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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

JAMES VANLAAK

March 12, 1998

Interviewers: Mark Davison, Rebecca Wright, Paul Rollins

Davison: Today's interview is between Jim VanLaak of the Mir-Shuttle Phase 1 Program and myself, Mark Davison, from SIGNAL Corporation. We're going to ask Jim some questions about his work and involvement in the Shuttle-Mir Program.

Good afternoon. With respect to policy, what benefits do you think resulted from the Shuttle-Mir Program?

VanLaak: Well, I don't know exactly where you draw the line on policy, but clearly the turning point when we decided to bring a former Cold War adversary into the International Space Station Program is what really put the emphasis on Phase 1. Prior to that it had been a couple of flights, an American on the Mir and a Russian on the Space Shuttle, which would have been an interesting exchange and some cultural contact, but nowhere near the integration that has occurred as a result of International Space Station and then the additional flights of Phase 1.

I think that it represented the inclusion of the space program as a major element of foreign policy, whereas previously I think the Apollo Program was, in a sense, a statement of foreign policy and the competition of the Cold War. Now the space program is kind of the closure of what used to be an adversarial relationship into one of partnership. For me, I think that's the most significant thing and it's what makes me feel that my contribution here has real value.

Davison: Kind of a follow-on to that question, what specific knowledge or experience from this program will benefit the International Space Station?

VanLaak: Well, this is something that has been misunderstood and somewhat misquoted from time to time. Fundamentally, NASA understands Space Shuttles very well. We've been flying the Shuttle for a long time and we are clearly expert at conducting that kind of a short mission, what I call a sortie mission. Basically people spend many months getting ready, they go fly ten days to sixteen days or so, and they come back. Every moment of that mission counts, has to be optimized. The training builds up for many months and is tuned to that specific set of activities to occur within a short period of time.

In addition to that, the Space Shuttle vehicle is optimized for many months. Approximately a million man hours of touch labor goes into the Shuttle to get it ready to fly that one mission. It is ready. When you transition to a Space Station environment, you have a continuous mission that goes on for many, many years. Crews come and crews go, but fundamentally they have to be trained months in advance of some of the activities that they do, with various kinds of refreshers that we provide them, but, nevertheless, they're not at the peak that they were when they prepared for a ten- or fifteen-day mission.

In addition, the vehicle itself is, of course, going to be maintained by astronauts on orbit and logistically supported by a train of launch vehicles coming from the ground. There's a development of a spare-parts plan, a logistic support plan basically and a maintenance plan, and it also reflects back on the original design of the vehicle to make sure that it's supportable in that environment.

Those things we understood intellectually as we were approaching the Space Station Freedom and then the early days of what was renamed International Space Station, but it wasn't until we became involved in the day-to-day operation of the Mir and became partners in the sense of the decision-making for logistics and other daily activities that we began to appreciate how complex and how intertwined they are, and we had an opportunity to challenge the mental models that we had and the actual former analytical models, but I think, more importantly, the mental ones that we all carried around in our heads, as to how things were going to go and what our preconceived notions were telling us about the reliability of U.S. hardware and so on.

We fundamentally discovered that if you run a spaceship for fifteen years or ten years or whatever, everything's going to break at some point, so you need to be prepared for that. You have to have either spare parts on board if it's critical, or if it's noncritical, a way to live with the inconvenience of the problem until you can get spare parts up there, or workarounds, whatever the appropriate technique is.

So what we've had is the opportunity to go from abstract concepts of how we were going to do it, to the practical application either by directly involving our processes or by following and, if you will, mentally modeling if we had done it as opposed to the Russians, what would have happened had we chosen to do our thing instead of watching the Russians do theirs. We did that kind of "what if" process throughout this time.

Those of us who have been directly involved have learned a great deal. We've learned how arrogant we were in some areas. We've learned that some of our deeply held mental processes were built much more around the sortie model than we thought. We became comfortable with the idea that if things got bad enough we could somehow save the vehicle and come home. Well, as a practical matter, that may not be a very good option, so we have learned how to engage those problems and how to deal with them.

Davison: To elaborate on the logistics and the maintenance side of it, what was your involvement in the Mir improvement program or the logistics that were brought up on Shuttle? This was the first time that Mir was able to bring hardware back, and we ended up, I guess, transferring quite a bit of hardware back and forth.

VanLaak: Well, there are a couple of aspects to that. The Mir Life Extension Program was really before my time, so I can't comment on that very much. Dennis Webb or someone can help you with that.

The aspects of maintenance of the Mir that we've learned about are many and some of them are quite subtle. One of the more interesting, of course, is the fact that the Russians have never had the luxury of bringing things back before. So the fact that they could get computers back and see what failed, and refurbish them and refly them, or at least just do the failure analysis and design out failure mode, is something new to them. Now, I need to qualify that by saying they do extensive testing on the ground. They do much more testing in general than we do. We have the ability to do a lot more analyses, so we analyze the daylights out of things, whereas they test. Nevertheless, there's no substitute for being on orbit in the actual environment and seeing how people actually use the hardware. They didn't catch on to that immediately, but once they did, they made every opportunity to take advantage of it. In addition, they had some problems with some of their suppliers. For example, the Kurs radar units and whatnot that are made in the Ukraine have, for various reasons, been difficult to obtain, so they were glad to be able to retrieve those and get them refurbished for flight.

I would say that we learned less in terms of the value of those than the Russians did. On the other hand, we did participate with the Russians in terms of understanding what--or trying to understand--what spares they keep on board and how they manage a critical system. There were a number of times when we pushed the Russians to get an additional computer on board, for example. This past September time frame when they were having repeated failures of the attitude control and motion control computer, as it's called on Mir, they had one ready to fly on Progress in October, I think it was, but we said, "We've got room. We will make room. Let's take one up on the Shuttle in September." So they got us a refurbished unit that we flew up on the Shuttle and we also flew another unit up, either of new manufactured, but of higher quality, on the Progress to follow. So they ended up with two functional spares, whereas they were prepared to live with one. So we did that on the basis of detailed discussions with them to understand the systems and not just on a higher level philosophical thing. And we learned a lot about why they do what they do in terms of their sparing policies and what the repairability of their components are on orbit.

Davison: How do the Russians view redundancy of their vehicle versus the redundancy that we're trying to build into the Space Station or the redundancy of the Space Shuttle? Are they similar or do you see differences?

VanLaak: Well, there are significant differences. They have more to do with the repairability of the hardware than anything else. I guess I would concentrate on two differences. The first is, the Russians are more inclined to favor dissimilar redundancy. For example, in the area of oxygen production, which is clearly something that's important to keeping people alive, they have a number of different systems. The first is, they transport gaseous oxygen up in bottles that they just vent into the atmosphere. Second thing they have is the electron systems, and there are two of them, that electrolyze water and break it down into oxygen and hydrogen. They vent the hydrogen overboard and, of course, the oxygen into the cabin for breathing air. The third thing they have is the oxygen candles. That is a system that although a failure of it, as yet not fully understood, canister, individual canister, caused the fire on Jerry Linenger's visit, that is a very reliable system that has been burned--they have consumed thousands of candles on the ground as well as in space, over 1,000 certainly on the Mir, maybe several thousand. I've lost track. And without failures. So it's a very high-confidence system. Unfortunately, it did have one gross failure. But they've reviewed and stepped up the quality-control program on the canisters and so on, and we see no credible mechanism for that to reoccur. So additional safety steps are in place on orbit to control the hazard of using them, but we have confidence that they'll work.

The other point I wanted to make on the subject of redundancy is along the lines of repairability. They have very simple systems relatively. Many of these systems, it's unfair to call them simple, but they are more inclined towards a hardware solution that a person can open up and fix than they are toward a totally solid-state solution that you throw away if it doesn't work. They, of course, have things that have the equivalent of firmware controllers on them and they have software and so on that's difficult for an individual to just change on orbit, but at the same time they have many units that have common hardware such as fans and pumps and things. If you have a failure in one critical location, you can go steal a fan or a pump from another noncritical application and move it over there.

