ROGER D. BILLICA

June 17, 1998

Interviewers: Rebecca Wright, Carol Butler, Mark Davison

Wright: This is an interview with Roger Billica with the Shuttle-Mir Oral History Project. Thank you for making the time with us this morning out of your busy schedule.

Billica: My pleasure.

Wright: Thank you for gathering so many wonderful things that we're looking forward to hearing about, all that you have out here on the table. We'd like to start with you explaining to us your roles and responsibilities with the Shuttle-Mir Project.

Billica: Okay. I'm the Chief of the Medical Operations Branch here at NASA Johnson Space Center, and Medical Operations Branch is the organization that essentially is responsible for all aspects of health care for every space flight. I quickly wrote down, so I could remember to tell you, what the different things are. It's actually quite a variety.

When we say "health care," we mean very comprehensively anything having to do with the human element of flight, anything that would affect health and safety, illness, injury, preparation for flight. So things that we cover in general for all programs, whether it's Shuttle, Space Station, and we did for the Shuttle-Mir Program, Phase One, are establishing what the medical standards are for the mission and performing the medical selection and certification of crews. Anything having to do with health care--pre-flight, before the mission, during the mission, and post flight. So, all aspects of that.

The design, the development, the manifesting, the management of all of the health care equipment, the health care systems, so that includes countermeasures such as exercise activities, environmental health, as well as what someone would traditionally think of medical care activities.

Anything having to do with crew training in the area of health. So, the medical training of the crew, the training on our medical equipment, the training of the crew of what they would expect to encounter and how to deal with this experience. And the support of the rest of the training. So when the crews were to do any sort of potentially hazardous training, the water training, the winter survival training, or anything, for example, in the water tanks or in the centrifuge or in the chambers that would require medical support or medical supervision, that came under our responsibilities.

Mission support in general. Preparing for the mission, planning the mission, anything having to do with the human aspect such as schedules, work-rest regime, the sleep shifting, how much could be done during a duty day. We're basically the advocate for health and trying to keep a rational approach to anything having to do with what are we expecting these people to do. And planning the mission and then providing a medical support team to the mission while it's occurring, in the Mission Control Center. And we did do that over in Russia.

So, all the functions I'm describing are typical for any mission, but we did for the entire Shuttle-Mir mission as well. Preventive health. Anything having to do with getting ready for the mission, physical fitness program to get in shape, an infectious disease isolation prior to the mission, a health stabilization program, anything just to help get them ready nutritionally, immunizations, things like that.

And then, of course, the countermeasure program, which a lot of people think of when they think of medical support to space flight during the mission. Things that are done to prevent the negative changes that occur to the human body from space exposure, from the lack of gravity, from radiation, from things like that, that present a risk to the human, make it potentially unsafe or risky to fly, we do preventive things to keep the person healthy, keep the performance at the level necessary for mission success.

Behavioral health, big area, particularly for long missions. The behavioral, psychological, and emotional aspects of a mission being out of country for, in some cases, a couple of years, being separated from family and home, and then being launched and left in this vehicle in space with only so many places to go for months at a time, that's a pretty big challenge for that individual. So the support to that, how to prepare them and then how to support them behaviorally, psychologically, and also, if necessary, being able to intervene if that became a little bit shaky during any of those areas.

Physical medicine, rehabilitation medicine. We have the responsibility not only to prepare them and to maintain them during the mission, but then when they get back, to help them recover and rehabilitate physically, emotionally, physiologically, and return back to their normal baseline. They do not come back the same as when they left, and our job is to get them back to normal in that regard.

Environmental health, establishing the environmental standards for space flight. What is safe? What is acceptable in terms of the atmosphere, the water quality, the microbiological environment, radiation, and noise, those sorts of things? We set the standards for those areas. The engineers and the design people, of course, then design to those standards. That's not our area. But then our job is then to be the health monitor, to go back and look. How did we do? How are we doing? As we talk about the missions, you'll see that that became a pretty big issue for Shuttle-Mir with some of the events, the power outages, heat and humidity, the atmosphere, the fire event that occurred. We were very involved. Then because of what we had up there, helping answer the questions, "Can we stay? Is it safe?" That became a pretty big issue.

Epidemiology, tracking the trends of what happened, looking at the data, doing monitoring. What can we learn from this? What was the effect of the exposure? Have we created any increased risk to them long term after the mission from what happened to them in space? Is there anything we can learn from this mission about health issues, all of the things we've just talked about, that we then need to apply to future missions? So the epidemiology and the medical data and the trends and what to learn. We have a project team that does that.

Then finally, using any experience in space flight to look at new technologies, medical breakthroughs, things that we can learn in terms of advanced capabilities that we can then apply not only in the space program, but then spin off back to society, that could be used. Some of the things that are on this table are some advanced technologies like that or represent some areas that we're working on that we were able to use Shuttle-Mir as a platform to continue to move forward on some new medical technologies that people are excited about.

So, I think that's a summary that describes the category and variety of things that fall under medical operations in space medicine. It was quite an experience for us to do that.

Wright: Tell us about your staff and what kind of folks that you have that help you get all of this done.

Billica: We've got just a great staff. It involves health care professionals. The team is led by physicians who are flight surgeons. These are physicians who come from a variety of backgrounds--internists and family practitioners and emergency room doctors, etc.--who at some point along their way decided they wanted to pursue aerospace medicine as a career, and either went to the military or some other training program and then came here to NASA to be NASA flight surgeons.

They come with those credentials and then they go through additional training to be certified as NASA flight surgeons, learning all of this about space medicine and becoming very knowledgeable in these things, and also being trained up and certified as flight controllers. So they're not only these physicians, but they're also flight controllers in the Mission Control Center, fully trained and certified for that. And they're also on flight status so that they can fly along with the crews, in terms of T-38s and getting to know and be part of the crew team. That's the nature and scope of who and what a flight surgeon is.

We selected and sent some outstanding flight surgeons to Russia. We assigned at least one to every one of the increments, and that flight surgeon went over to Russia with the crew and lived over in Russia, stayed in the Prophylactory there in Star City, and was there during all the training. Then while the crew member was in space, our flight surgeon then stayed in Moscow and staffed with the support team in the TsUP, the Mission Control Center, and came back in time for landing and then was the supervisor of the rehabilitation program. So our flight surgeons made almost as much of a time commitment and a time away from home and I don't know what other words to use, but did the whole mission just as the crew member did. It was a significant commitment on their part.

