NASA AT 50 ORAL HISTORY PROJECT
ORAL HISTORY TRANSCRIPT

CHRISTOPHER SCOLESE
INTERVIEWED BY REBECCA WRIGHT
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WRIGHT: Today is November 13th, 2007. We are at NASA Headquarters in Washington, DC for the NASA at 50 Oral History Project to speak with Christopher Scolese, NASA's Associate Administrator who previously served as the agency's Chief Engineer. Interviewer is Rebecca Wright with Sandra Johnson. In preparation for the space agency's 50th anniversary, the NASA Headquarters History Office commissioned this oral history project to gather thoughts, experiences and reflections from NASA's top managers. The information recorded today will be transcribed and then placed in the history archives here at NASA Headquarters where it can be accessed for future projects. Do you have any questions or can I answer anything for you?

SCOLESE: No, I think I'm good to go.

WRIGHT: Okay. In July of this year, you assumed the role of Associate Administrator, placing you responsible for all the technical operations of the space agency. We'd like for you to begin today by briefly describing your current duties, and tell us how you came to this current position.

SCOLESE: Because the boss told me. The last part was easy. The first part, what is the job? The job is really to coordinate programmatic and institutional aspects of the agency and bring them together, so that we work effectively. As you know, NASA is organized to accomplish missions to put people and machines into the air space arena and to do research in science and engineering. We have two fundamental organizations to make this happen the Mission Directorates, which do the programmatic aspects. They do the missions, the [Space] Shuttles, the robotic missions to Mars and around Earth. The Centers are where the work actually gets done. They have the people. They have the facilities to get that done.

It's important to bring those two organizations together so that the right work is done at the right time at the right place. My job is to facilitate that, and to facilitate that means making sure that we have the facilities that we need, that we're pursuing the right types of missions, after we approve a mission that we maintain its priority relative to other Agency and National objectives. So it’s necessary to communicate a lot with the Centers and the Mission Directorates to make sure they're all on the same page.

WRIGHT: You do have direct oversight of those programs and Centers. What are the challenges of that aspect of your responsibility?

SCOLESE: Well, challenges, I've been a project manager. Every project manager knows that their project is the most important in the world, not just in NASA but in the whole world. Then that works its way on up. Every program manager knows their program is the most important. Every mission director knows their mission directorate is the most important. Every Center director knows that their Center is the most important. So it's trying to convince people that maybe they're not the most important and that they have to bend a little bit in order to achieve the overall goals of the agency so that everybody can succeed and move on in the right direction. That's probably the biggest challenge.

When you couple that with the fact that there are limited resources, clearly NASA can't do all the things that NASA wants to do, let alone what the outside world wants NASA to do. That increases the challenge we have to go off and deal with. Plus we have the obvious external factors. The Office of Management and Budget has an opinion on what we should do and how we should do it. The Office of Science and Technology Policy has ideas on what we should do and how we should do it. The Congress of the United States has ideas on what we should and shouldn't do as well and how we should do it. So we have to balance those external factors along with all those internal factors.

Of course we have to account to the American public by giving them something that they see is of value, whether it's providing them excitement like flying the Shuttle and building the Space Station which is one of the toughest engineering projects ever , or whether we're giving them great inspiration, great science as we rove Mars or explore the outer reaches of our universe with things like Hubble [Space Telescope], or whether it's doing very practical things like helping NOAA [National Oceanic and Atmospheric Administration] get weather satellites up there so that we can better monitor weather and help out with disasters. All of those things are important. Helping the aircraft industry to become more efficient and therefore more competitive is another aspect of NASA. These all play into the balance that we need to maintain.

So balancing all those is probably the most difficult thing that we have to do, within those resources and within the desires of people outside of the agency that want us to do this, that or the other thing that they consider important. So that's probably the struggle that we have. Having been in this job for a few months now, it's a pretty dynamic environment to work in and to balance those various activities.

