The oral histories placed on this Website are from a few of the many people who worked together to meet the challenges of the Shuttle-Mir Program. The words that you will read are the transcripts from the audio-recorded, personal interviews conducted with each of these individuals.

In order to preserve the integrity of their audio record, these histories are presented with limited revisions and reflect the candid conversational style of the oral history format. Brackets or an ellipsis mark will indicate if the text has been annotated or edited to provide the reader a better understanding of the content.

Enjoy "hearing" these factual accountings from these people who were among those who were involved in the day-to-day activities of this historic partnership between the United States and Russia.

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Go to Oral History

FRANK L. CULBERTSON, JR.

March 24, 1998

Interviewers: Mark Davison, Rebecca Wright, Paul Rollins

Davison: Good morning. Today's interview is between Mr. Frank Culbertson, Program Manager for the Shuttle-Mir Program, and it's 24th of March, and we're in Mr. Culbertson's office here in Building 1. Good morning.

Culbertson: Good morning.

Davison: The first question is, tell us a little bit about the position that you held when you got started in the program and what your responsibilities are.

Culbertson: When we started the program?

Davison: When you started in the program.

Culbertson: Well, my first exposure to the program was back in 1992, when we first began working with the Russians. I was involved working with Dick [Richard O.] Covey and Steve Nagel in the astronaut office in dealing with some of the issues that were starting to come up, and making some plans for how we would work together in the future.

My first trip to Russia was in January of 1993 as a part of the Operations Working Group, to go over and start planning the rendezvous and docking of the shuttle and the Mir. Then I was involved in training for my most recent mission in September of '93, so I was out of it for a little while.

But a few months after I came back from that mission, I was asked to head up the JSC Russian Project Office, which began activities in May of 1994. I worked in that position for a few months until the Phase 1 office was established, led by Tommy Holloway, and I was named as his deputy in the summer of 1994. I guess my first official activities began in about September of that year with the Team Zero meeting in Moscow and activities with the Russians.

I just continued from there. I continued as the deputy for the program through August of 1995, when Tommy was named as the shuttle program director and I was the acting director for Phase 1 for a while. Then I was director by the end of that year, and I've been in that position since then.

Davison: You talked about your shuttle flight. Do you think that background, or the work you did in space station, prepared you for this job?

Culbertson: Definitely. Yes. I wasn't prepared for everything, and it's hard to find somebody who knows everything about a job they're going into, I guess. I had a lot of things to learn about NASA management and bureaucracy. But in terms of the operational side and understanding the shuttle and the objectives of the station, I had a pretty good grounding in that, but there's always more to learn, and I certainly did. I had a little bit of experience with international operations, both from the [US] Navy and from my [Space Station] Freedom days, and had studied a little bit of Russian prior to working with this program. So I had a little bit of background that helped.

Davison: You mentioned your Navy experience. How were your Cold War impressions and culture differences overcome to make the shuttle-Mir program feasible?

Culbertson: I don't know if I had prejudices necessarily. I had been trained to do certain things in the Navy, and it was quite a feeling the first time I stood in Red Square or was inside the walls of the Kremlin on my first trip. That was an amazing transition from what I had been trained to do for a long time. But as I said, I had a little bit of training in the Russian language, I'd studied it a year at the [US] Naval Academy, because I felt like it might come in handy some day. Since those guys were designated as our enemy at the time, I thought it was important to learn as much about them as I could, and I actually studied a good bit about the Russian people during that time.

So I wasn't unfamiliar with life over there, at least from what I'd read, and had always been optimistic that the Cold War wouldn't last forever, and felt like we always had a lot in common at the basic human level. So I wasn't really surprised by our ability to work together, and I wasn't too surprised by some of our differences, but they still were surprises. I saw in a lot of our people the need to overcome some prejudices and the difficulty it was for some people, and still is, I think, for some. You grow up with a certain attitude or certain feeling and it's difficult to change that when you get into a new situation for some folks. Others are more flexible.

Davison: Was it easier for you to relate to the cosmonauts, being an astronaut, and a lot of them were former fighter pilots like yourself?

Culbertson: Yes, that was pretty easy in a lot of ways. There was a little bit of checking each other out, you know, when you first met, to see who you were and what your background was and how good you were, but that's normal in that world. But I found there to be a lot of mutual professional respect for each other and the ability to communicate about things. A lot of common experiences.

Davison: So was that helpful in the Russian negotiations, or did you have to kind of develop a style for negotiating with the Russians?

Culbertson: It was helpful to a certain extent with some people, like General [Yuri] Glaskov or [Nikolai M.] Budarin or [Anatoly Y.] Solovyev, folks who were cosmonauts. But the majority of people we worked with were not cosmonauts. Their cosmonauts typically do not rise in management as frequently as ours, plus they don't have as many as we have astronauts. So there were a few people in key positions that I hit it off with real well, but I also had to learn a lot about negotiating internationally with the Russians specifically in dealing with all levels of management and all types of people. It's not unlike any similar job on this side; it's just in a different language.

Davison: They seemed to enjoy negotiating. Did you come to that level where you enjoy doing it?

Culbertson: I enjoy it also, yes.

Davison: Who was involved in bringing Phase 1 together, if we go back to the history at whatever level it might be, the congressional level, executive level, whatever you'd like to talk about?

Culbertson: Well, I was busy training for a flight and was involved in other jobs when the actual negotiations were going on, so I wasn't involved in the international trips or in the contract negotiations or any of that. There were some other folks who did a very good job on all that. But what I saw, I was involved in a lot of the early meetings and tag-ups and discussions on this side of where we're going and how many flights are we going to do and things like that, although I didn't necessarily make any of the decisions, but I was part of the discussions, or observed a lot of the discussions.

My impression initially was there was tension between the shuttle program and the space station program over who owned this, this in-between program, this Phase 1 program. I thought Tommy Holloway did a really good job of pulling together a compromise position in between the two programs that established a program office, a framework of working groups with which to negotiate and work the issues, and some of it was based on the Apollo-Soyuz experience which some of the people had been a part of, particularly on the Russian side. Some of it was just good common sense.

Tommy put together this package and had it signed by all the appropriate people so that everybody bought into, "This is the way we're going to manage this program. This is the way it's going to exist." And he was able to establish a budget for it, a schedule, and everything, and I thought that that was the real foundation of our success, was that early work Tommy did in that area. A lot of other people worked in it, too, but Tommy's the one who finally pulled it all together and was named the director of the program. Folks like Jim Gardner, Brian O'Connor, Steve Grissom, people like that all contributed greatly, and I think were major players in getting it going.

Davison: You mentioned that Tommy Holloway established a budget for the program in the beginning. Did that come out of station money or shuttle money, or is it separate? Do you care to talk about that?

Culbertson: I think the answer is yes to both. I guess the money was eventually counted under the station budget, with a $2.1 billion cap that we operate under each year. But I believe it initially came from the shuttle budget, but I don't really know the ins and outs of all that. Tommy can probably give you a better feel for how he mechanized that. But I thought it was very well done.

Davison: What do you think the turning point that prompted the MOU (memo of understanding) between U.S. and Russia to cooperate in space-were you directly involved? Would it be sought from--

Culbertson: Well, obviously the change in government in Russia and the end of Communism made a huge difference. It opened doors. Space was one area that we quickly stepped through the door on, because we already had the Apollo-Soyuz experience, we already had some common research and exchange of information going on particularly in the medical research area. We had some common work already going on. We had always wanted to share information, and this was sort of an enabling function or an enabling factor that we could now go ahead and do it. I'm not sure that many of us thought much about the foreign policy aspects of it. That was at a much higher level that those negotiations were done.

But space was an easy way for both countries to step forward and work together, because we already had international space station, what at that time was Freedom, in the works. Bringing the Russians in with all their expertise as the other leading space power made a lot of sense at the time. They had a lot of capability, but they were severely underfunded. I mean, their budget had been cut to the bone. They were barely able to maintain Mir operations and had cut every other program they had going.

There was obviously a feeling that if we helped them get through this period in space, that they would put more of their emphasis in that area than maybe in weapons or exported weapons. I understand that rationale, but I think preserving what they had done for the previous thirty years was also very important, because without that, that all would have been lost to history and it would have been an interesting and incredible series of accomplishments, but nothing following it if we'd let the whole thing collapse. A lot of talented people, a lot of hardware, a lot of experience would have just gone down the drain. So I think it's very good that we put the money and effort into working together in Phase 1 so that their program did continue to exist and they're able now to start to bring it back up, to participate as partners in ISS [International Space Station].

