NASA JOHNSON SPACE CENTER ORAL HISTORY PROJECT
EDITED ORAL HISTORY TRANSCRIPT

CATHLEEN S. LEWIS
INTERVIEWED BY REBECCA WRIGHT
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CHULLEN: Hello, my name is Cinda Chullen. I manage the United States Spacesuit Knowledge Capture Program for JSC. I'm here today to have a wonderful interview with our guest from the Smithsonian [National Air and Space Museum, Washington, D.C.]. Her name is Dr. Cathleen Lewis and she's been with the Smithsonian for 27 years now. She is responsible for the international aspects of the spacesuit history at the Smithsonian. In about 2009 she inherited all this work from Amanda Young, who wrote a book about the suits from the Smithsonian.

Since then Cathleen has been coming up to speed with all the different things and is in charge of all the spacesuit work at the Smithsonian. She's visiting JSC today and we are honored here with her visit. I wanted to give you a little bit of background on her education. She has a Bachelor of Arts and a Master of Arts in Russian studies from Yale [University, New Haven, Connecticut] and she also has a Ph.D. in Russian studies from George Washington [University, Washington, D.C.].

She's here to visit JSC today looking at a potential loan for spacesuits to head up to the Smithsonian. As you know we've had a lot of really good things in collaboration with the Smithsonian recently. We just had the Shuttle [OV (orbiter vehicle)-103 *Discovery*] transferred to the Smithsonian recently, one of our honored Shuttles. Also Cathleen has been in charge recently of a new facility that will be housing all the spacesuits that are on loan from JSC and around the agency. So with that, she's here.

We have invited her to be interviewed today by Rebecca Wright. Rebecca is our History Office Coordinator, and she's graciously agreed to do our interviews for our knowledge capture program. She volunteered to come over today to interview Dr. Lewis. So with that, I give you both of them.

WRIGHT: Thank you.

LEWIS: Thank you, that was very nice.

WRIGHT: Thank you all for coming today, we appreciate you being here. We wanted to make sure that for the record we know that today is May 14th, 2012. We are at the NASA Johnson Space Center in Houston, Texas as part of the knowledge capture initiative. Again I'm Rebecca Wright, the coordinator of JSC's History Office. We certainly appreciate you joining us for this conversation with Dr. Cathleen Lewis. As Cinda mentioned, she is the curator of the spacesuit collection at the Smithsonian Institution. We know your job duties are very many and varied. Start out by sharing with us one of the most challenging aspects of your job.

LEWIS: There are many challenging aspects. As a curator, my job is defined by the government as any other series. I'm a federal employee, and I'm responsible for research, collections, exhibition, and public service. Probably the most difficult thing is finding time to balance them all and fit everything in. The research component is really what drives my job, but that also involves collecting objects, finding out their history, finding ways to put them on display, and answering public questions. It's constant motion. Much like my visit has been today, constant

motion. We're trying to absorb a lot of information all at once and be able to put it back out there for the public and serving the public.

WRIGHT: As you mentioned, part of your job is to collect items, and Cinda mentioned that you're here looking at some items that may be on loan to the Smithsonian. Can you share with us more information about what you're looking at and what will happen, the process of these items?

LEWIS: Well, in our collection we have the finest collection of spacesuits in the world. I know that because I've seen the collections that the Russians have. It is one of the most complete in terms of period, from early flight suits all through the Apollo Program and advanced suits. We've come here today—I've come here with my colleague Hunter Hollins, who's the loan manager—to look at a Shuttle EMU [extravehicular mobility unit], which is one part of the collection that we don't have. We have very little from the Shuttle International Space [Station, ISS] Program era. Just by virtue of the components being reusable, the economy of the Shuttle Program and the International Space Station Program, they've changed much in the way that property has been disposed of.

The Air and Space Museum has had an agreement with NASA since the late 1960s of right of first refusal for historic artifacts. We preserve them, try our best to stop them at that point in time when they come into our collection. For that reason we haven't gotten very many objects from the Shuttle or ISS Program.