Supporting and working with the flight surgeons are hundreds of people. We have other health care professionals, nurses. We have a staff of biomedical engineers--BMEs, we call them--who do much of this list. Every one of these things I just told you, there's a project team or a core team of people who that's their job and they do these things.

We also have a staff of PhD scientists in the environmental health area, who handle all the environmental health aspects--toxicologists, microbiologists, water specialists, nutritionists, pharmacologists, all of these sorts of people.

There's a staff of laboratories, people who work in the laboratories, who are supporting the analysis of the exercise changes, the bone loss, the neurological changes, the nutritional concerns. A clinical laboratory with technicians who do that.

We have a behavioral medicine team with a psychiatrist and psychologist, several psychologists and some support people who do that, who handle that part of the team. We have a clinic with nurses and staff who do that, and the technicians who support them. A wide variety of just administrative support and secretaries.

It all adds up, and I'm sure I'm leaving people out, but it's a big team. It's a team that does support all the programs, but there were those who were totally dedicated to the Shuttle-Mir Program, and there were biomedical engineers who, along with the flight surgeons, went over to Russia for the entire time of the missions and stayed over there for several months and worked with the flight surgeons. Then a lot of these other people would then go over for trips, taking the equipment over to Russia, get things set up, support training. So, several hundred people, actually, on this team.

Wright: As Frank Culbertson has said, no mission is routine, but I'm sure you have a pattern of how you would put together your Shuttle flights. Would you tell us about the challenges that you had to undergo to get your team prepared for the Shuttle-Mir Projects?

Billica: I don't even know where to begin. This was a huge challenge. The last time we had done anything like this as an agency, of course, was Skylab long-duration flight, and then only went up to 86 days, 87 days, I think. I'm not sure that's the exact number, but in the eighties. And three brief missions, essentially, compared to what we did on Mir. And not too many people around from then. There are still some people around who supported that mission, but we really had to go back and dig out the records and try and remember and learn what was that experience. The Apollo-Soyuz, the only other joint mission with the Russians, and that was back during a whole different time frame of U.S.-Russian relationships. So, really not a whole lot of similarities there in terms of how that was done.

We had to learn again how to do long-duration space flight over a couple of weeks, and it's an entirely different experience, entirely different set of challenges, just a whole different critter than a Shuttle flight. So, a steep learning curve for us there. Of course, the Russians had been doing this for years, but, again, that was part of the challenge.

The other big thing was to learn the Russians, understand them, learn how they do business, and they do things very differently, not only just in terms of how they do space flight, but how they practice medicine. They have a whole different culture and a whole different approach to health care than we do.

Some of that was just fine in that it was just a matter of finding the common language, and some of that was not fine. Some of that was things that they do that were not what we do in terms of health care or philosophy approaching health care. We had to learn how to deal with that with them in a way that we did not compromise the ethics or the standards of United States health care, in putting together a joint program.

So, the two big categories, in summary, although there's lots of stories behind this, is long-duration space flight and how to do that, and how to work and get along with the Russians. I think we succeeded at both of those.

Of course, the big benefit of all of this is we are in such a better position now for International Space Station. If we had not done Phase One and just went from Shuttle to an International Space Station, without this experience, I'm not sure how well we would have done. I think we would have really fumbled around quite a bit trying to learn these same lessons, where here we had a much more structured learning experience where we were put into a situation where we basically had to fit into an existing program, learn from them, bring back from what the Russians do the best, and the experience and the knowledge that we could gain from that, at the same time learn what we wanted to do differently, and do it in a way that was less risky than just going out there and trying to learn it without that framework. So, a very worthwhile experience, but not necessarily always comfortable.

Wright: What are the differences from, say, preparing for Andy Thomas' flight compared to what you had to do for Norm [Norman] Thagard?

Billica: Oh, wow.

Wright: Can you walk us through some of the preparations or even share some of the stories with us about how you prepared for Norm's first flight?

Billica: Sure. When we prepared for Norm's flight, it was just a total blank sheet. We got a lot of different teams together that we had been using to get ready for International Space Station, various consultant groups looking at all of these things that I listed for you, and started putting together what we thought would be the appropriate things to do in terms of prevention and countermeasures in medical care. Yet at the same time going into that, our initial understanding was essentially we were the guests of the Russian program and we would do things the way the Russians had set it up. We were essentially going over there to support Norm, but that we would basically be guests and fitting into the Russian way of doing business. So we went over there just ready to support and help, but not really knowing what to expect what we were going to do, and we did not know how the Russians did things, and we really didn't know about the health care system or their processes or procedures, had no idea what to expect.

We sent two flight surgeons over there with Norm, and basically just showed up and said, "Here we are. What do we do?" Quite a scramble. Steep learning curve, as I said. We didn't know what medical support was present in Star City, so there was just a lot of communication back and forth. "We'd better get this over here. We need some medical kits."

Probably the biggest learning experience is the Russians had their own way of doing medical selection and standards, and so I made several trips over there to meet with my Russian counterparts. They made some trips over here. There was a weariness. There was an unknown. "Who are these guys and what are they going to do to our crew member?" I'm sure they were equally concerned about us. I mean, it was certainly a two-way thing.

The Russians view medical selection and medical training as one and the same. In NASA, we have standards and we select astronauts, and when they're selected, they're good to be assigned to any mission. And we do monitor them and we do some final checkouts before we okay them for mission, but essentially once they've been selected, the threat's gone and they can proceed with their training, and we support the training, but they know they've been assigned to the mission and their training.

On the Russian side, they pick cosmonauts, but all during their training they have more than one crew training for any given mission, and all during the training the things they're going through are part of the medical selection. They're being monitored and tested and put through various things where they're tested all throughout the training. It's not until right before the mission where they have another complete set of medical evaluation and tests--it's fairly extensive--that they're finally chosen who's going to do the missions. So it's high threat by the medical establishment throughout the training period. So the relationship of the crew to the medical doctors is very different.

The tests the Russians do, some of them are very different. There are things that we had a difficult time understanding, "Why do you do this? What do you benefit from this? What decisions are you making from these tests?" Some of the technologies that they had, and still have, are, for us, old technologies and things we would no longer do or no longer expose our crew members to. Lots of X-rays and lots of things like that, that we just don't do anymore.