Davison: The Russian people seem to be very proud of their culture and their space accomplishments.

Did you find that that was hard for them to let someone come and help them financially? How do you think they dealt with that?

Culbertson: To a certain extent that was hard at some levels. There were some people who were very realistic and understood this was the only way that they were going to continue in the business. There were also people who did resent the fact that they couldn't continue doing this on their own. And I don't blame them. It's kind of human nature. They had accomplished a lot, and they accomplished a lot with always meager resources to a certain extent. They're very good at innovation, very good at solving problems and surviving difficult times, and that's been proven by the fact that the country survived all that it has in the last thousand years.

But I think it was difficult for them to be put in a position of contracting with us for goods and services, if you will. I think that they had to change their mind-set on things and make a shift to a different way of doing business with the rest of the world. Some of them were very aggressive about it and some of them were very withdrawn about it, so I saw all sorts, just as I saw a lot of different approaches on this side, too.

I think eventually we've evolved to the point where we realize that it's to our mutual benefit to work together, that it's more than just a contract between us to execute Phase 1; it's a development of a partnership and a relationship that will carry forward into the foreseeable future, the contract between the U.S. Government and the Russian Government, which is a vehicle with which to enable that all to happen, and a lot more happened on both sides than just the content of the contract itself. So we got more than our money's worth and so did they out of Phase 1, I believe. I think it was a very inexpensive investment for what we're going to see as a product in the future and our ability to work together, and the fact that we were able to continue both programs in a very robust and aggressive fashion.

Davison: What were the initial goals of Phase 1 and who is responsible for accomplishing these?

Culbertson: Well, the initial goals that were set forth in the management plan that Tommy put out were four. The first one, as initially stated, was to learn to work with the Russians, but we changed that to learn to work with each other. I think that's a significant change. You have to make sure that when you write things down like this, that you think about it, because people do react to that and they do set their attitude based on the way you write these kind of things. So I think it was important that people realize we were not only teaching each other, but observing each other and learning from each other, and that both sides had a lot to offer. It wasn't just a one-way street by any means, and I think we've proven that over and over.

The second stated goal was to mitigate risk for the international space station, and we are always looking for ways to do that; to try out hardware that was going to be used on ISS; develop procedures that were going to be used; to react to the situations that arose and develop processes to respond to them. Again, we've got more than we bargained for in that, particularly in dealing with some of the contingencies that came up, such things as the fire, the depressurization. All that was not planned, of course, but certainly taught us a lot about what could happen during the ISS.

You could probably take most of the things that happened during the course of the Phase 1 program and predict that each of them will happen in one form or another during the fifteen or so years of ISS life, including arguing about when it should end and how good the station is after ten years. All that's going to happen. So hopefully enough of the people who experienced that will still be around to deal with it appropriately.

The third goal was to conduct long-duration studies for the U.S. side, the first opportunity we'd had to do that since Skylab, of course. We broke the Skylab record on the very first mission and we've continued to have four- to six-month missions. It's been a real good experience for us, and I think, again, a lot of the benefits were unforeseen.

One of the interesting discussions I've had with people in Congress and other critics of the space program, they appear to want a cookbook answer to a cookbook question before we ever execute anything. Of course, if you already have the answer, why go execute it? I think the benefit of the space program is the unexpected. The real benefit is the unexpected spinoffs, the unexpected products and benefits that we've seen as a result of stretching our capabilities by going into space. You can't say, "I'm going to go into space, and because of that, life's going to be better on Earth," in detail. You can say that in general. You can't say how it's going to be better, but I can guarantee you that as long as we continue pushing the boundaries, pushing the frontiers, we will benefit from it and we'll be surprised by how we'll benefit.

And the same thing's been true in Phase 1. We thought we'd be looking at how the human body responded, and we have been, of course, and we've been gathering data on people living in space for a long period of time. Some of the data the Russians already had; some they didn't. We have different ways of gathering information than they do, and they've not been able to share everything with us from the past, don't document it the same way. But we've also learned a lot about the psychological aspects of people being on a station for that period of time. You'd think we'd already know all that because we send people out to sea on submarines and send people to Antarctica, and we've done all that, but it's still a different environment and we have to keep relearning these things, and you've got a different group of people doing it.

So that aspect has been eye opening, as well as the effect on the people on the ground who are supporting these missions, and what it takes to support these missions from a ground controller standpoint. That, again, is an unexpected lesson learned that I think we're going to have to work on very hard to ensure that we don't burn out our people both in orbit and on the ground, and that we don't neglect them, and that we provide them with sufficient support that they'll want to keep doing this job over and over and over, because it's harder than we thought it would be.

Mir operations and life was hard. A lot of people have said it's the hardest thing they've ever done. I congratulate them on that. I hope they feel good about it. I think people should, at some point in their life, do something that's really hard and feel good about it, feel like they've accomplished something. If doing it in the space program is where they get to, then I think that's great. But what we've learned, and my prediction is, the ISS is going to be even harder for a lot of reasons that people don't understand yet until you've been involved in Phase 1. So this next ten years is going to be really, really fascinating and the story is going to be even more interesting than the one you're telling here, I think.

The fourth goal was to conduct a science research program, and I took a lot of heat from the scientists periodically because they said, "We're last priority," and I said, "No, you're fourth priority." We have lots of others that don't get stated as clearly, but still, during the research program, it was a high priority. Because that takes so much time and effort on the part of the crew members and the ground support people, it appears to be the main thing that we're doing, and it gets a lot of attention. If it goes well, it gets a good bit of attention. If it goes poorly, it gets a heck of a lot of attention and people feel like they're failing if one of the research experiments doesn't work. But you have to keep it in perspective.

We did have a very well thought out and, in most cases, very well executed research program that provided, I think, a lot of good data. Some of it will be used in ISS; some of it will be used for the benefit of people on the ground, just as pure research. A lot of it, however, will be development of better research for ISS, because you're now having a chance to operate the equipment for months at a time rather than days at a time on the shuttle. You have a chance to see what kind of pieces of hardware really support you well and which ones are critical. On a shuttle flight, for instance, a payload computer is crit three or worse, and if it breaks, nobody-I mean, people care, but it doesn't affect the success of the mission. However, if you have a critical payload computer on the station and it breaks, then you're out of business for the next six months, and that's a major disaster. So you have to change the criticality and the reliability of the hardware that supports the science, not just the infrastructure of the vehicle itself. It's easy to say, for instance, on the shuttle that they be used, which you need for landing, for crit one, but as long as you can land the shuttle safely, you can come back and repair anything that breaks in the payload area and you're not going to worry too much about it, other than the person who spent years preparing for that experiment. But if it's something that's going to support you for months, then you're going to take a different outlook, and we're changing the paradigm on that for the research community. So it's been good in that area, too.

The other important thing that people should remember is that anytime we have the opportunity to conduct research on any platform, whether it's at sea, in Antarctica, in space, we do it. As a nation, we tend to do that if you have a good program set up. So you have two things: one is the ability to establish the outpost, the ability to build a platform that goes to sea or it goes into space, the ability to operate it, and all the things you have to learn to make that happen successfully and safely; and then you have laid over that what do you do productively while you're there. The two are different and they should support each other, but you shouldn't confuse them when you're evaluating the success of a program or the plans for building something. They're two totally separate areas that you need to concentrate on, and a lot of people at NASA understand that, but a lot of people outside don't.

When we fly something for a university as an experiment, we're susceptible to the ability of that university to build this experiment and conduct that research. However, once it flies on the shuttle or on the station, it becomes a NASA experiment and we get identified with it. So it has to be a synergistic relationship. But we still can conduct safe and successful missions without that research, but you couldn't do that research without the ability to operate this vehicle.

Davison: To follow up on the science and research, the payloads are used to fly on the shuttle, like you said, and they had to adapt to the Mir environment and now they're going to have to adapt to the ISS. How did they transition from that and what lessons learned can we bring to the space station on the operations and how they get payloads ready for flight?