Having something like a full EMU would vastly increase the scope of our collection, and give us the possibility of telling the story of the Shuttle and the ISS and its construction to our

public in ways they can understand. Spacesuits really are the charismatic objects of our collection because even small children can understand how they work and function on a general basis. They can look at them and say oh, you need this, these are clothes that you need to wear to work out in space. They understand that, so that's what we're here for.

WRIGHT: If this process reaches fruition and the full EMU finds its way to your facility, walk us through the process of what happens to it when it gets there.

LEWIS: It's very complicated, and it always surprises people. Right now we're operating at three locations. We have the museum on the [National] Mall, which everyone has known about. It's been open since 1976. We also have a storage facility in Suitland, Maryland, which is an historic old facility largely consisting of Quonset huts [prefabricated structures]. We're trying to move out of there, but we still have some operations there. We've opened up a new storage facility for our collection at the [Steven F. Udvar-]Hazy Center. It's at the southeast point of [Washington] Dulles [International] Airport, easily accessible from the airport. We've opened up a new storage facility in the last year which will house our artifacts that are not on display.

When the spacesuit comes to us, it will go initially to the [Paul E.] Garber [Preservation, Restoration, and Storage] Facility, where our collections people will unpack it and examine it, document its condition. This is a much longer process than most people think. We like to make sure that we know exactly what we have and precisely what condition it is in.

Then our staff conservator, who's a specialist in spacesuits and spacesuit materials, Lisa Young, will take a look at it. We will work together to try to figure out what sort of support structure we'll need to construct to go inside the suit. Just having it on display as is used for

public affairs is one thing, but when we're considering long term stabilization of the suit—all of our suits have what we refer to as mannequins but they're not really mannequins. They're structural supports built on the inside of suits that with conservationally correct materials will help the suits withstand gravity and any sort of the trials of being on display for a long period of time.

From there it will likely go from Garber in Suitland to the Hazy Center because the conservation lab will soon be located at the Hazy Center, and we'll work on it there. Instead of being on display near *Discovery* at the Hazy Center it will be on display in a new gallery that we're hoping to finally open this summer, Moving Beyond Earth, which tells the story of the Shuttle and the International Space Station construction. It's a gallery that will draw some of our 8 million to 10 million visitors every year to the National Mall museum.

So it'll be a slow progress over about a 50-mile radius over a period of time. We'll have checkout, fitting for conservation correctness, preparation for display. Then our designers will come in and take measurements to make sure everything fits, that the lighting is appropriate for the suit. What we've found with our suit collection is that lighting gives the greatest potential damage to the suits, and that damage is cumulative, so we're taking extra care to make sure that the light exposure is very very limited.

In this new gallery that will be the case, so it'll take a long course, much longer than many people would consider. It doesn't just arrive happily in place on display. There are a lot of people who have their hands—my colleagues in collections, design, conservation will all play their part.

WRIGHT: But it becomes a star when it debuts.

LEWIS: Yes, absolutely. The suits are a tremendous draw with interviews and visitor surveys that we've done over the years. That is one of the major attractions to the museum. Seeing the suits, seeing how human beings function in space. That's very important to people.

WRIGHT: When you collect an item like the suit—we can use it for an example—what other related information do you gather with it?

LEWIS: We gather as much as we possibly can. Component history—through the Apollo suits it was very simple because we could track the components after the fact. The suits were custom-made for each astronaut, so we have an idea. We know about the fitting process, the sewing process, working with the soft goods, and the transport between ILC [Dover, LP in Delaware] and Hamilton Standard and then down to [NASA] Kennedy Space Center [Florida]. That process was very standardized.

With the EMU it's much different because the suit that we're looking at has components with different histories and different uses, so we will have to do research on each individual component. That'll take time and effort. That's what I'm paid to do, trying to gather as much information as possible. Not only about the construction but about the procedures, if components were flown, when their launch date was, whether they were on the Shuttle, whether they were on the International Space Station, what they were used for, when they were returned to Earth, what other work they've done. Just trying to document every single aspect of the history of each component. Flight history, postflight history, and going on from there. Not only

through logbooks and records, but also through photography, see if we can find situational photography showing components in action while on the Space Station.

