

NASA HEADQUARTERS ORAL HISTORY PROJECT

EDITED ORAL HISTORY TRANSCRIPT

W. MICHAEL HAWES
INTERVIEWED BY SANDRA JOHNSON
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JOHNSON: Today is November 28th, 2018. This interview with Michael Hawes is being conducted at the NASA Johnson Space Center in Houston, Texas, for the NASA Headquarters Oral History Project. Interviewer is Sandra Johnson, assisted by Jennifer Ross-Nazzal. Thank you for coming for the third visit. We appreciate it.

Last time at the end of the interview we ended after we talked about the time after [Space Shuttle] *Columbia* [STS-107 accident]. We were talking briefly about that time and *The Vision for Space Exploration* announcement by President [George W.] Bush. You were at Headquarters [Washington, DC] at that time as the Deputy Associate Administrator [AA] for the Program Integration Office in the Office of Space Operations. Do you want to talk some more? We briefly touched on a few things, but it was right at the end of the interview.

HAWES: I think we touched on most of the aspects of that at that point. There were separate Exploration Mission Systems directorates and Space Operations Mission directorates. My assignment within a lot of other cats and dogs was to be the prime interface to the Exploration Systems Mission Directorate. That went through initially with Admiral [Craig E.] Steidle and then on through a series of AAs on both sides with Doc [Scott J.] Horowitz and Rick [Richard J.] Gilbrech and then ultimately with Doug [Douglas R.] Cooke.

JOHNSON: You mentioned, and then it carried over into when you moved to that AA of Program Analysis and Evaluation at HQ, but the last flight to the Hubble [Space Telescope], the last repair flight. You just touched on it. We mentioned that it had been canceled by [Sean] O'Keefe and then Mike [Michael D.] Griffin worked to get that back in the schedule. I was wondering if you had anything to add about that or any details of that.

HAWES: There were a couple of challenges with the Hubble repair mission. There was the overall Shuttle manifest at the time. If you look back at the manifest charts that we built at that time, there were a couple flights at the end that were shaded out. One of the last ISS [International Space Station] flights, and the flight that ultimately took the AMS [Alpha Magnetic Spectrometer] up to the Space Station as well.

There were funding issues and challenges between NASA and OMB [Office of Management and Budget] in terms of getting those last few flights manifested. I think there were some folks who were counting on a Hubble flight not happening, so that gave them some flexibility to maybe do those others.

From a technical and programmatic challenge, one of the issues with the Hubble flight is after *Columbia* we had gotten in the mode of having the next Shuttle within a couple months' processing time so that the crew could live in Space Station if there was another accident like *Columbia* that we suspected damage to the orbiter. Obviously with Hubble you didn't have that capability, so it was a different risk profile, it was a different set of discussions.

Bill [William H.] Gerstenmaier as AA for Space Operations at the time led the Agency leadership through a whole other methodical review and discussion process of what we knew about the changes to the Shuttle vehicle over time, since this was a few flights after the *Columbia*

flight and the Return to Flight process, and how the system had been operating, what we had learned about our processes. It was really a risk-based discussion that we have a different profile. We're not going to have that safe haven on ISS capability, but do we feel that the risk-reward trade is in the right direction? Ultimately that's what the leadership came to believe, that having another Hubble servicing mission that would set the telescope up for several years of continued operation was worth the value given where we were with all the modifications we'd made to the Shuttle. I think that was one aspect of the system, and it was unique because of the post-*Columbia* actions.

JOHNSON: In 2008, you moved into that other position. Mike Griffin appointed you. But it was also a time of transition because President [Barack] Obama came in right after that. The person that was in that position before you was Scott [N.] Pace and he actually left the Agency I believe.

HAWES: He did. He went to go take the director of the Space Policy Institute at George Washington University [Washington, DC].

JOHNSON: In that position you were responsible for providing objective studies and analyses in support of policy, program, and budget decisions by the NASA Administrator. If you don't mind, explain what that position was about and what you were doing in that position.

HAWES: Mike's desire was to pull a bunch of functions that had been somewhat disparate and roll them all together at a higher strategic level. It was patterned after a similar office in the Department of Defense that was also labeled Program Analysis and Evaluation. It had been a

longstanding function within the Department of Defense. In fact I think if you go back and research it it started under Secretary [Robert S.] McNamara back in the '60s in terms of having an independent body that wasn't tied to a mission area that would review Agency programs, would work Agency strategy, and then would do unique studies.

Within that Office we actually had all of the independent review of programs across the Agency. The Independent Program Analysis Office that at that time had been moved to [NASA] Langley [Research Center, Hampton, Virginia] was in that group. We had all the cost estimating function at the Headquarters level in one of the divisions there. Then we did a few special studies of topics of interest and debate. But we actually did studies across all of the entities. The cost group did lots of studies of program performance, so we actually had quite a varied set of activities that we did.

The thing that was interesting for me particularly is that I had been a human spaceflight person my entire career, and so this was my biggest exposure to all of the robotic missions and the Aero [Aeronautic] Mission Directorate functions. It was a good learning experience for me to understand a lot of those missions, and understand some of the strategic advantages of some of those missions. Literally you could work on four or five planetary or Earth science missions in your career, where you may well have worked on one or two human spaceflight missions, just because of the long timeframe of them. We also had that difference where some of the missions were actually built in house at JPL [Jet Propulsion Laboratory, Pasadena, California] and at [NASA] Goddard [Research Center, Greenbelt, Maryland], whereas on the human spaceflight side most was built out in industry. I got to see much more of that.

We did a lot of performance studies. Particularly, Mike was really interested in program performance from a cost and schedule standpoint. He had brought into the Agency this

methodology of confirming programs at a certain cost confidence level. We started as a cost confidence level and then the team over a period of time evolved that into what we referred to as a joint confidence level so that it factored both cost and schedule. Now programs in the Agency still are measured against a joint confidence level assessment.

The other interesting job that we had at the time—we also worked on the budget side, we owned the front end of the budget process at the time, and strategic planning for the Agency. The Agency was required to produce a strategic plan every three years by administration decree. Out of that we also were the ones that built the transition materials that would be used in the transition from the [George W.] Bush 43 administration to whoever was likely to win the next election. Because of that strategy role and the transition role, I also supported a lot of White House meetings having to do with transition.

I would say that that Administration team worked very well. They knew they were done. Somebody was coming in. They weren't being biased one side or the other. They were trying to make data available to teams on both sides.

JOHNSON: Was this before the election?

HAWES: This was before the election, yes. Clay Johnson was running the management side of OMB at the time, and he ran what was called the White House or Administration Program Management Council, and Clay was the one that was driving most of that activity. I thought he was very fair and evenhanded in terms of making things available to both teams that were in the election at the time. Then that naturally transitioned into being involved in transition activities once the election happened.

JOHNSON: Were there any surprises in that transition? Working in the area, as far as the policy and budget decisions, and then trying to transition to a new administration, which we all know every President wants to change things. Was there any surprises right away?

HAWES: There were a couple things that happened right away that were interesting. The new team comes in. The election is in November. You have a transition team to deal with through November, December, and January. Transition is done as of the inauguration, so technically those folks are done and go away.