Culbertson: Well, there are several aspects to that. One is the fact that we were dealing with a Russian vehicle with payloads carried up on American space shuttle, and operated by both Russians and Americans, so we had to worry about not only transport of the shuttle but operation on the Mir, transport to the Mir, existence on the Mir.

The Russians have different safety standards than we do. Some are more stringent, some are less. We had to work out a way to carry and operate each other's equipment, particularly in the payload area, that had some growing pains, and we still don't have it all as smooth as I would like to see it. I'd like to see a safety and certification and acceptance testing program that will take any piece of hardware from any country that's operating on the station and accept it based on the certification that comes along with it for any vehicle. We're not there yet.

We're working towards that, and that has to be the goal, or the overhead is just too hard. You can't send it through your own safety and certification program, send it through the next country's that you've got to [unclear], and then the next country that owns the module. I mean, you just can't do that for the long term. So we're working on ways to standardize that. ISS has come a long way in that area, and I think they're pretty close to it, but we learned in the Phase 1 program that the reality and mechanics of doing that are different than the documentation, because you're still dealing with people who have to sign their name to a piece of paper that says, "Yes, this thing will operate safely and won't hurt anybody in orbit." And people take that very seriously, so they're reluctant to take other people's word if they don't know the system and don't know the pedigree of the certificate that comes with a piece of hardware. So we've got to work that out.

The other thing is, as I mentioned earlier, the difference between a short-duration and a long-duration mission on operating hardware. A lot of the hardware that we took to the Mir was originally certified for use on the shuttle and had a guaranteed life of a month, let's say. A lot of it the research program accepted and flew on the Mir with that certification, hoping that it would last a long longer than a month, but not necessarily a guarantee. Most things did, of course, but others didn't, so we had to learn what was robust and what wasn't, how important reliability was in the research area, just as it is already in the operational area.

So you start to identify what are your critical lab components, for example-centrifuge, computers, glove box, things like that, that you have to use on multiple experiments. They've got to work every time, and you need sufficient redundancy and reliability so that you can count on them, because a lot of experiments don't start till halfway through the mission, for instance. And if you've already broken the glove box and this one is relying on the glove box, then you're not even going to start it. So you have to sort out what's really important in your core hardware.

We learned on the computers, for instance, that on a shuttle flight we don't see it too often, but there's an anomaly called a single-event upset, where you're hit by a cosmic ray somewhere in the computer's core, and it can wipe out a program or shut down the computer. You have to reboot it or it can totally disable it. It's a random event, and there's a statistical frequency, but because the shuttle flights are so short, we rarely saw it on orbit.

However, on the Mir, we had a component called a PCMCIA card that goes in the side of a laptop that turned out to be extremely susceptible to cosmic ray or single-event upsets, and it became a consumable, because this is where our programs were located for booting up the computers for the different experiments. So you put in the appropriate card for the experiment you were doing, then bring the computer online, and it would gather the data and store it. But if the card didn't work right, you didn't get your program up and you couldn't start the experiment. Those cards eventually became consumables, because they might last three days, they might last three months; it was unpredictable. But they weren't hard enough to withstand the cosmic rays. We eventually got hardened versions. They are available; we just didn't know we needed them. But it took a while to overcome that problem and to come up with a better solution. Now, that's going to be, I don't think, a problem on ISS if people remember their lessons learned, but it's something we would have run into eventually if we had not one this on Phase 1.

Communications and data transfer, the ability to do that and the way you schedule it, the way you sort it, the way you compress it, that's all been something we've been improving on over time, that they're going to have to work on on ISS in terms of bandwidth and satellite availability for COM and sharing of resources to send things like email down and data files. We all now have a databank on that, how it works and how it doesn't work, and I'm sure the operators will be much better for having experienced it now than learning it the hard way in ISS.

Experiment management and the number of experiments you have on board. We learned from the very beginning that, first of all, you want to keep the people busy while they're up there, because psychologically it's not good to be bored if you're stuck in a can. We've learned that from submariners to POWs. You need something to do as humans. So you need some experiments that are kind of long term, like Shannon [Lucid] had her greenhouse where she was growing the wheat, and she tended it every day. She looked forward to that, and that was a good changing experiment that she could report on and experience and participate in. John Blaha had his bioreactor which required daily attention.

Each flight has had something like that, each mission. So you need a mix of those kind of experiments with the little short bursts of high activity where you might just go gather data for a few days or do some work on an experiment and then put it away and be done with it. So you get both the long-term continuity and variety of starting and stopping new experiments, and you need a good mix of those on an increment to keep it interesting and to help keep the crew productive, because that's a part of the whole formula that you have to factor in.

You also need standby experiments, because if you've got one of these shorter ones that you take out of the box and you start it up or it doesn't start or it doesn't work the way it was expected to, and you're just going to have to fold it up and put it away, you need something. Let's say you were planning on working on that for three weeks. You need something to fill that time. So we need backup experiments on board. We call them below the line. If they don't get done, no loss, but if they do get done, it's a bonus. If something breaks and they fill in for it, then you've still got a good full mission.

So our way of scorekeeping had to change. What's 100 percent accomplishment, 100 percent success on a six-month increment? You can't really say that before the flight, what 100 percent is going to be. You kind of have to go back afterwards and say, "This was an A+ flight," or, "We lost everything on this one." And a lot of it has to do with did you use the crew members' time efficiently and effectively. That's something you really can't say until after the mission's over.

But you have to have the ability to be flexible, to respond, and to fix things while they're on orbit. We found that some of the experiments would initially not go so well, but then if a little care and feeding on orbit or some time spent by the people on the ground analyzing it and evaluating the data, you'd come back to it later and start it over again with a different approach, reprogram the computer, whatever it took, and be responsive to it and get a lot more out of it than you would have on a shuttle flight, for instance, where you say, "It's not going to work. Close it up. Take it home."

We need to make sure that our people are trained. Most of them kind of have this bent anyway, but they need to be trained to fix things, to be inquisitive and innovative about repair jobs, and also be able to recognize when something needs repair. I've told folks that we probably ought to just send our people off to shop class for a couple of weeks and then put them in a diesel submarine for a couple of weeks under the ocean and make them keep that thing running, and then they'll be pretty well prepared for station. It'll seem easy then.

It's clear people need to have some ability to conduct in-flight maintenance. For all the shuttle astronauts who are jealous of the IFM specialists on the crew because they got to play with the tools, now it's a chance for everybody to be familiar with the tools and to conduct repair. It's not just on the payloads, of course, but it's also on the systems, because sometimes things break in a way you don't expect and you don't have the cookbook procedure or the ready spare part to get it going again. So I think that kind of experience for our people and that kind of attitude, that they're Mr. and Ms. Fix-It while they're up there, is important.

Davison: Do they need to be as mechanical as Jerry Ross in rebuilding his car in his garage or somewhere in between?

Culbertson: It can be somewhere in between, but somebody like Jerry would be ideal. [C. Michael] Mike Foale, for instance, was really good mechanically, plus on the computer, he could reprogram the computers when they needed to be fixed. So he was very handy to have up there. Dave Wolf is not only a medical doctor, but a mechanical engineer out of Purdue [University], and an inventor, so he was very good at working on things and keeping them running. So folks like that, I think, are going to be very valuable on

ISS, and we need to identify who they are and make sure we have a mix of them. You don't want one crew with all that kind of people fighting over the toolbox, and another crew with nobody who even knows what a wrench is. Nobody's that bad. But, you know, doesn't have an inclination to do that kind of work and get their hands dirty. You need a mix on each crew, and that will kind of sort itself out, but we, as management, need to look at that carefully, too. [William Shephard] Shep, by the way, is going to be ideal. Shep rebuilds his house every couple of months, I think.

Davison: How did the payload community respond after we had the depressurization of the module and you had to get new experiments up there for that?

Culbertson: They responded very well. Obviously they had lost a lot and there was a lot of disappointment, but they turned to right away and came up with a new plan, both to capitalize on what was still available. Most of their stuff was in the Spektr when they shut it down, plus Mike's personal stuff. But they came up with a plan that got the most out of what they had remaining. They scrambled and put together some spare parts and some backup experiment and put it on the next Progress that went up, so they were able to regain some of the experiments. Then, of course, they had to replan the next couple of increments because of the loss of Spektr, and they had to come up with a new plan for them, too, and put either replacement experiments on the shuttle or plan a whole new program. They did both, and I thought they were very responsive to the situation, which is typical of people here at NASA.