Of course the practical part of it for me is to make sure we have the right projects and the right programs assigned to the right place and to assure that we have the necessary resources to be successful. This is not done alone as there are many people in and out of NASA that I work with to accomplish our missions. However, in this position it is necessary to assure that our activities start out properly; by that I mean that we understand our requirements, understand the risks, have the correct resources, and have the support required to accomplish our objectives. Recall that NASA typically does things that have not been done before so establishing a good baseline in the beginning is critical. Not only does this help us to succeed but as often happens when things change it allows us to adjust. So when the funding profile changes for whatever reason if we have a baseline we can now adjust our plan based on priorities so that the internal and external to NASA communities understand the rationale. Of course this has longer term implications as well since to have the correct resources also means that we must make sure that we have the right skills within the agency to do what we need to do. To help universities and schools bring up the skills that we're ultimately going to need, the scientists, the engineers, the technicians, the mathematicians, the accountants that we're going to need in the future to make these things work.

That the facilities we have are capable of doing not only what we need to do today, which is more of an availability issue, but are also capable to do those things that we need to do down the road, like Constellation [Program], where we're going to have to develop some new capabilities. We'll use some existing facilities, have to modify them. But we'll have to build some new ones as well. So that all plays into the absolute practical aspect of what we need to do. Then stay within the constraints that we get. We get a certain budget every year. It doesn't grow as fast as we'd like. So we have to balance all that within that budget.

WRIGHT: You mentioned you just have been in the job a few months. Prior to that you served two years as the agency's Chief Engineer. How did that job and those duties help prepare you for what you're doing now?

SCOLESE: Well, that job was an interesting one. As a Chief Engineer of the agency you're truly looking over the technical aspects of it. That means the capabilities that we have, the skills that we have, and making sure that those skills in engineering meet the needs of the agency, that we have the right people and the right skills to do the jobs at the various locations.

One of the things that Mike [Michael D.] Griffin asked me to do when I came in was to reestablish the technical integrity, technical capability, technical respect that the agency had in the past. We developed something called technical excellence, to establish a common policy and a common language across the agency so that whether you are principally at a Robotics Center or principally at an Aero [Aeronautics] Center or principally at a Human Space Flight Center you can communicate with each other and work effectively without having—well, without calling a bottle one thing in one place and calling it a jug somewhere else and you're really talking about the same thing. We wanted to get a consistency of language, a consistency of process so that we could be effective, yet at the same time allowing for flexibilities, recognizing that an airplane isn't a spacecraft, and a robotic spacecraft isn't a human spacecraft, and a spacecraft that goes in Earth orbit isn't the same as one that's going to the Moon or Mars or further. So that was really the challenge that was the challenge that Mike asked me to take on.

We did that with various processes and procedures that we started putting in place. Probably the most notable of them was 7120.5D, which was a revision to the Program and

Projects Practices document. It did many of those things I talked about. In addition we began working with our partners outside the agency, with the Department of Defense, with industry, Department of Energy, to try and establish some standards that we could all agree on so that we weren't asking each other to do things in different ways that resulted in the same product. So we worked with those.

Personally for me it was a broadening experience, which allowed me to probably be able to step into this job, because my career in NASA, which began in 1987, was almost exclusively on robotic spacecraft, principally Earth-orbiting spacecraft for Earth science or NOAA, and then it broadened out into space science, planetary, astrophysics, heliophysics, that type of thing. So I had limited professional interaction with the human space flight community and the aeronautics community. Being Chief Engineer broadened me and got me engaged with all of those people. I knew many of those people from professional societies, but this gave me an opportunity to really work with them and understand their fields better. So as a result, I think when I was able to step into this job since I had the knowledge of those other communities to help me. I think it would be very difficult to step into this job without knowing that.

Also, prior to that I was a Deputy Center Director at [NASA] Goddard [Space Flight Center, Greenbelt, Maryland] and the Deputy Associate Administrator for Space Science. That gave me a strong institutional background, so I understood what it is to get personnel and human resources and facilities and all of those things that engineers try and stay away So that helped as well. So that was probably about it.