They have a Chief Medical Commission that it took us a long time to understand. What is this Chief Medical Commission? It's made up--essentially if we put together the equivalent of it, it would be our Surgeon General, Surgeon General of the military, the head of the National Institutes of Health, the president of Yale and Harvard Medical Schools, the head of Centers for Disease Control. I mean, all of their top medical authorities in their country that form this Russian Chief Medical Commission as part of their Department of Health of their country, basically a Cabinet-level organization. This is the group that would come together and meet and, at the selection of the crews and right before a mission, would have a week-long set of medical tests done, then present it to them. It was very strange and very different from us.

So the first time we went through all of this experience I just described with Norm Thagard, we were sort of standing on the sidelines going, "This is very different," and at the same time trying to protect Norm from any undue risks or exposures, because we'd heard a lot of horror stories about--and I'm not trying to paint a bad picture. I mean, the Russian medical people are very well trained, very professional, very smart and brilliant people, but the resources they had to work with in a lot of cases were not up to American standards. You heard a lot of horror stories about reusing medical supplies and reusing needles and things like this. So we were on edge and looking for where we needed to protect our people.

We had heard stories about some of the other countries who had sent crew members, who were basically put under the authority of the medical doctors in Russia, and ended up having procedures done to them that we would never allow or never do, but if these people wanted to fly, they had to now subject themselves to this medical system in Russia that was very different, and a different philosophy and approach to health care and medicine. Different doctor-patient relationship. Not a same attitude toward confidentiality and privacy of data. Not a same attitude about informed consent, that you gave the patient the information and they had to agree to things. So, very different atmosphere just in terms of health care that we went into.

We got into some confrontations with the Russians on these things, saying, "No, you will not do this to our person." They had been used to other countries coming in and basically saying, "Well, here's our crew member. We want to fly, so we've got to let you do whatever you want to do." Well, we had a different philosophy. So there were a lot of tug-of-wars that went on. There were a lot of phone calls, a lot of meetings. There were aspects of the Norm Thagard mission where we threatened to pack up and go home. We, essentially, as the doctors were throwing our body down in front of the crew member, saying, "Over my dead body you will do this to our crew member," after having talked to our management and to our crew member, saying, "Here's what they want to do. We don't think we ought to do it. We think this is more and beyond. This is a risk that we shouldn't do."

So there were some very uncomfortable times during the first one or two missions where we reached a point of conflict that came close to ending the whole program, and had a lot of meetings with NASA management and elevated issues all the way up to the Dan Goldin level, where we had to stand firm if we were not going to allow a praesen of things that just were totally unacceptable.

As I get into this now, the emotion of that comes back to me. There were some pretty tense times. Of course, we were expected to go solve this. "Don't let this happen." And, "Why is this happening?" And, "Go fix it." But I think there was an appreciation on the crew member's part that, "Thank goodness the doctors are not letting this happen, and standing up." So a lot of trips back and forth, a lot of negotiations, a lot of writing agreements and protocols.

So the difference was, having gone through a couple of times, we established a routine that by the time we got to Andy's mission, we knew what to expect, the Russians knew what they could do and what we were willing to do, and we pretty well had it figured out. We knew now how to do the Chief Medical Commission. The Russians knew what tests we were going to allow and what not. So it smoothed out and it became routine.

By the last few missions, this conflict that I'm describing was gone and we had a working relationship and a comfort level and an understanding we knew how to do things. We understood what things were for the formalities that we needed to go through so that it would feel okay to the Russians, and they knew what things that they could not demand of us so that we wouldn't get in a conflict.

That's just in how we did the health care things. Also, by the time we got to the Andy mission, we were contributing a lot of medical equipment and supplies to the missions, where initially we just sent some extra medicines and things up.

Wright: Tell us about how that evolved. I know when we've had a chance to visit Mike Barratt, he shared with us the book that was put together with Russian-English, how to do everything from headache to some of those procedures that still mystify me, but it was a "how to do everything" book. But that was just one sample. Can you give us other things that evolved through this process that the United States contributed to the Mir?

Billica: By the end of the process, we were sending up environmental monitoring equipment, some of the equipment where we were getting ready for International Space Station. Some of that was sent up in a hurry, with some of the environmental problems that happened. I'm sure you've got all that down in history. But with the fire event and the smoke, there were some other problems where the environmental controls went out, the carbon dioxide system, the humidity controls, these sorts of things. As we had crew members up there being exposed to these things and there were questions being asked on the United States' side, "Well, is this safe? Is this healthy?" and the Russians had limited technology. They have some, but not enough really to satisfy a lot of the commissions that were coming together, asking some very tough questions about, "Is it the right thing to do to stay up there? Is it the right thing to do to send another crew member up there, just in terms of health and safety?"

And so at some instances, with very quick turnaround, we were sending up things on the Shuttle. There were even some missions where we weren't completely sure at the time that the Shuttle docked that we would leave our new crew member up there, and we were doing some real-time testing going onboard the Mir and looking at things and testing the atmosphere and getting calls down to confirm that, indeed, the atmosphere was okay, the toxic levels were okay, and we could kind of say, "All right. It's okay. It's good to let the crew member go on there."

So, some things were real-time quick decisions. "Let's send some stuff up there." So as time went on, we accumulated some hardware and equipment, and as medical events occurred on the Mir, where we realized there were some medical problems, we started expanding the level of some of the medical kits. They have Russian medical kits, they have Russian equipment, but, again, in some cases different medicines, different approaches. They don't have the same pharmacy that we do in some cases, so we would send up additional pharmacies. It got to the point on some of the missions where there might be a medical problem or a medical event that would occur, mostly minor, but still, where we would talk with the Russians. They'd say, "Well, what do you have and what do we have?" And that's where the joint medical book came together.

Wright: That's great.

Billica: It ended up at any given medical event we might use some Russian stuff, we might use some NASA stuff to deal with that event. But it evolved. It's hard to go back and point, other than to maybe some of the environmental events that occurred, where there was a definite step-up, it's more that in most cases where the Russians became familiar and we learned their system, where gradually we added some things on.