Very early on they announced that they wanted a study. I'm trying to remember all the processes now. We did the transition material. We started working. The transition team for NASA was led by Lori [B.] Garver. She had a couple folks working with her. We had a NASA person from my group, Phil [Philip] McAlister, that was the official government liaison to the team. I was the executive over that function. We had some meeting room space that we had carved out with door cipher locks for privacy. Apparently we stood out amongst agencies by the fact that we actually had prepared for that and gave folks a place to actually work from.

They talked to lots and lots of people. We had an opportunity to talk to them from a transition standpoint, they interviewed probably all the directorate heads. They interviewed a lot of industry folks. I was not in those sessions. They were working through that and formulating their plans. I do recall that because of the economic conditions at the time, the handover between the Bush administration and the Obama administration, the first budget included this healthy stimulus piece. All the agencies were encouraged to find projects, and they used the phrase "shovel-ready." Something that you could actually go and step on, not just a down

payment of something that was going to be four, five years, and work. That actually came in the first budget release. January is the inauguration. Usually the first Monday in February the budget comes out. Obviously it was delayed because it always is in the first year of the administration. I can't remember whether it was March or April that it came out. But it included this stimulus piece. This is February of '09.

It also carried with it an interesting little piece in that it had for Constellation [Program] explicitly moved the Moon off the table. If you go back and look at those documents, it had actually given additional funding in the first couple years but it had taken the explicit Moon nature of the endeavor off the table. That probably should have been the first sign for everybody that there was more to come.

JOHNSON: Did you recognize it that way then?

HAWES: I did not. I did not recognize it at that time. The next step that I was involved with was the creation of Norm [Norman R.] Augustine's panel [Review of US Human Spaceflight Plans Committee]. In that role again Phil was the official government executive that every FACA [Federal Advisory Committee Act] panel has to have. But I was tied to Norm running a NASA analysis group that supported his study team.

We actually worked with him to schedule all the witnesses and to do all the additional analyses that we had to do. I had three teams of folks that were working in support of that activity. We went through that whole process through the summer. Norm, when they asked him to do this, he had a unique set of days that he could actually give to the task, and so it was all

defined as it was going to be a June through September and then pretty much done kind of activity.

Obviously it highlighted some challenges with the program of record, the Constellation Program, at the time. We had lots of meetings within NASA. One of the things that we then took on in our PA&E [Program Analysis and Evaluation] role was to formulate the discussions of all the major recommendations for Charlie [NASA Administrator Charles F. Bolden]. Charlie and Lori had come in in July during the study process. This had gotten started before they came in. When they came in we had a midpoint meeting with Norm and Charlie and Lori. Then when the report was in its final stages and had a series of recommendations, then we formulated review sessions for each of the major recommendations for Charlie and the leadership team to go through.

One of those of course was looking at a Commercial Crew Program. We tried to formulate the discussion around the topics in terms of what does it take to say yes basically to buying crew services to the Space Station. The Cargo [Resupply Services] Program had already been in its formulation stage. The vehicles were being produced. I don't think the vehicles had flown yet, but they were well on their way. Trying to follow that model of what would it take for the Agency to be comfortable with flying their employees on systems provided by other folks.

We had been working through all of those. We had been doing some focused reviews of the Constellation Program because of the issues that Augustine's team highlighted in terms of cost and schedule risk, and had continued to have those, up until literally the weekend before the budget came out, when they called the senior staff in and said, "You're all canceled. This is what the budget is going to look like. It's in these three big pieces. Salute and move out."

JOHNSON: That's how it happened? That quick?

HAWES: Yes. I want to say it was Sunday afternoon with the budget rollout on Monday, and it had all been staged on the White House side between OSTP [Office of Science and Technology Policy] and a couple NASA folks. It was never clear to me how involved Charlie was in the prep discussions or not.

JOHNSON: I know he described it. He's quoted as saying it felt like a death in the family to NASA. To him and to NASA.

HAWES: Its suddenness and the way it was rolled out came with a very negative aspect to it. Like because you've performed so badly we have to do this to you. We're going to do these other things.

The actual rollout, I still have my notes from that rollout day that I found at home. I think most all of us in the room were incredulous, not just in the movements. I think we all had anticipated, again just as you said. They would want to make their mark on some things, so we expected some things to be modified and tweaked. But I don't think too many folks saw an out-and-out cancellation as the end answer. Then that of course set off a whole cascading set of events. We had flight test programs that were ongoing. The Ares I-X flight was well on its way. The Orion Pad Abort 1 test was well on its way.

JOHNSON: The funding continued because of the way it fell in the budget cycle. For a limited time.

HAWES: The funding continued but it dropped precipitously, or I would say everybody took actions as it was dropping. We went to—I say “we” as a collective thing. The leadership team had debates about Ares I-X, had debates about PA-1, and in each case approved those as a technically good test to do to get data, whether you’re building that exact system or not, and also the right type of transition activities for the teams to be involved in. Each of those were approved by Charlie’s whole leadership team.

We also tried to formulate and figure out assignments. The budget was so dramatic from what had been, when you just cut out Orion and Space Launch System [SLS] and then go through this process of now you have this big huge technology budget, okay, that’s kind of fun, NASA has never had a big huge technology budget before. How are you going to structure it? What are you going to do? So the whole formulation of the three or four themes that came out of that technology budget, the propulsion budget that was proposed. There were a lot of actions that had to take place of if you were going to make this budget work how did you populate these programs, what Centers had which roles. There was a ton of work put into how do we make this work.

Then there was a lot of work going on outside of the Agency in terms of how do we keep the fundamentals of Constellation going even if it’s not the same program. A lot of that work culminated in what was the NASA authorization bill of 2010 that said, “You’re going to build a Multi-Purpose Crew Vehicle, you’re going to build a Space Launch System. It’s going to have these basic characteristics, it’s going to have these basic missions.”

All that was happening outside of the swirl of the Agency while we were doing the other aspects of how do you make this budget work. If in fact that's what you're going to do, what do you do to actually transition any of these other systems?

Then there came a point in time, I guess it must have been shortly before I left. The bill with MPCV [Multi-Purpose Crew Vehicle] and SLS came out in September of 2010 and was passed unanimously in the Senate and by a huge margin in the House. Whatever the administration had done, evidently they chose not to coordinate that with the Congress. So it was immediately dead on arrival on the Congress side.

Some folks would blame partisan politics. You're taking jobs out of districts. But in reality I just saw it as they had cooked up a plan that they hadn't built any stakeholder buy-in of, which in a way was similar to the [President George H.W.] Bush 41 go back to the Moon plan. The administration built this wonderful plan but did not have the buy-in on the other side of Pennsylvania Avenue.

As the themes in the authorization bill came out, then more folks were focused on okay, is Orion the MPCV, and how do we demonstrate that. We have these very general requirements; how do we demonstrate that Orion meets the MPCV requirements? We went through a process. The folks here on the NASA and Lockheed Martin side went through that process of providing data, which ultimately ended up I want to say May of 2011 with a review at NASA Headquarters that validated that the MPCV as envisioned was the Orion Program of today.