Another interesting element is that several of the modules have components like--well, they all have an attitude control system on them because they all flew up there autonomously. The only module on the station that didn't fly up there autonomously is the docking module that we transported up in the Shuttle and put on with the RMS. Every other portion of it flew up as an independent module and docked to the station. So when they had a failure of one of their attitude control sensors in the base block, they ran a cable over into, I believe it was Priroda, but I don't honestly recall, and they were able to take attitude control data from that module and wire it directly into the main motion control system.

So it's a very flexible process. If you look at it compared to the technique that we use for our portion of the Space Station, you'd say it was suboptimum, because you have components that don't get used after the initial flight or are not optimized to a narrow optimum for their final application. On the other hand, they give you the capability to redirect those assets and use them as may be required by some circumstances in the future. Very flexible.

Davison: This next question is about funding. How was Phase 1 funded?

VanLaak: I don't really--Jim Nise is the right person to talk to about that.

Davison: Okay. I thought so. One thing that is somewhat related to funding, but let me ask you this question. When you mentioned the Priroda and the Spektr modules made me think about that. Are you familiar with any of the funding of Phase 1 that helped bring those modules up? Was that part of the negotiation, do you know?

VanLaak: It was, but again that was really before my time, so Jim's better to address that.

Davison: How did the Phase 1 Program specifically benefit the American and Russian space programs? I think I already asked that. I'm repeating myself. The second part of it was, what effects, if any, did the program have on the relationship between the United States and Russia?

VanLaak: Well, let me address the first question for a moment. You'll recall in 1993 we had a bad year for the Space Station Freedom Program. That was the year of the redesign. It was also the year that the Space Station Program survived in the Congress by a single vote. At that time I happened to be part of the transition team in Crystal City, and although we were working sixteen hours a day, seven days a week, we did come up for air long enough to recognize that it had survived by a single vote, and we knew that we were perhaps bailing the last gulps before the big wave was going to come over the bow and take the ship under.

It was the introduction of the Russians in the program that changed the Space Station Program from principally a technological activity into an arm of U.S. foreign policy, and I have absolutely no doubt in my mind that that is what allowed us to survive that year. We survived the one vote more or less on the basic merits of the program, but there were sufficient challenges in the budget and other arenas that we all felt that--or some of us, such as myself--felt that come the next year, that one vote might not be there. So it was the dramatic change in the whole balance and tenor of the program by including the Russians that made the difference.

At the same time, the Russians didn't suffer from lack of public support in their own country; that they suffered from was lack of financing. I think that the core team that remains there today might not have remained had they not seen the prospects for a future in front of them. By entering into this long-term agreement with the United States, I think that made their program more secure or more real perhaps in their eyes. I've never asked that, but I think it's true.

The second question was relations. I'm not quite certain at the national level how to address that. I will say that for many individuals who had heretofore conceived of the Russian people as on the other end of the rifle in a military situation, it changed them from being that kind of a character--a cartoon character, if you will--to being real people. It certainly has changed my view of them and the former countries of the Warsaw Pact and so on dramatically. I think that one of the most interesting things in my life, and probably for everybody, was going to Red Square the first time and Lenin's tomb and into the Kremlin.

On one occasion I was in Star City, which is where they train the cosmonauts, and I heard an airplane take off. It is a military base, basically. I looked out the window and a MiG-23 was taking off, which is an older Russian airplane, but it's one that was front line when I was in the Air Force, and one that I trained to fight against. And it was loaded wall to wall with bombs. About forty minutes later, it came back and there were no bombs on it at all. Of course, they'd just been dropping into Chechnia to spread sunshine down there. Nevertheless, you know, at that time it was clear that there was a real military element to this, that this was still the former Soviet Union, and that these people we were meeting with were twice and thrice heroes of the Soviet Union and so on, and yet they were flesh and blood people with their own concerns and their own families. One doesn't have to look very far in Russia--in fact, you can't escape the fact that their economic strength, the individuals, their economic well being is much less than ours, their standard of living and so on.

So I think that insofar as the relations between the countries is built in large part on the feelings of the individual citizens of both countries, I think this has been a watershed event. I know that many Russians were suspicious of us, probably jealous of us for our material wealth and those sorts of things. I feel confident that a great many of them have come to understand that we just live in a different culture. We're still good people with sound moral values and so on, and that they can come to trust us as we have learned to trust them. So in the aggregate, I think it's been a wonderful thing.

Davison: The flip side of that question, what difficulties were experienced in integrating the American and the Russian space program?

VanLaak: Well, quite a few. There were probably many that I do not know of because the hardware things occurred before I got involved on Spektr and Priroda, bringing our science hardware in there and so on. At the same time, there was deep-seated suspicions on both sides. Various people from the Russian delegation were whispered to be members of the KGB, collecting everything they could possibly find to take back, and all different things of that nature, some of which I'm convinced were nothing but empty rumors, but I have no doubt there were agents among them trying to assess what was going on, at least.

But in the end, these decisions and these agreements are based on trust. We have to trust them that they're giving us accurate information in the technical arena. We have to trust them that they will fulfill their obligations in the critical areas. A lot is being made, as we sit here today, about the failure of the Russian Government to support Space Station hardware production such that they have fallen behind in delivering service module, principally, and that is certainly true that they have failed to meet their agreement. On the other hand, it's a less critical failure than it would be, for example, failing to bring up food when it was required for the crew or failing to ensure that our crew were safe by not training them adequately or something like that.

So we were able to build, ultimately, a trust relationship in the areas that counted, at the working level, principally. We found many, many differences in culture, and I say that both from the standpoint of day-to-day living, but also in terms of their standards, for example, in training, or their techniques in training, but also their standards. A difference in training technique would be the fact that we depend heavily on written materials. We give people training materials. We talk to them in class and so on, but then we send them back home to do their homework. The Russians depend almost entirely on lectures, and so the crew is expected to sit there and absorb this and take what notes that they can, but they're not given materials to go home and study in anywhere near the depth that we have in this country.

Then they also, in some areas, would train to a standard that we gave up a long time ago, that of rigid memorization of technical specifications as opposed to demonstrating a good grasp of what is really going on, what does this system do and why, things like that.

Davison: Some of the stories I heard when I first went over to Russia was some of the stories about having to deal with Customs and getting hardware into the country and making sure you talked to the right people, because something would sit in some office until somebody called and had it delivered. Did you experience anything like that or hear of any stories like that?

VanLaak: Things like that certainly occurred. I think that many of them occurred before I joined the program or early in the program when I was busy doing other things. I became deputy director in basically October of 1995. Prior to that, I'd been involved as much on internal processes within the program office as anything. After I took on that job, then I got much more involved in the details of implementing the actual missions.

In the time that we were trying to get training hardware over there for Shannon Lucid and John Blaha and so on, we did have some very serious problems getting things through Customs. Again, the economics of the country, I think, led to a certain amount of black marketing and that sort of thing in terms of paying people off. Not that we did that, but that they were expecting it. Until somebody came from Energia and laid down the law, or from the Russian Space Agency and said, "Doggone it, don't you realize that this is a major national embarrassment? Get that thing out of here." Things began to move.

Davison: I wasn't trying to focus on Customs so much as making sure the right person had the right information. It seemed like they were very focused on one person knew what to be doing and the next person right next to them might not have known, so you had to make sure you had the right contact.

VanLaak: That's a good point. In general, we used to make a lot of jokes about having to integrate the Russian side from over here, and there's some truth to that. Valery Ryumin, the director from the Russian side, the director of Phase 1, wanted to receive all the official correspondence. We would send it to him as we expected them to send it to Frank Culbertson. Then, for example, correspondence that came in here, we would distribute it to all the affected parties. We assumed that Valery would do the same. Bad assumption. Whether because they didn't have the copying machines or for whatever reason culturally or whatever, he would get a copy, put it in his little folder, and that would be the end of it. If we expected various other people to react to it, even if they were included as CC's, that we expected to have courtesy copies forwarded to their offices, unless we directly addressed those copies to those offices, they wouldn't get there.