Gathering as much as possible, overburdening our servers with as much information as possible, but trying to preserve as much information. Oftentimes we've found a lot of this information gets lost over the years. That's one of the problems that I have finding information on the Apollo Program. At the time when the Apollo Program wound down, much of that documentation was lost because corporations don't like to hold on to documents. They have lawyers who insist that they don't need to. Only the things that go through the records schedule for the National Archives [and Records Administration] get preserved at Fort Worth [Texas]. We're often looking for those personal stories that if we don't capture them right at the moment, they go uncaptured. People retire, people forget. They take their personal files with them, or they don't take them at all and they get shoved aside when the office is moved and things get lost.

What I try to do is get as much of that documentation information—including the little notes and notebooks that engineers have had and technicians have had over the years—just to precisely be able to say this is what this piece did. This is its history from the time that it was on the cutting boards in Dover [Delaware] to the time it came to us. We can tell the history of each component, that's the ideal. Don't often get to that ideal, but that's our ideal.

WRIGHT: It's quite a range and collection of information, considering that you have I understand somewhere between 200 and 300 suits in that collection. Is that correct?

LEWIS: We have 278 either full or partial suits, depending on the circumstances of how we acquired them. We would love to have that much documentation on everything. We don't, but we hold out hope. Every once in a while someone comes through. I'll get a call, one of my colleagues will get a call. "Oh, I remember when this happened." Or, "My father had this box of papers. He's gone on, would you be interested?" Suddenly you find this absolute gold mine of information. We want to document everything in that manner. We don't always meet it, but we keep that ideal in mind when collecting. Especially collecting new things that we know that the documentation exists now. Better now than later and waiting for it to appear.

WRIGHT: Tell us about some of the suits. Of course most people know that you have very historic suits of the Moon walkers, but if you could share some information maybe about some of the suits that people would be really surprised to find were in your collection.

LEWIS: Everyone knows—well everyone assumes, and it is true—we have all 12 suits that have walked on the Moon. Those are the iconic images of the Apollo Program. But we have prototypes, we have test suits, training suits—suits that were never meant to fly but were contract suits. We have four of the contract suits that were submitted for the initial request for proposals through NASA for the Apollo program. These are suits that were manufactured by companies that people no longer assume have anything to do with the space program, but were involved in the space program, or interested in working on the Apollo Program back in the 1960s.

We have engineering model suits that are asymmetrical, that are designed to test different options on joints. They tell a lot about the history of developing joints and the limitations of engineering a suit so an astronaut can actually do productive work in space. We also have hard

suits that date back from the 1950s, the Litton [Industries] vacuum chamber suits that they produced while they were working under contract with the Air Force.

The Air Force continued that program, and when they turned it over to NASA they turned into the RX series of suits, and went on to the AX series that [NASA] Ames [Research Center, Moffett Field, California] worked on as well. We have this large spread of hard suits, and they're very useful to explain to our public how they came about—how they were really the first suits to be designed to work in a vacuum, and after NASA went through soft suits like the Apollo suits, they've come back to the hard suit idea yet again after years; and the difficulties of combining both launch and entry suit function with EVA [extravehicular activity] function, and how that works, and how that split off again.

We also have early flight suits that NASA was testing at the Marshall Space Flight Center [Huntsville, Alabama]. We have very rare suits, for example an Arrowhead Mark IV that Arrowhead Company had submitted to the Navy as a flight suit. The Navy pilots really really hated it, because it had a corrugated torso and legs for flexibility. They found it very uncomfortable. The remarkable thing is that for some reason [Marshall Center Director] Wernher von Braun loved that suit and there are photos of him walking around in it. Interesting enough, it was that convolute technology that ILC had proposed that caught NASA's eye and got them the contract in part. So you have suits that show technologies over the years and how they've come.

We also have a diving suit from the Navy from the beginning of the last century. It's not in my collection, but we have one of Wiley [H.] Post's suits [first pilot to fly solo around the world] that he designed with Russell Colley [Mercury spacesuit designer] to build that first flight suit in order to go higher and faster. The range of suits is amazing.