I mean, we joke about it sometimes. We need a small emergency every now and then to keep our people going because they deal better with crisis management than planning. That's not totally true, but people get really excited when they've got anything from the Apollo 13-type scenario to a computer crisis on orbit and you've got to reprogram it. That's what people really like doing here, responding to a problem and solving it.

Davison: When we look at the physical aspects of payloads, we're looking nowadays, in the shuttle and the Mir program, we're looking at locker-size-type payloads. Originally station was looking at rack-size payloads, and they've had to change their mind-set to go to the drawer or locker-type payloads. Do you think that's a good adjustment? How are we going to do glove boxes and furnaces, the larger ones?

Culbertson: I think you'll see a mix of both. I think the mid-deck size or locker size is a real good way to go if you can, because they are more easily interchanged, more easily worked on. You don't have as much invested in them if they go bad, and you can refly them later. It does limit what you can do in some cases, though I've found people are extremely innovative about it. Everybody comes in and says, "I want a whole rack to do this," and you say, "You only have one or two lockers." "Okay, I'll fit it into there." They figure out ways. And with miniaturization nowadays and automation, it's pretty incredible what we can accomplish.

I think there will be a place for some rack-size either facilities or experiments, because eventually I think we'll evolve to fairly big science up there, but I don't' think we should be overly ambitious at the beginning. I think we should be patient and give the station a chance to mature and operators a chance to mature and the procedures a chance to mature so that once we do invest in really big science and large racks, whatever, then we've got everything else pretty well in hand.

That's another thing we've learned in Phase 1, is that the aggressive, energetic, "can do" spirit of going after a shuttle flight and getting everything done right on schedule and getting it accomplished per the book is great for shuttle operations, for airplane-type operations. But one thing that aviators who are in the Navy learn the hard way, when they first go to sea on a carrier, is it takes a lot of patience to operate a ship. We're used to yanking an airplane around the sky, and if you're going to maneuver a ship around, you've got to be very patient. You put in the ten degrees of rudder, then nothing happens, so you wait a little while. That's kind of the same way in a station program. You put in ten degrees of rudder, in program direction nothing happens, and then you wait a little while, then it will start slowly changing.

Same thing is true on an emergency, even. There are a few things in a station environment that you've got to immediately jump to and do something about real quickly. Those few things are readily identified, everybody knows what they are, and they're trained to take care of them, like a fire or depressurization. Almost everything else, you go, "Darn. It broke," and as long as you're still breathing and you've still got a way to escape, then there's really no need to panic or to get excited about it. You just say, "Okay, ground. This broke. What do you want to do? Do you want to work on this or you want to leave it for now and come back to it in a few days?"

And so we've had to learn a more patient way of operating in space and on the ground than we're used to on the shuttle, because the shuttle flight is very limited, and when something breaks on a shuttle flight, I mean, MCC brings in the cavalry and you work on it really aggressively. And that's the way we train in our sims, so people are used to doing that, because you have got to be able to land before you run out of consumables, and you've got to land in the same vehicle that's got the problem. Not true on station. You're not going to land in the same vehicle. You're not going to ever bring it back, at least not with people in it, and your life is extremely long. We carry at least thirty days of consumables on the Mir. ISS is planning to have ninety days of consumables, so you've got at least that long to respond to any non-life-threatening problem. And it's hard for some folks to slow down to that pace.

I remember in my early flight training they taught us that sometimes the best thing to do is sit on your hands, get your hands off the stick, don't do anything, because the airplane will take care of itself, unless you know exactly what you're doing. Sometimes the best thing in station operations is just to sit on your hands and make sure you understand the situation thoroughly before you do something that's irreversible, because you can make it worse real easily by overreacting or acting too hastily.

Davison: You talked about the different planning templates, the shuttle planning everything down to the hour and every move that you make, compared to the Mir, which is very relaxed, and you might say, okay, this is what you're going to do today. Do you think international space station is going to end up somewhere in the middle there?

Culbertson: I think it will tend more towards the more relaxed. Mir is not quite as relaxed as you may have described. Particularly the Russian crew is given a fairly strenuous schedule each day, and they tend to work mostly to that schedule with a lot of other stuff thrown in. So it's pretty long and hard days for the folks up there.

We've had a lot of input from people who have flown, that they'd like to have more flexibility to do the planning themselves, and if we went with the easy CAP concept on the shuttle, the CAP was a correctivity plan, and that plans you out day by day. We eventually evolved to the point where you had a small section that was called easy CAP, that said you don't have to do this per any schedule; just get it done sometime today. But it was usually a few things like clean some filters or something like that.

I think that a lot of the people who've flown Mir would like to see almost the entire schedule be that flexible, in that you say, "Okay, we want you to accomplish this experiment, this experiment, this repair. Hit this milestone," whatever. "And tell us you've done it." And that would be sort of the extreme but ideal situation from a crew member's perspective.

Now, the reality is you've got people on the ground who are standing by to support you, to communicate with you when you're doing an experiment, to back you up, so you have to coordinate all that, too. So you need at least a block of time in which you know you're going to be operating that.

There may be other constraints, such as power usage, thermal constraints, things like that, that have to fit in, so you can't be totally flexible. You've got to share resources and apportion resources in a logical way, particularly when they're limited. But there's certainly going to be a different mode of operating than we've been used to on the shuttle, and people are going to have to manage their own time to a certain extent, which some people like and some people hate.

So we're going to learn as we go, but we've already learned a lot on Mir. We agree with a lot of the ways the Russians do business; we disagree with some of them. So we're going to end up someplace in the middle between the two systems.

Davison: What difficulties were experienced in integrating the American and the Russian space programs?

Culbertson: I thought we only had an hour. (laughter)

Davison: Top five.

Culbertson: There were lots of difficulties. Some were major, some were minor. I think they add to the measure of success of the program. They're not an indication of failures, necessarily; they're an indication of the difference approaches we all took to both space flight and culture and growing up.

Probably the most difficult initial challenge was the language and being able to communicate clearly. Some of it was easy because there are a lot of technical terms that the roots are essentially the same in both languages, particularly the space program. But that could also be confusing because something that you think sounds like a word you're used to using might have the same root but have a totally different meaning in Russian. I'm trying to think of an example of that, and I will before we finish all the interviews. But that happened not infrequently.

For instance, the word for "efficiency" in Russian is "efectivny," and there's a difference between "efficiency" and "effectiveness." So that sometimes, I was afraid, was either misunderstood by the interpreters or by the people on both sides of the table, and occasionally caused a little confusion in minor ways. There were others.

Davison: I remember one when we were in station was "command and control," how we viewed command and control was completely different from how they viewed command and control.

Culbertson: And, of course, communication difficulties branch out and ripple out into lots of other areas. Other difficulties, of course, were in hardware area, just integrating our hardware, though, again, that's an area where people can come in and solve concrete problems and reach a solution that's a lot easier to achieve than something more abstract such as command and control or operational philosophy. Hardware was an area where I think we had a lot of successes. There were a lot of challenges, still are, particularly when it comes to safety certification and structural analysis, things like that. But we've reached a point that we can at least operate on common ground in most of those areas.

An early challenge, of course, was building the docking module and making it compatible with both the shuttle and the Mir. That particular piece of hardware and that flight, I think, are frequently overlooked in their significance, because there was no crew exchange, not that much cargo was carried up other than the docking module, but that really was the first station assembly flight and the first time that we had the docking on 71, which was the Russian mechanism on the shuttle, which was a challenge itself. But the docking module was a big piece of hardware that could end up on either one. There were a lot of contingencies associated with it. It had to be manipulated by the arm and it all had to go very well, and you had to dock with this thing sticking out the payload bay. So to me that was a good example of overcoming a lot of the hardware and operational differences between the two countries.

Other difficulties were just getting our people into Russia and getting them out occasionally. The Russian Government is not-and I hesitate to say this-is not as integrated as ours is, and I'm not trying to use our government as a good example necessarily, but they're even worse in terms of the different departments talking to each other, the different ministries. Just because we had an agreement at the governmental level with the Russian Space Agency that we would be able to send people and hardware in and out freely didn't mean the foreign ministry agreed with that or the Customs agents agreed with that. We still had to overcome those obstacles.

