million over about five years to give industry a chance. Congress wanted it, and they were getting lobbied all the time by the NewSpace community. I'd say even much of the industry, like Lockheed Martin, who expected their expendable boosters would probably get some of that market, were supporting it. That initiative got under way.

I was involved in the ISS Commercial Cargo Services effort as the manager for Space Station strategic planning. To put it in a more general sense, the systems engineering and integration function. ICCS was getting moving, and it was going to be led by [NASA] Kennedy Space Center [Florida (KSC)], but of course the Space Station was a big part of that because the commercial vehicles would be flying up to the Space Station.

We had an industry day, which is what we typically do when we're going to have a new government purchase or acquisition or procurement. You'll hear those different words for it. We had a big industry day in April of 2005 with about 500 people attending. It already had this initiative and momentum, and was briefing up how to fly to Space Station and our requirements and interfaces.

This new to-be-named COTS initiative was to get under way. It languished at [NASA] Headquarters [Washington, DC] for a while. Headquarters was going to do it themselves, but I don't know if they really had experience with it, and so nothing was happening. I hadn't even heard about it, then I ended up getting a call from Alan Lindenmoyer. Alan had been contacted by [William H.] Gerstenmaier [Associate Administrator for the Space Operations Mission Directorate] about this initiative, and he was going to have a meeting with Griffin.

I got a call from Alan. He didn't tell me all that was going on, and he hadn't talked to Griffin yet—but he knew that I had helped run this industry day on this ICCS, and I had all these packages we prepared. He said he was going to be getting involved with it, so I came over to his office and I briefed him on everything we'd been doing. I was already, as I said before, very much an advocate for moving everything we could to the private sector for the efficiencies that could be achieved there. We'd been running this from our side in the Program Integration Office on the Space Station Program, so it was being led out of our office, at least our piece of it.

I was really happy to hear the news—I really believed in the effort. Some people, when they found out somebody else was being assigned to work something, would not be cooperative. It wouldn't be unusual for people not to cooperate, because people don't want to give up good work that they really want to do. I just wanted to see this really happen, I was very motivated to see this happen.

I got Alan up to speed on everything we'd done to that point, and at the end of the meeting he told me about what was going on. I didn't know the details, but I said, "That's great. I'm really happy." I could see how it was being reshaped, what we were doing. I say hijacked, but I mean in a good way because I think it was the right thing to steer it off in this direction. Not just on providing cargo, but with a long term goal of actually flying crew to space, providing commercial crew services. He asked me if I could come and help him out with this.

At the time it was all just about getting this acquisition going and how we were going to organize to pull it off. It was still uncertain, but I was very excited about it. We'd been going through some restructuring in Space Station, and the new exploration program had been announced. There was not enough money to fund it, and we were going through a bunch of

strategic relooks at Space Station and what we could do to free up money to support Constellation [Ares rocket and Orion Crew Exploration Vehicle].

Then the *Columbia* accident, the timing for that being down—I decided, "Well, yes." Actually I was still a Space Station person for the whole acquisition and procurement for the COTS effort. I was tagged at the time to just support that and get that moving, but of course I was one of the principals as we developed an architecture and the model for how this would work. Near the end of the first COTS evaluation board [Participant Evaluation Panel], Alan asked me to become the Deputy Program Manager for the new Commercial Crew and Cargo Program being formed and I accepted.

As I mentioned before, the reality is, if you hadn't learned it already, that there's really a circular thing going on in terms of establishing space policy. Not just space policy, really all national policy in everything. NASA can't go lobby directly to the Congress, but industry can do that kind of thing. There's no clear, linear top-down kind of thing. As part of that, several people had written white papers and had met with Griffin already.

A company called t/Space [Transformational Space Corp.], which I don't think is in operation now—one of their principals was Brett [Bretton] Alexander. He'd been in the Office of Science and Technology Policy, OSTP, for the White House a number of years before, and he'd worked for the FAA [Federal Aviation Administration]. He as well was an advocate for this NewSpace community.

He'd written a white paper, and he'd met with several people and congressmen in DC. I think we had his white paper, we'd heard their ideas about how this would work. Fundamentally what they were proposing was to do something the DoD [Department of Defense] had been doing for years, which was using what they called their Other Transaction Authority, or OTA.

When you get into contracting it's not particularly exciting, but it's really important to put some energy into understanding it, because it ends up setting the boundaries and ground rules by which you work with industry and with government.

You have to get your head into this to sort out what are some of the problems with the way we do business. Fundamentally, they were proposing that instead of doing a Federal Acquisition Regulation, or FAR-based kind of contract—which very much puts NASA in control, and has all this overhead and all these requirements, and is something that basically only a fairly large aerospace company can deal with due to all the administration required—to use NASA's version of OTAs.

For NASA, the closest analog to that is called the Space Act Agreement. When you look at the legal paperwork that created NASA in 1958, the [National Aeronautics and] Space Act, it outlines NASA's charter and its mission. One of those is to transfer technology to industry, to help commercialize. One of the legal instruments that NASA can use to accomplish its mission objectives are the Space Act Agreements created back in that original legislation. Not exactly like an OTA, but it's the closest analog.

Fundamentally, that was the message we were getting from industry. "Don't use a FAR, it brings in all this bureaucracy and collapses people under its weight. Use this SAA, the Space Act Agreements, so that you have a more efficient legal instrument." I believe as part of that too—the DoD would very much use OTAs like normal contracts. For a Space Act Agreement, generally the government wasn't providing money. Historically, mostly they were setting up a partnership to cooperate on things and transfer information.

One of the unique things about what we were doing was to have what is now called a funded Space Act Agreement. We would be able to take all the benefits of establishing an

agreement, try to minimize all the overhead of having a FAR-based contract, but yet still be able to provide some financial help. It's been years since I've seen the original white paper, which is one of the sources of input in terms of how we might organize, but then we had of course our own experiences with things.

I had mine from my 15 years in the key role in Space Station and our flagship program, seeing the inefficiencies there in our processes and in our contracting processes. Alan, in fact—I call Alan a lawyer engineer. Much of his career was more on the administrative side of things. Really sharp technically, but he has more experience in the administration of large projects from configuration management. He'd worked a number of previous acquisitions and procurements, so he had experience with the process.

I was famous for being mostly the technical guy. I had this long experience with Space Station from almost the very beginning, even way back to when I was working some of the advanced concepts at Rockwell in Downey, to then heading up the systems engineering and strategic planning effort.

Alan ended up being tapped for this because he was known for his experience with procurement and acquisition, and he's very well organized and he's dealt with that community. They needed this new way of doing business to move very quickly. And if you're going to do things differently, you need someone who knows the way it's normally done and has dealt with those communities. For example, our procurement office and our legal office, who are used to administering those processes, are stakeholders in the old way of doing business.