There were some things where we met with some of our Russian counterparts right at the beginning of the activity, and we agreed that jointly here was the level of medical capability that should be in place for a long-duration space flight. That list of "Here's what should be in place to support a long-duration flight"--advanced life-support medical equipment, things like that--was essentially a wish list on the Russian side. They didn't have some of this stuff either. For example, a defibrillator monitor. If there's a cardiac event or a heart arrhythmia or something, that's what you'd want to have. We both sat down and signed an agreement between the Russian medical and the U.S. that this is what should be there. They didn't have it. We didn't have it. But by doing that, we had an agreement and we said to the Russians, "All right. We'll go develop one. We're getting one ready for Space Station. Then we'll provide it to you and then you can make it part of your medical equipment up there." So part way through, we had one ready. We flew it up on the Shuttle and it became part of the Russian medical equipment that was available up there. So, some things like that. And we have that on the table here.

So, different pathways. Different ways we were able to gradually expand things to, first and foremost, make sure we had a level of comfort for our crew member, but, secondly, to jointly evolve and expand our joint medical capabilities and experience to a level that both of our teams had always said, "This is what we should have," but the opportunity wasn't there. You're always competing with, of course, other resources, and we have to be able to use a risk management analysis that convinces not only the medical group, but the rest of the NASA program management that there is a sufficient need to justify putting some additional medical equipment or medical capability up there.

Wright: It's not like you can make a house call.

Billica: No.

Wright: They're pretty self-sufficient, aren't they.

Billica: Right. And it's not like you can just walk in the door with a truckload of medical equipment and say, "We're the doctors. Send this up there." You've still got to have a rationale and a justification that makes sense. So that's where the epidemiology and all of that comes in. What are we learning? What are we seeing?

And there were some significant medical things that happened on Mir that I think opened a lot of people's eyes outside of the medical community where they finally were saying, "Wow. There could really be some bad things that happen. We need to make sure that there's a medical program available to support this."

So one of the things that happened as a result of Shuttle-Mir was a realization on the part of NASA management where we had been getting ready for Space Station, we'd been fighting a lot of battles saying, "You guys, we'd better have some medical stuff up there. There's going to be some problems." And we're telling this to people who had not had the experience. So here comes Phase One. We get the experience and now all of a sudden everybody's saying, "Boy, we need some psychological support. We need some environmental health monitoring. We'd better have some stuff ready in case somebody gets sick."

So, finally, gosh, for the first time in years our battles, our struggles convincing our own NASA management that you needed this stuff went away--not completely. Got easier because now they're asking for us. So in a way it was kind of nice for us, because now instead of us trying to force our way in, they want us. So I think, again, it went a long way to helping the paradigms, the attitudes about what's needed for long-duration space flight for ISS. So it made preparation for ISS a whole lot easier.

Wright: I know that every member of the crew, American and Russian, not all have been physicians. They've had to undergo some type of medical training. How was that a challenge to your group, to train folks to be gone for that long a time, to be self-sufficient? I know that if I don't feel well, I can go down to my pharmacist or I can call my doctor, but yet they may be able to call a doctor, but they may not be able to get what they need. So how did you take care of that part of the program to make them feel like whatever happened up there, they were going to be taken care of?

Billica: Again, we started with the Russian experience. They had been doing this--and I give them credit--successfully for many years, so they had evolved a fairly solid program in terms of how to prepare the crews and get them ready. Again, they formed several crews before a mission and that crew goes

through a lot of training, not only to get them ready for the skills and the technology of the mission, but also to bring them together as a crew. And they do a pretty good job of that.

We had some challenges during Shuttle-Mir because we swapped out some crews, and so the crew that had trained together at the last minute was changed out, and that presented some challenges to those crews just in terms of learning real time, "How do we get along with one another?" because they didn't have the luxury of training together. Big lesson learned there.

We also had a pretty good idea from the Russians of what sort of things that they'd encountered medically, so what sort of things were needed. There are some things that were fairly obvious that we knew to get ready for that.

By the fact that we assigned one flight surgeon who worked with the crew the whole time getting ready and then was *the* doctor there at the TsUP for our crew member, I think was a huge benefit. It was a really smart thing to do, in retrospect. We did it initially just because we only had one or two docs who were willing to do it, but it makes sense. We also knew it was a good thing to do. So what it did is it made it so that crew member knew this doctor and was comfortable with him and willing to really work with him when there were problems. It wasn't some strange voice or strange person; it was *their* flight surgeon. I think that helped a lot when things came up, when the crew member had questions or concerns, for them to feel comfortable, secure, confident that we were going to be able to deal with whatever the situation was.

We do a lot of telemedicine. That's how we practice medicine. Our patients are in space and our doctors are on the ground. And even those situations where the astronaut is a physician, the physician for the crew and that astronaut is still our flight surgeon; you've just got someone who's a lot better trained and their skills and their background. But the person who's responsible for the health care issues is still the flight surgeon on the ground.

So I'm not sure I'm answering your question.

Wright: You have. That brings up another subject. There were several physicians that flew. Did at any time these physicians turn into be the physician in residence?

Billica: Absolutely. Some of the things that happened, particularly with Jerry Linenger and some of the other situations that happened, there were calls being made by that astronaut physician that contributed significantly into the decisions about the medical and environmental situation, having that crew member being a physician, so that when we talked things over and that physician said, "Well, I've checked the crew out. I've done a brief exam. Lungs are clear, burns are minor," things like that, and we can speak the same language and have that person on the scene to say with a little bit more confidence, "I think we're okay."

There were a couple of incidents where that contributed significantly to the decision about whether we could stay up there and were we good to continue the mission or not. So, most definitely, I wouldn't want to play down the benefit of having in long-duration missions one of the crew members being a trained medical person.

Wright: Because they were able to help with other facts.

Billica: You bet. You bet.

Wright: All the different incidents that happened. We've talked about American crews, but we know we have cosmonauts that trained here as well, that flew. How did your area work with these cosmonauts?

Billica: We actually ended up negotiating exchange where, since we had flight surgeons over in Russia, we had the Russians send a flight surgeon here. So all the time during the program we had one of the Russian physicians here and tried to work with them the same way we wanted to be worked with over in Russia.

The interesting thing is, the concept of a flight surgeon, the concept of who that person is and what they do and all the things they cover, there was no equivalent of that in Russia. Russians split things up very differently, and it took us a while to learn this. In Star City, in the Gagarin Cosmonaut Training Center, that's a military establishment. They have military doctors, but these doctors were responsible for the pre-flight training and the pre-flight selection. Remember how they're both together. That's what those doctors do, and they have their different departments. But they have doctors who do physicals. They have doctors that do the training. But then those doctors do not support the mission. That's Institute of Biomedical Problems at TsUP. So there's another whole team of doctors and a whole different organization, very separate, very different, that's the medical support team to the mission. They were not used to working together. The only time they came together was at the Chief Medical Commission.