In the early days in particular, the liability of getting things through by fax was very poor. Now, whether that's because the fax machine ran out of paper or somebody stole the paper, they unplugged it, they didn't know how to turn it on, or they simply ignored it because they didn't want the fax in question, we have no idea. But if you wanted to get something reliably transmitted, you told them ahead of time that it was coming, you sent it, and then you checked to make sure that it had gotten there. Now that we have people in the major office areas and we can fax, if we choose, to an American fax machine and have them walk down the hall and hand-deliver it, that ensures that they'll get it, but, in fact, it's become a very reliable form of communication.

I might point out that the Russians always said to themselves and from time to time to us, that they were always having to integrate us as well, that our internal communications were not very good. So I'm sure that it depends upon your point of view.

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

VanLaak: That is a very interesting question and one that could probably involve about a week's worth of discussions. I'll try to keep it to the highest level.

Fundamentally, as you know, in the Soviet Union we knew very little about their space program. I was not briefed on any of the classified information that might have existed about the Soviet program, so I will have to tell you mostly what I've learned since and what I've learned from people who pursued it more or less as an avocation, Jim Oberg being an outstanding example. He did it essentially as a hobby and as a side business, not in an official capacity. His knowledge was limited by what comes of that. He had to depend upon news sources and things like that, and he did get to Russia, but he didn't have official status, so he was afforded access to some things and not others.

The point being that our knowledge of the capabilities of the Russian system were very high level, superficial, and yet it's clear that they have conducted an extensive space program for many years and it has, on the whole, appeared to be as safe as ours. They haven't lost a crew in a spacecraft in many years. They have had problems from time to time, but they have recovered from them safely. We agreed more or less on the basis of the foreign policy initiative as much as anything to be jointly involved in the Space Station program.

But when we were asked to look at that, which was in the summer of 1993, we were asked to go off and evaluate, over a period of about four months, and I'm thinking now from about August to late November, whether it was feasible and appropriate to include them from a technical point of view. Now we're addressing Phase 1, but the additional flights to Phase 1, not counting Norm's [Norman Thagard] one-time deal, was closely tied to the Space Station initiative.

During that time we did the best we could, sitting down with the Russians in Crystal City being the principal mechanism for this, to assess their engineering approach to things and so on. At the level that we were able to penetrate, we found it quite satisfactory. For example, I sat down with one of the chief designers to talk about redundant system design. There are many different ways you can achieve redundancy, some of which allow you to literally be two failure-tolerant. The third failure, you're out of business. Others, you need a smart two failures or three failures to be out of business, but, in fact, you can tolerate tens of failures that are more or less random, depending on cross-strapping and other designing limitations.

I found the Russian approach to be essentially identical to ours, and in some cases more robust than ours. They had, in fact, been pushing the state of the art for operating these spacecraft for long period of time. When we were flying sortie missions and worried about the reliability over ten days, they were trying to make stations fly for years at a time and encountering a different set of problems. So within the realm that they had chosen as their mission, I found their expertise to be good and their approaches satisfactory.

The bottom line is to say that our knowledge base was fairly small to make this decision, this judgment. It was based in large part on the external evidence that they had been conducting a vigorous space program for many years, safely, and it was also done with the express knowledge and understanding that we would never have the level of insight into their design methodologies that we have in our own. So it was a large leap of trust.

In saying that, it was tied to, in my judgment, a very real expectation that it would be worthwhile. As I mentioned earlier, in my judgment, it has turned out to be totally worthwhile, one of the smartest and best investments we've ever made as a country. There was some expectation, some possibility that someone could get hurt, much more of an expectation possibility that we would get into it and decide that we were not comfortable and would not fulfill the entire program, that we would get part way through and something would be unacceptable and we would stop, or that the Russians might not be economically capable of supporting their end of the deal.

So, from the risk point of view, all those things were there, but as we addressed the foreign policy value of it, but also as we began to appreciate the difference between flying a Space Station and the Shuttle, we began to appreciate that it was a tremendous opportunity here from a technical value point of view, hardware design and operational understanding if we choose to engage it. Everything that has happened since then has only buttressed my belief.

Davison: Were you involved with the study that the Russians--we studied a proposal that the Russians made about using the current Mir as the service module because of their funding problem. Can you elaborate on that and tell us how the decisions were made not to?

VanLaak: Well, that was about two years ago, a little earlier than that. I recall it being two years ago in January that it kind of reached its peak. The principal reason for it, I believe, was financial. The Russians didn't have the money or were very concerned about being able to find the funding to outfit the second Mir core, what is now the service module, or at least to do it on the schedule that was proposed, because essentially all of the discussions I recall still involved bringing the service module up to the Station. It would come at some future date. I guess I would reiterate that that was also a time when it was clear they were falling behind on schedule, and there was a group in this country that was pounding the table that if they didn't show up on schedule, that was the end of the program, go away, and leave us alone. Now, history will record that the United States, the U.S. segment, has been late in a number of areas, so the actual schedule impact of the Russian delay is relatively modest, but, nevertheless, it was clear at that time that there was going to be some kind of a schedule problem on the Russian side.

So, the Russians came forward and suggested that we simply attach the Station, our Station elements, to the Mir, and we could go ahead and man up the Station early ahead of the schedule, based on the service module, and ultimately perhaps get us in the Mir at a later date. That was unacceptable to the U.S. from several points of view. One point of view was political. There was a significant group of people apparently who were adamant that they didn't want to be seen as an adjunct to the Russian space program.

In this country, at least, ISS, of course, grew from Space Station Freedom, which was notionally a U.S. space station with a few international partner modules attached to it. ISS became a partnership with a much larger portion of the vehicle and the critical functionality now belonging to the Russians, and they simply were afraid that there would be a further dilution or confusion in terms of where the center of gravity was going to be in terms of decision-making and so on. This was still going to be an International Space Station program led by the United States, and they didn't want that part to be confused. I don't cast any judgment on the wisdom of that position; I just record it.

The other thing that I can offer some judgment on is the viability of the Mir to continue operation for four or five years into the future. I'm certain that we would be talking about that as a time frame. It is conceivable that you could do that. I can't point to any critical safety issues in the next couple of years or we wouldn't be flying people up there right now. On the other hand, the basic hardware is getting very old and the maintenance demands are quite significant, or very significant. In order to be able to do the mission of the International Space Station, you can't have half of the crew running around doing maintenance on systems that are so old that you can't even get parts for them any longer. So I do agree that it would have been inappropriate to tie the program to the Mir unless it was absolutely required, and a satisfactory agreement was met to avoid that.

Davison: Thank you. What was the Russian approach to operations, training, and engineering and how did their philosophy differ from NASA's philosophy?

VanLaak: Well, they're each different, of course. I think I touched on the training a little bit, probably about as far as I can really go with much detail.

Let me talk about engineering and then operations. The people who have worked individual issues on the Russian side can speak to that obviously with far more detailed knowledge than I can, but looking at it kind of from the top down, in the United States we've become very heavily dependent upon analysis and we have pursued optimization in narrow regimes. For example, structural materials. As we continue to go to higher and higher strength materials in the hopes of making things lighter and stronger and so on, we do that at considerable cost, cost in terms of money to develop it, cost in terms of inspection requirements and so on. For example, many hard materials were also brittle materials, which require sophisticated fracture mechanics, analyses, and flaw detection and so on and so forth.

The Russians don't have that analytical capability. Therefore, they're going to do things by test, but they've had enough experience to recognize the limitations of their statistical database. You can't test enough samples, and there are problems with loading your flight unit up to the critical loads--in some cases, fatigue and so on. So they tend to use, for example, in the case of materials, often they use more ductile materials, which means softer, lower ultimate strength materials, but also far less susceptible to fracture, or the fracture critical flaw sizes, the size that could result in the catastrophic failures larger and more easily detectable, either by visual means or some fairly straightforward inspection technique.