He was really the perfect choice for the position of leading up the effort, because he was an engineer, he knew how NASA did business, he'd done several procurements, he was very good at it, he was very process- and procedure-oriented, and he'd dealt with those communities

and knew where they were coming from. We were going to do things differently, so he was tapped for that because of that experience. For me, I was coming from mostly this technical and engineering expertise and background and reputation you might say.

Alan asked me to chair the technical committee for the Participant Evaluation Panel [PEP]. That was to give it a different name than a Source Evaluation Board, because it wasn't going to be a FAR contract. It'd be called the PEP. The first competition was fairly large. We were new to this whole way of doing business and this new effort that was getting under way. We didn't really know all the history of what was going on in the NewSpace community and who all the players were.

It was getting a lot of attention. We had a fairly large team that was going to look at the first awards of these agreements for what ended up being COTS Round 1. I chaired the technical committee, and we had a chair for the financial committee as well. Of course you then recruit in teams of experts in different areas.

But before all that happened, we had to develop this model. Fundamentally—I've mentioned some of the basic elements of it—we were trying to avoid the burden and overhead of a FAR-based contract. We wanted to be able to provide financial assistance, but we also wanted to create as much trade space as possible for these partnerships in the design of things.

When I say trade space—typically it wouldn't be unusual that when we're going to do a project we'll study something quite a bit. We'll study with industry, and oftentimes fund them to study some problem, some mission objective we want to have. Then we will decide how we want it done, and we'll have a competition for contracts to execute it. We'll dictate, "This is how it will be done." So our partners, our contractors, will have to execute it as we've laid it out.

One of the criticisms the government would get was that we didn't provide enough latitude and flexibility for companies to innovate and to be creative. So rather than dictating design solutions, we were going to just provide very broad goals and objectives. For example, instead of saying, "We want you to make a spacecraft that is this big, this diameter, this long, and we can put this many of these size bags in it"—that would be being very specific. We'd say instead that every year we need to have—I don't remember the exact number—6,000 kilograms of pressurized cargo, which would be internal cargo. Then we need 3,000 kilograms of external cargo, things that are outside components.

This model was that we weren't going to come in and say, "Here's exactly what we want you to build." We were going to tell you, "Here's what we want. We want cargo delivered up," and we talked about crew to the Space Station for the crewed missions. I think we were indicating how many of the crew on the U.S. segment [of Space Station], which is the non-Russian segment, and then a range of time in which they could be rotated off. We were trying to step back as far as possible to these high-level macro needs and not say, "Build a spacecraft that can fly this much on every mission and is this big." That was one of the key tenets of this model.

The other key tenet was that the partners had to be contributing money as well. The phrase that was used a lot was "skin in the game." They all have to have skin in the game. This was also key to another important element, which was that the partners retained their intellectual property rights. After working on it really hard with our lawyers, we could never really just sign the intellectual property [IP] rights over to them as long as we were paying for any of it. But we did agree that as long as they were actively working to use that intellectual property that was developed as part of the agreement, we would refrain from our rights to use it. But if they discontinued the effort, then we still had the rights to take it and use it however we needed to.

That was important. It was really important for them to have the rights to the IP, intellectual property, because we wanted them to bring in their own money. Oftentimes that meant they had to go find investors. If you're looking to invest in a space company, and you're going to put money in—yes, that's great that the government is subsidizing this to help get this industry moving, but if you don't own the rights to the intellectual property at least in some form or another, then you're going to have a hard time raising money for that. So it was a really important part of this model.

Under normal FAR-based contracts the government is paying for everything. We own all the intellectual property and we're leading it, we're dictating solutions. Here we're in a situation where we're acting almost like a lead investor. But we're the best kind of investor for a company because we don't take any equity in the company. We're doing this with the idea that the benefit will be to the public and to the Agency down the road as these much more affordable services are made available that reduce our cost of performing the NASA mission, we can use our scarce resources for things that the government should be doing that don't make any commercial sense yet. We're really pushing the boundaries of the space frontier. Developing the new technologies required to make that happen is really the better role for the government as they bring this along.

Those are the fundamental aspects of this model. We're providing financial assistance. There's skin in the game, our partners are putting money in. They retain rights to intellectual property as long as they're working to use them. We're not dictating design solutions; we're providing overall objectives for some services we're going to buy eventually. We framed it in that context, so now all the companies working can all come up with whatever concepts they think fit this the best.

Another key part of making this work—the government, we've been used to leading it all, running it, micromanaging every detail. These are fixed-price, FAR-based contracts, though for government R&D [research and development] work they are not usually used. These typical NASA FAR contracts are cost-plus contracts. That means that if you're a company and you're doing the work, whatever it cost you do the work, you're going to get paid for that, plus some reasonable profit on top. Given that, there's really no risk because you can't lose money. We didn't invent this, NASA has been doing business this way since the beginning. We inherited it from the way much of government does business, including the DoD.

What do you get when you have that kind of an agreement with a company that you're working with? If you have a company and I say, "You can't lose money. Whatever you spend to do this work you're going to get compensated for." Well, anytime I have anything that possibly needs to be done, you're going to be right there, "Sure, we'll do it, we'll take care of it." Because the more work you do, the more money you make. Fundamentally the incentive you have is to do more work, not to find more efficient ways to do work. Any time the customer, in this case NASA, has some new requirement, new idea, you embrace it. Certainly businesspeople are going to embrace it.

We've had decades of that kind of practice. So over time you see this steady inflation in what it takes to do business, because people almost lose the benchmark about what it really takes to do the work. You end up with so many people all trying to do the same work. I would argue that in some areas you might easily have five to ten times as many people trying to do that function as are really required. Part of that is cost-plus contracting, and part of that is the nature of government contract spending, and the politics of a democracy, and Congressmen and the

politicians being first concerned about where the money is going. Money's going into their districts and not so much concern about what's being done exactly.

So you end up with a lot of people. That's why these programs and projects cost a lot of money. The problem with it now is, after several decades of operating that way, we've seen this inflation. We'll have a program working for a few years, and then there's a big outcry about how long it's taking and how much it's costing and how behind schedule they are. Then Congress, part of the people responsible for getting us in the situation, have to make a big statement about how they're going to come in and fix it. Force it to restructure, or cancel the program and start all over again, and we never got anything out of it.