I think one of the other things that we did when I was in the Chief Engineer's office is we really tried to bring together the relationship amongst all of our Centers' engineering organizations so that they could support each other and share resources more efficiently. When you are in this job you realize how good the people of NASA are and how willing they are to help each other by sharing knowledge and resources to get the job done, so this part wasn't hard it just needed a little nudge, I also wanted to foster closer cooperation with our Safety and Mission Assurance brethren because there's a tight overlap amongst those fields. Engineering is pretty much focused on design and development and test and what have you. Safety and Mission Assurance is engaged in all those activities to make sure we're doing the right thing as checkers, but also bringing in reliability engineering, sustainability or maintainability and those types of things. So we really needed to have a closer relationship. So I worked closely with Bryan [D.] O'Connor to try and bring that. I asked all of our Center Engineering Directors to work with that, to work with their counterparts in safety and mission assurance at their Centers, to establish a closer relationship.

The other aspect of it that was really actually more fun than anything else was working with the NASA Engineering Safety Center. It was already established under Ralph [R.] Roe [Jr.] and they were doing a great job. When I became Chief Engineer it was absorbed under the Chief Engineer's office, and I'd like to believe that as a result it became even more of a utility for the agency and outside. So we ended up doing a lot of things to address issues and concerns clearly, which is what it was originally set up to do, principally for the Shuttle, but it expanded to not just the Shuttle but the [International Space] Station and all of our activities.

We also moved into those other areas I talked about, because they had the interaction with the whole agency. They had an interaction with the outside world. To a lesser extent we were able to go off and create within the NESC [NASA Engineering and Safety Center] what we called technical fellows, which served as the stewards of their particular discipline. So if you're talking about avionics or electrical systems or thermal systems or environmental control life support systems, we either have or are putting in place people that are respected both within the agency and outside of the agency as the person to go to if you have questions. And their responsibilities are to advance their discipline; to make sure that the people at the Centers that have similar titles are competent and capable; to help maintain the curriculum for training programs; and to develop career development paths that will allow others in their discipline to be effective and ultimately to succeed them as technical fellows. We also want technical fellows to be available to go off and work the hard technical problems, whether they be actual problems or they be questions about new capabilities that we would like to have. Last they should serve as representatives outside of NASA to advance NASA's interests in terms of specifications and standards so that we can get that commonality throughout the industry and within NASA, but also to be there to show that NASA is at the technical forefront of whatever that field they represent, so they need to participate in professional societies and that type of thing. So that's pretty much what I did when I was the Chief Engineer, along with lots of missions that went on during that time. It was lots of Shuttle missions and robotic missions and exciting things that happened all during that.

WRIGHT: While we're talking about missions, share with us what you believe to be the relative importance of human and robotic space flight.

SCOLESE: Well, I think they're both really important. I don't think that we can have one without the other. I would relate it to actually when I was growing up, both aspects of space got me excited in the space program, for as far back as I can remember. Probably John [H.] Glenn [Jr.] was the first mission I really remember, and being pretty excited about a human going into space.

I know that [Yuri Alekseyevich] Gagarin and [Gherman Stepanovich] Titov went before and [Alan B.] Shepard [Jr.] and [Virgil I. "Gus"] Grissom did suborbital flights. But I don't really remember those. John Glenn was really the first memory I've got of that. I followed every human space flight mission since then.

But I also remember sitting there in front of the television before we ever landed on the Moon watching the Ranger Spacecraft crash into the Moon and waiting, as if you saw anything in real time back then, but waiting for the paper to come out with the first images of Mars when the Mariners went to Mars or they went to Venus. I think a lot of people today think the same way. Not that they leapfrog over each other in the public's mind, but we do some really exciting things out there, and the human space flight community is doing some really neat stuff and we're doing spacewalks and we're building the Space Station, people are excited.