So you had a group of doctors who'd been training and working with the crew, the cosmonauts, in preparation for the mission, then a whole different group of doctors who did not work and know the crew supporting the mission in the Mission Control Center. They did not call them flight surgeons. They were not used to giving them the authority and responsibility, and there was no one doctor who worked with the crew through the whole thing on the Russian side. So this was very confusing to us and confusing to the Russians, because they weren't used to investing the amount of authority and responsibility into a physician, a single flight surgeon, that we're used to doing, who is the medical authority for a mission. So for us to tell the Russians, "Well, send us a flight surgeon," they didn't even know what we were talking about. So essentially they ended up sending us a military physician from Star City to come over here, but then we were expecting this physician to work with us like a flight surgeon.

So we're essentially, for the first time ever, training Russian physicians to be the equivalent of a NASA flight surgeon, and we've had, for a year at a time, we've had a series of them now, great people. We've enjoyed meeting and working with them. We've trained them up as NASA flight surgeons, and then they go back now, and now they're working back in Russia. This has been great for communication and building a rapport.

So in answer to your question, when cosmonauts were over here, we said to those Russian physicians, "All right. You are the flight surgeon for these cosmonauts." And we would have to train and explain to these Russian physicians what was expected of them, but they were expected to essentially be the medical liaison with their cosmonauts. And all the stuff that we do then, we did with that Russian flight surgeon, I think in a lot of cases surprising the Russians at the amount we expected this doctor to do, of course, supervising from our point of view. But it worked out great. We gave them an office and they're teamed up with our flight surgeons, and it went real well.

Wright: That's a great benefit for their program, that first-hand experience.

Billica: Yes, it's really paying off for ISS now, because now as we get into this and we're meeting all of the international partners, saying, "We expect whenever you have someone flying on ISS that you provide a flight surgeon," the Russians now know what we're talking about. So the first few increments of International Space Station, the doctors who've been over here from the Russians are the ones they're assigning as their flight surgeons for International Space Station. So that went real well.

Wright: We've talked a lot about the program and your staff and the team as a whole, but we really haven't talked about your personal experiences. You've worked so many times, so many years with Americans and American space and some international partners, but this has been a full-time international partnership. Share some of the experiences personally that you've felt your growth or maybe even a high point or a low point that you could share with us, something personal.

Billica: For me it has been very enriching. I think it's taken me to another level of what the job is, and to go from just taking care of the NASA program to now having to grow into someone who is negotiating on an international level medical issues. We've done some things that when you step back and watch what's going on and say, "My gosh, we're here negotiating standards, medical standards, with other countries and coming up with joint standards and protocols between the United States and Russia on how you practice medicine." We're not sure that that's really ever been done before, and we're setting some precedents.

So for me initially, we sent our first two flight surgeons over there, Mike Barratt and Dave Ward, just two topnotch people, and they're over there and I'm back here having the usual misconceptions, suspicions, paranoia about the Russians whatever. Up until that time, the only people from the medical side who had ever gone over to Russia were high-level management, and I'm kind of half management,

half flight surgeon. I'm kind of the interface between them. I still like to think of myself as a flight surgeon. That's my background and that's what I've done, and they stuck me in a management position. But I still work missions, so I'm kind of the point in between.

The only doctors who had ever gone over were high-level management, who would go over, and this is not to say anything bad about them, but in their role they would go over to Moscow and meet in meeting rooms and things. So then we sent our flight surgeons over, and they're over there in the trenches. They're over there in Star City doing training, dealing with this tug-of-war day-to-day, and they're calling me, saying, "This is not easy. We've got problems. We need help. We need you to come over here."

So with some uncertainty and trepidation, I agreed to go over. They said to me, "Now, when you come over here, you don't go to Moscow and stay in a nice fancy hotel. You come to Star City. We'll find you a room over here in the Prophy where we're training and where *we're* living, and we want you to stay here with us and see what it's *really* like." Because they're telling me that they've got some problems and some tough times.

So I go, "Okay." I've done a lot of travel, but never to Russia before, so my first experience was to go over there by myself. Of course, it's very different coming in. It's not the same as going to England or France or something like this. It's a different experience.

So I end up over in Star City and they meet me, fortunately. It's getting through Customs and even just any of that, it's different. And they meet me and take me out to Star City. So I stayed out in Star City with the team for a couple of weeks and got to really know what it was like. And there I started meeting with the true counterparts--the head of medicine from IBMP and the head of medicine from Star City, where before over here we'd met a couple of times, but never on their turf. So there were a lot of late-night meetings, sitting in a room, negotiating, arguing, working out all of these things. I told you we had challenges about really getting down to the detail nitty-gritty, staying up late night. That first time we ended up writing a joint medical requirements document, and we stayed up, we worked all night.

I was staying in the Orbita, which is their equivalent of a hotel there at Star City. Very different. And still very early in the program, so they're suspicious. They've got guards. It's military. So I'm up late at night with my team, working on this document, up at two and three in the morning, walking back through the snow to the Orbita. It's shut down. There was one night--when you leave, you left your key at the counter; you didn't take it with you. And there was one night I got back there about two or three in the morning and they had shut down. There was no one around. So there was no way for me to get to my room. So I ended up sleeping on the couch in the lobby of the Orbita that night, worrying at any moment that some guard, military guard, was going to come in and I would wake up with some guard sitting there wondering who was this American sleeping in the lobby of the hotel or something. So, just little adventures like that. It wasn't ever a problem.

What happened that first time was, I really got to know the Russian counterparts. I got to really see what it was really like, because I was the first one of the management that actually went over there. I experienced a camaraderie of the team there in Star City and they got to know me, and I got to know them. It made a huge difference, because now when they would call back, I knew what it was really like.

One thing that happened that was really special was, one of the Russian flight surgeons who had been over here and had gotten to know me was now back over there in Star City. Dr. Morgun, who is my counterpart, Valeri Morgun, who is the head of medical at Star City, invited me one night after everything had shut down, to come over to their training facility where they have their sauna and their pool and their workout facility. He showed me around. We had no interpreter; it was just Dr. Morgun and myself and this Russian flight surgeon. He showed me the traditional Russian ceremony of the sauna and the bath. So we had refreshments, and it was just us. We had some refreshments and it was just a whole different setting, and toasts and all of that, and little snacks and things. We started out with that. Then we went in the sauna and he explained all the tradition to me. Then we would go swim in the pool and then come back in the sauna, and swim in the pool, and do that bath tradition that the Russians have, and then retired back to a room and continued. And we got to know one another and we established a relationship which we didn't have before.