As I said, we didn't invent this. We inherited this. The former Associate Administrator for [the Office of Manned Space Flight] at NASA in the '60s, during Apollo, was George [E.] Mueller. He's pretty famous. He was the architect of one of our commercial concepts that was picked in the first round. It was called the Kistler concept [Rocketplane Kistler proposal]. During our Constellation effort, which was our latest effort to go back to the Moon that was under Griffin's watch, he was asked by a reporter, "How many people does it really take to go to the Moon?" Because we've done it before, and he's one of the key leaders that helped do it on Apollo. It was a great question to ask him.

His response was, "I don't know how many people it takes. But if we'd had one more, we wouldn't have made it." That's what he said. And this was in the '60s. As I sit back, looking at my 15 years on our flagship program, frustrated with all the people and the bureaucracy and all that it took—when I see that quote, it reminds me that they were dealing with that during Apollo as well. They almost had too many people, because of the politics and

the way it was all structured. We didn't invent it; we inherited it from our grandfathers, but it's just gotten worse over the decades.

When we talk FAR-based contracting, this cost-plus contracting, that's fundamentally what's wrong. NASA is leading it and controlling it and micromanaging it. So part of what we needed to do in this new commercial model was to find a way that it's self-regulating. The concept that we had, coming from us internally and perhaps even from other examples—I don't know if it was in the original white paper that Brett Alexander and his team from t/Space put together—was that we wanted to establish these milestones with our partners. Just like driving down a highway where you get to milestones, we wanted to have these progress milestones that would clearly indicate that they made progress. And our additional investment was linked to them successfully achieving those milestones.

There was no opportunity for more money from NASA. There was no cost-plus kind of stuff at all. It essentially looks like a fixed-price contract, but they weren't going to get all this money up front, and then we have to micromanage and make sure that they were doing what they said they were going to do. Instead, we lay out these breadcrumbs like a breadcrumb trail, these progress milestones. When they make those milestones, they get additional investment from NASA.

And we didn't dictate the milestones either. The government was getting a lot of criticism from the NewSpace community that we were dictating too many things. Everywhere we could we tried to be flexible. Even in terms of the milestones, we let them propose the milestones. We negotiated with them, but we let them propose what they thought made sense. We said, "We need one probably about every quarter or so." Not too close together because there's going to be some administrative overhead, but not so far apart that we don't have them as

a barometer of how things are going. That was another key element of the Space Act Agreement, this commercial partnership model that we established.

The other thing that we did—and I'm the author of this aspect—was the idea of us having NASA consultants. For our COTS effort we called them the Commercial Advisory Teams, or CATs. I happen to be a cat lover, so I like the nickname being CATs. One of the challenges we had though was every partner was going to need different kinds of consulting help and involvement and insight on our part.

Our CATs are consultants—but they're also our way of helping monitor how things are going, maintaining situational awareness. We call that "insight." It's very difficult to put the CATs consulting support in the Space Act Agreement legally, because each partner needed something different. I don't think the CATs were ever described in the Space Act Agreement language—but it was just understood that we were going to have this.

We were funding it, and it was an inherent part of our partnership with our partners. It was a benefit of it, that they had these limited free consultations and access to the Agency-wide experts, most of them part-time. We'd bring them in as we needed to help us certify milestone completions and, depending on the nature of the milestone, help us review those milestones. I think it's been very effective and helpful for all of our partners.

Even though they're small teams, the reality is even for a small commercial company team there will be these very specialized areas where very unique expertise is occasionally needed. If you're a small company it just doesn't make sense to bring in and hire, and have the expense of having an expert in that area on all the time. But you need that kind of expertise at times to at least to help point you in the right direction.

It was a very powerful and effective tool to allow them not to have on their own staff and at their own expense some of these world experts in some of these specialized areas. We could bring them in and help them, guide them in the right direction. Then they would go execute and the CATs experts could consult with them as needed along the way. That was another really key important element of the COTS effort. CATs we called it, CATs team effort.

HACKLER: It's so interesting to hear how this all came to be put together. If you wouldn't mind, could you share how the lobbying efforts and the precursor effort of the ICCS came about? Can you talk a little bit more about the industry day that you had? What kind of companies were involved, what kind of questions and topics were discussed, and how did that lead into some of the principles for COTS?

THORN: I have very limited insight into the political influence process that happened that got ICCS going. In fact, there was even a precursor to ICCS called Alternate Access to Space [Station] that was led out of [NASA] Marshall [Space Flight Center, Huntsville, Alabama].

For the ICCS industry day in April 2005, really the entire industry was represented, from all the major aerospace companies—Boeing, Northrop Grumman [Corporation], Lockheed Martin—to the small NewSpace community. Again, at that time ICCS wasn't shaped as friendly to NewSpace, to try to bring along these entrepreneurs and people who really want to do things differently. It was really more the about the big guys who had some assets that could provide cargo services rather than the Shuttle. They wanted to sell more of their assets to provide service to the Space Station. I would expect, just connecting dots, that Lockheed Martin with the Atlas,

maybe even Boeing with the Delta [launch vehicle]—probably both of them, with their political influence process, a.k.a. lobbyists in Washington, were able to get some momentum behind that.

It was the right thing to do, but we had the problem that the Shuttle really was providing all the logistics needs that we had for the Space Station and people hadn't really accepted the idea that we were going to retire the Space Shuttle any time soon. From the long-term macro-view of economics, trying to develop the industry and move as much as possible to the private sector was the right thing to do. But we still had our human spaceflight vehicle, which was basically a big giant space truck, with a 60-foot-long and 15-foot-wide [payload] bay, that needed something to haul up. It wasn't going to haul up just people. So it was difficult keeping political traction, I think, because we didn't really need the commercial cargo capabilities at the time.

The ICCS industry day was at the [JSC] Gilruth [Center], and we had hundreds of people there. We can certainly look up all the companies that participated, but it was pretty much everybody. But again, it hadn't become the NewSpace effort yet.

HACKLER: One of the other things that I understand you did when starting up the COTS program was the Interface Requirements Document. How did you use your experience with Space Station integration requirements, which are very complex, to distill that to a format that was understandable to these companies that were trying to be able to provide services to Station?

THORN: We needed to compile them in as concise a manner as possible, an easy-to-read manner, because once we became the NewSpace effort we were also trying to be very friendly to smaller

enterprises, and not just the big aerospace companies. Of course I'd been working Space Station and managing our SE&I effort for so long that I was fairly familiar with most all the disciplines.

I did lead creating the Space Station Interface Requirements Document, all under one document that was reorganized in a little bit more friendly format for them to work from, pulling in things from other documents we call ICDs, Interface Control Documents. Because we'd been integrating visiting vehicles already. We'd had the Japanese [Japan Aerospace Exploration Agency] vehicle [H-II Transfer Vehicle] and the European [Space Agency] vehicle we call the ATV [Automated Transfer Vehicle]. It wasn't like we hadn't already had some interface requirements, but they weren't perfect.