At that time there still was no real discussion of lunar missions or Mars missions. The asteroid mission hadn't been proposed yet. The bill mentioned going to the Moon and on to Mars, but it was all about basically building this fundamental transportation capability.

JOHNSON: Mike [Michael L.] Coats and some others that we've talked to credit Charlie Bolden as being a major factor in saving that Orion Program as you were talking about that it would be to continue on. I know he took a lot of flak also during that time period from all sides. Do you see that as what happened also?

HAWES: Absolutely. Charlie obviously had great relationships with Congress, particularly through Senator Bill Nelson, and so had worked very hard with the Senate on crafting what the bill language was. The Senate asked for a NASA detailee to help. Can you give us a NASA employee to help us work through this? That person ended up being Tom [Thomas E.] Cremins, who worked for me at the time in that Program Analysis and Evaluation group. Tom had actually been loaned to that same committee when the Republicans were in charge back in Sean O'Keefe's timeframe, that *Vision for Space Exploration* timeframe.

Tom had experience in doing that, and was known by several of the staff, so he was welcomed as the NASA liaison. As they would formulate their ideas he could pose the questions back to NASA. How would this work? How would this be done? I think that that had a lot to do with keeping a heavy lift vehicle and an MPCV form into the mix. It was very clear that that's what the Congress wanted to do. They wanted large aspects of the program of record. They weren't going to argue that you had to have the Constellation Program per se, because they recognized that there were some challenges in the program as it was structured. But they felt they wanted those fundamental capabilities.

Charlie, with his support on the Hill, but he also I think was able to influence some of the administration folks as well, like John [P.] Holdren, the President's science adviser, that tossing everything away didn't make sense. Having some technology spin-up was good but you needed

to build fundamental capability because continually redoing it was not going to help us ever get further than we were in LEO [low-Earth orbit]. The team had also embraced finishing the Shuttle Program once ISS was constructed, so that theme had started under the Bush administration, and the Obama administration felt that was a reasonable tack. So they continued on that tack.

You're going to have this gap of no human spaceflight except on other vehicles. That was starting to get postured. Then that led to both the commercial crew and keeping the Orion and SLS formulated.

JOHNSON: At the same time the Shuttle was flying out the last flights.

HAWES: At the same time the Shuttle was flying out. The last flight was July of 2011, so not only did we successfully fly that out but we also were in the process of transitioning all of the assets. I had started that in my space operations job before I left to go to program analysis and evaluation.

We knew the Shuttle Program would be coming to an end, so we started the process of how do you transition people and assets. We started the whole process of where are the orbiters going to live. But by the time it was actually done I wasn't part of that process at all anymore. I don't take any accountability for where they ended up.

JOHNSON: In 2008 you authored an article with Mike [Michael R.] Duffey for the project.

HAWES: Oh yes. That was based on my doctoral dissertation.

JOHNSON: I just thought that was interesting. For financial valuation methodologies for NASA's human spaceflight projects. Part of it I was reading, it said that—

HAWES: You were really desperate if you were reading that puppy.

JOHNSON: I didn't read all of it, but I read parts of it. "Over the next few years representing amazing opportunities to effectively share resources across the Agency in a manner never considered before in the future of human spaceflight, and a real option analysis framework." But it was a real option analysis, that's what the paper was on, right? I just thought that was interesting.

HAWES: Real options were a way to evaluate business cases if you will in more volatile systems. A standard evaluation might count on an internal rate of return or a net present value calculation of what the value of a project would be over its lifetime.

What the real option methodology does is it underlies that with some financial formulations that recognizes that you have more volatility in the system. In a simple way it says that if the highs are really high the value of the process can have a net present value greater than zero because the lows aren't as low. They're not balanced because of that volatility.

That was a technique that was interesting that my adviser and I, Mike Duffey, agreed would be interesting to see how would we apply it. At the time Bill [William H.] Gerstenmaier was the AA and we talked about a handful of cases of Space Station upgrades and Shuttle upgrades that might be interesting just to see how those trades were.

The trades that we picked all came out very positive, not that we knew that per se. But part of it is you had some volatility, but you also had really big costs. A Shuttle flight, depending on how you framed its cost, was a big number. Things like the power extension that we did, where you could pull power off of Space Station and stay on orbit longer, when you get to the point where you take a couple extra days at a time, and so you've actually made the equivalent of a Shuttle flight over a few flights, that's about \$500 million back in those numbers.

The study came out pretty positive. I don't know that anybody has ever done anything with it. But it shows that there's some reason for business cases in this area to not just rely on more traditional net present value kinds of analyses.

JOHNSON: Around the time or right at the same time that we had the last Shuttle flight, that's when you decided to leave NASA and move to Lockheed Martin.

HAWES: I pretty well knew that I was ready for a change. I knew that Charlie and Lori really wanted to restructure that office that I was running. They kept pulling pieces away largely into the CFO's [Chief Financial Officer] office. You could argue that many of them had lived in that office in the past, and what Mike had done was put them all together in a different formulation. So, I knew it was pretty much the right timing for me. I stayed in the traditional civil service retirement system, so 55 years of age and 30 plus years were the magic numbers, and in June of 2011 I was 55 years old with 33 years of service. I chose to retire at the beginning of July.

A couple months prior to that when the word started to get out that I was thinking of that, Lockheed Martin asked if I were interested. I was talking to three or four different groups. But I

actually formally applied for a job with Lockheed Martin and that was what I transitioned to after my long weekend of retirement.

JOHNSON: You didn't take a long time off evidently.

HAWES: There were timing constraints on both sides in terms of when I could be done at NASA and the advantages of being into the system with Lockheed Martin by a certain time. It just made it work out that I did have one extra day. It was the Fourth of July.

JOHNSON: So you got a holiday.

HAWES: I got a holiday and showed up for work on Tuesday.

JOHNSON: What were you working on first when you went to Lockheed Martin?

HAWES: The job that I was in, the wording is kind of careful. I call it a government affairs job but they don't really call it that because that implies more of a congressional lobbying role. I was meant to be the liaison to—they called it Director of Human Spaceflight Programs. It was meant to be the liaison to the agencies, not the congressional side per se. I could go and support briefings and do education kinds of things, but I was not a lobbyist per se at all. We have a handful of folks that do that. They're all registered. They do their normal thing. I just go and give briefings with them occasionally, but I maintain the relationship with NASA and with the administration folks. I can talk to anybody on the administration side.

Now I did have my one-year exclusion from NASA. We used other folks to do those detailed sessions while I had that exclusion, and that way behind the scenes I could advise my bosses and folks. Here are the points I would make. Here's the questions I would be asking. Here's the type of thing that I would be trying to drive to. But I could work a lot of other kinds of activities that didn't deal explicitly with the folks at NASA.

In that period we started our Orion and SLS suppliers conference. I could deal with all the outside entities that I was dealing with at the time. I just didn't make all the connections with the NASA folks. We're now I think planning for our seventh conference of that in February.

There were lots of things that I could do. I could also do a lot of inside things in terms of advising the teams. I could work on proposals. I could do all those kinds of things until I finally had my one-year time, and then I could go and fully represent us back to the NASA team.

JOHNSON: Working on proposals from the other side, was that interesting?