The Russian port of entry is not user-friendly yet. It's getting a little better, but it's still very difficult. Long lines, a lot of bureaucracy. I mean, you've got to go through Customs going out of Russia, not just going in, unlike the U.S. So it was somewhat of a shock to a lot of our people, how difficult it was to get in and out of the country. Of course, it's a lot easier than it was in the Communist days, and for people who went earlier in the program, it's a lot easier now than it was.

Also, living over there was extremely difficult for a lot of people. Some people were pretty adventurous and saw it as the equivalent of a camping trip and just kind of rolled with the punches, and whatever came was fine. Other people who were more used to our typical American style of life had some difficulty with the Russian apartment living versus living in houses around here. The lack of common goods and services, particularly in the early years, there were a lot of shortages of things that we took for granted. Heat, for instance, was centrally controlled wherever you lived, and you didn't control either the temperature or the fact that it was on and off. The government decided when the heat was going to come on in the fall, so you were kind of at the mercy of somebody else.

That lack of control, personal freedom and control, was difficult for some folks to deal with initially. We went through a lot of culture shock, I believe, in the early months and years. And it's still difficult for people, because housing is expensive. There seems to be a shortage of what we would consider adequate housing. And getting around Moscow is still somewhat difficult until you learn the system. It's not like here where you can just go jump in your car and drive down to the convenience store and pick up a bottle of milk. It's more of an ordeal to do something like that, though, again, that's getting better, too. But that was a real difficult early challenge.

There were other challenges that were not because of the fact that we were dealing with Russia, but just because we were doing something new that we had not done in a long time and NASA had never done, folks in the military were used to deployments and being away from family, and the difficulty of having to move things back and forth overseas and the long trips, but people in NASA had not done much of that except in the early days when they were sending people to the tracking stations all around the world. Even that was just for the missions, primarily, except for the people who set them up.

So we had a lot of people who thought they were going to spend their whole lives in Houston and were comfortable here, who all of a sudden had to either go spend three to six months in Russia away from their families or move their families over there and figure out how to do all that. We, back here, had to figure out how better to support people who were traveling frequently or who were deployed overseas. It took a while to do that. It was clear to some of us what needed to be done, but until you get the whole institution to buy into it, you're really pushing a rope to try to get the responsiveness you need when people are deployed overseas.

I think some of the early stories of this program will focus on those kind of difficulties, and when people tell anecdotes, I think that's what you'll hear about, is the difficult adjustment to that kind of life. It's hard, when you're overseas and things are not going well back here, like the car breaks down or the washer and dryer break, or whatever. I made twenty trips to Russia, and every appliance in my house is new, because they all knew when I lifted off from Intercontinental, and broke as soon as I was airborne. I mean, the car would die. We have a new refrigerator, new washer, dryer, hot water heater, air-conditioner, you name it. If I went to Russia, something broke. And I don't think it was arranged.

Davison: Some appliance dealer's real happy.

Culbertson: Oh, yeah. But it happened to everybody. It's hard to plan for these kind of trips and have everything in order if you're not in a career path that's like the military where you are trained and supported in making sure everything's in order. I mean, simple things like power of attorney for the family, and making sure the bank accounts are correct, and all that stuff. Even if you're just gone for three weeks, you've still got to think about those things.

The core institutions here, the organizations like FCOD and MOD and engineering, who were sending people overseas, had never had to deal with that with their people before. Programs generally work with the technical side of things and the budget side, and the people are handled by the institutions. Phase 1 was a little bit unique, because since nobody had any infrastructure of understanding of a lot of what we were doing, we ended up kind of doing it all, and with an extremely small staff. I think there's thirteen civil servants on the staff. At that time the shuttle had about 150. They're down less than 100 now. The station has over 300. So we felt kind of caught in the middle, and being asked to do a lot with a little, but people turned to and got it done. We had some contractors helping.

But, still, we were expected to take care of the personnel side of things because we were unique and it was Phase 1 related. A lot of things fell to the Phase 1 office that I hope will be done better by the institutions in the future. That's one of my goals, is to try to migrate functions to the proper places around the center and around the agency. And we're working on that now.

Davison: Did you ever set up any kind of ombudsman-type program similar to what the military has?

Culbertson: Actually, by coincidence, my wife is trying to set that up. She's been very active on the flight crew side, trying to help them with that. I want to evolve that into all the institutions. That's exactly what we need, is an ombudsman-type program. It's an evolving thing. It's hard to get people into that mode if they don't know what it is, but we'll get there. I want to see it done for all organizations and not just the flight crew who are training and on orbit, but for the people who are supporting ground operations in Moscow, who are doing engineering activities, Star City training, whatever.

Davison: You mentioned different aspects of the crew. Can you talk a little bit about crew selection on the shuttle-Mir, on the station? Should it be a committee that's involved? What parameters do they use?

Culbertson: There is a bilateral committee now for station that works the Russian and American crew selection. I'm not sure how sophisticated they are yet on their ability to select crews and to match them up, because we're still a little bit limited in who's available and who's qualified. Soyuz is limited a little bit because of size. There are other factors that are constraining us.

In shuttle-Mir, I'd say we were not sophisticated at all. We took whoever was volunteering, and FCOD chose the ones they thought would do the best in that environment, and then they put them in a list and we flew them in order. We had to make some changes because of early Soyuz limitations. We sent one guy over who was, it turns out, too tall. They thought they could make modifications and they couldn't. Then we sent one person over who was too short for a while until they finally agreed to make some modifications, but then she ended up not flying anyway because of EVA suit limitations. So that's another lesson learned that we experienced, that I think will be very valuable if it ever happens in ISS, changing out a crew member and how to make that happen. Again, that was done very well by everybody.

But as far as selection goes, I think we need, at the very initial selection of people under the astronaut office and into the critical flight controller, flight director positions, we need to think carefully about the type of people we're getting and how they would adapt to this type of operation versus the shuttle operation. And there are ways to do that.

You don't want to be too restrictive, because you want to get really good people into those positions, but once you've selected them, you need to think about what do we do to support them better, to make sure that they are psychologically, mentally, emotionally prepared, and their families are prepared, to deal with what's coming. Those are the kind of tools that we're trying to identify and ways to make it easier. You can't just hand somebody a piece of paper and say, "Okay, you're assigned to this flight. Go off and do it and make it happen, and ask for whatever you need." It's not that simple. It's a lot more complicated, a lot more intrusive, has a longer-term effect on you than a shuttle flight. It's easy to name a shuttle crew and tell the commander, "Put the crew together however you want. Make them all work. Feed back to the training system what you need, whether it's going well or not, and put together a new mission." And a good commander will do that, and the system responds to that. Of course, the same thing goes for flight control teams for the shuttle.

But for long-duration flight, first of all, once we launch that first increment, the mission has begun and it will not end until we bring that ISS down. It will be a continuous mission. It's a different way of looking at things than we have in the past, a different level of responsibility for people, different anxieties, different needs. Also, with the shuttle flight there's a finite end and you know that as it ramps up and the training gets hard, certainly you're going to go fly, it's going to be a lot of fun, a lot of work, but a lot of fun, and at the end of it, it'll be over and you can go off and do your post flight and get ready for your next mission.

Station, it's kind of like it just lasts forever. And even after you've flown, the physical effects of it will last a long time. There will probably be emotional, psychological effects that may or may not last, depending on how you deal with the isolation and the family separation. There will be experiments that will want to continue gathering data on you for long periods of time. So the mission is not just the four to six months you're on orbit; it's years. That's a totally different way of looking at things, so we have to select people and train people who can do this. It's going to be a challenge. Like I said, it's going to be harder than people think and it's going to be harder than Phase 1.

The Russians already had a station and a system in place to take care of all this, and we sometimes fit poorly, but we fit. And they helped guide us on occasion or pushed us on occasion, but they already had a system going. ISS is going to be different.

Davison: What were the safety and operational risks involved in the program, and how did the benefits outweigh the risks?

Culbertson: There are always risks in space flight, and that's something that we all accept in this business. You incur different risks on the Mir than you did on shuttle. A lot of them I don't think we really understood at the very beginning of the program. We understand them pretty well now. The risks are acceptable based on what we're accomplishing in benefits to the program and the fact that you always have a Soyuz as a way home, and the Soyuz we see as very reliable and always has been.