We were on such a tight schedule, and a really comprehensive effort to do the book right was going to take about a year. Basically we brought up a small team under my leadership, and I actually put a little contract out with Booz Allen Hamilton [Inc.] that helped do a lot of the legwork. So we were able to get together this Space Station Interface Requirements Document in a matter of weeks, in time for the competition, because it was really important for them to see. They didn't really understand the Space Station or what was going to be required, and how we operated and what the mechanical interfaces would be and data interfaces and all the safety. Yes, that was one of my responsibilities. It's a pretty big book.

Once we finished and the Space Station fully stood up to integrate and work with us, then they did one of these yearlong [reviews] where every discipline was relooking at their requirements. They rearranged the format back to what we normally do, which is this DoD format, which isn't as intuitive.

I had reorganized it so it was easier to follow, under one book, for this effort. But then it got put back into this DoD kind of format, and then got a whole bunch of very careful review

from all the different disciplines, which we didn't have time for. But, in my opinion at least, it was over 90 percent to where it needed to be. I think that's proven by the pace that we were able to continue to work at. We did award the agreements, then Space Station stood up an office to help do this integration.

Then our partners were encouraged to push back on the requirements. Part of establishing good requirements isn't just somebody in a room who owns something, some discipline, saying, "Here is my requirement," and never having to actually integrate it into a program or some other spacecraft that's working. We'd had a lot of that, and that's one of the things we're still struggling with today as an Agency. We have a bunch of what we call human rating requirements that have been created, but they haven't been tested or refined by actually being implemented by a real spacecraft development program.

That was one of the problems Orion and Constellation were having. They were going to be the first ones to try to do that, then of course our commercial partners had to deal with it too. We're dealing with it now with our ongoing commercial crew effort which I'm a part of.

HACKLER: You also used a lot of that technical know-how and awareness of the Station requirements when you chaired the technical committee for the Participant Evaluation Panel.

THORN: I certainly knew the Space Station very well. It wouldn't be overstating it to say I was a Space Station expert. It would probably be a push to say I'm still an expert, because things change, but I was one of the most knowledgeable. Certainly on the broad level of expertise, because systems engineering is about multidiscipline optimization and integrated performance.

It's the whole architecture and the way everything plays together, not just optimizing one particular area.

To do that, you have to learn more than you normally would about all the areas. You may never become an expert in one, but you know much more about each discipline than the more casual engineer or somebody who has a particular specialty and focuses in that one area. That's why I was a particularly good fit.

Also of course I'd been there 15 years. I'd been very involved in all the key things we'd done in terms of architecture changes and ops [operations] changes and improvements. Certainly the Space Station community knew me, and they knew I know who to talk to. They knew that as we developed concepts and ways of operating, that I understood what the Space Station was going to need.

HACKLER: Can you talk more about your role on the Participant Evaluation Panel and how you evaluated proposals and what sort of things you were looking for?

THORN: As I mentioned before, I was the chairman of the technical evaluation committee. That meant we focused on the engineering and technical aspects. We had another group—and in this model the commercial or the business side was very important, because we were looking at things more like a venture capitalist. Alan Marty was a consultant venture capitalist that we brought in to help us think like a venture capitalist.

As the chairman of the technical committee, and also a voting member of the Participant Evaluation [Panel], I was involved with all that we were doing. We intentionally operated as much like a typical Source Evaluation Board as possible. We knew that what we were doing was

very much an experiment. Frankly, most people didn't think it was going to work, and we were going to get a lot of scrutiny.

The processes and procedures we use for conducting competitive acquisitions or procurements, or going out and hiring companies to do work, has evolved over many years. Over 200 years of the government enhancing and improving the way it spends public money. If we deviated from that too much, we knew that we would be getting in quicksand easily and that we'd be open to criticism for those deviations. So we really looked very much like a typical source acquisition board.

What does that mean, for people who might be reading this later? I don't want to bore everybody with the whole process, but ultimately—and there's a lot of work to get to this point—you put out a Request for Proposal, which is where the government describes some product or service that it needs. If we're getting a product or service, we have to use a FAR contract to do that. In fact that's one of the tests for COTS. In order to use the Space Act Agreement, we weren't going out to buy a product or service—and in fact we weren't doing that.

We had this objective, for the good of the public, to try to help develop the human spaceflight industry so that we could all afford a ticket to space someday, to put it in really simple terms. If the government kept doing it, if we were the only ones flying to space, then none of us or our grandkids are ever going to be able to afford a ticket to space, and we're not going to open up markets in other industries that need lower-cost space transportation.

Because there was such sensitivity about it not looking like a FAR acquisition, everything got renamed slightly. Like Source Evaluation Board became Participant Evaluation Panel. The Request for Proposal, I wanted to call it Announcement for Proposals, or Announcement for Agreement. It ended up just being called an Announcement, which is crazy and confusing, but

we were stuck in this thing where people were used to the way we always did it. We had to always use language that would make a statement that we were doing it slightly differently so they weren't locked into a certain way of seeing what we were doing.

This Announcement, RFP [Request for Proposal], which we built and wrote—in fact I originally found an analog format for it that we used. At the last minute we had some difficulties with some of the people who had tried to draft the first version, who were coming from the old way that we usually did FAR stuff. They weren't seeing it the way we did. So last minute—in fact the night before—I'd found this format that worked, and Alan drafted out the Announcement to go out for industry. You tell them how long they have to respond, how many pages they can use, how many pages for each section.

Then we form our evaluation team. The companies work on and submit their proposals, and we have our team. We'll break up into those functional areas like the technical and business side, then we'll bring in specialists. We have people who are permanently on the team, and then some part-time people come in and review sections of the proposals and they'll write what we call a finding.

A finding—basically if you imagine that you read the proposal, and everything you're seeing is pretty much about what you expected, it's this mid-level expectation, then you don't write a finding. A finding is pretty much describing something that you see as particularly good or not so good. It's something that looks like a strength—in fact we call them strengths—or a weakness.

Part of what an evaluation team has to do is find out what is our expectation of what we consider normal. Then we can identify what looks exceptional, a strength, and what looks weak in an area. People go through, and they see something they think is a strength or weakness.

They'll write up a little description about it, which we call these findings. There'll be different categories: significant strength, strength, weakness, and significant weakness. This is very much like a typical FAR thing.

Then once we consolidate all those, the Participant Evaluation Panel looks at all these findings that come in. Some aren't written very well, so they'll have to work on the wording to make sure that it's saying really what we want to say and it's diplomatic enough. We're trying to get the good content. You use those findings to form an evaluation of each different section of the proposal, then those all flow up into which are the better ones, and you grade them.