HAWES: Oh, it was definitely interesting. It's interesting because you're coming from the standpoint of what would I think if I read this. That was what I was working a lot on was just telling the story. We had plenty of folks who were great at going through all the details and working the costing. I said, "But there's no story to it. You're not really describing what this is trying to do." I think maybe I helped with some of that. But it was very interesting to see.

I also was able to do briefings on the Hill, and I knew a lot of Hill staff from my NASA days because I had done a lot of that kind of educational briefing both back in my Space Station days for many years. I could still talk to all of those folks that I had known, and would say, "Here's what Orion is. You authorized it. Here's what kind of progress it's making. Here's

what it looks like. Here's how it works." Building the ships, to be able to do that, I had to get out to Denver [Colorado], I had to get down to Florida. I had to see the beginnings of those pieces coming together.

JOHNSON: I would think that would be really interesting.

HAWES: Yes, so it was an easy transition for me. But all along, without telling me so, the Lockheed folks had pretty much planned to try to twist my arm to get back here [to Houston].

JOHNSON: They did in 2014.

HAWES: Yes, 2014. Clearly they had been working me over for a while. The manager down here at the time, Cleon Lacefield, had been wanting to retire, and they were looking to try to find somebody replace Cleon. They were looking for somebody that had a fair amount of NASA experience.

Earlier in that year they approached me as to "Okay, we need a decision. Are you really no? Or are you really interested in doing this?" My wife and I talked about it and decided that we could find a way to make it work. It was a great job. Then they announced it in June of '14. I started basically at the job at that time. Cleon hung around through the end of July-ish as a transition and then it was all on my own, with this big flight test coming up in just a few months.

JOHNSON: That was a busy year for Orion.

HAWES: It ended up being a very busy year.

JOHNSON: Talk about that buildup to that EFT-1 [Exploration Flight Test-1] and what was going on from the Lockheed side.

HAWES: EFT-1 was a really interesting mission in a lot of ways. It was initially conceived as a mission to do a few risk mitigation activities. Understanding the heat shield was one of them. Turned out to actually demonstrate a lot more.

By the time we flew we talked about it actually mitigating 13 of the top 17 risks on the program, which was really just if you looked at a Pareto chart of the highest risks of the program, we were able to check off significant mitigations on 13 of them. That included not just the heat shield, but it was the parachute system, all of the separation mechanisms, the guidance, navigation, control, reentry software. All of those kinds of things were demonstrated. But the way that NASA had contracted it—and I had been involved in this process prior to being assigned to Orion—for a number of reasons NASA decided to do this mission, not as a NASA-run and controlled mission, but as a data buy if you will.

I think Lockheed Martin proposed it to NASA that way as we think we can be cheaper and simpler if we do it this process. We, Lockheed Martin, purchased the Delta IV Heavy, we did all the integration work, and we delivered data at the end of the day. A couple months after the mission, the real product to NASA was all the data.

We did that in a multiday technical review of what our team saw and actually physically a big hard drive with all the data from all the sensors on the mission. For what would be considered a typical government project, a typical cost-plus contract kind of development, it was

a different way to actually operate, and it put Lockheed Martin in a different role than we typically are. We ran the mission management team; we ran the interface with the United Launch Alliance. NASA participated with us in every step, but we were the ones that were actually driving those processes.

We also probably had more process on the Lockheed Martin side because of that, where we went all the way up through the company. For significant events we'd go to what we call a president's review, which is basically the space company executive VP [Vice President] Rick [Richard F.] Ambrose. We went through that whole process and briefed through that. So there was a lot of internal Lockheed Martin process that frankly that was really my first experience with. That was a pretty quick learning curve.

Here's Orion, here's all the teammates, here's how we're actually building it in July, to November going through the final president's review with Rick and everybody to convince them that we understood the mission, we understood the vehicle, and we had high confidence of success in doing the flight as we had it. All along with all the final integration steps and all the mission prep, we did mission management team simulations, we did a number of activities along the way in that lead role. It was four years ago next week.

JOHNSON: Talk about that day and seeing the U.S. have that successful flight again and being such a big part of it. I was reading another article, and you were quoted as saying, "We started with the Apollo guys still there, so we've kind of now finally done something for the first time for our generation as far as beyond low-Earth orbit."

HAWES: Yes, that's right. For me personally that was very much a reflection on what I had done and several of the folks on the team had done because I did have the advantage of working with the Apollo crowd, who was largely still here when I started in '78. But my generation hadn't been past LEO, and that struck me that day. Actually it was as Mark [S.] Geyer and I were driving to the press site that it hit me. I said, "This is the first time we've actually been able to do this." I think certainly when I started with the Agency that was in the post-Apollo we're going to be back to the Moon, we're going to be on to Mars, we're going to be much further along.

I think the mission was a great success.

JOHNSON: You mentioned you satisfied 13 out of those 17 risks, or demonstrated that. A lot of lessons learned from that flight.

HAWES: Huge lessons learned. We've changed fairly significantly how we process the vehicle down in Florida, all very positively. Just like you would in early builds of anything, we had some stumbles along the way. At that time we had built one flight-like structure vehicle that we called our ground test article. Then we built EFT-1, and from EFT-1 we made dramatic changes to EM-1 [Exploration Mission-1], the structural test article, and now EM-2. The structures for EM-1 and EM-2 were delivered right on time. In fact EM-2 was about a month early. We transitioned from 33 welds to 18 welds to 7 welds, which also translated to the number of pieces that it took to construct the primary structure. All of those were both great cost savings and mass savings.

We were able for EM-2 to actually buy those large structures for about 50 percent of what EM-1 was. We had a huge amount of learning in how we manufactured all the pieces. We also learned that the fundamental systems that we flew all worked. The flight computers worked. We saw single bit upsets. We saw recovery from single bit upsets. The GNC [Guidance and Navigation Control] software flew the whole reentry profile. All the separation devices worked, which included the service module fairings, the launch tower. We had the live jettison motor on it to blow the tower. The crew-module-to-service-module separation bolts. All of those worked flawlessly. The parachute systems worked flawlessly. The targeting, we were within sight of the ship. All of those were just hugely successful.

Those were things that we didn't have to go spend a lot of time redoing, redesigning, rebuilding for EM-1.

JOHNSON: Why do you think it was so successful? A lot of people put long hours of work into it, but not everything NASA has done definitely has been successful the first time. Just what are your thoughts on what made this one so successful? We did some interviews with people working in the Orion Program a couple years ago. It was specifically about EFT-1, and everyone said it was incredibly successful.

HAWES: I think there was a lot of folks that spent a lot of time and really focused on what we needed to do that flight. We didn't try to do everything. We didn't try to integrate a full service module. It was basically just a structure that we built. We were just in the formulation of working with this European deal. There were things that definitely were—I would say we scaled

the test to the right types of things that we could demonstrate, but I still personally expected to have more issues and anomalies to deal with after the test.

I think that's just a testament to the folks that put the time in integrating all the systems. The fact that we had built the early version of our integrated test lab to run the hardware and the software together. The team processing in Florida, it was the second vehicle they'd been through, so there was still learning involved and there were still stumbles along the way, but we didn't kill the schedule with them, and we didn't take shortcuts to not fix problems that we found along the way.