Now, I had done Russian cultural training before all of this, to prepare, so I was prepared, but this was different. And things changed after this. I mean, this went well into the night and we became friends. So even though after that we would have tough negotiations, and I had also built a relationship with Dr. Bogamolov, who was the head of medical for IBMP, and after this, whenever they came here, we always would go--I would take them out to dinner, and we didn't do a lot of this again. This was really the only time we did this. This was my first time there. But it changed the whole relationship and we're friends now.

As a result of that, I think it made a huge difference in our relationships. The suspicions were gone. There's still the struggles. There's still the arguments. But what I learned was that you could have the arguments in a meeting, but now there was a level of comfort and trust. It's made a huge difference. Mike Barratt and Dave Ward said this made a huge difference. It changed everything. So that was a real turning point. I've made many trips after that. I've lost count of how many times I've gone to Russia now and done this.

The other thing I've learned was how to negotiate with the Russians, and I'm told I'm good at it. It's a different way of thinking and you concentrate. It's very draining, but I've developed the ability--and I sound like I'm bragging here.

Wright: No, no, no.

Billica: But I've developed the ability to figure out what they really want. I would sit there and we'd be talking, intense several-hour meetings, and they're going on and on about something and I'm just sitting there trying to figure out what is it they really--what's the real point here? Because they don't come to the point; they talk around it, and you have to kind of figure out what is it they're really after. Then you have to figure out how to address the point without addressing it, but letting them know, "Oh, all right. I figured out what you want now," and kind of deal with it.

But I had to learn that they say no and don't mean no, and that's just on any negotiation. They start out saying no. Then that's your starting point and you go from there. They don't mean it, but they're just trying to see what the real agreement level is. We'd just go over and it was a problem initially, where you'd sit down at a meeting and they'd say no, and you'd go, "Okay, they said no." And you'd leave, and they'd be thinking, "Well, that must not have been very important. We said no and they left." They're ready for you to get in with it here and get emotional and pound the table and leave the room.

We got into all of that and did that several times with them on things, sitting there and learning how to use an interpreter to make things work and not look at the interpreter, but instead be right eye to eye with them. Based on some of the earlier things I described to you, we had some really emotional "get up, leave the room, storming, pounding on the table" negotiations, where they were insisting that things would be done their way and I was drawing the line, saying, "Absolutely not." And coming back the next day after huddling with your management. So we did a lot of that kind of stuff.

It's been real interesting then to take that and then, as a result of it, have some international discussions where you've got the Russians on one side and the Japanese on the other, where the Japanese always say yes and don't mean it, because they're so polite and they're trying to keep everything comfortable. So here we're in the middle of a meeting with the Russians saying no and the Japanese saying yes, and nobody means what they're saying, and trying to figure out.

So I've learned a lot about international negotiations. I've learned a lot about the Russian culture. I've gotten to where we've basically--the first time I went over there, it was like a honeymoon. They treated me great. We did the sauna thing. They showed me around. I came back from that first meeting just on an emotional high. "Isn't this wonderful! Isn't this going to be great." Then went back fairly soon thereafter there and really had to deal with a lot of the conflicts, and came back with an emotional low, thinking, "This is not going to be easy. I'm not going to enjoy this. Those dang Russians," you know. And then we found the common ground and now it's a great thing. I enjoy working with them. There are still struggles. There are still things we don't agree with them on. There are still things even now, getting ready for ISS. They were over here with other partners. These same people, Dr. Morgun, Dr. Bogamolov, and their staff, are the team that we're working with for International Space Station. So we're now starting over again, figuring out what's going to be the precedent for Space Station.

I know I've rambled, but those are some of the memories and some of the experiences.

Wright: No, that's exactly what we want to hear. I'm sure it's been very reassuring to them to know that you have been with them the entire time. That's been a constant. I know that in any negotiations it helps when you get to know somebody so that you can continue on with them and not change that pattern out.

Billica: Yes. I think of Star City and I think of the Russian staff who supports our team over there in the Prophylactory. They're such wonderful people and have taken such good care of our staff, and because of that first time I stayed over there with them, and sometimes subsequent I've stayed with them, they're just always so delighted to see me. I get my wife to help me prepare some gifts, maybe some skin-care things or some gifts or something, so I show up. And they've never met my wife, but I always come and say, "Here's some gifts for you from my wife." And so then they send stuff back. Occasionally they've sent something back and say, "This is a gift back for your wife."

It's just been such a treat with my flight surgeons and some of the people when I'm staying in Moscow, that we'll meet and then we'll go and we'll wander around Moscow just to see the culture and the tradition, and go to some of the Russian restaurants. It's just been a real treat.

It's been a real eye-opening experience in terms of the Russian way of practicing medicine and how they have combined a lot of the Eastern approaches--the herbal and holistic and some of the other aspects and some of the things that they do and how they have evolved their health care without the technology that we have. So how then have they evolved how to take care of people without the reliance on technology that we developed?

Wright: And that we've learned a lot from that? You've been able to study their methods as well, to see if some could be put here?

Billica: Yes. And some of the things that they do in space for countermeasures that we don't do, and we're still trying to figure out is there any validity to this or not, and is this something we need to agree to for Space Station, or is this something we want to create an exception and say, "We'll agree for Space Station to have the capability, but you're still going to do some things differently than we do," and now maybe we'll learn a little bit more and see who's got the best way.

Wright: Let's take a look.

Billica: Okay.

Wright: If you'll remember, as you're walking us through this, we do have audio going as well, so if you can tell us what it is as well as show it to us, we'd love to have your tour.

Billica: Okay. Let me start over here with the medical kits. What we started out with when we set Norm up, we took a couple of our Shuttle medical kits, which is what these two blue containers are, that are, oh,

I don't know, cubes of eight inches square. One of them is the emergency medical kit that has in it a lot of our emergency medical equipment: stethoscope and otopthalmoscope [phonetic], the medicines that would be used in a medical emergency, that you would find in an emergency room for a heart attack or a bad problem, with the injectors. All these pouches have different medicines and things in them. It's a very tightly packed kit. It also has the blood pressure cuff and the otopthalmoscope and things to do an emergency exam.