We had a somewhat novel way of grading them in terms of what we call confidence ratings. We had red, yellow, green confidence ratings, but they were also part of a two-dimensional matrix. One side was how many of our goals were being achieved, and the other side was our likelihood that they could actually achieve them. In this two-dimensional matrix, five-five was they met all our goals—because there were about five levels—and it was very likely that they'd achieve those goals. That would be the highest confidence rating for that particular thing. The major category areas would get these confidence ratings that way.

Then, after having sorted out all those proposals, we'd take the most attractive, most promising proposals, and they would be selected for additional due diligence. I say it that way because essentially I think of them as finalists. The lawyers don't like us calling them finalists because the way we were structured is the Selection Authority could really pick from anyone who'd bid. It was a legal technicality. It would have been really unusual for the selection official to not take one of the companies that we'd identified as one of the best proposals, but legally that was their right. We internally called them finalists, but externally we couldn't do that for these legal technicalities.

The ones that were selected for additional due diligence would get our preliminary findings back, and they'd get to respond to them. They'd provide a written report, and we'd go meet with them. For the first competitions, since we were really very much learning this industry, and we had all these new participants, and we didn't know how credible some of them were—we made a point that if they were in the finals, we would actually go out to visit their facility.

Once we really got to know the industry and who all the players were, we didn't have to do that so much. It saved time to be able to just do it all at JSC. They'd come here and meet with us and we'd go over their findings and their responses. They'd provide some additional material and we'd reevaluate our findings. Based on those reevaluations, they'd be ranked again, sorted out. Then we'd take that to the selection official, which was at Headquarters.

The selection official for the various competitions were whomever was leading up the Headquarters commercial effort at the time, or at least our commercial people working for them. Though for the first COTS competition, it was Scott Horowitz, the head of the Exploration [Systems Mission] Directorate where the commercial division was located organizationally. He had several advisers and they were also included in the selection briefing. We call it the selection briefing, where you summarize all these results and findings from all these proposals to support a decision on selections.

All the key players on the evaluation team would make their presentations summarizing the results, then the selection official would hear comments from all his advisers. Then he or she would decide—it was he in all these cases—who they wanted to bring forward as partners. We'd have draft Space Act Agreements as part of the proposals that were turned in, then we'd do some final negotiations and adjustments on those as we thought was needed. Then, once they

were picked, they'd get a signed agreement on both sides. We'd be off and running, with the model I just described.

As I said before, the agreements establish performance milestones and we'd have our expert consultants. What was really beautiful about the model with these performance milestones is that it is very much self-regulating. There's no incentive, there's no way for them to get more money from NASA. They get more money when they make a milestone. We don't have to go in and give them a hard time about being behind on schedule. They have every incentive to be on schedule to get things done in an efficient way and to spend every dollar like it's theirs. That's a key aspect of this model.

We wanted to set up a model where your partners that you're working with spend every dollar like it's theirs. It's just that simple. It doesn't have to be complicated. Just like the simple rule about a cost-plus contract and look at the results you got from that. Our model is self-regulating, so people spend every dollar like it's theirs. NASA doesn't have to get in and try to help make every decision for them, which in fact we intentionally didn't want to do. We were trying to be a bit at arm's length so that they were leading their own development effort, and we were this lead investor venture capitalist, but also a potential future customer. Certainly we were bringing in all the expertise that we could.

That was really what was nice about it, that it was self-regulating and didn't require that kind of management to make it work. To this day we still struggle with people who don't understand that, who only know how to work in the cost-plus model. So when a partner would be behind, they'd say, "Well, what are we doing to get them back on schedule?" Because that's what you have to do if you're in a cost-plus. Some NASA guy has got to come in and say, "Enough is enough. You've got to make this happen." Drive them back, try to get them on

schedule. We don't have to do that with a partner that's working on these performance-based milestones. They want to get to that milestone.

Just an aside that comes up—SpaceX [Space Exploration Technologies Corp.] was a new company led by Elon Musk who came out of Silicon Valley [high-technology region around San Francisco, California] and talked about a new way of doing business. The way he saw things, frankly from his somewhat limited understanding of how things work—which was actually good, because someone that fully knew what he was getting into might not have wanted to do it.

They had a very aggressive schedule. They knew it and we knew it. Even as a project or program manager, you're never going to get something done ahead of schedule. Part of how you challenge people is you have a challenging schedule, and they had a challenging schedule. We all knew it, we knew it when we picked them. All the people at Headquarters, all these managers—we all knew they're not going to make that schedule, but they're trying to challenge themselves, test themselves and see what they can do.

Then sure enough, it ends up being more like what we expected. They'd started with like a three-year schedule, and of course it ended up being about five years. They're developing a whole new rocket, a new spacecraft. They're making incredible progress, but as things got much more politically sensitive—eventually space policy was changed with a new [presidential] administration coming in [in 2009], and now this commercial effort was getting more political focus. All the guns at NASA turned on the commercial effort.

People who knew from the beginning that we understood this was a challenging schedule, and they weren't going to make that schedule but they were still going to be on a really good schedule, were all criticizing our program office for why we must be mismanaging it. We knew they were going to be behind schedule, and we don't have to go in and micromanage their

schedule, they have every incentive. People who knew exactly that, in the midst of all that political internal turmoil, were not so sympathetic—it was political ammunition in the debate over the commercialization policy.

HACKLER: We've heard from a lot of people in the COTS office that when the program started it was an underdog because there was the Constellation Program and other International Partners that could provide services to Station. Do you feel that the cancellation of Constellation [in February 2010] was the tipping point when there was a greater sense of urgency to provide these services commercially?

THORN: Underdog would be a nice way to put it—but really most didn't believe there was any credibility in the commercial human spaceflight effort. And when Constellation was terminated I think there was certainly more awareness of our commercial effort. It didn't change the emphasis we'd always had as a program, internally. The new space policy itself certainly gave it more emphasis at all levels.

Just reflecting back on some of the history—ultimately for the first competition, what we ended up calling Round 1, where we picked Space Exploration Technologies and Rocketplane Kistler—remember I mentioned earlier the Kistler concept, which was a fully reusable rocket where you recover all the pieces, bring them back to Earth. It had some technical challenges, but it would be really interesting to see pulled off. It had stalled in development but needed help to get finished.