JOHNSON: You mentioned Mark Geyer. In the last interview you talked how you always seemed to—

HAWES: Yes. I said Mark and I have bounced off each other many times.

JOHNSON: Yes. Basically you were in the same positions, only him for NASA and you for Lockheed Martin.

HAWES: It was good. It was a very positive experience I think. But Mark had the foresight as the Program Manager to push for the mission. When they were coming out of the cancellation mode, there wasn't another test mission after Pad Abort 1. He worked with the Lockheed Martin team and the NASA team to help formulate that test and to scale it appropriately so that it could do a lot of very important things but it wasn't trying to do too much.

JOHNSON: I think it was important for morale as much as anything.

HAWES: If you looked at just the press clippings, the worldwide impact, it really was significant. Which surprised me. I was not totally convinced that the general public would get the fact that this was outside of LEO. Relatively speaking, we only flew 3,600 miles. The Moon is still 240,000 miles away, so 237 thousand further miles away. But all the public response, they got the exploration piece. They got that the Earth looked different in the camera view out the window than they had seen from Space Station for all these years. I thought that was really exciting.

JOHNSON: There's a whole generation that haven't seen those photos.

HAWES: That's right. I think even though I was making a statement for my generation, it also spoke to a lot of generations younger that this was something really significant that they were part of and did. Now we just need to fly again.

JOHNSON: That's right. There is an international aspect to it of course with ESA [European Space Agency building the service module.

HAWES: Yes, there is.

JOHNSON: Do you just want to talk about that relationship with ESA and how that works?

HAWES: The relationship is good but it's hard. I had spent a lot of my career working on International Space Station and its precursors, so I had a lot of experience in working with the international partners. If you remember and go back and look at the Augustine report, one of the things that the Augustine team felt strongly about was that NASA should not only continue its international collaborations, but should strongly consider utilizing international partners in the critical path of programs.

Orion, there you have it writ large, the NASA team. This was happening just as I was retiring. They were starting the studies to carve some portion of Orion, and they were working with the Europeans. I knew this was going on tangentially as I was getting ready to retire, but I hadn't been involved in any of it.

The study teams went through, looked at everything. "What is it that Europe could do? We want something that's somewhat based on their ATV [Automated Transfer Vehicle] experience from Space Station. Oh, by the way, this development, since they don't want to build ATVs anymore, is going to serve as the offset for their common systems operating cost for the Space Station extension years."

Space Station had always been like that. I helped set up the process. I get it, that we don't exchange money. We try to always barter goods and services to pay debts to each other. But that makes it very challenging in that it's not real money. ESA has a bill to pay to the U.S., so they develop something of value to the U.S. The common systems operating costs, the bill and the checkbook are owned by [ISS Program Manager] Kirk [A. Shireman] on the ISS side.

On the NASA side [Orion Program Manager] Mark [A.] Kirasich has to have the conversation with Kirk. It's a good positive relationship, but there's still multiple bodies that have to be involved to get anything done in this relationship.

From my experience on Space Station, I got to the point where Tommy [W.] Holloway and I decided that we actually wanted to pay for some things. We didn't have a contract mechanism to do it, we couldn't make it work, so we still had to create these barter arrangements to do that. So I insisted that on the industry side, Lockheed Martin and Airbus actually build a contract structure so that if there's a need to pay we can do it outside of this barter arrangement kind of deal.

We've actually used that several times, although oddly enough, I expected us to be funding some things on Airbus; they've actually paid us to do work for them three or four times now. A challenge on the government side because you have this barter deal offset that everything is being tracked against, so it's a lot of process on Mark and Kirk's side, and with their ESA counterparts. At the industry level, we work closely with Airbus. We do have a way to contract between us that we've continued to keep up.

But you still have the loop. There's only a handful of things that can go straight industry-to-industry discussion. You still have a loop that goes and involves all the Agency interactions, which just makes it somewhat clumsy. But as my NASA friends remind me, I helped invent all of that process, so I don't have a right to toss too many rocks at it.

JOHNSON: Nobody to blame but yourself.

HAWES: There's a few of those things. They remind me that I helped invent joint confidence levels too. I think it's a positive. I have always felt, myself, that a new deep space exploration program had to be international. Maybe I should say should be international. It's not that we couldn't do it if we wanted to as a country. But given the experience of ISS where we had built

such a strong cooperation with so many countries and have done it so effectively—we've demonstrated multiple launch vehicles supporting the ISS; we've demonstrated multiple control centers supporting ISS—that to me is an existence proof that you can do continued projects like that at a large scale.

Orion is the first example of it. Through a number of challenges the ESA module has been delayed, but we have it now. We're actually physically mated, and we're moving into the clean room in the O&C [NASA Kennedy Space Center Operations and Checkout Building] today to start into cutting and welding propulsion lines and gas lines. We're moving forward with it.

From a big picture, I think the cooperation is really important. How the rest will play out in terms of building a [Deep Space] Gateway and what partners we will have involved, we'll see. It's time. It's a lot of new process. I went through Space Station Freedom with the original partners and then adding Russia, and now doing this in the critical path partner with Europe and Airbus. There are challenges to all of them, but I think that's the way we're going to explore.

JOHNSON: The value extends beyond just getting there. It proves international partners can work together no matter what's happening politically.

HAWES: Absolutely. We've seen that with the Russians so much. The agencies continue to operate. But all of the agencies, I took ISS as an example, there are times when every one of the agencies has swung through a down cycle, whether it's in funding, whether it's other issues that are driving it. But the partnership has held together with only minor trades and tweaks. The

Canadians started at 3 percent. They made trades because of budget that they're down to 2.7 percent. The U.S. picked up other responsibilities.

Those things have been worked out over the years and it continues to demonstrate that it can work. It's also not really a purely domestic versus international aspect of it. I do actually buy a couple European parts for our portion of the Service Module. Europeans buy a lot of U.S. parts for their portion of the Service Module. That's just the way the industry is arranged today.

JOHNSON: It's expertise you're looking at.

HAWES: Yes. I think it's a positive thing. But we're glad that we have the module to work on now.

JOHNSON: That's good. The next flight that's scheduled is the Ascent Abort Test 2 [AA-2].

HAWES: Ascent Abort Test 2 is scheduled. I don't think they've really announced it. We picked a date when we did the study of April 27th. Turns out that's a Saturday, so that's not really a launch day. I think probably that next week in early May is going to be the target date when they announce it. We're building the launch abort system for that down in Florida today, and that includes the structural piece that mounts to the capsule. JSC has built a special capsule for the test, so we have the structure and then all three motors that are involved in the launch abort system, and the covering fairings and ogives are all in work. We will be basically handing over what the government calls the DD250 [Material Inspection and Receiving Report] step of the launch abort system for that test, which is in the third week of January is the plan. That's all

coming together. We've got one more motor finishing up in Elkton, Maryland, this month, and then everything will be coming together in Florida.

JOHNSON: Good to see something go again.

HAWES: It will be good to see something go. It's an interesting test. It's a short test. Aborts are not very long, but they're critical to show the capability. We've done it from the ground level on Pad Abort 1. Now we do it at max dynamic pressure, so we see all the interactions. It'll be a good test. That'll help keep our momentum going so that now we head to the EM-1 mission in mid 2020.