We basically just modified these two kits. The second one here is called the medications and bandage kit, and it's full of bandages and medicines. These are all pill bottles and things, and bandages. We just took these two kits--this is a subset of what we fly on Shuttle--and modified them with things that we thought would be more appropriate for long mission, and sent these couple of kits up with Norm. Every time a Shuttle went up, we would send a new kit, restock, and bring the old ones home, and just kind of swap them out each time.

As the missions went on and we realized there were some other needs, we made some additional kits specifically for the Mir program that we started sending up in addition. This one, we called it the medical resupply kit, and everything in these kits is both in Russian and English. This is where one of the books that Mike Barratt may have showed you, where we came up with a book, just as we do for the other programs, that explained what's in the kits, how to use them, what medical problems that you would use them for, in Russian and English. Of course, all of this stuff not only had to go through our certification, but then it also had to go through the Russian system and for them to say, "What is this? What's the danger?" We had lots of discussions on that and everything.

So some things that are in this kit, for example, the resupply kit, we've got a clinical analyzer that would do blood tests and would allow you to get tests on your blood sugar and your electrolytes and sodium and things. This was used to help monitor and diagnose how the crew members were doing. You can see this is something that a technology that we developed where it's a modification of something that's off the shelf, and here's these little cartridges, but it basically uses just a little bit of blood and you're able to run this through and get blood tests from it.

We also have a real small pulse oximeter that we modified for space flight, that essentially allows you to check blood oxygen and things like that just from placing this on your finger and getting data. This was all miniaturized and new technology that the Russians did not have, that expanded our capabilities to diagnose and monitor things.

There's also additional IV fluids and bandages and things that we learned that we needed. I mean, they had some heart arrhythmias up there, the crew--I can't say who and I can't get into specifics. There were cuts and there were lacerations; there were skin infections; there were foreign bodies in eyes. After some of the fire, there was some smoke inhalation. There were some other spills and things that occurred where we may have had toxic exposures. So we learned that we needed this sort of stuff. Some of those

things happened with the Russian crews, some with ours, and it got to the point where the Russian crews were using our medical kits as well. And it got to the point where the Russians were asking for things. At the end of the program, they asked us to leave a lot of our stuff up there. So now that Andy's come home, some of this stuff I'm showing you is still on Mir for them to use.

Then we had another kit that's our extended duration pack that we put together for the mission that we added even more stuff into. So again you open this up. This is all additional medicines and things that are in the kits. You see how it's designed and organized with different pallets. It's quite a packing job, actually, with things stuffed in. Then this is also our airway supplies if we had to start an airway. These are different aspects of putting an airway together if somebody needed that. This is now starting to get into emergency medical equipment and things like that, that you'd find in an ambulance, that we traditionally fly on the Shuttle. Some of this they had. Some of this they didn't have up on the Mir, so we looked at that with them and agreed that we needed the capability in space at any time to respond to a medical emergency, stabilize them so that we could transport and have a good chance of getting them home.

We've learned that the body changes in space and there's a lot of things that are different about the physiology and how it works, and we don't know whether some of that triggers medical problems or just puts them more susceptible to it, but we have seen some heart arrhythmias, we've seen some changes. The Russians have even brought one of their crew members home early because of heart problems, not during Mir, but earlier. They've had people that once they've come home right after the mission they've had some heart problems that may have developed during the mission.

So as a result, we agreed there needs to be a defibrillator and a monitor. So we developed an off-the-shelf defibrillator that then was modified for space flight, that real quick could be deployed and set up with the cables and get a rhythm and, if necessary, to defibrillate. This was the first time a defibrillator's ever been flown in space. It's actually now part of the Shuttle program and will be part of the Space Station program.

Along with that, actually, you couldn't do a lot of medical procedures or couldn't defibrillate or something like that with someone just floating around. Medical restraint is an issue. So we went and we sent some of our biomedical engineers over to their mockups to look and see where would we do all of this. They designed this pallet, this medical restraint, which unfolds, that goes on the table in the Mir, the galley table, that these things actually would hook around the legs of the table and then you could strap a person in. It has insulation in it so that if you defibrillated, the shock's not going to go into the structure of the--we're not going to send the Mir into some kind of out-of-control spiral there. This is the precursor of the medical restraint that we're going to fly on Space Station. So we had to do this.

Now, the other things that we had to do were some environmental monitoring. These are some things that have been developed. Some of this is new technology that doesn't exist outside the space

program that's pretty exciting. But we had an air sample analyzer that would take air samples and then we would bring this down. We'd take several samples and bring it down and analyze it and produce a report. This played a big role in determining whether the atmosphere was safe. So these sorts of things were used, and you could get several samples. You basically turn it to the next sample you need and then just turn it on for twenty-four hours and it actually brings in air. Then turn it off and then later get the next one.

We also have these grab samples. This is basically a bottle with a vacuum in, that after an event, if you just want to get a sample of the air, you just open this up and it gets the air. You close it and we bring it down, and now we've got air from the Mir after the fire or after something, and we can see what it really was.

We have a combustion products analyzer with some new technology that allows us to actually get a real-time reading of carbon monoxide, hydrogen, chloride, hydrogen fluoride, and some other contaminants that would tell you real time do you have an unsafe atmosphere. This is something that they didn't have the ability to do. This was used quite often, and there were some times when we had some abnormal readings that we were able to track and say, "All right. Let's make sure this comes back down to normal." So this played a big role.

We had to put together, because of a lot of the science equipments that we were doing, it was possible that we could end up with some formaldehyde, and the Russians were very concerned about things like this, as were we. These are just little samples of formaldehyde that you would see some color changes to. They hadn't designed their air filtration system on Mir to handle some of the stuff that we wanted to send up there to do science, and so we had to come up with our own ways of monitoring, to reassure that we wouldn't create some problems.

So these are just some of the things that we put together and designed. It's not everything, but it's an example of things that we had to then contribute, where we started out just being a guest and we ended up being a partner. Any questions about some of this?

Wright: It's fascinating. Any questions for the medical equipment?

Davison: I have one. You said that you adapted this equipment to the Mir. Did you end up changing some of the equipment as well for ISS through what you learned on Mir?