I would say that when we started up, if people even heard of it they thought, "What are we doing, and what does commercial mean, and are we crazy?" Why are we sacrificing our

careers to do this? We've got this whole Moon effort that had restarted up. Even congressmen—I remember sitting in after a meeting, and some of these Congressional staffers who had been getting the lobbying from industry, who were advocating and wanting to give them a chance—we briefed them before the selection, so that they knew it was coming.

As a typical courtesy, Congress gets briefed on a new selection. Here's my take, at least from one in particular I saw. I wouldn't say they didn't care that we succeeded or not; they wanted them to succeed. But they just wanted to give them a chance, and they were tired of them bugging them about giving them a chance. Those are my words, but it was the sentiment of it. He was happy to see that things were going along. I would say even at most levels people were still very skeptical.

I told you already my motivation. I'd seen from my role that I'd had on our flagship ISS Program that there's just a better way to do business and operate. I could see that we could really reduce the cost and the time it takes to do a development space project. My patience for getting on another flagship program like Constellation had been consumed, so I was all for trying. I thought this was very important as part of NASA's charter, and I wanted to see it happen.

That was the context initially that it was in. People weren't really paying attention to us. We were part of ESMD, the Exploration Systems Mission Directorate that Constellation was under. [Scott J.] "Doc" Horowitz was running ESMD at the time. We were part of that organization, and we'd go to their quarterly reviews. We'd status, and he'd see what was going on. Some people would speculate we were there just to try to keep a finger on us. Even though we were the Commercial Crew and Cargo Program—our nickname was shortened to C3PO,

which by the way Dennis [A. Stone] came up with—some people speculated in fact that we were in ESMD to keep us in check.

Our strategy was that we're going to start with flying cargo, show that that would work at that scale, and then move on to crew. All of our company proposals were to eventually do crew. Moving on with cargo, I don't think it was seen as so much of a threat. Most of the Agency was very much occupied with the Constellation effort. That's where so much of the money was going. This looked just like a big experiment, and people half expected it to fail.

Now I didn't. I didn't believe it would fail. This probably would relate to why I was willing to come here. About 15 years ago, I got involved with the Experimental Aircraft Association, the EAA. That is a group of people and industries that are involved in creating aircraft that people build themselves. They call it the home building community. Burt Rutan is the poster child of EAA. He's been a member of the EAA from the beginning from all the companies he worked with.

I got involved with the EAA because of my interest in building an airplane, and I saw how quickly these small teams would put together really fairly sophisticated aircraft. Design them, and provide kits if not build them. Then I got in my own project, and I'm making modifications—I became so convinced because I was getting to touch more areas of engineering and actually got down into executing. It just solidified my belief that we could do this more efficiently.

Then of course with Scaled Composites flying, and that was a member of EAA, it was just further evidence for me. I really always believed this would work. I knew it would work. All these people who were so skeptical and didn't believe it, I'm sure they all thought I just drank the Kool-Aid [belief without critical examination]. But I'd had different experiences than

the people who'd been here just working at JSC and had this perspective. That's part of why I wanted to make this work, because I really, really did believe it would.

When SpaceX finally launched—like I said, the sentiment from most of management, as seen from our ESMD briefings, was just this very high level of skepticism and not really believing it. But then the more and more it made progress and showed that this was for real and how fast they were moving through Preliminary Design [Reviews] and Critical Design [Reviews], you could tell that people began to get a little bit more scared of what this meant. Because it was really forcing people to question how we were doing business.

The benchmark I was looking for, which we have now, at least a good partial benchmark that I saw as a strategy to really help the Agency come around to changing the way we do business—about the time we began, which was 2005, was about the same time period that Constellation was set off on its course. We had two partners, and we had $500 million spread over about five years. Now within five years we've had one of our partners, SpaceX, build a low-Earth orbit booster and a spacecraft that was flying cargo. And it was being designed to fly crew from the beginning. Where it mattered in terms of structural strength, launch abort, it was being designed for that.

We put in $278 million in our basic agreement, then they got some extra optional milestones [fiscal year 2011 C3PO budget augmentation]. It ended up that we did find some other ways to increase our funding because we were turning on some other work, then they did get some advance payments from the ISS Cargo Resupply Services contract for work.

It was well less than $1 billion in five years, and we had a flying low-Earth orbit spacecraft and launch vehicle. Of course we didn't have crew in the spacecraft yet. In that same time period—yes, it's the Exploration effort, and ultimately it's supposed to go to the Moon—

but this whole Block 1 version was a low-Earth orbit rocket, the Ares I. It was going to be a crewed vehicle, but it was going to just fly to the Space Station, same thing that these COTS systems were doing.

In that five years, the Constellation Program got to Preliminary Design Review and they spent about $10 billion. $10 billion in five years and they got to PDR. Nowhere close to flying. We got just one of our partners, the one that we first started with, all the way to flight. It was flying. It was still on a test flight, but it was flying.

The way Elon and SpaceX have done business might be one extreme end of the spectrum and a unique confluence of things made all that work, from his personality and the way he did business. But when you've got $10 billion and you just get to Preliminary Design Review, which is a stack of paper about how you think you're going to do it, versus a flying system—even say it was $1 billion, there's no comparison. Those two benchmarks are so far apart.

We didn't have that then, and that was what I was looking for. I knew that was going to happen. No one would ever know that even Alan wasn't so sure that this was going to work. But when it finally did, he was so happy. After the SpaceX mission success, he came up to me at the celebration party and he gave me a big hug and said, "Valin, you *always* believed. You *always* believed." He knew that I always believed from the beginning. I'm happy to say that it worked out. I'm not surprised though, because I believed from my experience that in fact it was going to work out the way it did.

You asked about what was the sentiment. That was the sentiment. Few people believed it, it was seen as an experiment. But the more and more progress it made, the more and more the old school way of doing business guys got concerned about what it was going to mean, because

they could see what was happening. They could see those benchmarks starting to take shape and how it was going to disrupt the way we did business.

Before that had happened though was when we had the new administration come in. They gave it additional focus and attention, and then recognized some of the issues with our Exploration program, and wanted to re-architect it and get some of the technologies needed. It ended up not doing exactly what they initially proposed—but frankly the way that new space policy was rolled out did not help us.

The way the media spun it was that we're canceling human exploration of space to go do this commercial stuff. That was not really their message—but even when I first saw it that's almost what I thought they said and I was disappointed. In fact the day that was announced, I don't know if Alan was out, but I had to go a to JSC senior staff meeting. It was like going to a funeral, and you're the lawyer representing the murderer that killed the family. Seriously, it was not good. The whole way that policy was rolled out could have made it easier for us.

People blamed us internally, and they were angry. Sometimes overtly, sometimes not so clear and obvious. I think you could say that probably was an element when the commercial crew side of this was fully engaged. A whole new program was created, and it didn't leverage all these people who had put their careers at risk to help get this started. They weren't being taken care of, they were being punished. You didn't see Alan—he's not heading up the Commercial Crew Program.