We also have little known suits from the Manned Orbiting Laboratory Program, which really are the only pieces of hardware from that program that have survived, the Defense Department's program. Those suits give us a clue about the intentions and what that program was going to be. They have gloves that have sharkskin applied to the palms of the hands, and also have stainless steel fingernails on the exterior of the gloves. What we understand from what the plans were, they needed to give the pilots from that program extra manual dexterity so they could turn dials and have fine motor control, which they wouldn't normally have at that level of glove technology.

I could talk on about any one of them, but we have a range of suits. Not just the lunar suits, but a lot of things in between.

WRIGHT: You mentioned suits as a full component. Do you have some of the accessories that you accept as well, although you may not have the whole suit?

LEWIS: Yes. In total there are about 1,300 objects, give or take depending on how you count, in the spacesuit collection. As I said only 278 are the pressure suits themselves. That includes gloves, helmets, and boots in cases where they were detachable. That includes suits that have had their cover layer separated. Oftentimes we receive suits from NASA that have had the cover layers removed. Gene [Eugene A.] Cernan's Gemini IX suit is one case in point.

There was a lot of interest on how that suit performed. It was taken apart and put back together, and the cover layer was removed. But that too tells us a history. I'm very optimistic about showing that to the public just to say look, the suits don't stop working when they come

back to Earth. That's when a lot of the learning begins, in how it performs. That tells a story as well. We have those components, and those are all out in our new storage facility now.

WRIGHT: Tell us about the challenges of trying to preserve and maintain this wide and very long range of suits with the different materials and the different specifications that they were all made from.

LEWIS: There's a saying among conservators—and plastic conservation is having this great surge right now. People are looking at plastics and synthetics from the point of view of art that was done about that time, and including the suits. Plastics have a half-life of 50 years, so if we're looking at our collection, by and large it's hit its half-life. Plastics aren't forever. They deteriorate, as everybody knows. Your vinyl lawn chairs will eventually turn yellow and brittle and start falling apart. The problem that we have preserving the suits is that they're combined materials, and some of them don't react very well together.

In the strictly conservation sense, the one thing to do to assure preservation of all the components would be to take them apart. Well we can't do that, so we have to find a way to preserve them best when they're together and combined, and to isolate components that are cross-reacting. My colleague Lisa Young, who's a conservator, has done quite a lot of work on trying to find the optimal situation. As I mentioned light is limited, humidity is limited, temperature is limited.

We used to think that very cold storage worked. That didn't work, that actually accelerated some of the cross-linking in the plastics. We've settled on 60 degrees Fahrenheit and held to under 35 percent humidity, which is quite a relief. We always used to joke that the suits

came from Dover, Delaware to Houston to Kennedy, and then went to Washington. We're talking about the most humid places you can get in terms of heat and humidity, but we're trying to ameliorate some of that.

There have been occasions where we've had to remove components of the suits. The polyvinyl chloride is a material that we just can't seem to stabilize. In order to preserve the rest of the suit we've removed some hoses on some occasions. [Alan L.] Bean's suit is one case in point that there was nothing we could do to stabilize it, so taking the hose, taking a minor part off the suit in order to preserve the greater suit is one way to do it.

At this point we know that's stabilizing it, and we're always looking for the next thing. There's certain suggestions that have come up over the years that may not be feasible. Storing them in an inert gas—oxidation isn't the major problem we're having, and storing any object, especially a large object, in an inert chamber has other problems: access, expense. Whether that cost outweighs the benefit over time is something we're looking into.

But we keep trying. Lisa is constantly talking to materials scientists, plastics experts, and also materials engineers, the people who built it, trying to get the details. That's one of the sides of the details that I'm looking for when I collect an object, trying to find as much information about how the soft goods were made and produced. Because sometimes things change. People forget over time, and it doesn't absolutely get documented. If we get it right at the time we don't have to go back and find that after 1975 they started adding another additive, and the plastics were lasting longer. We have to look and see what that additive does to the rest of the suit.