When we're doing the seemingly routine stuff people don't notice. People don't notice our weather satellites, even though images show up on TV every day, unless we're tracking a tropical storm, then everybody knows what's going on and sees our results. However, when we're roving on the surface of Mars or we make a discovery with Hubble or we add an element to the space station or we repair Hubble that gets out there. So I think from the imagination of the public, they all play in, and at any given time one is more exciting than the other. But you really need both the human and robotic missions to have a space program that advances our frontiers as humans and improves our place on Earth and hopefully allows us to expand our presence beyond Earth.

Technologically speaking, space is a hostile frontier, and we need our robotic missions to go out there and find the safe landing sites, as an obvious choice. We need to map where we're going to. We don't have oxygen and water up there. We can't just send a group out there like

[Ferdinand] Magellan and say well there's going to be water, there's going to be air, there's going to be food along the way. But we don't have that luxury here. So we have to go off and scout and see where the safe places to land are and where there are resources to be used – then we can send our ships with people on them with just the amount of fuel, oxygen, water, and food that is needed to accomplish the mission.

So we have to learn about the environment at the desired destination and understand it, and it's a lot safer and cheaper to first go out with our robotic spacecraft to find out what is it like at the Moon, what's the radiation environment like there, what's it like at Mars, what's it like at an asteroid, what can we expect. To test out components and capabilities, communications systems, the ability to orbit and change orbit around planets, the ability to land. Atmospheric characteristics when you go to someplace like Mars or Titan. So we need those robotic spacecraft to go out there and do their thing, or else it would be extremely risky for a human to go there, and probably much more costly than it is today.

The other thing I think that we have to realize is you can't have one without the other. Today the Station orbits the Earth every day. There's three crew members or four crew members on there, soon to be six. All their communications come through something called TDRSS [Tracking and Data Relay System Satellite] which is a robotic spacecraft sitting in geosynchronous orbit. We launch missions based on weather. Well, where do we get that from? We get it from our robotic spacecraft sitting in geosynchronous orbit and polar orbit.

Those spacecraft were developed by NASA. They're maybe operated by NOAA but they're developed by NASA. When we go to the Moon we'll have communications satellites around the Moon so that we don't have to lose communications when we go behind the Moon like we did during the Apollo days, so we'll know what happens when they go behind the Moon.

We'll have communications. We'll have better coverage on the surface of the Moon. We'll probably use robotic missions to supplement human missions so they don't have to do as many EVAs [Extravehicular Activities]. That's coming up in I think in March when Dextre [Special Purpose Dexterous Manipulator] goes into orbit on a couple of Shuttle flights from now that has more capabilities as a robot to do some things that astronauts would have to do.

So I think we're seeing that robotic missions served as test beds for understanding the environment, they served as sentinels or scouts for finding out what's there and where's the best place to go, and today they're serving as a vital part of the overall infrastructure to a) allow us to do our job with humans and b) I think in the future and the very near future to supplement humans and allow us to do more than we would be able to do otherwise. Human space flight then takes us another leap in a different direction.

To get people into low-Earth orbit is quite a challenge. To get them beyond low-Earth orbit is an even bigger challenge. We have people living in space. I think on the human space flight side there has always been a motivational aspect to it, but there's probably even more of a practical aspect to it, if we can keep humans alive in space with regenerative systems, with medical systems, we obviously have technologies that we can bring down to Earth. As we take them further and further away we learn more and better ways to keep people healthy when there's no doctor around, when there's no hospital around, stuff that you could never think about doing otherwise and you wouldn't really need to do otherwise. But we need to do it, and it'll help us just like it helped us in the past.

So I think there's new technologies that come out of it as well as the motivational stuff, and like I said, I think the two ultimately marry together. I don't think you can put one over the other. In every aspect that you put into it the motivational aspect, what would be neater than flying in space, to encourage people to do it? What's neater than building a robot that can go places where no human can go, go near the Sun, go on the surface of Mars right now, go near Saturn? Go onto Titan and see what's there.