For me I had a different view, because frankly I fully suspected that by the time that we really stood up to go fly people—you could see it. Nervous as people were getting as SpaceX was having more and more success, things were going to get turned upside down. I wasn't really

prepared for the idea of the whole space policy changing, new administration coming in and embracing [commercial development] like they did. It was great in a lot of ways.

Eventually the dust settled and everybody was cooperating, because this was really for NASA's benefit. If we want to keep doing Space Station support ourselves with our transportation systems, we're going to be in low-Earth orbit for another 40 years. And I don't think anybody at NASA wants to be stuck in low-Earth orbit for another 40 years. I know Mark [S.] Geyer from Constellation, and I'd talk to him and people when I had a chance. For a long time I had been advocating the message that you've got to hand this stuff over to the private sector. Let NASA focus on this really hard stuff, push the boundaries of the space frontier.

I wrote the script for the little [promotional] video for our office. I was like the producer. It was my project, and I hired a company to do it. I wrote the script about what we wanted to communicate, and then we interviewed all these people and put in when they said what was in the script to tell the story. You see the message I was trying to get out, that this is synergistic, that this lets NASA focus on doing the hard stuff, getting out of Earth orbit, doing exploration, new technologies, bring the private sector in to do the more routine spaceflight.

It may look more obvious now because you see that message everywhere, but it was very difficult to get everybody to see it that way. It was really to the demise in a lot of ways of the Constellation effort, because Constellation was holding on to the Space Station mission like an insurance policy. They were worried politically that they were going to get canceled, and they wanted to have the Space Station mission as a default.

What they thought was an insurance policy I saw as death for them. They should have been saying, "No, we're not doing that, you have to have these commercial guys do it. Then you can get out of Earth orbit and do all these things we all want to do." That's where we're at now,

but it did not start that way. It was very ugly getting to that point. I can't remember the exact timing as far as the NewSpace policy, but things were getting pretty far along by the time that happened.

Like I said, all the guns turned on us. A new program was created that took over the crew side that we were hoping to get and had been working on for some time. Recognizing that all the people that came to this office really weren't taken care of, having taken this risk to try to get this going—I wasn't surprised, because it's one thing to fly cargo. It's like being a trash hauler, it's not nearly as glamorous. But when you start flying people, now you're really getting in on NASA's charter. As kids we grew up knowing NASA does that. We feel an ownership.

For me, it didn't matter that the government was running it. It was always a government-industry team. If an American spaceline is flying, an American flag, an American company, and they're flying people to space, I'm just as proud of that. I had that view, but emotionally there's a level where people don't see it that way. Most all of us grew up knowing NASA flies people. That's our country, that's our Agency. We feel a more direct ownership of it.

On an emotional level, not just within NASA but even in the public, there was that kind of response to the commercial effort. I knew things were going to get turned upside down once we stood up to crew, so I was prepared for that. For the same reasons, I just really believed in what we were doing. I felt if we take care of the objective of this effort, this commercial initiative, in time hopefully we won't be punished too much for it.

When it played out that way, and the politics with all the Shuttle people at KSC losing that work out there—in fact three months before it happened I was telling people in our office, "I can see how this is all aligning. They're going to get this new program, they're going to give it to KSC." And I could see why they would. It's a purple state, meaning red-blue [Republican-

Democrat battleground state], and also there was sympathy for all the Shuttle work being lost there without a lot of other work to replace it.

Sure enough, that did happen. When that happened, I did just like I did when they decided Alan was going to be heading up the effort. I brought all my stuff over and just tried to help them as much as I could to get going and move it along. I guess I'd already accepted that the mission, the purpose, was more noble than one's personal progress. It wasn't about self-promotion.

I get inspired by working on things that I really believe in. I really believed in the Space Station, it inspired me. And what we're doing, I really believe in this initiative. That's why I had no problem missing a beat. We were doing it over in Space Station, then Alan gets appointed to do it. It's like okay, I'm passing the torch. Then he asked me to join him. Great, I'm glad to help out. Really I did the same thing for the new guys coming in.

I just wasn't too surprised about it. I didn't think it was fair to Alan and the people in the office because of the risk we'd taken, but it was what it was. A little office of 20 people and whatever other budget we had for our technical specialists was way below the national politics of Florida, Texas, the space centers, and the Shuttle retirement that was getting under way. Of course people were blaming us for the Shuttle retirement even though it was set in motion by the Constellation/exploration program. The media was on the side of all the people who'd seen that the exploration program had been pulled out from under them.

Now I'm in this new Commercial Crew Program. In fact before it actually stood up we'd already gotten the Commercial Crew Development effort underway. I actually headed up that effort. We had about $50 million in stimulus funding [from the 2009 American Recovery and Reinvestment Act] to get it moving, and we had about five commercial partners. I took over that

for our office while the rest worked on the COTS effort, and I welcomed in this new program. We didn't have to do that, but I thought everybody'd be taken care of if we accomplished what I thought was a very noble goal of getting this industry established.

After CCDev1, Commercial Crew Development 1, which I led, and then CCDev2, which was going to be picked up by the new program, I said that after all that traveling every week and dealing with all the partners, I really wanted to focus on one particular partner. We'd done so much to help SpaceX get the momentum that they needed, and they were doing really good by then. They had a $1.6 billion services contract and were well on their way to accomplishing all their milestones. Orbital [Sciences Corporation], who'd come in after the second round when Kistler couldn't raise all the money they needed, was coming not far behind and, as of the date of this interview, is a few months off from doing their flight for COTS.

So I asked that I could focus on one particular partner, the one that I thought actually needed the most assistance. That was Sierra Nevada Corporation, which had acquired SpaceDev [Inc.], which originally had this Dream Chaser concept that's derived from the NASA HL-20 vehicle. It's a flying spacecraft that lands on runways like a Shuttle, it looks like a little mini-Shuttle. I really believed that to open up these other markets we need a flying spacecraft that could land on runways, and not a capsule.

The reason for that is it's a much more benign environment for the passengers in terms of acceleration and Gs [gravity]. Capsules can have a fairly high-G environment, so you tend to need professional astronauts, athletes that are well conditioned for that kind of a flight environment. And when you're coming back to the runway, instead of coming down in the ocean, your reusability aspects are much easier.