Likewise, I mentioned their engineering approach in terms of using relatively simple systems and relatively maintainable systems. It just crosses many elements, far too many to try to talk about, and it just is a characteristic of their engineering, whereas, again, we try to optimize things. We're much more inclined, for example, to put a microprocessor in something to do a job than to put mechanical devices in there to measure positions and simple analog mechanism to do essentially a simple calculation. If a potentiometer that reads the position of something goes bad, you can take it out and put a new one in on orbit. If a firmware controller that uses some other technique to measure position goes bad, well, you may or not be able to change that out on orbit.

So, their engineering approach appears crude by our standards, in some cases--in many cases--but, in fact, may turn out to be far more suitable for the environment that you're in. Another element on the electronic side, of course, is as you continue to microminiaturized electronics, they become more and more susceptible to radiation effects, and whereas they have big, heavy circuit boards with transistors and things like that on them, shoot, you can blast them with radiation till the cows come home and they probably won't even know that it happened. So we have had to assess that and make certain that our systems can tolerate it. We are, in fact, flying some hardware for the express purpose of experiencing that radiation environment on the electronics, and we'll have to see what kind of design adjustments will be made. We'll make it work safely, but we're having to take a lot of effort, whereas they just said, "I know this will work and I won't worry about it."

Davison: So in that example that you just gave, it sounds like we're using some of their engineering techniques of testing as opposed to how we might have tried to do that analytically through some model on the ground. We're actually taking them up on Mir and testing them?

VanLaak: Well, we're doing it on Mir because we have the opportunity, but we would have done essentially the same thing had we not had the Mir opportunity, in terms of the design. But then we would find out whether or not it worked when we got to orbit. There's more potential for a schedule and cost impact when you do it that way than if you can fly it on Mir. That's one of the risk mitigation experiments.

To talk briefly about operations, the Shuttle Program, again, has dominated our planning. In fact, all of our planning has been oriented around sortie-type missions. We did fly a 74-day to Skylab four mission, I believe 74 days or 84 days. My memory doesn't serve. But in any case, you could almost think of that as one long sortie. I'm certain there were several Control Center teams that rotated through. Nobody stayed on console for that period of time. Nevertheless, it was a manageable length that you could go off and deal with it as a discrete and try to optimize it.

When you fly a space station for ten or twelve years at a time, you have to give that up pretty quickly or the divorce rate just goes out of sight, not to mention the heart attack rate, which, by the way, is something we've learned in Phase 1. No divorce or heart attacks to my knowledge, but stress level has been very, very high in the workload.

In any case, the Shuttle Program continues to be built around this idea of a fairly discrete, short, manageable period of time when everybody's going to really work hard and get the job done to a very highly polished luster, whereas the Russians, I don't know if they ever had that philosophy. They probably did, but they long ago realized that, "Hey, tomorrow is another day. If you don't get it done today, we'll do it tomorrow. There's no need to kill yourself, and that applies just as well to the people on the ground as it does to the people on orbit." "Relaxed" and "laid back" may or may not be appropriate terms to apply, but the sense of urgency is not there in the same sense that it is when you go into the Control Center here for a Shuttle flight. It is appropriate that it's not there.

On the other hand, there are some things that we have evolved in this country because of our visibility before the public and before the Congress that the Russians have not developed, and some of them are to their loss. For example, the Progress collision that occurred last July or June--June--was in large part because it wasn't planned properly, by our standards, on the ground. It was possible to design the mission so that there were belt-and-suspenders kinds of approaches, especially from a safety perspective. What they did wasn't stupid, but it did not employ all the techniques that are available to us today. I would characterize it as being representative of the flight test programs that we fielded in this country in the fifties and the early sixties, in days when it was understandable that from time to time you'd lose an airplane in a flight test. In fact, some airplanes, we lost many in flight tests. But that was the way it was done.

Over the years, as airplanes became more valuable and television and other mechanisms made it possible for people to see a world-famous test pilot get killed in an airplane, the pressure came down on the flight test business to clean up their act and stop losing airplanes and people. And they did that by developing much more rigorous techniques of planning and reviewing and executing the flight test activities, to the point where now airplanes go through an entire flight test program without losing a single airplane. For example, a B-2 that costs a half a billion dollars, you don't want to lose that airplane in a flight test. Well, it still has to be tested, and the people who go fly it are still challenging some unknowns when they fly it, but it has been modeled and understood, and we have techniques in place to dramatically reduce the risk.

Well, the Russians have not developed those techniques to the same level that we have. So we are working with them. I'll address this on one of the later questions, but we have over the last year been able to communicate some of our techniques to them in these areas, and we are both benefiting as a result.

Davison: Thank you. Over time, how did training preparation and operations evolve on events and the experiences? Did we change how we did business?

VanLaak: Well, we certainly changed the way we did. I'm sure somebody like Rick Nygren would do a better job with training than I can. I know certain things to say, but I'd rather you get it better from somebody who knows that. And I'm sure they'll, likewise, have many more words to say on the subject of preparation from the immediate crew preparation point of view.

We did, however, learn--of course, NASA has a process we go through to prepare for missions. We call it the flight readiness review process. Again, we traditionally focused it on sortie missions, but fundamentally the same process can apply to the long-duration mission when we leave someone on the Mir. What is new is that we have these international partners and we have dependencies on hardware and data deliveries and an uncertainty, if you will, on future behavior that we're not used to.

In the Shuttle Program, you know who everybody reports to. You know that the boss is going to get people to do what they're supposed to do on time and so on. When you have an international program--and I'm not picking on the Russians or anyone else--when you have to depend upon a far less direct connection to get things done, your uncertainty about those things getting done increases significantly. So as we prepared for these things, in the beginning we simply took a schedule that the Russians gave us and pretty much counted on it, and we made decisions with relatively little allowance for deviations from those schedules, in principle. I mean, we were not too limited in our thinking from a safety point of view, but in terms of did we carry extra science activities in case there was more time available or how would we reprioritize things or postpone a scientific investigation to a subsequent increment if it didn't get done, we didn't really carry those options because they said we'd get it done. So we assumed we'd get it done.

As it turned out, we didn't get all those things done, and so we had to prepare more thoroughly for subsequent missions or retrain people, the actual crew members, or whatever was appropriate on that particular mission. So our preparation process did change significantly.

Our operations changed in a lot of subtle ways. The day-to-day operations that we performed were oriented around our research program, and there are others who can talk to them in more detail than I can, but I will point out some of the obvious things. Again, to go back to the notion of planning everything, first of all, in advance, that was impractical. I mean in advance of the entire mission. We realized that we were going to be working on a planning horizon of a few days, not months, for detailed time lines.

But even beyond that, we began to recognize that the techniques we'd used in the Shuttle, where you kept the crew member from 9:30 to 10:00 is going to be doing this, from 10:00 to 11:00 is going to be doing that, from 11:00 to 12:00 is going to be doing something else, that didn't work from many points of view, the lack of communications to the Mir being one of the outstanding ones, but also the fact that some of the hardware didn't always work as it was supposed to. By the time the next com pass came up and you found out that it didn't work, the whole opportunity to do the experiment had been lost.

Those caused us to develop a much more flexible approach where we, for example, might tell the crew member, "Today we'd like you to accomplish the following three things. Go for it." If they began the first thing and the hardware did something funny, they'd postpone it, start a second project till the com pass came up, and they'd give us the information of what went wrong. They might go back to the second experiment, because it would take the ground some time to figure out what to do next, and then the following com pass, they'd uplink a solution to the problem and they'd go back to the first experiment and so on. In hindsight, as so many things are, it seems obvious, but until you actually experience it and try it, it wasn't clear what level of freedom there was appropriate. So that's been a fundamental change.

Davison: Thanks.

[Begin Tape 1, Side 2]

VanLaak: Ninety-nine percent of the time we've been here, it's Rick Nygren. Right now it is Jeff Cardenas. Under him he has a training IPT and hardware integration IPT and several others. Working Group 7 is EVA.

Davison: Richard Fullerton.

VanLaak: Yes.

Davison: I know Richard. I know Jeff, too.

VanLaak: Working Group 8 is medical ops. That's Tom Marshburn. I just went blank. And Working Group 9 is no longer really active, and that was communications.. So that's the working group structure.