From a practical standpoint, humans in space have enabled so many technologies and so many capabilities here on Earth that benefit us every day. Robotic spacecraft orbiting, never blinking, giving us our weather and helping us mitigate disasters, probably half the people in the world don't know, that it's two NASA spacecraft that help them track fires on the ground, that help mitigate the fire disasters in California. We even used a UAV [Unmanned Aerial Vehicle] to go off and support that. So aeronautics even plays into this discussion. So I think that you can't pick one over the other. I think you have to look at both of them and say that they all add lots and lots to make our life here on Earth even better.

WRIGHT: My next question is about aeronautics and the development of research in aeronautics.

SCOLESE: Well, actually it is important for a lot of different reasons as well. We talked about robotic and human just a moment ago. The development of Constellation right now is very dependent on technologies that have been developed on the aeronautics side. Acoustics is a big one. As it travels through the atmosphere, and in the lower part of the atmosphere, it's traveling very fast. That creates a lot of noise as that air rushes over it. We spent lots of time with airplanes trying to make them quieter so they can go into urban areas, it's better for the passengers and people on the ground.

Now many of those people are now working on Constellation to allow us to reduce noise levels for the crew as launch or have an abort. Had we not been investing in that over the last 50 years, we wouldn't be ready to do that today. People probably don't realize it, but all of our studies of supersonic aircraft and hypersonic aircraft and atmospheric physics allowed us to land on Mars, allows us to bring the Shuttle back safely, will allow us to bring Constellation Orion back from the Moon and from Earth orbit safely. Without the people in the aerothermodynamics world we wouldn't be able to do this. . So there's a synergy there amongst all of those things. So I think we need the A in aeronautics.

Also long-lived sensors in extreme environments that allow us to monitor engine performance. Inside of a jet engine is a pretty hostile environment, high temperatures, lots of vibration, lots of mechanical stress, and we develop sensors that will allow us to see if things are not quite right, so you can more effectively schedule maintenance, more effectively determine what's needed so you can reduce the amount of time on maintenance and improve safety and performance. That'll clearly help us with our spacecraft as well. So there's a synergy amongst all of these things that I think would be bad to separate. So yeah I think we need that A For Aeronautics

WRIGHT: You mentioned earlier that you joined NASA in 1987. How has the space agency changed over these last 20 years overall generally and then in your area of expertise?

SCOLESE: Well, I think when I first came in here there was a real battle between human and robotic space communities. I'm not sure it was within the agency, but it was certainly on the outside. I think that might be one of the biggest changes. I don't know that there was ever really a disconnect between the communities, but I think there was a mistrust outside about who was going to take more money from whom. I don't see that as much now. I think that's a big change.

I think that the science community and the human space flight community and the space community in general recognizes that we all hang together or we hang separately and it's better to hang together. So I think that's probably the biggest change I saw.

I think from a strictly NASA perspective, when I came here we were basically just going in circles around the Earth. I think all of us inside of NASA had this desire, we all came to NASA so that we could go to the Moon, we could go to Mars, we could go off and do these great discoveries. Yet we weren't doing it. You could fill in the blank. Robotic or human, we were pretty much stuck in low Earth orbit. Galileo I don't believe had launched at that time. But even still all we had was Galileo and Cassini on the drawing board. So we really weren't doing much.

In that 20 years it's totally changed. We are now doing sophisticated Earth science missions. We're taking into account comparative planetology if you will. What's the climate on Mars like and what does that tell us about the Earth? We went out beyond Earth orbit. We're have a total presence on and around Mars. We're heading towards Mercury. We're heading towards Pluto. We've been to Jupiter. We're around Saturn. We're making great discoveries. I think all of that together with people seeing what can be done, we now have a vision that allows us to get humans finally out of low-Earth orbit.