JOHNSON: Then through all of this now we've had another presidential administration transition.

HAWES: Indeed.

JOHNSON: I had read that actually there was talk when President [Donald] Trump first took over that he possibly wanted to put a crew on EM-1 or had thought about the possibility.

HAWES: Shortly after the new administration came in they posited the question to NASA of could you do it, what would it take. Robert [M.] Lightfoot, actually he came to our supplier's conference as the [NASA] Acting Administrator, and he joked with me beforehand. He said, "I'm going to tell you guys to study early crew." We had actually been pushing that we should look at it after EFT-1.

One of my themes was that we had flown so successfully that we could look at accelerating some capabilities. We worked a deal within the company. We took some funding at risk, and we started to build, for instance, the actual crew hatches for EM-1 instead of EM-2. That one I was forced into, because if I was going to change the hatch, there were some things to change on the structure. I had to make those decisions almost in 2014. They were the quickest things that we had to decide.

We decided we would accelerate the crew hatches. We would try to put more money into the life support systems and the crew displays and controls. All of those things have borne fruit in terms of getting an earlier leg up on their development, even though the crew hatch will fly for EM-1 most likely. It's in vib test today. The other systems we didn't complete enough to actually fly but we got a leg up on their design and manufacturing for EM-2.

Robert tasked us to look at flying crew on EM-1, and we identified what we felt would have to be done. We identified extra resources that it would take to do that. Slipped what was then a—I want to say December 2019 launch date. We'd take a few more months. We'd have to get more dollars to really accelerate displays and controls and the life support system. We wouldn't need to deploy a full life support system with all of its redundancy. We could do some different things across the system.

It was a really positive study. There were some technical issues that folks raised that were characterized as challenges with the study. I think we probably could have worked through those. But I think at the end of the day, the additional cost rolled up from across all the elements, the administration decided not to pursue it. But I think it was a good exercise to go through. Actually out of that study was when we decided that we could actually move AA-2 earlier in the sequence, because AA-2 at that point was actually after EM-1. It was meant to always fly before

the crewed flight, but at the time it had been pushed beyond EM-1. So, we actually decided, out of that study, that we could advance that, and that formulated the whole crew capsule. It was a good exercise from that. That actually helps us in the flow of things moving forward as well.

JOHNSON: During the transition, or it might have been right before, NASA released an RFI [Request for Information] for continuing Orion past EM-2. Was that something that came as a surprise that they were doing that?

HAWES: No. The initial contract for Orion was a design, development, test, evaluation contract. It went through EM-2. NASA had always said that their intention was to then do a longer term production operations contract, but they didn't have a full acquisition strategy set for what that was going to be. Fairly early on in my tenure, and Mark Geyer was still in my counterpart role, we already started seeing things where we were having to make decisions about EM-3.

We were just barely building EM-2, but there were decisions that were being raised of EM-3, and we started talking about it. I said, "Well, that's great but I don't have a contractual mechanism to do anything on EM-3 yet. We may think about what it's going to take to get us there."

I think out of all that the NASA side decided to probably move up their thought about a production contract. They warned us that they were going to do that kind of an RFI, that they had been having the procurement discussions in terms of a strategy. We expected it to come. We responded to it, and it goes into the NASA system and churns. Several months after that they announced their intent to award a production and operations contract. Then we went for several more months of the NASA side working on a request for proposal and then a few months

for us to respond to it. Now we're in the midst of negotiating back and forth. They've given us their counteroffer, and we're in that back-and-forth mode today. That contract was stated. Their initial notice of intent they call it to award the contract was for 12 missions up through the year 2029, meaning they could order up to 2029, meaning that would actually fly in '32, '33 timeframe.

JOHNSON: Now they're talking about the Deep Space Gateway.

HAWES: Right. We've gone from in the early Constellation days the mission was very much a lunar mission. We certainly went through the whole Mars mission. We spent a lot of work on our own internally assessing the vehicle and requirements. We don't have Mars design requirements, but we actually have Mars capabilities in terms of the design that we have. We've looked at the reliability of the spacecraft. We've looked at Mars reentry profiles. Can the heat shield handle it? There's a lot of cases that it can handle today with no modification at all. We're pretty comfortable that we're building a Moon and Mars spacecraft today.

Out of the Obama administration we had the whole Asteroid [Redirect Mission, ARM]. Whether the R is redirect or retrieve. From an Orion standpoint I could always say it's a great demonstration mission for Orion. I'm not going to argue the case of whether the small body committee thinks it's a smart thing to do. But from a demonstrate Orion capabilities, go hang out in the Moon for a couple weeks is a great demonstration, and that's basically what EM-1 is. We'll go out into that distant retrograde orbit for three weeks and demonstrate all of Orion's capabilities and it'll be good test flight for Orion.

Now with this administration we're back formally to we're going to do the Moon first. I always felt we were going to do the Moon first. Debate how much of the Moon you're going to do. To do the Moon, NASA has proposed a Deep Space Gateway. On our own we had proposed things like that as well. Our study said the same kind of thing. If you want to enable really a sustained lunar exploration program, having a place in orbit as a base from then which you go and travel down makes a lot of sense. It gives you more access to the Moon, because going direct from the Earth you're going to be limited to the sites that you have. You're going to be essentially an Apollo redo. You'll do a few more aggressive things, but you're not giving yourself that full flexibility.

I feel, and as a company Lockheed Martin feels, the Gateway is a good idea. It's interesting. On our own, a couple years we've formulated a Mars mission that we called Mars Base Camp. It's similar in that you have an orbiting platform that you can either control rovers, hoppers, drones, whatever on Mars from there, but you can also do sorties with the crew down to the surface. You can go to Phobos and Deimos [moons of Mars].

In our mind that really was galvanizing the idea of orbiting platforms as part of an infrastructure for exploration, so the Gateway fits very well with that model of doing that. We can debate how much of the Gateway you have to build at a time and how soon before you try to do landings, but I think the Gateway makes a lot of sense as a way to do that, and it's certainly fitting within Orion's mission.

JOHNSON: Hopefully instead of things coming to a full stop, things can continue from one administration to the next.

HAWES: Absolutely. I think getting flying is an important piece of that. I look at the drama. There were cost problems between the Bush 41 administration to the [William J.] Clinton administration. That got the whole Space Station redesigned and the Russians added, and high high drama and issue. Clinton into Bush 43, there were actually much larger cost problems, but Space Station was flying. We got constrained and didn't build out some of the elements, found other ways to do things, but survived, and the Space Station is a huge success now.

I think there's just a huge huge value in flying and being in the midst of missions in terms of a political sustainability.

JOHNSON: The Space Station has also demonstrated the commercial side because of the way it's set up and then I guess the Gateway could do the same thing.

HAWES: Gateway can easily do the same way. It's a harder mission, no question, but the idea of being able to send supplies on an independent route, other elements, maybe smaller elements, makes perfect sense. NASA said, "Well, the power and propulsion element will fly on a commercial launch vehicle, expendable launch vehicle. Then Orion will take other portions of the Gateway out.