[Off camera talk]

Wright: We were talking about the day-to-day operations.

Davison: How will operational experience of the Shuttle-Mir Program benefit the International Space Station Program?

VanLaak: Well, in two principal ways. First I'll address the less valuable of the two, and that is being ready to operate International Space Station, making decisions, exercising options that we hadn't previously thought we were going to deal with. For example, we've all along talked about the potential of a medical problem for a crew member on orbit, but I think, just like fire and decompression, we thought that was a relatively low likelihood event. Something like a sore throat or like that probably happened in the past, but we didn't anticipate a serious issue.

Of course, there was one with a cosmonaut last August or July. I'm just off by one month for some reason last summer. In any case, we had to address some very complex issues. Could he, in fact, function? Was the reentry on Soyuz going to be a safe event for him, or did he need to recover from his medical problem before he was brought home on the Soyuz? Because it's not a particularly soft ride home. Or even should we consider trying to bring him home on the Shuttle as opposed to bringing him home on the Soyuz? So those kinds of issues were addressed.

We worked time-lining issues, as we talked about just a minute ago. We developed better ways to plan our science and so on. All those things are highly beneficial, but none of them defined the success or the failure of the program, because after a year or two of operating ISS, we would have uncovered those things. So it gives us a chance to get a head start on those and hopefully be more efficient and effective from the beginning.

The much more significant thing, which unfortunately is somewhat reduced by the fact that we got to this late, if we had done the Mir Program five years before we started flying ISS, we would have gotten a lot more value out of it. That is, to look at our fundamental design concepts and how they tie into the realistic operational environment. To go back, for example, to the maintenance concept, if you give me a space station that's full of hermetically sealed boxes, the only maintenance option that the crew has is to move and replace the hermetically sealed boxes. If you give them a system that's got boxes you can open up and fix with pliers and wrenches and hair pins, then you can do a lot on orbit. Unfortunately, ISS is biased in the direction of the hermetically sealed boxes, but even within that, there are opportunities to make some improvements and those are being implemented.

We're also learning more about the realistic demands that we put on the hardware and may be discovering that we may have over-specified some requirements. We can operate hardware without beating it up or, in some cases, the environment is more harsh than we thought it might be. So there's a tremendous amount of value in this operational experience, somewhat mitigated by the relatively short period between the Phase 1 Program and ISS.

Davison: Did you want to elaborate on either one of the fire or the decompression benefits?

VanLaak: I'd like to talk about that altogether. Specifically, when Phase 1 began, the U.S. role was that of a customer. We were going to do a research program back in the laboratory and the Russians were responsible for flying the Space Station. As such, we would have the opportunity to look over their shoulders and see what they were doing and participate in this long-term mission and so on, but we didn't have any direct responsibility for the flight of the vehicle. As such, we didn't get, as deliverables from the Russians, detailed systems schematics and things like that. Mir is an old system. Most of the engineering and systems disciplines in this country were focused on getting ready to fly ISS.

I think that as we observed things on the Mir, we wished that we had had more involvement on the systems side. I would point out, for example, during Shannon Lucid's stay, there were some failures that caused some periods when the crew was not allowed to drink the condensate, for example. Even though the condensate is processed and sterilized, it does not remove glycol from that. So when they determined that they had a metallic taste to the water--by the way, the camera looks like it's canted. Is that satisfactory, the way it is?

Rollins: Looks great to me.

VanLaak: Okay. Maybe I'm the one that's crooked.

Davison: I think that the base is on the tripod.

Rollins: On the viewfinder, it's squared up.

VanLaak: Okay.

Davison: I see what you're talking about, though. The base is--

VanLaak: Yes. It's just the--

Davison: Maybe it's an optical illusion.

VanLaak: Disorienting, yes, that's what it is. During Shannon's increment, there were periods when the crew was not allowed to drink the water. They detected a metallic taste and they immediately suspected glycol, and they found some small leaks in some plumbing. Some other things along those lines occurred where things were going on on the systems side that did not pose a serious threat to the crew, but we really wished we understood what was going on. But since we didn't have an agreement with the Russians and nothing rose to a level of criticality that we really wanted to force the issue, we didn't. We were not very successful in increasing our level of understanding.

Let me just expand slightly and point out that we did ask our ops leads, our teams in Russia, to get as much information as they could, and the Russians were not totally uncooperative, but they basically said, "This is additional work for us to try to explain this whole system to you, and it's fundamentally none of your business anyway." So they would give us enough information to quiet us up and basically go about their own business.

So we pressed our relationship and tried to get more information, but since we didn't have anything that represented a critical safety concern, we more or less lived with that slow accretion of technical knowledge of the Mir, up until the time of the fire. As I mentioned earlier, we knew enough about the oxygen-generating system, the [solid] oxygen generator in particular, that we knew that it had a long operational history and were relatively confident that it was safe to operate. Nothing has occurred to change our fundamental belief in that, despite the fire. Nevertheless, the fire did occur, and once we knew that the crew was safe and the situation was stable, we immediately began reviewing fundamentally our knowledge of the Russian hardware design approach, in general, but also specifically, and we also wanted to know whether the crew had responded correctly. Were they trained correctly? Were they given the right tools and assets to do their job?

As a result of that review, which was kind of an informal thing--we didn't make a big board or something like that, but we did send people off with action items and they did come back and talk to us--there Russians passed on both counts. We looked at the data on the [solid] oxygen generator and thousands and thousands of candles that had been burned. I shouldn't overexaggerate. Two to three thousand at least have been consumed without any incident. And they talked to us about the techniques they used for inspection, nondestructive inspection of the units that they fly and how they mix the chemicals and the batch methodology they use and so on. So we were very confident in that.

We also reviewed with our crew who were on the ground, John Blaha and Shannon Lucid, at least, the preparation they had gotten for fighting a fire or for escaping in the Soyuz. We found that satisfactory. Over the next month or so, as we got more details from the Russians, we continued to hold it up to that measure. Was this something that said we were safe to continue or was this a close call that showed that we were exposing the crew to a nonacceptable hazard?

We felt--and I still feel--that that was a satisfactory outcome. They were okay in terms of having been prudent, both in the hardware design and ops. But as a result of that, I went over to MOD and said--we had already for several months been talking about trying to get some systems help from the systems engineers in MOD, systems flight controllers who were going to be doing things on International Space Station in the life-support systems area, for example. You'd think they'd have some knowledge applicable to the Mir and some interest in exercising that knowledge by watching the Mir. For a variety of reasons, that support was not available. Following the fire, I went over to MOD and said, "Look. I need it. I'm here to pay for it. What can you do for me?" And we had some negotiations and they agreed to provide a certain level of support, which is the nucleus of our systems team that we have in Moscow at this time and who, by the way, have been doing a very good job for us.

So we began to formalize our pursuit of more detailed knowledge of the systems and we began to pay more attention. We augmented the team in Moscow slightly and tried to pay more attention to the operations that were going on on the Mir, just to try and stay a little further ahead. There was nothing adverse in what we had seen, but we wanted to understand better.

The next thing that happened was the ethylene glycol (glycol) leaks. The cause here is that the Russians chose to not apply a primer, a corrosion-inhibiting primer, to the inside surfaces of their vehicle primarily to keep the paint from flaking, I believe. They depended upon the environmental control system to keep the humidity levels to a point where you wouldn't get condensation in local areas that could lead to corrosion. Well, over the years they've had problems with power and with the thermal system. There are areas where significant amounts of condensation have developed from time to time. Some of that condensation has led to significant corrosion locally on coolant tubes. The coolant tubes, tending to be cool, would collect the condensation, and when dissimilar metals, for example, grounding straps, would come in contact with these coolant tubes, corrosion would occur, which eventually weakened the walls to the point where the glycol would weep out. There were places where it didn't weep; it broke the tubing and there were actually significant spills.