WRIGHT: It's been quite a learning process from what you're saying, because when it was started—to stabilize and maintain these suits there wasn't a book that you could take off a shelf. Could you give some other examples or maybe some anecdotes about the learning process?

LEWIS: The learning process has been, as I said, very long. It began really with my predecessor, Amanda Young, who back in 1999 applied to the Save America's Treasures project, which was a millennial project from the White House [White House Millennium Council]. I think Hillary [R.] Clinton as first lady was the major sponsor of it through the [National] Park Service. She applied for a grant and got matching funds from Hamilton Sundstrand to examine the components of the Apollo suits and determine why they were aging so badly.

We had had the suits since the 1970s and we had many suits out on loan. About a third of our collection is out on loan. They were coming back in very bad shape, not as a result of abuse but as a result of aging. The beta cloth was deteriorating, the badges were gone. You could feel that the suits were becoming brittle on the inside.

She got the grant and she was able to convene working groups on materials, to gather some of the technicians and engineers who had worked on it so they could brainstorm and remember exactly what happened, what their intention was in the beginning. When you're making a suit with a 6-month working life expectancy, you're not necessarily motivated to make it so it can be preserved for 50 to 100 years, but that information is necessary so we could learn what these materials are.

She worked with Lisa Young at the time to develop an ideal situation. Suits were made to work in zero-g [gravity] or the one-sixth gravity on the surface of the Moon. They were collapsing on themselves and we had to design supports. Lisa and Amanda worked together to

design supports that would not interact with any of the suit components but would stabilize the physical shape of the suits.

In working together they put together a booklet that Hunter, my colleague, has on the care of the national collection of spacesuits. It's The Preservation, Storage and Display of Spacesuits. That was the product of their research, and it focused on specific materials. They couldn't do everything, but it got a lot of the information in stabilization, especially in the problem areas: the convolutes, the zippers. Brass and rubber don't like each other. Over a long term they start to attack one another, and we were finding the zippers didn't work anymore. They were either frozen open or frozen closed. We had to look into what we could do to solve that problem, and what we could do to stabilize it. Stabilization is the key.

Reversing the problem is longer term, and we still haven't come up with any ideas. But stabilizing it for as long as we can, slowing the deterioration until we get to the next step. It's an iterative process. They're getting stabilized, and now we're starting to find other ways. Maybe we can do something. Maybe we can do testing, find other ways to work with objects.

WRIGHT: Were there lessons learned along the way of what not to do? You mentioned the zippers should be left open, but maybe they should have been closed—those types of things.

LEWIS: We've learned a lot. The tradition when we first got a collection was to try to recreate the iconic image of the man on the Moon, of Buzz Aldrin on the Moon. We collected the suit—well, as much as came back of course. Apollo 11, all the astronauts left their personal life support systems on the surface of the Moon, and all but Cernan and [Harrison H. "Jack"] Schmitt left their overshoes on the surface.

We put together as much as possible in a full-up assembly, and we found one of the contributing factors to the deterioration of the interior of the suit—by doing that we were closing up the suit entirely and causing a microenvironment to form inside the suit. You have not a constant airflow, and humidity and everything else would build up, especially off gassing of materials. So we no longer display our suits that way. You'll never see an Apollo suit all as one thing. We separate the helmet, the gloves.

The zippers are always open by virtue of that and also virtue of display constraints. In order to create a structure that would support the weight of that suit, we have to find a way to insert a steel armature on the inside that will support the weight. That is padded with padding-support material, conservation-correct material. Those are the major learning things. Keeping temperature low, humidity low, monitoring for light.

If anyone's ever been to the museum, we have lots of ceiling windows, and we have tried to limit the light. We've taken the suits out of open galleries with lots of visible light as well as UV [ultraviolet] light. Visible light is as dangerous to the materials as UV, and we're putting them into closed galleries with limited light.

WRIGHT: Was there a tendency to clean up the suits?

LEWIS: No. That's always a funny story, because the popular legend is that when the suits came back they were sent to the dry cleaner's. Well, that's the truth. NASA did send the suits to the dry cleaner's, but in the 1970s that was the standard conservationally-correct treatment of textiles. You sent them to the dry cleaner's. That didn't happen to all the suits, and we've been able to retrieve the chemical process that was used on those suits at the time.