When I was a kid, I figured we'd have been to Mars by now and populating the Solar System. The scientific discoveries, the revolution in the last 20 years has been huge, not only in Earth science where I think it'd be fair to say that we have better capabilities of dealing with natural disasters, we have better predictive capabilities for severe storms, we're starting to get to the point where we can develop climate models, we have a better understanding of our Solar System, we have a better understanding of human physiology, and our understanding of the universe has been greatly expanded. We probably influenced aeronautics in ways that I can't even describe at this particular point because I just don't know all of them. But in engine design, quiet engine technology and what have you. All that happened in the last 20 years. So I think we've had a pretty exciting 20 years. As a result of all that, we now have a charter that'll take us out of low-Earth orbit, which I think is the neatest thing around.

WRIGHT: Just stay for a second on your last 20 years, because you've worked with such an array of projects and disciplines. You've possibly picked up some good lessons learned that you could share with putting your strategic vision together these next few years. What are some of those lessons that you feel will serve you well in this position and the ones that you'll have in the future?

SCOLESE: I think it's probably not worth going through all the technical ones, all the lessons learned there. Things like test before you fly and don't trust heritage, treat everything regardless of what it is as if it's new.

WRIGHT: Those sound good.

SCOLESE: Well they are. They're important things. I think one of the things that's probably really important that'll help me in this job is a recognition that space missions are complex regardless of how big or how small they are. As a result no one individual can make it happen. It takes a team. That team can be composed of people all within your organization, within your Center, within your Mission Directorate, but it's still a team. More than likely it requires participation of multiple Mission Directorates, multiple Centers, probably multiple agencies and probably many countries. Once you realize that, you realize how important it is to be able to communicate effectively, to build those partnerships, to respect the technical capabilities and the performance of other organizations. Or else we're just plain not going to be able to accomplish the things that we want to do.

Look at the Space Station. You'd have to check me on this but 17 nations are engaged in that. If we made every one of those nations do it exactly like us, I don't think there would be any nations. Yet it's a marvel. It works. It's an extremely complicated system both technically and, if you will, organizationally, when you have to bring in people that don't speak the same language as you do, that don't use the same tools you do. Yet you can put it all together. I think that all by itself is a perfect example of it. Every once in a while from here in Washington you look up in the sky and you can see it. It works. It is working. I think that's important, not just for us, but for the whole world, if you will, to see that you can work together as an organization.

Probably less visible to people, most of our robotic missions have international participation. The last satellite I worked on, I was a project manager of, we had US instruments, Canadian instrument, Japanese instruments, Canadian parts, German parts, we had things from all over the world. We had investigators from all over the world. That's typical. The two rovers on Mars, part of the science package came from Germany. So I think once people realize that and realize that you can in fact work together, that's really important. When you realize that then you realize that communications and clear communications is really important, that building a team is important. I mention communications first because you can't really build a team unless you can communicate with them and express whatever it is that you want done clearly.

I think the other one that's in there that I learned is integrity. We do have a lot of challenges. A lot of people ask us to do a lot of things that are let's say challenging. I think we have to have the integrity to be able to go back and say we'll do it but this is what it's really going to take. So I think those things, communications, teamwork and integrity, are the three biggest things that I can think of.

WRIGHT: What do you believe NASA's role is in the future? On the other side of that, what do you believe its impact has been on society as a whole?

SCOLESE: Well, I think NASA's role has been to expand our frontiers, period. Both our intellectual frontiers by giving us better knowledge of the Universe, better knowledge of the Solar System, better knowledge of the Earth. I think it expanded our frontiers in technology. You could talk to anybody about the spin-offs, all the things that we've done with autonomy, with medical technology, with making long-lived reliable systems, and how they play into any number of different things that we have on the Earth today. I think we expand our imagination by being able to look outside where we're at. I also think we expand frontiers of relationships, just like I was talking about.