It was the spring of 1997 when that began to, if you will, blossom. There had been small incidents that we didn't know too much about, but there were some fairly significant problems that developed in the spring. Fortunately, Dr. Linenger, Jerry Linenger, on board, a medical board, and he was able to assess the impacts of this on the crew. There was not a good detector on board for measuring the concentration of ethylene glycol in the atmosphere. Jerry was assessing the symptoms in the crew, and there were some symptoms in terms of redness in the eyes and that sort of thing, and was able to advise us that it was an irritant and it was unpleasant at times, but it did not constitute a health hazard. Of course, our toxicologist on the ground continued to follow that.

This did several things. This caused us to get our medical teams more closely tied together. It also got our engineering team working on a technique for measuring ethyleneglycol concentrations on board. In fact, we flew hardware up on STS-84 in the spring of last year, May of last year, to do just that. And it began a process of integrating us into operational decision-making with the Russians. They were asking us for our help on some things, and where previously we had always had to go and ask for information, now they would come to us and ask for information or even volunteer information to us. I don't want to oversell that, but it was a significant step.

We went to considerable effort--by the way, at the same time they were having problems with the electrons on board--I'll come back to that in just a second--and we took fairly extraordinary steps to accommodate the late loading of an electron on STS-84. We had to modify the delivery of the Space Hab to the pad. It went out after the Shuttle to the pad, for example. The Space Hab people had to expend some extra money and certainly a lot of time and effort to accommodate this large, bulky unit into the module. It was directly as a result of our concern about the life-support system being able to do its job. It is something that we began. We more or less volunteered to do it, and we began, and once the Russians saw that we had that capability, they latched onto it and it became a done deal.

Let me digress for just a moment and talk about the electron, lest I forget. The electrons take water and electrolyze them into hydrogen and oxygen. Obviously when it's water, it's inert and it's safe. When you have gaseous hydrogen and gaseous oxygen, the potential for an explosion exists, and so the system is very carefully designed to sense the potential for mixing hydrogen and oxygen and to shut down if it senses something that indicates that might in fact be occurring. So there are a variety of sensors in the system that all have the ability, or many of which have the ability to shut it off. Because as the units became older, they got air bubbles in them, various and sundry things would happen in the water supply and so on, and anomalies would occur which would just shut down the electron.

You'd see that in the newspaper as "The critical life-support system is broken, has failed again." Okay. Well, it failed in the same sense that the old radio, you have to go over and whack it on the side before you can get it to listen. Twenty-five or fifty years ago, that was perfectly acceptable. Nowadays you expect your solid-state radios to play for 10,000 hours without missing a beat. The technology of electrons for space use, this is the first time they'd been used in space--period. So one has to anticipate that kind of finicky behavior.

In any event, so through the spring we had a series of opportunities to work more closely with the Russians in terms of supporting them logistically and addressing some fairly serious life-support issues with the electron system and also with the ethylene glycol. And that was a step forward in our joint work together.

The next major activity, of course, was the collision, and a lot of things happened as a result of the collision. One of the most important is that we undertook another review of what we were doing. Were we putting our crew members at risk? Were we doing something fundamentally foolish? I think Frank [Culbertson] and I arrived at the conclusion more or less simultaneously that whatever else might be true about the history of the Russian program and so on, they had had a couple of significant events in a fairly short period of time, and we simply couldn't ignore that. We could not continue unless we had a lot more insight into what was going on and direct participation in key decisions, key operational decisions that could affect the safety of our crew. We informed the Russians that that basically was where we were, that we were not going to be able to continue without that kind of understanding.

I think in a fairly remarkable turn of events, the Russians said, "We understand, and that will be fine." Now, it would be untruthful to say that everyone was delighted to have us involved at every step or that all of the information flowed freely to us. Nevertheless, they recognized the reality of the situation and they worked with us. They did an excellent job of cooperating, for example, in the actual investigation of the collision, and we have an excellent understanding of the events that took place and why, and have great confidence it will not occur again, because the circumstances that led to it are well defined and easily avoidable in the future, not just for that particular event, but for similar events. Every time a Progress goes up, somebody calls up and wants to know whether or not there's going to be another manual docking, and we understand exactly what's going to occur and what the boundaries of the system are and what's new or not new.

So, ultimately we have become far more knowledgeable about the operations of the Mir. We get weekly summaries of what the consumables are, what the status of the major systems are. When we have concerns or just questions, our people are able to go down the hall and talk to the specialists and get good answers. I would be overstating it to say that any of our people is expert in the Russian systems, because even though I said they're relatively simple systems, they are not simple and they're not built in the Western engineering traditions, so there are things that are done that are not intuitively obvious to the Western-trained engineer, and it sometimes takes a period of time before we fully understand why they did what they did. But pretty much without exception, their systems are intelligently designed. I can't think of an exception at this time. And we have confidence that all the critical systems will function very well.

It's an application of the experience and the new trust. I mean, the level of trust that the Russians have in us and we in them as a result of these events is dramatically greater than it was before, as it has to be. Only people who have been in an emergency situation together are going to have the same common sense of mutual dependence and so on as we do now with them. I think it is a tremendously valuable thing for Space Station.

Davison: Thank you. What issues were raised by the cultural differences between the United States and Russia? How did the parties involved deal with these issues?

VanLaak: That's very broad.

Davison: Maybe focus on your experience or some example that you might have.

VanLaak: I looked at that question ahead of time, and nothing really leaps to mind.

Davison: Okay. The next one is probably even a little tougher, then. Want to try that one? What were the benefits of the Shuttle-Mir Program to the nation and the Earth in general?

VanLaak: I'd say they come in two principal forms. The first is, there really has been scientific work done, scientific value, accrued as a result of Phase 1. Sometimes we in the program get all wrapped up in the setbacks we have from day to day. When you fly a mission that's four or five months old--and by the way, we just passed or are about to pass two years of a human continuously on orbit, an American continuously on orbit--there are many, many little setbacks. Many days, sometimes even weeks, when it seems as though we've gone three steps backwards and not forward at all. But even in things that on first blush appear to be setbacks are frequently data that's very valuable and some good science has come out of the program.

Of course, the second thing is that if you take the two principal antagonists in the world and you make them partners, you've got to believe that reduces the tension overall and reduces the likelihood of a major nuclear exchange that wipes humanity off the face of the Earth. So I don't think we've done anything to reduce the possibility of a Third World country getting hold of a nuclear device and blowing up a city, but the likelihood of turning the face of North America into a glass bowl is dramatically reduced. I think the rest of the world benefits from that as a result.

Davison: Sure. These next ones are more personal questions. I probably should have asked these first so people would know where you worked and how long you've been in the program, but I'll go ahead and ask now and we'll splice and change order.

VanLaak: Okay.

Davison: What position did you hold while you were in the Phase 1 Program, and what were your responsibilities and when did you join the program?

VanLaak: I joined the program in the beginning of April 1995. I came over from the International Space Station Program. Initially I was just a member of the staff. Tommy Holloway was the director at that time and Frank Culbertson was his deputy. There really wasn't any specialization in the staff below that, with one or two exceptions. Essentially we all did whatever we were assigned and pulled together as a little core team to try and implement the program.

That was shortly after Norm Thagard was launched, and it was the very beginning of the operational phase. As such, it was a time of great challenge for the program and a time when this flat organization without specialization reached its limit very rapidly, and it became clear that some specialization was required. We were in the beginnings of defining or deciding what that was going to be. I was fundamentally orienting or sliding into an operational or semi-operationally focused job.

Then in, I believe it was, August of that year, Brewster Shaw decided to leave NASA and the Shuttle Program. Tommy Holloway was chosen to replace him, and I recall the day very clearly when Tommy pulled Frank and me aside and said, "As of four o'clock this afternoon, I'm no longer head of the Phase 1 Program. You two guys are going to have to figure out how to deal with it."

So I was essentially a de facto deputy to Frank right off the bat, and for about three or four weeks we functioned in that manner as we tried to figure out what we had just bitten off. Then about three or four weeks later, Frank formally asked me to remain as his deputy. I've been in that position ever since. So, almost two and a half years as of this point.