What we do now, our focus is to stabilize the suits at the point when we receive them. Cleaning is limited. It has to be reversible, and it can't damage the components of the suit. So we clean with ethanol and usually just a light vacuum with a HEPA [high-efficiency particulate air] filter to try to get surface debris and dust. Lunar regolith doesn't come off, and we're very glad about that because that's led to later research. Just to get the surface contaminants that got attached to the suit as the result of transport or everyday use post their mission life. Basic cleaning, but nothing harsh or abrasive. Nothing that's irreversible, nothing that will take away from the working history of the suit.

WRIGHT: I understand that X-rays were taken of some suits. Can you share why that was done?

LEWIS: X-raying has become a tried-and-true technique in museum conservation. Art conservators have used X-rays to penetrate layers of paintings. It turned out that one of the conservators at the Smithsonian Museum Conservation Institute [Suitland, Maryland] was looking for something to do, and he heard about the work that Amanda was doing on suit preservation. He wanted to know if he could try X-raying a suit to see what's inside. We also tried CAT [computed axial tomography] scanning, but unfortunately the CAT scanner that the Smithsonian has is very limited in size. We could only do a glove or boot, but you can begin to see how the interior structure, the structure you couldn't see between the pressure layer and the cover layer, was deteriorating and deforming.

The X-rays gave us that added information because using the old wet check technique of X-ray, Ron [Roland H.] Cunningham could lay out the suit, lay out all his plates, and go from plate to plate. Then our photographer could knit all the components together into one big X-ray

so you could see all the infrastructure inside the suit. You could tell if there was any deformity. You could also see the structure inside the suit that nobody sees, that people are often surprised to see. There are wiring and electrodes that go down through the entire suit, to give them a sense of it's not just restraint layer, but also you have electricity going through. You've got everything going through and operating, and how really complex these machines are to preserve life in space.

WRIGHT: Tell us why you have included some Russian spacesuits in the collection.

LEWIS: Well, I came to the Smithsonian as a curator of international space programs basically. Everything not American was my bailiwick, and my specialty is Russian and Soviet history. In 1996 we were planning to redo our Space Hall gallery, and it just so happened that came a couple of years after the Russians began selling off some of their space hardware at auction. [H.] Ross Perot purchased many samples of Soviet hardware, and there were several other collectors as well and he offered it to us. At the time we thought well, this is a fantastic opportunity. We can pair Russian and American components and show the difference between the two sides' approach to the technologies, especially during the Cold War when there wasn't a lot of communication between the two sides. They were taking very different routes for the same objective.

It just so happened that at that time when we were preparing the gallery, that was the beginning of the Shuttle-Mir [Russian space station] Program. Norman [E.] Thagard had returned. He had gone up on a Soyuz [Russian space vehicle] and he came back down on a Shuttle. So that meant, importantly for me, that he brought his suit back with him. His suit

landed in the United States and didn't go back to Russia, where they traditionally take them apart.

NASA offered and we accepted to transfer that suit, that so-called launch and entry suit. The Russians refer to it as an emergency suit. It came into our collection, then several years later Dennis [A.] Tito, who was the first space tourist—though he prefers to be the "first privately-funded space traveler," which is much more difficult to say than "space tourist"—went back to [NPP] Zvezda [Russian aeronautical and space manufacturer] and purchased his suit after his flight and in turn donated it to the museum.

So now in a very odd situation we have the world's foremost collection of American spacesuits, but we have no launch and entry suits from the Shuttle and International Space Station Program, but we have two Russian suits from that vintage. We're hoping to collect more in that area, just documenting it. By virtue of the way the Russians build their suits, test them and recycle the components, there are things that become available on eBay [online auction site], but getting them directly from them with a documented history is much more difficult.

WRIGHT: Were you also able to get a suit that Shannon [W.] Lucid wore when she was part of the program?