Each Soyuz is no more than six months old while it's up there, even though people talk about how old the Mir is. Age was a factor that I think people looked at early on, but did not see as a major risk in the base block. Two of the modules are less than three years old, which is not very old by station standards. So you've got a mix up there.

But we learned as we went and as we were given more insight into the Russian hardware and the way they operate, some of the good and the bad. They had some design flaws in there that they will not repeat and we will not repeat on ISS, such as an outward-opening airlock hatch or bimetal contact on thermal control loops, and some of the integrated systems, things like that. It was an early design, and you learn as you go.

I think they had anticipated the Mir lasting for ten years or more, but there was a period of time when they had very little infrastructure support to make sure that that happened in a good way, so they were kind of operating on a shoe string for a while, which affected their ability to respond to problems like ethylene alcohol leaks in the depressurization. They've recovered very well. The Mir is extremely capable right now, probably in better shape than it's ever been, more volume, more power, more thermal capability, so it's operating very well. But it is old and it is taking a lot of maintenance.

Initially the agreement was we would assure the safety of any cosmonauts on the shuttle and they would accept that, and they would ensure the safety of any astronauts on the Mir or the Soyuz and we would accept that. We did that pretty much on faith. They knew what they were doing, we knew what we were doing, and we didn't require a lot of justification or documentation of risk factors or redundancy or things like that. We tried to get some understanding of it and they did of us, too, and they asked some good questions, like, "Why don't you wear stiffer boots if you have to bail out? Won't the crew break their ankle if they come down on land?" That's a good question and we didn't have a good answer for it.

There are other things on the Mir side that we had questions about, and we evolved into more of a partnership, more of an integrated working relationship than what we initially had, which was kind of, "You have your part and we have our part, and you'll trust us and vice versa."

Particularly when they had the fire, the ethylene alcohol leaks and the depressurization, we started looking more closely at why did these things happen. What were the risks if they reoccurred, and how could they be handled safely? And we did a lot of reviews both internally and jointly with the Russians. I believe we have a good understanding of what the risks are based on that and the debriefs of the crew members. In general, the crew members have said that the things they bring up are mainly comfort items, which affects them psychologically, which, of course, the ability to operate, and they're not minor, but still they're not life-threatening necessarily or mission-success-threatening, though that could be a factor.

The structure appears to be sound based on all our people who have been up there and looked at it. In fact, our analysis shows that it could withstand another Progress collision and still be okay. Not that we would want to test that. But a pretty robust piece of hardware.

The Soyuz is always available and in an acceptable amount of time. It's hard to envision anything happening so fast, so catastrophically, that you couldn't get to the Soyuz in time to get away unless it were almost an overwhelmingly catastrophic situation, which the Soyuz isn't going to do you any good in anyway, like a mile-wide meteor hitting you, something like that.

So most of our people up there have felt very comfortable that they could get home if necessary. They may not able to save the station, but they could get home, and they could do this. They have great confidence in the Soyuz, and our experts all feel the same way and I feel the same way.

So the questions that were asked about the risks were good. I didn't appreciate the attitude of some of the people towards the space flight that we had to put up with, but this is America and everybody has a right to their own opinion and free speech. But that's part of the job and part of the learning experience in justifying what we do, and I think we should justify it and we should be able to justify it from both a risk standpoint and a benefit standpoint.

The benefits are immense, and I've tried to cover some of those in our discussion. The benefit of evaluating the risks and being able to do that is a big one. The benefit of figuring out a way to keep the station going in adversity is something that I hope we are learning. It was very discouraging to me when there seemed to be so many people in the media and Congress who just wanted to walk away from everything when it got tough. That's certainly an easy way out and you certainly guarantee that nobody's going to die in a plane crash if they don't fly, but you don't accomplish much by staying on the ground if you want to accomplish things in space. This was an excellent way for us to learn from people who've been doing it a long time. It was a satisfactory, if not pristine, vehicle to be in, and we were able to conduct operations and conduct science, and we could do it safely.

The benefits, again, were often unexpected and it was very hard to say, "If we do this, this, and this, you're going to see this, this, and this benefit." You can say, "We're going to accomplish this and this if nothing breaks and things go well," but the benefit is TBD in many cases. Plus when things happen that you can't plan, such as depressurization, and you learn from that, what price do you put on that? We're far better off in ISS and operationally having experienced the fire and the collision and the depressurization than we would have been otherwise, but you can't put a price tag on that because you can't plan it.

It's like most of the improvements to aircraft travel nowadays due to accidents that occur to somebody. Particularly in the safety area, in survivability and landing capability, all that is increased because somebody had a problem, and probably because somebody died. If you don't learn from those things, then you're not paying attention, and that's what we do in this business, we pay attention to what happened. If it was a close call, we identify it as a close call, and probably sometimes you just go, "Whew, that was a close call." But you ought to go in there and dig and figure out why that happened and how you're going to keep it from happening in the future.

If you look at the history of the shuttle program, even before Challenger we had an incredible number of close calls, what I would consider close calls. Some people might say we were really lucky that some of these didn't turn into disasters earlier. I think the reason they didn't turn into disasters is for two reasons: one, we had an excellent design, with sufficient redundancy, and redundancy worked; and we had really good people who could respond to the unexpected and react accordingly, appropriately. For instance, the engine shut down on STS-51F, I believe it was, and that could have been a [unclear] very easily. And who knows how that would have turned out. But-what's her name?

Davison: Jenny Stines?

Culbertson: Jenny saw what was happening with the sensors and took the appropriate action and saved the vehicle. You couldn't have planned for that, but that was a close call. It could have been a disaster. But should we have stopped flying because that occurred and we hadn't foreseen it? Did anybody vote for that then? No, I don't think so. But this is part of space flight, and that's the rationale for continuing. As long as you know what happened and you know how you're going to do your best to prevent it in the future, and if it reoccurs, how you're going to react, then you're doing the appropriate things. If you stick your head in the sand and say, "Boy, that was a close call. Hope it never happens again," then we're not doing our job, not being very professional.

It's hard for people to accept that things are going to go wrong in space. I really worry that if something doesn't fit on ISS and we have to bring it back, or if the crew's up there for a while and something breaks that we didn't foresee, didn't work right, there's going to be too many people who are too vocal, just throwing their hands up and saying, "It's not worth the effort. It's too hard." And they won't be in NASA or in our contractor team, I don't think, but they'll be out there, and some of them have a lot of noise to make to get attention. I just don't think that's a good example to set to our people or our children, to say that if things get tough, we walk away from it.

Davison: You have to learn from your failures.

Culbertson: That's right. And I could go into a long philosophical discussion about why society is the way it is, because too many people walk away from their problems rather than dealing with them.

Davison: Maybe another tape and another interview.

Culbertson: Maybe so. Next life. But I think that's, again, a benefit of Phase 1, is relearning what types of problems we can deal with, and how to deal with them, and the fact that they are going to occur, and that you have to persevere. It is worth it. We continue to learn new things. We are not going to go back to the moon or Mars if we don't build a station successfully and operate it successfully, not in our generation or the next one even. This is something we need to do to get back out into space.

The Apollo program was kind of like the Scandinavians coming to North America early on and then getting a little bit out of it and not really capitalizing on it until other Europeans came later and began to settle it. There was, what, 200 years in between those two events? It's already been a generation since we went to the moon, or more. The last landing on the moon was twenty-five years ago, twenty-six now, almost. It's incredible, to look at it from our time span, that we haven't done more, but looking back on it in history, it will probably seem pretty normal, because once we go again, we'll be there to stay. Mir and ISS are going to be the stepping stones that will enable us to do that, because people have been in space to stay on those vehicles, not just to go for short trips. It's getting there to stay that's important. If you do research while you're there, then you're maximizing your effectiveness, and you should be doing research, but the main thing is to get there and stay there. Who knows what the benefits will be. Look how hard it was to live in this country when people first arrived from Europe and other places. It was tough.

Davison: Space is a frontier. You've just got to keep reminding people of that.

Culbertson: That's right. And I think too many people believe too much of what they see on TV, that it's like studio space, and it's a great place to float around in. In fact, we make it look too easy. But I wouldn't have it any other way. When the drama enters, people occasionally realize there are real lives at stake and maybe it's not worth it, but it is. And it's not a piece of cake; it's very, very hard to fly in space.