I think there's certainly value in extending that model, but we also need to be realistic about it, and recognize that as challenging as buying a service in LEO has been, getting to the Moon and figuring out what that marketplace is is more challenging. But I think it's totally open to what we're going to do. Whether that's also what enables small landers and other folks doing that, I think there's a high likelihood that it will. That's also part of the rationale for why a Gateway makes sense.

JOHNSON: It seems to be an exciting time right now. Maybe it's not as dramatic as Apollo was, but there's so many options. Then with the landing on Mars this week and that getting the public excited. I was seeing scenes from Times Square [New York City], people standing there watching it. I think getting that public excitement going makes a lot of difference too as far as keeping it going.

HAWES: We actually convinced our communications team to let us call ourselves Lockheed Martians for a day.

JOHNSON: That's great.

HAWES: We've been part of every NASA Mars mission since Viking, and so Lockheed has been the industry partner, whether it's been orbiters, landers, or the entry systems for rovers. It was a good week. I think you're right. I have a talk next week to give, and that's the theme that I'm taking, that there's a perception that this is a down quiet time. But, if you really look at it, you have private capital going into building new launch systems, you have three human capsules being developed and built, and those are just the ones that NASA is funding. You have another one on Blue Origin that is today a suborbital system, but they have design and ideas to move further out into that. You have a whole series they're going to announce tomorrow the small lander contracts that they're going to award.

So, it really is a very busy time, but it's different from past times because it has a whole spectrum of private capital, different contracting methods, different oversight methods, different

roles across it, and frankly some not written yet. How are all these things going to play? How is the suborbital market going to change things if you get a Blue and a Virgin really on a regular flight rate? What does it mean for a vehicle to be flying every couple weeks like that? I think there's still some big changes.

JOHNSON: Like you said, the spectrum is so wide, whereas in Apollo everything was laser-focused. The purpose could be—well, it was explained by the President in one sentence. Go to the Moon and come back safely. I think it's exciting.

HAWES: I've been reading one of the Apollo histories just to remind myself of all those pieces. It's right up there actually [pointing at bookshelf].

JOHNSON: Which one?

HAWES: *Apollo*, by Charles Murray and Catherine Bly Cox. It's good.

JOHNSON: It's the definitive. We use it a lot.

HAWES: I enjoy it because it mentions so many people, and so many people that I know from when I started. Even folks that retired shortly thereafter I still had some interaction with, a lot of the folks. That's kind of fun.

JOHNSON: One of the things I had from an article in 2000, it described one of your jobs and assets at the time, in 2000, was you were good at boosting morale. You're quoted in it as saying, "When I get pulled in all these different directions by so many tasks and so many people, I can maintain an even keel and not overreact to situations," and that you were praised by your coworkers as a "rousing locker room motivator, a man who can revive flagging troops."

You credited a wrestling coach that you had had, Dave Clelland, as a role model. In our first interview you also talked about those engineers that you were just talking about, the people that got us to the Moon, and how they were your mentors, and you were working with them. While we have a few minutes, talk about the importance of NASA and these other companies too, like Lockheed Martin. How do they inspire the next generation? I know we have STEM [curriculum based on Science, Technology, Engineering, and Math], but do you see it when you go out and give talks or just talk to people?

HAWES: It's an interesting thing. NASA is such a recognized brand. Everybody understands NASA and what they do. It's easy to talk. It's easy to sell. You still have some challenge. It's one of those things that folks either get it or they don't want to get it.

If they're excited about a potential for space exploration, they're all in, and they really love it, and they really follow everything you do. If it doesn't excite them, doesn't raise anything with them. They could just be agnostic. It's not on their care meter if you will. But it's an easy brand to sell.

On the company standpoint it's different in that, for instance, in the human spaceflight side NASA is very open about who their industry partners are. Mark and I do stuff together

constantly. It's always NASA, Lockheed Martin. It's NASA, ESA, Lockheed Martin, Airbus. We have all of those dynamics going on.

On the planetary mission side, we'll talk about Lockheed Martin every once in a while, but you're in the background here. It was interesting this week to see the company choose to be so much out in the forefront. NASA was still the lead, but all of our branding with Lockheed Martin was really unique for us because we have found that if you go to college campuses, unless there's some tie, most folks think of Lockheed Martin as oh, you build fighter jets. You say, "Well, now we're also building the next human spacecraft and we build most of NASA's, almost all of their, planetary probes."

Folks don't necessarily expect that when they come into the door of the company, but once they're in, we talk to them from that standpoint, that they're going to work on some of the hardest problems that the human race chooses to work on, and some of the most far-out missions. Like an InSight [Mars] Lander that lands and then lets a little mole device drill several feet down into the surface. Juno [space probe], which flies out to Jupiter under solar arrays that are the length of this hallway. There's some pretty innovative and crazy things that people get to work on.

In terms of the young workforce, once they're in and understand it—I'm not allowed to say young by the way—the early career workforce—they're really excited by what they're doing, they really see the potential for all these activities, and they really are excited. Then taking those and getting them to be more of the face to their own generation and to the generations that follow is part of what we're really trying to do.

We'll keep advising and mentoring and trying to put them in places where they can stretch and succeed, and then get out of the way. I keep telling them I am going to retire a second time and they need to be ready.

Actually we have a lot of interest. Once folks recognize the breadth of things that Lockheed Martin does, we see that. Like I say, NASA is an easy sell, it's such a recognized brand. People really get how exciting the various NASA missions are.

JOHNSON: Yes. I think it's different because when you and I were younger it was working for NASA, but now with all the commercial ventures and the different companies, the opportunities aren't necessarily of course with the federal government anymore because of funding and everything else. They're in the commercial sector.

HAWES: Now that I'm on the other side I also see more of the differences as well. In the human spaceflight side, if you want to build stuff, go to one of the companies. That's part of the most fun part of my job today. I'm much closer to nuts and bolts than I ever was on the NASA side. I knew our designs, I knew the processes, I worked with the companies, but really understanding nuts and bolts of how things are manufactured and why they're manufactured that way and what the challenges are is on my side.

In the planetary world, JPL still builds rovers. Goddard has done some missions, and they do an in-house build as well. But in the human side you don't get much of that. You do some technology stuff, like the [Project] Morpheus stuff and the crew capsule for the abort test. There's a handful of things like that.

Depending on what it is that you want to do, now that I know that, I can make that part of the story as well. If you want to drive the architectures and the strategies, you still have to be at NASA. That's the team that's going to do that. If you want to learn nuts and bolts, you got to be in industry.

There are dozens of entrepreneurial folks if you want the small company feel, because NASA—I'm trying to think Lockheed Space. Lockheed Space is probably about the size of NASA peoplewise. A little smaller than NASA peoplewise, and different portfolios. But if you look at it, Lockheed Space is about an eight-to-nine-billion-dollar-a-year business. NASA is an \$18 billion a year business. They're still big entities. They're big companies.

That was desired when you and I were coming out of school. That spoke to stability and pensions and all these great kinds of things. The current generations, they're never going to get a pension because that's just not done anymore, and they have a different view and attitude, stability, it's not that it's not valued, but it's just a different trade.

JOHNSON: It's a different world.