The other thing they had that I thought was important was non-toxic propulsion technologies, so they literally could land that spacecraft at about almost any airport if it has at least an 8,000-foot runway. Whereas the Shuttle had these toxic propellants on it, so there's only certain places it could land. If you've ever seen people recovering the Space Shuttle afterwards, they'd be in these chemical exposure suits and we'd have a big fan blowing the air past in case there's a leak. It is very, very toxic chemistries. These would kill you, if not at least cause birth defects in your offspring. Those non-toxic propellants were really key attractive aspects of that commercial concept.

Sierra Nevada wasn't as well known. Boeing was the other prime contender and they'd built every spacecraft that Americans had ever flown in. They didn't need the same kind of help. For me, having come from a flight mechanics background, I have a commercial pilot's license, and my involvement in the EAA, I was also most attracted to it on an emotional level from the flying aspect, instead of a retro 40-, 50-year-old capsule that comes down in the water.

I asked to work on that, and the new Program Manager [Edward J. Mango] said that'd be great. The new program's concept was to have people in residence with the partners. They're out in Louisville, Colorado, which is near Boulder, northwest of Denver. I went out there to help them, in residence, to advance their concept.

You asked about sentiment and how things happen. I gave you an idea about how this office generally wasn't taken care of after all the risks they put out there. In spite of the success, and in fact because of the success, there was a tendency to want to punish them. These are very candid comments I'm making, but I'm just putting it out there. This is my view for historical purposes. I don't think anybody would be surprised.

Sometimes you have to do what you know is right. You know that in time people will see it was the right thing to do. A lot of progress and change is like that. Change is difficult for everyone. We had the status quo. If our programs were costing more than they needed and taking a lot longer but we were actually finishing them, then it wouldn't matter so much. But we'd gotten to the point with this inflation where we were just getting programs canceled all the time.

It'd be one thing to say oh well, it's not as efficient, but it gets done. The last one we got done like that was Space Station. Let me tell you, that was tough and it took a long time and it was very expensive. I don't know if the Agency or the nation would tolerate that again. I really believe that. One of the things that I did, I was the internal advocate for the [COTS] program. Alan was focusing on up and out. I do many of the up and out presentations, but I do a lot of the presentations internal to NASA, to JSC, about what we're doing and how we're doing it. Of course when people were very busy with Constellation, they didn't really care so much.

One of the criticisms you'll see from government employees and engineers, one of the worst criticisms you can give to somebody is that they're selling. Because the government, we never have to sell. That's the difference between us and commercial industries. You have to market and sell your products. There would be times I would get that kind of criticism, that I was too good at the marketing and telling people about what we're doing and how we're doing it and why it's going to work. That all played into the negative sentiment I think, especially when people started blaming the commercial initiative for undermining our exploration efforts.

HACKLER: It's great to hear the progression of the very origins of how COTS got started to where you are now. Before we close out today, even though there's much more we'd like to ask you, do you have any final thoughts?

THORN: Nothing comes to mind.

WRIGHT: If can throw out one really quickly—the foundational element to anything NASA that does is safety. Can you just touch on the safety elements? Especially with your technical background, and how you were able to weave that in.

THORN: Yes. Probably you're asking because we hear that a lot, the criticism that these commercial companies and partners are not going to be as safe. "They're going to cut corners. They don't have as much money, and so they're not going to be as safe vehicles. How are they going to implement all the normal NASA safety protocols?"

I really understand where that's coming from, but I think it's exaggerated. I think that is an excuse that people make when they try to justify the inflated cost of doing NASA projects the way we normally do. Our commercial initiatives are not achieving these efficiencies and cost reductions and schedule improvement by deleting safety requirements. That is not how it's happening. It doesn't mean that some requirements won't get challenged based on their merit and value and their benefit. There's always a cost-benefit tradeoff that has to be made, so it doesn't mean that there still won't be that pushback on some things.

But that's been an often-used and exaggerated criticism of this effort. It's really just as simple as that. To answer that more clearly, as part of the Commercial Crew Program there was

a whole relook at all of our human rating requirements for the development of a space transportation system. Those have been reviewed exhaustively by all the different stakeholders of the different requirements, the specialists that own a particular area, how they believe something needs to be done to be the most effective and safe.

Our partners have had those requirements, and most of their requirements mirror them almost exactly, but there's some tailoring. In fact, NASA has just implemented a contract, an actual FAR contract called the Certification Products Contract. It provides all the legal authority that we need to work with our commercial partners to negotiate these requirements—the requirements that we think are required for sufficiently safe human spaceflight, versus how they think they need to be shaped to be practical for commercial purposes, and to pass the cost-benefit test that is required.

That CPC contract was just announced [on December 10, 2012], and it begins on January 22 [2013]. We've already been talking, but we haven't been able to give them formal feedback for where they want to do tailoring to deviate from our exact requirements. But I'm completely confident, very, very, very confident that the commercial human spaceflight systems that are ultimately developed, that will fly our astronauts and whoever else might fly in the system someday, will be as safe as if we did it under our normal FAR-based contracting practice.

In fact in some ways I think they may be safer, because there's a hazard when you have too many people working on a program and sometimes inflating documentation, because then it becomes hard to find the things that matter. It's a lot easier to write a 20-page document than write a two-page one that's covering the same thing, because you have to really get down to the things that matter the most. Whereas free-flowing information for 20 pages, and now somebody's trying to use that—it's harder to get information out of it.

In fact one of the aspects of what we did in our competitions with industry was we had fairly small proposals, and our RFPs were fairly small. Most of our partners actually said it was harder to do it that way because every word, everything mattered. Whereas when you can do a 500-page proposal, you're just putting everything in there. They'd say that, that was the reality. When you're trying to evaluate and you're trying to find the most important information, it's more difficult.

I think it's natural for us to think that if you spend more and you do more work, that somehow that's going to be better. But you get to a point of diminishing return. The reality is that any project, whether it's a space project or a personal project, you can have too few people and so it takes you longer because you don't have enough. Then, as you add people, it speeds it up and speeds it up. At to some point though, as you put more and more people on a project, it's like how many people can fit in the kitchen. You get to the point where you're slowing things down, you start adding people and you actually make it take longer. The challenge for all of us as program managers or project managers, in everything we do in our life and at work, is to try to operate as close to the optimum level as possible.

Of course it changes throughout a program, but I would argue that we typically have programs that have way too many people for what we're trying to get done. I personally have ideas for how we straighten that out. We can have too few people; we've had partners who sometimes are behind the power curve, meaning they don't have enough people for what they're trying to get done, and it takes them awhile to catch up. But it's better to come from that side than to start with too many people trying to skinny down to it.

We can go ahead and close it up for today. I haven't covered much of the actual execution of the COTS effort yet. I'd be glad to talk with you again next month if you think it'd be useful.

HACKLER: Thank you very much.

[End of interview]