Davison: Do you think that the Russians would have been so willing to change if they hadn't had the international exposure when these incidents happened-the fire and depressurization?

Culbertson: That certainly was, I think, an important factor, the fact that people now are looking at them through an open window rather than a closed door. They were not able to control the amount of information that went out or the types of information that went out. That was a new environment for them, particularly when things were going poorly and they were under a lot of scrutiny. I think that they learned a lot about how the rest of the world operates and how they're going to need to operate in the future through these whole experiences. So I think it was a growth experience for them and a shift in their mind-set on how to deal with these kind of problems.

We also spent a lot of time with them on saying, "This is the way we deal with a problem like this." They have a similar system of investigation and evaluation; it's just not as open, nor is the structure the same way ours is. We now realize we need a common way of doing this, because when an event occurs on ISS-not if-but when an event occurs on ISS, we're going to need to jointly evaluate it with all the partners that are involved in it, so that we reach a conclusion and solution that's satisfactory to everybody concerned, and that there's enough rigor in it and discipline and depth that you know you've got the right answer and that you're going to be able to fix it.

Davison: We talked a lot about operations. We haven't really touched on training and engineering. What was the Russia philosophy for training and engineering?

Culbertson: You could spend a long time on both those subjects. Their training philosophy is more oral than ours. We tend to now work with a lot of printed material, computer-aided education. I started grade school in the fifties, and they seem to have a similar philosophy to what I was exposed to when I first started in education-a lot of lectures, a lot of memorization, a lot of tests. So they'll have a lecturer talk to you about the systems and they show you a few pictures and a mockup of some sort. Then you have an oral test of what you've learned, and practical test, but a lot of it's done verbally rather than written. Our people were frustrated because there wasn't enough reading material to study beforehand. There was some, but most of what you got, you had to get out of the lectures.

So they have a different approach to education than we do, and a lot of it's grounded in their own educational system. You tend to repeat what you learn, the way you learned as you came through grade school, high school, and college. So the cultural differences really come out in a situation like that.

The impression of a lot of our people, particularly initially, was that it was not very efficient, that we could come in here, clean house, and do all this in a couple of days and everybody would be thoroughly trained. The Russians, for their own reasons, and I think a lot of it based on practical experience, didn't agree with that, still don't agree with that. They still believe that you need a certain amount of this type of training to be really ready to do what we're asking you to do.

I saw a note just recently from Dave Wolf, who, in retrospect, says, "Maybe that was the right way to do it. It made me learn the systems in a different way than I would have otherwise. It made me think about them rather than just read about them, and it made me exercise the language and the jargon." Because you're not dealing just with the Russian language versus the English language; it's like when you first come to NASA. I mean, how many of us understood the first lecture we sat through at NASA? I mean, it was like a totally new language.

Davison: A different set of acronyms.

Culbertson: Absolutely. And Russian space language is different than Russian. So anybody coming into that kind of a program has got to learn the glossary of the language. It's like going to med school. Those men and women spend hours and hours memorizing all the glossary at med school, and it's kind of the same thing in the space program. You can't afford to have the wrong term in use when a life is in your hands.

I could go on a long time about the training and stuff. It would probably be better to talk to folks who went through it themselves, to get the meat of that. Some things were very similar. They do survival training like we do, for kind of the same reasons. I think that they put different stresses on their people who are in training to evaluate their readiness to fly and to prepare them for difficult situations, differently than we do. It's not always obvious to us that that's what they're doing. We think, "Why in the world do you want to do this pressure chamber test? I know how to get through this. It's not a big deal." My theory is that there was something else in the original plan as to why they do that. Some of the Russians who are executing may not even remember why, because they've been doing it for thirty years, but I think it was a psychological stress on folks to do things in this particular way. And that's not all bad when you're getting ready for a difficult mission like this.

Americans are always saying, "Well, why do I have to do it that way? You've got to tie this to some training objectives that's going to tie to some mission objective. I don't want to waste my time with all this other abstract stuff." So it's difficult for people to be patient with that.

I had a little bit of experience with that when I was at the Naval Academy, because a lot of the stuff they did to us was pure crap, in our opinion, when we first started out. It seemed so trivial. Why memorize all this stuff and regurgitate it all the time? Until I realized, when you're in combat, you don't have time to read anything; you've got to have it all memorized and you've got to know what you're doing and you've got to know what it means, and you've got to be able to respond instantly when somebody asks you a question or tells you to do something. And that's more the Russian training philosophy.

So it may seem trivial, but a lot of these things are steeped in what seems to be tradition, but actually experience, that this is the kind of person and the kind of performance that you want to get the job done best. When you start diluting that too much or lopping things off without some thought as to why they were there in the first place, you might lop off an appendage that keeps bleeding and you can't stop it. But you may not notice it for a while. So we have to be very careful about judging too harshly what somebody else has been doing for a long period of time, and what seems like either ridiculous traditions or cultural isolation may really have valid rationale behind it.

Davison: How will the operational experience from the shuttle-Mir program benefit the international space program?

Culbertson: Oh, in dozens of ways.

Basic engineering, of course, is engineering and analysis and structure and electrical engineering is pretty much the same on both sides. The educational systems are excellent on both sides. But once you get operational or out in the field, we have different ways of doing our engineering, different ways of developing hardware, different ways of testing it and analyzing it. We, of course, have gone into more of a computer-oriented system of engineering where we do a lot of analysis, a lot of studies. A lot of our work is done on paper, where the Russians are still-and with good reasons, I think-in the mode of doing more testing than analysis. They do plenty of analysis and they have a pretty good predictability on their testing, but they will test a piece of hardware to ensure that it will operate in the envelope that they want it to operate in. So they're not surprised, or rarely surprised.

For instance, before they launch any module to space, they repressurize it in a vacuum chamber down at M____, right before launch, to make sure everything is good after they've done all the modifications and loading of it and everything. We were not planning on doing that. I think we will now, on ISS. But, for example, we don't put the shuttle in a vacuum chamber before every flight, and a lot of the components. So it's a different approach, and I think combining the two approaches is going to benefit all of us, and people are learning what's best from both sides, and using each other's tools. So I think we're evolving into a better way of doing business.

We tended to have a lot more computers, a lot more sophistication in that area than they did. A good example is, early on when I'd go to a review over there-if you go to a review here, you see a lot of viewgraphs and people cranking through their presentation. I don't know if you remember in grade school, we had a lot of roll-up charts all around the classroom, and when you'd study some part of the world, the teacher would pull down this roll-up chart and you'd look at it. When I was in college, any presentations you made, you generally made these big huge charts on either butcher paper or on a roll-up thing, and that's how you showed your graphs and your diagrams and all. And they still do that. That's still the way they present information, on big roll-up charts.

So, somebody works very hard in draftsmanship and mechanical drawing and they put out really good charts to give you a lot of information, but they're not the computer-generated ones and they're not viewgraphs, though they're starting to evolve into that. But when we first got there, there were almost no viewgraphs or computers at the individual level. Occasionally a company would own a few, but it was not a common piece of hardware or way of presenting information. That makes it seem more strange to us as we go back and forth to each other's country, because you're not used to seeing things you're used to, in a format you're used to.

But from a basic engineering standpoint, we found the folks on both sides to be very cooperative, to work together very well, to communicate very well, and to accomplish great things. The orbital docking system led by Dave Hamilton and his group was a great example of two groups getting together and resolving their differences early on and coming up with a piece of hardware that worked. It's worked extremely well. The docking module itself, with Don Noah and that group, is also very good. So at the engineering level, the folks like working together.

Davison: I think in some of the early interviews, when the Russians agreed to build the docking module, they said they could do it in a remarkable amount of time, and NASA said, "You can't do it that quick in Russia." "Sure we can." It kind of shocked them. I thought that was interesting.

Culbertson: I have rarely found them to be wrong on estimates like that. Their only unknown nowadays seems to be money and people resources, which is tied to money. The docking module they finished on time, on cost. FTB was finished on time, on cost. We paid for it. Service module-they don't have the money. It's behind. Spektr and Priroda, once they figured out the funding situation, they didn't launch them when we told them we wanted them launched, but they ended up launching them when they said they were going to launch them, based on the way the money and everything flowed in.