You know, it's kind of the traditional deputy roles. In general I think it would be safe to say that neither Frank nor I was prepared to operate this program. I'm not sure that Tommy was prepared to operate the program either. But we clearly were not prepared for the job that we had at that time, and we got together and established a team, I should say a partnership, that was absolutely necessary and, I think, highly successful in terms of figuring out what our job was and working through the issues together. We did reorganize the office and specialize it and assign people to operations tasks and hardware integration tasks and so on, and put some structure to it. Basically it's a typical deputy thing where I have tended to specialize more towards operational things and Frank more towards the up and out things, but it's been very fluid back and forth.

Davison: Which part of your background do you think prepared you to work on this project most? Was it the Air Force or MOD or all that combined?

VanLaak: That's an interesting question. Probably all of that combined. The operational experience of actually flying in the Air Force for the better part of ten years gives you a certain sense of urgency, but the space business is different from flying airplanes. The first work that we had to do, basically, was program management, and I have had experience in that in Space Station and also in the classified technologies before that. So I would say the operational aspect, the Air Force and so on was kind of background that kept things in perspective, but fundamentally what we needed to do was sort things out, get people going in the right direction, and do the program management kinds of tasks.

A significant amount of it, by the way, was learning to work with the Russians and to be able to develop agreements, because we had months before launch, not years. Whereas some of the agreements were arrived at fairly late, perhaps a month or so before some of the launches, nevertheless, we came to closure when we made those agreements and were successful.

Davison: What do you feel was the most significant contribution to the Phase 1 Program?

VanLaak: Actually, that's a question I haven't quite addressed. I would say that Frank and I counterbalance each other very well, so it's a blend of our capabilities together that is most significant, so I guess it's the fact that I'm able to counterbalance him. He sometimes is the big idea man and I'm the realist, and other times we swap those roles. Each of us is able to step into the other's shoes when one is not available. He has not been available for some key activities and I've been gone and left him holding the bag on other occasions. So I think that our ability to work together and to carry the load individually when required is probably the biggest.

Davison: You all didn't get into any discussion about doing it the Navy way or the Air Force way or anything like that?

VanLaak: [Laughter] No, we just knew we weren't Marines.

Davison: Okay. We might have to cut that part out. [Laughter]

The next question is, how were the Cold War concepts and culture differences overcome to make Shuttle-Mir Program feasible?

VanLaak: Boy. With great difficulty, but with a recognition that both sides needed to, that our futures, by all indications, were tied together. I think that there was a great deal of mistrust in the beginning, but we got over that because we had to. A problem that I have seen a lot since, and still exists to some extent, is, I think, a sense of superiority on the part of some of our NASA colleagues that makes it difficult for them to appreciate the wisdom of some of the Russian ways of doing business.

I'd be the first to admit there are also plenty of things about the Russian way of doing business that are not appropriate for ISS, but there are also things that we just have to get over our arrogance and accept are appropriate and superior to what we are proposing to do. It's just a matter of personal maturity, I think, and seeing the reality, the value of what they do. In other words, experiencing their way of doing business.

Davison: What were the negotiations with the Russians like that you dealt with?

VanLaak: Well, in most cases the Russians are very good negotiators, far better than I am. If playing poker is the model you use for being a negotiator, I'm not a very good poker player. On the other hand, I think I can be very persuasive.

I will recall one specific incident when I was in the Russian Mission Control Center arguing with a specialist who wasn't going to allow us to conduct an experiment because he was concerned about his little area of expertise, which happened to be electromagnetic compatibility. We had been over and over and over this particular point, and I think that he was playing some kind of a game with me. So finally I said, "This negotiation or this discussion is going nowhere. On the basis of what we have covered, I'd have to go home and say we're not going to get this experiment. And I regret to do that, because I'd like you to understand just how critical some people are of this program and how tightly intertwined I believe the success of the future of our two space programs are." And basically I gave him a very sincere but a fairly somber speech that said that if we continue to run into these kinds of little bureaucratic snafus, that the success of the entire program was in jeopardy. It was probably something like a five-minute monologue, at the conclusion of which the room was very quiet. There were about five of us there. And then he responded to me by saying that he was impressed by the sincerity of what I had to say and that he would get back to me within an hour with an answer to this problem.

I had, of course, brought several options. He came back in an hour and said, "I think I can live with this option," and we spent another hour talking about it, and ultimately the experiment flew.

So, my own personal style is to get to the bottom line and say, "You know, let's cut out the funny business and make this work." They, on the other hand, are used to, I think, from a cultural point of view, a very elaborate series of lines drawn in the sand. So in the technical environment I've been successful. I don't think I personally would be very good at some of the political negotiations, because it's just a lot of poker that gets played.

Davison: Did you get any practice at the flea market before you went to the Control Center?

VanLaak: Yes, I did. Yes, I did.

Davison: Seems like that's the culture, to barter for the price. They like to barter just in general.

VanLaak: Well, at the flea market there's somebody right around the corner that will sell you the same [unclear].

Davison: Right.

VanLaak: It doesn't work that way at Energia. [Laughter]

Davison: Where do you go from here, then, Jim? I know the Phase 1 Program's winding down in September. Do you have any desire or plans?

VanLaak: It's going to wind down more like the end of June. The last flight, STS-91, will be landing early in June if things go on schedule. We do have some experiments that continue to the end of the Mir-25 increment, which they will return in August sometime. So if you allow a little room for close-out of that stuff, I guess you could say in September.

There have been discussions, well, basically directly to Mr. Abbey, on what he wants to do with Phase 1 team, and he has a number of very strong feelings on the subject that I guess I'm not supposed to disclose. But I think it would be fair to say that he recognizes the value of the Phase 1 team and he has no intention of letting it go to waste.

Davison: This is a question for headquarters, and you don't have to answer. What's your favorite beer?

VanLaak: [Laughter] Not a beer drinker, actually. It's a null set.

Davison: I didn't think you were.

Rollins: Will you give us a small tutorial about the different modules on the Mir?

VanLaak: You want a tour, huh. Well, this is going to put me to the test.

Rollins: For instance, how many of those modules do they live in? Some are living quarters, some are labs? I think you understand the question.

VanLaak: I will try to give the basic highlights of what each of the modules does. First of all, the original module that was launched is this one right in the center, which is called the Mir core, or the analog now for the International Space Station, as the service module. It has the primary living quarters in it, the sleeping quarters, the eating area, the main computer terminals, and those sorts of things. It's been on orbit the longest time; it's in its thirteenth year on orbit right now. I'm not going to try and recall the launch dates on all of the modules.

Rollins: We can always look that up.

VanLaak: This module on this end is a Kvant. One module, and it has primarily services in it. It is a utility closet, if you will, with an electron in it, some thermal control systems hardware in it, and the Vozduhk CO_2 -removal system, which is a system that scrubs carbon dioxide out of the atmosphere with a mole sieve system, which basically collects the CO_2 in a reaction bed and then the bed is vented to vacuum to expunge the CO_2.

Kvant Two is this module up here. This module is partially a laboratory and partially a systems module. It has the air lock out on the tip with the hatch that has been a great problem. Right behind that air lock is a secondary air lock, which is what they also have used on a number of occasions as a backup air lock, and other systems. Another electron, for example, located in there.

The Krystall module down here is primarily a laboratory module. The very first docking, STS-71, was to the end of the Krystall module, and at that time Krystall was sticking off the end of the station. It was repositioned to this location, and this orange module on the bottom is the docking module which was brought up on STS-74, and its major purpose was to provide enough space that the Shuttle could come in and dock without hitting the arrays on the base block and so on. So it's a spaceship, primarily.

The next module to go up was the Spektr module right here, which was launched up in 1995. It was a module that, of course, is out of commission at this time because of the collision, but it is a laboratory module with a bunch of U.S. hardware in it, in large part for life sciences investigations, but for some other things as well. You may recall when it was originally launched and deployed, one of the solar arrays failed to extend completely. To be honest, I don't recall; I think it was this one. Because a latch failed to separate cleanly during the automated deployment sequence. So in about a week, our EVA team went off and developed a tool that allowed the Russians to go out and cut that link and deploy this array. It was a brilliant piece of work by the people in one week to develop an amazing little tool.