In 1987 who would have ever believed that the US and the Soviet Union would be building a space station together? Today no one thinks about it anymore. Of course it's not the Soviet Union, it's Russia, but still, it's the United States, it's Russia, it's European nations, it's Japan. We've got everybody. Who would believe that we'd be flying satellites with the Argentinians and the Brazilians? Yet we're doing it. That we'd be sharing data with everybody in the world that can listen basically? That's something that I think NASA can do that other agencies can't, because we have that reputation for expanding frontiers.

I think the other part of NASA is that it motivates children, like it motivated me and motivates others, to want to go off and do difficult things. I'd like to believe they want to go off and do things in science and engineering. But I think when you throw a grand challenge out there, something that's very difficult, that's just at the reaches of known capability, that you encourage other people in other fields to try things that they view as difficult or different. So I think that's where NASA was in the past, and I think that's what NASA's future is.

From the practical standpoint, because people always ask that question, what NASA does for us, it's clearly the spin-offs. There's no question about that. It's clearly the knowledge that goes into the technical textbooks and the school textbooks. But also I think people have to realize the everyday stuff that goes on. You can always argue about spin-offs. I typically don't but other people do. But you can't argue that NASA-designed satellites are orbiting the Earth and telling us what the weather is. You can't argue that those same satellites are helping us to mitigate natural disasters when they occur. You can't argue that NASA-developed technology hasn't made aircraft more efficient and therefore made our air system safer and our airline tickets cheaper. You can't argue that NASA helped pioneer communications satellites and spawned a whole new industry.

So I think there's some very practical things that we have to get out there as well. That's what the skeptical taxpayer wants to hear. It's something we don't talk about as much. But I think the main thing that NASA does is really expand our frontiers and demonstrate that really difficult things can be done and that other people should attempt really difficult things.

WRIGHT: Well, as our time starts to draw closer, I definitely wanted to ask you to share with us why you, knowing all that you know and knowing all that you've experienced, because you've experienced being involved with high-profile projects like Hubble and Cassini too, those day-to-day efforts of trying to find money and stretching it far and wide, why would you encourage someone to have a career with NASA?

SCOLESE: Well, that's easy. Actually when I talk to kids I always tell them the same thing. This is the one place where you can come into work every day and you have a new challenge. If you want to create something that's never been created before, this is the place to do it. I have a joke for the engineers around here that at NASA no two identical spacecraft are the same. That's true. Every one of our orbiters is a little bit different. Every one of our communications satellites is a little bit different. They all have a personality. Every time we're asked to do a mission you may use the same parts but you use them in a different way.

So if you really want to have your creative juices flowing and use your knowledge to make something that's never been made before and to deliver something that's a new capability, regardless of what it is, to put humans on the Moon, to give us better predictions of weather, to go to Jupiter or Saturn or the surface of Mars, this is the place to do it. When you think of all the other things—because I was in the Navy early in my career, and I left for industry a little bit, when I was in industry I was in a company that made blood gas analyzers as well as doing space stuff. I was on the space side. I spent some time with the blood gas analyzers, and you could always make a better one, and then you make thousands of the same thing, and you watch them make a thousand of the same thing. I don't have to make a thousand of anything, and everything I do is different.

Risk for us is will it work, will it land on Mars, will they safely get to orbit, will they safely be able to do what they want to do, how do I fix a solar array that's torn in space, versus could I make this a little bit smaller. It's a heck of a lot more fun to go off and do those things. So that's what I tell people. If you really really want to tax your knowledge and you really want to do something that's meaningful and you want to do something that's different and you want to do something that requires real creative energy come and work for NASA.

WRIGHT: That's a good place to end, unless you have anything else you'd like to add before we close out, looking forward to the next 50 years?

SCOLESE: Yes I am. You did exactly what you said. You finished five minutes early. I couldn't ask for anything better.

WRIGHT: Well, then we'll stop now before we start running late.

SCOLESE: Okay, well thank you.

WRIGHT: Thank you.

[End of interview]