Billica: We basically were already preparing equipment for ISS, and the timing is such that by the time we're done with Phase One, we had to be well along with-- [Brief tape interruption]

... exercise equipment, the treadmill, as a result of our experience on Mir. And we've added a resistive exercise devise which we didn't have before. So, yes, I guess there are some things we've changed and done different, but these things that I've shown you, other than maybe changing what some

of the medicines are, these were well along in their ISS design. In fact, if that weren't the case, we probably wouldn't have been able to fly them on Mir if they weren't as far along, getting ready for ISS as they were. So, for us it's more just a nice testbed and proving ground that we're on the right track.

Wright: We started our conversation and you listed all these many, many areas that your group takes care of regarding Shuttle-Mir Program. Was there one more difficult than the other, or were they all equally challenging?

Billica: There's two areas that we've probably grown the most in, and I wouldn't say that they were difficult, but we probably had the farthest to go, because they weren't things that we typically had to do for Shuttle. That, number one, is the area of behavioral support, the psychology support. The other area is the physical medicine and physical rehabilitation. For a week to a week and a half, two-week-long Shuttle mission, neither of those are big deals, but for a several-month mission and deployed overseas and those sorts of things, they suddenly became very important and very big deals.

We, in the time period of Phase One of Shuttle-Mir, had to build up a program in both of those areas from scratch and put a team together. It was not only a challenge for us, but it required some changing and thinking of the management and the people back here at Johnson Space Center, because the Mir Program is going on over in Russia and it's real easy for the people here at Johnson Space Center for it to be out of sight, out of mind, and for the people over here to still have the Shuttle mentality, because they're still doing Shuttle missions and they're thinking short, quick.

So we start coming to the people over here, saying, "We need to put together a psychology program, behavioral support. We need to do some crew training. We need to do some family support. We need to come up with some things that will be of entertainment value and relaxation value. We need ham radio communications. We need some people to help with the training and selection of the crews." All of these sorts of things that fit into a behavioral and performance support program. And had to go from concept to reality and convince the management that it was needed. So that was a challenge and a lot of lessons learned, and they did a good job, a real good job.

Wright: Was this due to a result of what you were hearing back from crew members or was this something you did as more of a preventative, or maybe a combination of both?

Billica: All of the above, realizing back from Skylab, realizing from looking at some of the analog groups that we study--Antarctica, submarines, things like that--that part of our epidemiology we study other groups, what kind of problems, what kind of needs do they have, that we can then look at and apply to the space program. So we expected there to be some issues in this area. We also knew this from talking to the Russians and we learned it very quickly from the experiences as it happened. So, a steep learning curve. It grew as it went.

The same thing for the physical medicine and rehabilitation, that before this program, we did not have a structured exercise fitness program for the astronauts. We had a gym that we supported and stuff was there, but we didn't require any of them to do any kind of structured program. They just did whatever they felt like. As we started going into this, we hired an exercise physiologist strength and conditioning coach, a trainer, who then brought on some other trainers and a physical therapist, and we put together a structured program for crew members doing these long flights, and put them into a mandatory fitness and training program that was monitored, and then led into what they did during the mission.

Then this was the same team that when the people came back, they were very involved with getting them strong again, getting their bone density back, their strength back, their coordination, all of that, and actually put them through, as Andy Thomas is going through as we speak, a reconditioning, recovery, rehabilitation program. And none of that existed, and we had to put the program together. We called in experts from all over the country to help design the program, leading experts in rehabilitation and physical medicine to come in and advise us and help us put a program together. We now have our own program that we do, that we have a facility. The old WETF, the old water and training facility that's not used now, we now have. We've put in exercise equipment. We have a treatment room there and we have the pool that is now part of our medical facilities for rehabilitation that we do.

So, both of those areas, I wouldn't say that they were problems, but we'd not done that before, and we had to build up programs from scratch and put them in place. Those were probably two of the biggest areas. The main problem areas were things I've already described to you just in terms of learning how to do joint medical support with the Russians. That we had some problems with and really had some struggles with, but we succeeded.

Wright: Now that Phase One's closing down, are things going to get back to whatever normal was before? Are you looking at things to have a different type of normality for your department?

Billica: That's a good way of putting it: a different type of normality. I mean, I look forward to the break. I'm thankful that it's over. It's been a very strain and drain on our resources. We did staff up somewhat, but we have always been right at the limit of our resources here in supporting this program, and it has burned out some of our people. We've had some people leave after doing it, just like some of the astronauts, I think, got burned out and left. Some of our best doctors and some of our best engineers, biomedical engineers, after doing their part of the program, left. That was real unfortunate. I think we just used them up and burned them out. That was not our desire. So it wasn't easy on everybody.

So, thankful we're through it, learned a lot, glad that this part's over. I think it's been a real historic part of our program and I think there will be a lot of looking back on it, going, "Wow! That was really something special." But looking forward to now having a few months' break here to kind of figure out what did we learn, what do we need to do now, and giving people a break and moving on with ISS.

But we've got four crews training for ISS. I've still got doctors and people over in Russia. So, really, it's just pressing on. The thing that's different, however, is we're not guests of ISS; we're the lead partner for International Space Station, so now it's sort of like, "All right. We've done it your way. We've learned a lot. Now we're in charge." And we have a little bit more control over how things are.

We're not under the Russian authority in terms of the medical, so there's some significant changes in how we're doing business for ISS versus what we had done for Phase One. For example, our crew members don't have to go be approved by the Russian Chief Medical Commission now. They approve their crew members, we approve ours. But as a result of Phase One, we've got joint standards. So, I mean, like I said, if we were starting now for ISS, having to come up with the joint program with the Russians and were having to go through the struggles and fights and negotiations now that we did at the beginning of Phase One, I don't know that we would be able to do it and meet the time line for ISS.

So, there is some normalcy. There is a sense of stand-down a little bit, but not completely, because we're delivering hardware for ISS, we've got crews over there training, so I've got docs over there back in Russia, and getting ready to send Mike Barratt back again. So it's changed. We're in an international mode now, and we're not out of it. Just because Phase One's over, we're not back to just doing Shuttle flights. I don't know that I foresee us ever going back to what it was like before Phase One. When I took over in 1991, I think we had about 6 flight surgeons; we've now got 15 flight surgeons. They may be trying to cut us back a little bit, but I don't see us going back to like what it was.

Wright: There's literally the whole horizon out there to take on, isn't there.

Billica: Yes.

Wright: Sounds like that with your list, I'm sure it's going to grow and your contributions will be many to the program. We certainly thank you for talking with us. Again, thanks and good luck in the future.

[End of interview]