HAWES: I probably know a handful of folks in their twenties that have their own companies. My son-in-law has his own company and he creates new businesses regularly. We've seen some folks in our generation build that, but an awful lot of us have been in one of these big entities.

You're right. The spectrum of opportunity for somebody wanting to get into just say the space business is much much broader than it was perceived when I came up. I think there's a lot of excitement there. You can find things that you're looking for.

JOHNSON: A couple things I wanted to ask you about. It's a broad question, but you've had an opportunity to work with a lot of different NASA Administrators. They're anywhere from engineers to people that came out of the business world and everything in between, and now people that their whole life was in politics, astronauts, different people.

Maybe if you want to just talk about the differences, the way you perceived their management styles depending on what area they come from, and just a little bit about the different Administrators that you've had direct work with.

HAWES: I actually used to lecture NASA classes based on Harry [W. Henry] Lambright's monograph of different NASA Administrators. What I tried to say, it's not just who they were as people, but what were the environments around them at the time, and how did that work.

Probably the first Administrator that I actually interacted with—I interacted with Jim [James C.] Fletcher a little bit when he came back after *Challenger* [Space Shuttle accident, STS- 51L] because that's when I moved up to Reston [Virginia] and Headquarters.

But probably Dick [Richard H.] Truly was the first one that I really knew. I had also worked with Dick as an astronaut, so I knew him from his flight time and others, when he was Office of Space Flight at Headquarters. Dick I felt I knew pretty well. He was the astronaut leader, manager, but he was focused on the first return to flight in Code M [Office of Spaceflight]. The things that he did were really largely driven by that environment, coming through the first Return to Flight, and trying to start to restructure NASA in ways to move forward from that, at least the human spaceflight enterprise. He was starting into that. Let's have operations separate from development, and Space Station ought to be on this side.

Then Dan [Daniel S.] Goldin came in also in that context. I think that transition was right when the Berlin Wall fell. That whole opening of the East, if you will, and the Russian entree really were more marked in Dan Goldin's timeframe, and the Russian partnership I think is what largely defined Dan. He was trying to bring some innovation in. You talk a lot about faster, better, cheaper. Then everybody also said, "Well, yes, you can have two of the three."

What Dan was trying to do was just get people to think differently about injecting new technologies and taking some technical risk. Not in terms of the crew risk, but taking some technical risk in terms of demonstrating some new capabilities. He was largely defined by the Russians, and he came in, he was handed the Space Station cost issue, ended up working through the Russian, and that defined what was going to be done.

He had lots of other challenges. The Shuttle had fuel problems. They had a lot of challenges around the time. But, I would still say that Dan was largely characterized by the Russian involvement, spent a lot of time in Russia. I spent a lot of time with him in Russia doing all of that.

Then Sean coming in. Sean was an administration fixer is the way that I viewed him first off. What was interesting at the time was he was more directly tied politically to an administration than anybody we had seen probably since Jim [James E.] Webb. There were things that you didn't worry about in the same way. He was prepping for his first budget rollout—this was pre *Columbia*, the year before *Columbia* I think—and a whole bunch of us were just in the audience. We're all studying away, writing on paper. He finally looks up. He says, "What in God's name are you guys doing?"

I said, "Well, we have all these OMB questions that we have to write answers to to submit for your budget rollout."

He starts laughing, said, “Nobody ever uses those. Stop that. Pay attention. Make sure that we’re saying the right things up here.”

Everybody said, “Well, OMB has demanded these things for every year that we’ve been in Headquarters. Okay, got it.”

When *Columbia* happened, that level of support and interaction was absolutely critical. Just knowing quickly that we had to have Tom [Thomas J.] Ridge declare an emergency right away, and that opened us up to everything the government had, FEMA [Federal Emergency Management Agency], the FBI [Federal Bureau of Investigation]. Things like that that we probably would have tumbled to in a few days were done almost immediately.

Obviously then Sean’s whole tenure was formed by *Columbia* in terms of the whole recovery effort in East Texas and dealing with the press, dealing with the families. I thought he did an excellent job with that.

That really was what marked him, but again it wasn’t a matter that he had been a comptroller of the Navy and then Secretary of the Navy. It was his deep connections. He was a huge fan of space. He also had things that he was trying to get. He was trying to get Space Station in its box; he was trying to hold the partners a little bit at bay so he could get his own house in order. There were lots of things of that. It is kind of funny. We had a study team at the time that was a Multilateral Program Planning Team [MPPT]. Obviously if you look at the name, “Muppets” screams to you. They called themselves the Muppets. Actually Geyer was on that team. I think I may have mentioned. Now Geyer, Tom Cremins, who just finished as Chief of Staff, was a Muppet. Donna [M.] Shafer, your Chief Counsel, was a Muppet.

JOHNSON: Melanie [W. Saunders].

HAWES: Melanie was a Muppet, yes. There were plenty of them. Somehow being on these teams with me doesn't ruin your career at NASA. That formed Sean, but I think having other people in the role at that time I just can envision so many worse outcomes in so many different ways.

Then Mike [Griffin] came in as the engineer in chief. I'd known Mike for a long time. I'd known Mike from early Space Station days when he was in the Agency. He had been head of exploration in the Agency before; he'd been the Chief Engineer of the Agency before. I had worked with him. It was nice in that Mike wasn't overtolerant of a lot of process, so when you needed to work things rapidly, it worked very well.

The challenge that I had is that he was okay building a process that could run all these decisions up to the Administrator because of who he was. He was the Chief Engineer, and his view was these things are going to come to me on appeal, I might as well be part of the process and do that. I think that worked great for Mike, but it didn't work the same for Charlie [Bolden]. It's not going to work the same for Jim [James F.] Bridenstine. A lot of the processes Mike let build to play to how he was going to manage them, but now they're embedded in the way we do things and it doesn't work the same for other things.

Charlie came in and Charlie did a lot of things that probably aren't recognized by folks, but he'll always be the cancellation of Constellation. He did a lot of things for diversity, did a lot of things for education, and overall the Agency was very successful in that timeframe. He sold Mars better than anybody had sold Mars, because up until that point it was mostly show me you can build Space Station, show me you can go to the Moon, don't talk to me about Mars yet. He

actually managed to sell the continuum of Space Station to Moon to Mars better than I think anybody had done. At some point he'll probably get credit for that.

Now Jim we're learning about, but he seems to be listening to people, and he's owning the storytelling really well. We'll see how it plays out.

JOHNSON: I've noticed that on some of the things I've seen on NASA TV, he seems to really enjoy that role of explaining things.

HAWES: He's doing well. I can tell when he's talked to people. I can tell what's new if I've heard him a couple times. I can tell where that's new information. I've talked to him a couple times about things and it gets incorporated in the next talk. He is learning quickly.

JOHNSON: That's good. Okay, well, we've kept you a little bit over. But is there anything else you wanted to mention before we left?

HAWES: No.

JOHNSON: I think we've covered you pretty well.

HAWES: You'll figure something out if you need me again.

JOHNSON: Yes. We have flights coming up so it might be good to talk to you after those. Yes.

HAWES: That's true. We do have other things coming up.

JOHNSON: Okay. Thank you, appreciate it.

[End of interview]