They knew how their system worked and they knew what they were doing, and they make good estimates. We didn't always believe them, because we didn't want to believe them. We wanted Spektr up there in February. They said, "It's not going to go till May. Okay. If you want to say February, say

February, but it's not going till May." It went at the end of May. And same thing for Priroda. They were very realistic about what they could do, based on the resources they had.

Now, you could argue all day about the prioritization of resources and whether more money should have come to this or that, but once they were given their allotment by the government, they said, "This is the way it's going to be. If you can change something, have at it."

Operational things we've learned from Mir? In addition to the top-level ones I mentioned already, I think we've learned you can go into a lot more detail about communication priority and communication capability. The Russians actually are being fairly innovative in looking at new ways of improving communications. They know that's a limitation on the Mir. In fact, they're working with space [unclear] on an INOCET [phonetic] type system that would provide basically cell phone and fax capability from orbit, which we don't really-we have it in a different form.

Being able to apportion the communications capability, to plan them, you know, a lot of us have heard the story that on Skylab the crew got so irritated with the ground, they just shut off communications for a while, and that's, I think, because they had limited com capability and you had to plan it around AOS at the ground sites. There was no TDRS in those days. You couldn't just call when you wanted to talk to somebody. So you'd come AOS-and I see this on the Russia side-you'd come AOS, you've a whole bunch of stuff you've got to tell the crew, you've been saving up. They've got a whole bunch of stuff they want to tell you, or maybe they don't want to talk to you at all. But to be in sync both data-wise and emotionally is really, really difficult. It's like being gone on a long trip. You come back in the house, the kids and the spouse have all this stuff they've been saving up to tell you. You're tired, you've got stuff you've been wanting to tell them or not tell them, and you just want to relax. To get that in sync every single time you walk in the door, even from just a day at work, is extremely difficult.

And it's the same problem when you're dealing with limited com, because if you come up on the com pass and say, "Okay, we're here, blah, blah, blah," you start talking about everything, and they say, "Wait a minute. This broke while you weren't looking. So start over." Or the crew will start telling you something and the ground will say, "Wait. We've got a solution for you. We've been working on it." It's really a telephone game. The Russians call it a telephone game. So you've got to be careful about that.

Some of our ops leads who did most of the talking, along with the flight surgeons, to our crew members learned how to do it very well. They would come in very relaxed at the beginning of a com pass, not jump right into some kind of set agenda. They would come in as positive as they could and then react to the crew members' mood, to try to fit in with them. If they didn't get everything said or done, you wait till the next time. So, again, it gets back to this American impetuosity and haste to get everything done.

"Look, I've got this whole list of things. I've got to say it all in ten minutes. I'm going to talk really fast." "But wait. I wanted you to listen to me." There will always be another com pass. You can wait. So you have to learn how to structure the com and how to treat it as a resource, not just as a convenience.

The same thing is going to be true on ISS, because despite the fact that we have continuous TDRS coverage, we're not going to have continuous TDRS availability, as you probably well know. So I think we're going to have to learn to be a little smarter about it in that regard, too.

The other side of the coin is something we've seen on the shuttle, where if you call them every time you think of something to tell them or ask them, the crew is going to be in the middle of something, and if you don't have them on video, you don't know what they're doing. If you keep interrupting them, you're going to end up with a Skylab type of situation, or like one of our space lab missions. "We're not robots up here. Leave us alone. Let us finish the job you gave us. Quit bugging us." And we've all experienced that before, one way or another.

Davison: You talked about communications. I think one of the lessons learned at space station, the ISS did, was they came up with early com. It wasn't originally in the design, and they saw how the shuttle-Mir program was going, and they said, "We need to be able to have this capability." They developed it in house.

Culbertson: Yes, it needs to be there when you need it, and you need to discipline yourself to use it appropriately. It's like any other very valuable tool. You can't treat it lightly or abuse it, but you sure want it available when it's necessary.

Davison: One of the things that some of the crew reports talk about was private communication lines, whether it was medical or with their family.

Culbertson: It's critical. It's critical for somebody in an isolated situation. People have survived without it. When I first started to go to sea in the Navy, other than letters, which are very highly valued, I had no way of communicating privately with my family. If you called somebody on the radio, everybody's listening. If you called on the ham, the whole world listens. Same thing is true on the Mir right now. Even email is dubious in terms of its privacy, though it helps. So that's going to be an essential part of the mission, that has to be maintained. We're pretty good with it on the shuttle because of our encryption capability. Mir, if it has it, we haven't been allowed to use it. So that's something that will be a part of ISS. I understand it's a hardship for the folks that are doing the Mir program, and we've tried to mitigate that as much as we can.

Davison: How did the increment teams develop with the different crew rotation? You had an ops lead, like you mentioned before.

Culbertson: That's a good question and an interesting evolution. To go back a little bit in time, when space and life sciences was running space lab missions, they were treated as a separate part of the operation during the mission itself and had their own line of communication, their own CAPCOM, and generally they would use backup payload specialists to communicate with the crew during that time. Well, I found out part way through Norm's mission, I said, "Why don't you have someone designated as the CAPCOM to talk to the crew?" They said, "Well, we thought Bonnie, as the backup, was going to be our CAPCOM." I said, "But she was training for STS-71." "Oh, yeah, I guess you're right." And so they didn't think about the fact she's have to come back for training and wouldn't be available to talk to Norm about all the particulars of the mission. So they were kind of winging it.

The flight surgeons were ending up doing most of the communication. Fortunately, we had two of the best guys in the world, Dave Ward and Mike Barratt, who just were incredible in their capabilities to learn the Russian language, practice medicine, and do all the operational and training things that needed to be done. I mean, these guys were just amazing. Without their ability, we'd have had a really hard time on the first mission. I mean, they deserve all the recognition you can give them in terms of performance.

We realized that that wasn't going to work for the long term, and we needed to get a flight surgeon out of the ops business, not because they couldn't do it, but because it just was too much crossover. We needed to designate somebody to talk to the crew. At that time Tommy asked MOD to provide to Rick Nygren's group, who was managing the mission from a research standpoint, what we ended up calling an ops lead, to act as both the CAPCOM and a leader of the team from an operational standpoint. I designated some people. Bill Gerstenmaier was the first one. Again, a tremendously capable individual who really threw his whole heart and soul into it and did a great job, and established some procedures that have carried forth.

The program's been expanded and improved on since then, but basically what we evolved to was a team of people that are together from early training through the mission, through the post flight, and that's the crew member, the flight surgeon, and the ops lead. Our goal was to have those three people become a good solid team and stick together through training, know the mission very well, and be able to execute it together. And that ended up working out in the long run. It was some hardship on folks because it's hard to stick with a mission like that, especially if you're not the crew member, but people did it, and I think we're going to need some kind of similar concept for ISS. It will be a different look, but you'll need somewhat the same thing.

The crew needs somebody to be their spokesperson when they're going through training and when they're on orbit, who understands what they're going through, what the difficulties are, what they're thinking, how they approach problems, things like that. We had one mission where we didn't really have that because the ops lead didn't work out, and we didn't have a good solid team. It made it harder for the crew member, harder for the team, too. And you need to start that way back in training.

At least on the shuttle missions I was on, on my last one, between the commander and the lead flight director, we started to establish the same relationship where we knew what each other were thinking and involved each other in the things we were doing. I think you'll need that same type of relationship for the increments, and even tighter, for a shuttle mission, though you'll need some backup capabilities and interchangeabilities just because of reality. People are going to get sick or plans will change or whatever.

Davison: We have time for one more question here. What do you feel is your most significant contribution to the Phase 1 program?

Culbertson: To the Phase 1 program or of the Phase 1 program?

Davison: Your personal.

Culbertson: My personal contribution. [Pauses]

Davison: You don't have to be modest.

Culbertson: I'm trying to think of anything. It was a team effort, obviously, and a lot of people contributed a heck of a lot. What I hope I did was identify, acknowledged, and enabled the people who did have talent to do these kinds of things, to go do their job, and not get in their way. I think that one of the things I was able to do, not through any special talent, because I just happened to be the person in the place at the time, but because I really believed in the program and figured out how to communicate about it, was the ability to explain to the outside world what was going on through the most difficult times. I think I was reasonably effective at that.

Davison: Very effective.

Culbertson: Keeping the uproar down.

Davison: Thank you. It's been very enlightening.

[End of interview]