LEWIS: Yes. Shannon Lucid wore a Penguin suit, also made by Zvezda, which is a prophylactic body-loading suit. She wore it during her stay [aboard Mir] to try to ameliorate some of the deterioration of muscle loading capacity, and NASA also donated that. That is one of those suits that is far more interesting on the inside than the outside. It just looks like a jumpsuit on the

outside, but on the inside you have this very intricate elastic and pulley system that actually works as simulated gravity, which the Russians have explored over the years.

I understand the [U.S.] Naval Academy [Annapolis, Maryland] also has one that they obtained through Wendy [B.] Lawrence, and they have it on display in Annapolis. It's a very neat technology, and it also explains a lot. At the time Americans weren't working on it because they weren't doing long term spaceflight, but it's a very important technology. The Russians are very proud of it because they've tried to adapt it for use for other means on the ground as well.

WRIGHT: You mentioned earlier in our talk that you have a new facility that you're transitioning into. Tell us about the advantages of being there, and what will happen to the facility at Suitland.

LEWIS: As I said, the Garber Facility at Suitland is a very old facility. It was squared away largely by Paul E. Garber, who was our first curator of the National Air Museum. He managed to get Quonset huts and temporary buildings built. It's adjacent to property that the Smithsonian also owned, and it was able to use that for storage. Having a collection such as ours, we have 60,000 objects today ranging in size from the Saturn Vs [rockets] that are around the country on loan, to we have media bowls that were used to grow cells and tissue culture. We've been storing things at the Garber facility under not ideal circumstances, not climate-controlled. The advantage and the purpose of building the Steven F. Udvar-Hazy Center was to build a state-of-the-art storage facility where we can have absolute climate control. We were able to design the facility to fit our collection, which is a wonderful opportunity.

We had designed a spacesuit room, "my room" as I like to call it, and it's actually reserved for rubbers and flight suits. We designed it to fit the size of the collection, the scope of

the collection, and to fit those rigid requirements for temperature and humidity control. It's very controlled access. Even I don't have access. Our collections people guard it very seriously, and it's actually a room inside a room. The outer room houses fur and leather collections that had previously not been stored under optimal circumstances, all with an eye to preserve them for another generation.

We've initiated the move from the Garber Facility, moving slowly. The spacesuits were first. We'll be moving fur and leather next, and then small objects. I think the move is now scheduled over the course of five to seven years, depending on funding and resources. We've had to hire a number of contractors who have developed expertise in handling objects, packaging objects, finding a way to package objects so they can have the minimal handling. You can have a tray for a glove that will pack nicely and stack inside a larger container, so you can transport that to the new facility and then pull it out, remove the packing, and put the glove in its final storage position without touching the glove. That takes a lot of knowledge and technique and understanding of the fragility of the glove and how you prepare the glove for storage.

The Garber Facility eventually, once we vacate it—that's going to be a very long time, five to seven years just to move the small and medium objects only. We still have airplane fuselages that we don't have the space for. We outgrew our space while we were planning for it. As we turn over the buildings, the Smithsonian is hoping to build new expanded improved storage buildings in the area on the premises. It's going to take some time, but we'll eventually get there. If we can build some larger facilities on the Hazy grounds that'll hold the fuselages, we'll be able to do it.

WRIGHT: An ongoing process.

LEWIS: It's very long, it's very time-consuming. But we're making slow steps in this progress, and we're getting a lot of press coverage as well. People are beginning to understand that it's not just putting something in a drawer. Everybody thinks about Smithsonian storage and they have this vision of the final scenes from *Raiders of the Lost Ark* [Indiana Jones film]. It's not really like that. We take far more care. You can unpack that crate, and there would be ethafoam [polyethylene foam] padding around it and inside. Not the same.

WRIGHT: It is, as you mentioned, very fragile and delicate items that you're transporting across town, and although it doesn't seem very far away sometimes that transportation effort can be a long one.

LEWIS: It's a very elaborate move. Going from Suitland, Maryland to Hazy, that's about 40 miles. But you have to take into consideration traffic. We have several trucks, one tractor trailer semi. In order to get from Suitland to Hazy there's only one time you can do it, and that's before dawn. Even then the traffic is horrendous. Our truck driver who's been doing this for years moved the aircraft from Garber to Hazy. He assured me, "Cathy, if you get on the road by 6:00 a.m. you'll be fine."