The last module to be delivered to the station is the Priroda module, which has a variety of experiments in it, everything from this large radar antenna on the outside to a variety of Earth observation and other hardware inside. It is the principal laboratory module that we're conducting operations out of at this time.

There is basically a Soyuz usually on this end of the vehicle and the opposite end usually has a Progress vehicle on it. These models both appear to be of Soyuz; they're not really high fidelity. Soyuz and Progress are almost identical to look at from the outside. Of course, the Soyuz is the up-down vehicle that the crew arrives and goes home on. It's not just an emergency vehicle. It's their way home if they need it, but it is a fully certified up-down vehicle. The Progress is a logistics vehicle that comes up in a completely automated docking. Then they fill it with trash and whatnot over the time that it's up there, and then dispose of it into the--it burns up in the atmosphere when they're done.

Rollins: Thank you. And what's an oxygen candle?

VanLaak: It's a lithium perchlorate canister that is activated. It goes in a housing that has a fan in it and a series of filters, mostly for odor control. It's used as an initiator. You might think of it as a primer in a rifle shell to heat up a local area on this lithium perchlorate chemical, which then begins an exothermic reaction which generates oxygen. One canister produces 600 liters of oxygen, which is essentially enough for one person for one day. It does not require any electrical power other than the fan, and is a highly reliable system. Most of the time that the Mir has been in operation the last few years, at least, it's had one electron available, or perhaps because of power constraints, only one could be operated, because it draws a lot of power to electrolyze the water. And that's sufficient for a crew of three, basically.

During times when they're changing over crews, and they'll have a Progress on both ends and they'll have six people, up to six people on board, the single electron cannot sustain the six crew, at that time they will burn--I use the word "burn"--it's not strictly accurate, but that's the common usage--the oxygen candles to supplement the oxygen generation.

Rollins: Do we use oxygen candles or is that a Russian--

VanLaak: We don't use them on the Shuttle. We will use them on the Russian segment of the International Space Station. Technologies very similar to them are very widely used in specialized applications in the West. For example, oxygen systems in airliners that you reach up when the mask falls down and you pull the pin, in many cases that pin activates a small canister. It's typically a slightly different chemical, but the mechanics is virtually identical. And also in some shipboard applications in this country they do similar things.

Rollins: Thanks.

Davison: Thank you. That's great.

Rollins: I've heard that there's cable-cutters up on the Mir because there's some door that has to be closed. What part of that--

VanLaak: Cable cutter?

Rollins: There's some quick disconnects.

Davison: You're talking about between the hatches when they had the vents and the cabling.

VanLaak: I don't think I have any pictures that I can draw quickly. Fundamentally, if you go and look at the International Space Station on the U.S. segment, the way the modules go together, there is a smaller inner hatch. I use "smaller." It's about four feet square. But outside of that is a large structural ring which is the actual ceiling surface when the two modules are brought together. When those two modules are brought together, they put air into this little area between them. They open the hatches, but there's no electrical or other connections between the modules yet. They go in and install jumpers to that area, and in that way there are no cables that pass through the hatch. So if you want to close the hatch because of a pressurization problem or something like that, the hatch just slams closed. There are a few small cables and hoses, but very few.

On the Mir, see, the problem with that is, each one of those penetrations, as they're called, where the cable goes through this area, has to be sealed against the vacuum and so on, and it's a reliability and weight hit to do that. The Russian approach--and I would remind everybody that the Russians are fifteen years ahead of us in this, so if their technology isn't quite as sharp as ours--

Rollins: It was state of the art at the time.

VanLaak: Well, it was first. And whoever goes first finds some things they'd probably not do again. Their technique was to pass the cables through the hatch and connect the cables to terminal plates right inside the hatch, and they have what are variously called quick disconnects. I think in most cases they're more appropriately thought of as cannon plus, for those familiar with major electrical connectors, and some air ducts that pass through the hatches. In almost every case, these things either can be pulled completely out because they're not that long--like an air duct--or the cables go to these terminal plates that you can reach in and disconnect the cables and pull them out of the hatch.

There are a few cables--and I emphasize very few--and they're all data cables, which means they don't have power in them, that the Russians have permitted to be strung through some of the hatches, with the understanding that they're easily cut. For example, we flew an experiment up there called MISDY, that runs cables to all of the modules. For a complicated series of reasons, we didn't end up putting quick disconnects on those cables, so the Russians said, "Okay." In this one region where all these modules come together, this is actually part of the base block. This is called the node. All these cables pass through the node, so they said, "We want you to hang a pair of cable cutters either on the wall or on one of the cables in the node so that should you have to close one of these hatches, you can cut it."

Now, when the collision occurred to the Progress, the first thing that the crew did was they went down--the commander stayed at the command position, basically, and talked to the ground and assessed what was going on in terms of pressure, but the flight engineer and the U.S. astronaut, Mike Foale, went to this Soyuz and began activating the Soyuz for emergency egress from the station. Once the Soyuz was ready to go, Pavel Venegradov, who was the flight engineer, knew that--I'm sorry, not Pavel Venegradov.

Davison: I'm trying to remember who it was. I don't think I have it listed.

VanLaak: Vasily Sibliev and Aleksandr Lizutkin. He said that he knew that the collision had occurred on the Spektr and that the leak was in the Spektr, so he passed into the Spektr, heard air leaking out behind the module wall or behind the panels--there are instrumentation and experiment panels in there--and turned around so that his head was by the hatch and he began disconnecting the electrical cables. He asked Mike to help him, so Mike came over and helped him, and they disconnected the cables. They had to cut two small instrumentation wires, one American and one, I believe, was French, some other nationality experiment they cut with a knife. Then they put the hatch over the opening and the air pressure held the hatch in place.

Rollins: So they had plenty of time to recover.

VanLaak: "Plenty of time" would be pushing it. The process is that there were procedures on board that authorized the crew to leave if the leak rate exceeded a certain level. The way to view this is, if you were sound asleep and a piece of orbital debris punctured a module and you didn't have any idea what module it was, you need to go figure out how much time you have to look for it. So the first step is to go find out how much time you have. In parallel, the flight engineer goes and starts getting the Soyuz ready. Then I won't try to trace all the steps, but fundamentally if you have sufficient time, you start looking for the leak. If you don't have sufficient time, you're authorized to get in the Soyuz and leave.

In this case, they did the prudent thing. They got the Soyuz ready to go while they were figuring out. Their analysis indicated about twenty-eight minutes, just strictly a projection based on the leak rate. They estimated about twenty-eight minutes before they would reach a certain specified minimum pressure which corresponds roughly to the altitude of the environment of living in Denver. We're not talking about people falling over unconscious. Nevertheless, that was the kind of a threshold that they wanted to say, "If you don't have the leak under control, get into Soyuz and leave."

That kind of conservative approach helps us feel better about the things that we don't fully understand and don't know about the Russian system, because that shows an understanding and a willingness to err on the side of safety and say, "If you're not comfortable, get the hell out of Dodge." And they were authorized to do that.

In this case, it has been pointed out that the procedure is written directively, in the sense that it says, "If you have less than forty-five minutes' time remaining when the puncture occurs, leave." But as I say, I believe that--and essentially everyone I know believes that--is an enabling clause, if you knew that the leak was because a valve had failed and you could close the valve in twenty seconds, you would be an idiot to leave the space station because of the valve. In this case, they got the Soyuz ready. They literally were three feet away from the Soyuz hatch while they were trying to close the Priroda hatch. Maybe four. But very, very close, a matter of seconds to being in the Soyuz and close the Soyuz hatch.

So they followed a very prudent path and they were successful in isolating the leak through the Spektr, and it worked out very well. It was, all in all, an outstanding performance on the part of the crew, despite--

Rollins: It was an unfortunate accident, but everybody learned a lot from it, so it's one of those lessons learned.

VanLaak: Indeed.

Rollins: Thank you for your time.

[End of interview]