The first time I did it following the truck, I said, "But Doug, I went on the road at 6:00. Where did all these people come from?" I couldn't believe that there were all these people on the road. We have the worst traffic in the country in the DC area, so got to be on the road at 6:00 a.m., and not a chance of making it in 45 minutes. You have to wait out the traffic. Everything is prepared for storage, packed, and then stacked in the tractor trailer the night before. Take the

truck out, unload the truck, put everything away, and then prepare for the next time. It took us about two months. One day packing, one day unpacking, and we moved 175 suits in that time.

One of the really—what I think—cooler aspects is trying to figure out how we box the suits. The suits were not in crates in storage, we came up with the idea. I think it was Hunter's idea to use the containers that the coffin companies use to transport coffins. They're rugged enough to be able to withstand the weight of the suit, and they're also wide enough to hold our largest suits and some of the hard suits, have a 38-inch width at the shoulder. We could retrofit them with conservation-correct materials and strap them down, so we had 13 coffin boxes every other day going out. But everything was protected. It went really really well, it's a great bunch of guys.

WRIGHT: Interesting picture of the coffin box with the suits in them.

LEWIS: Yes. Well, they're cardboard boxes with wooden frames, but coffins fit into them. It was the only thing we could come up with off-the-shelf that would fit our suits. Anything else would have been too narrow or would have been prohibitively expensive.

WRIGHT: Perfect, great idea. Before we close this afternoon, I wanted to ask you—having such hands-on experience with these suits and learning so much about their history and how each one can tell a story all of its own, what do you feel is the importance of keeping them and preserving them? Not just as historic items, but what role do they play in helping to develop spacesuits for future exploration?

LEWIS: It's a twofold effort. On one hand the Air and Space Museum has an agreement with NASA. We get right of first refusal on hardware when you're through with it on programmatic use, and we also stipulate that if there's ever any call for NASA to look back at objects they're always welcome. And we will give things back. We worked that way with the [OV-101] *Enterprise*. We lent back the leading edges of the wings, the landing gear.

We've had a number of groups of engineers from JSC, from the various contractors, come in and look at our suit collection, just as a way of training the next generation to see what's been tried in the past. That's always very important, because there are no textbooks on suit development. People tend to forget. They see the finished product but they don't remember oh, we tried this, this, this and this, and we finally decided that this is the only way given these limitations that you can work out a shoulder joint in these confined spaces. So we work in that way.

On the other hand there's the public aspect, which is really fascinating because the museum routinely has family days when they bring in demonstrations. ILC comes out and brings parts of gloves and other suit components. Recently we had people from [NASA] Goddard [Space Flight Center, Greenbelt, Maryland] working on the Hubble Space Telescope repair who had tools and equipment that was used in the Hubble Space Telescope.

There's just nothing as wonderful as seeing a kids' eyes light up when they realize that they have their hand in that glove, that thick bulky glove, that has all these layers for a reason. You can explain to them what each layer does, and they have to be able to hold this tool and operate this tool. What amazing amount of engineering and science goes into that, explains that. That's generating the newer generation. Not just the new generation of engineers and technicians, but the newer generation of kids who understand that—as I said, these are really

complex machines. They work a purpose, and they took a lot of time and energy. Just as there are many layers of the suit, there are many layers of the work that goes into that. Kids are always very fascinated.

As I said, the suits are very charismatic objects. They're very personal. Children understand, everyone understands them at some level of what they have to do to function. Showing them the inside out, explaining the layers—really it's a wonderful feeling when you see that light up—"Oh, to be able to do that... How can you grip that? Why do you make these tools with these huge knobs?"—it makes sense. That thought process is wonderful.

WRIGHT: Well, thank you. I really appreciate you sharing some of the insights of what you do and what happens to the suits, and all that's being done up there to make sure the suits are saved for the next generation. Thank you again for today.

LEWIS: I'm very glad to.

[End of interview]