NASA JOHNSON SPACE CENTER ORAL HISTORY PROJECT
ORAL HISTORY TRANSCRIPT

JOHN W. O'NEILL
INTERVIEWED BY CAROL BUTLER
HOUSTON, TEXAS – 12 JULY 2001

BUTLER: Today is July 12, 2001. This oral history with John O'Neill is being conducted for the Johnson Space Center Oral History Project. Carol Butler is the interviewer and is assisted by Jennifer Ross-Nazzal and Sandra Johnson.

Thank you very much for joining us today.

O'NEILL: My pleasure.

BUTLER: To being with, if you could tell us how you got interested in engineering and how that led to you becoming part of the space program.

O'NEILL: Well, I think I was interested in architecture and engineering all the time I was growing up in a small town in Nebraska. After I got out of high school, the Korean War was upon us. So after about a year out of high school, I joined the Air Force. I was fortunate that the Air Force had the aviation cadet program at that time. So I passed the necessary tests and all of that and went into pilot training in the Air Force and served as a fighter pilot in the Air Defense Command. I don't think that command exists any longer, but, anyway, I did not serve in combat because the Korean War ended about the time I was getting out of flying school.

But from the time I flew in the Air Force, of course, I was very interested in aviation. Because I didn't yet have a degree, I elected to leave the Air Force really with the intention of

going back. But I left the Air Force and went back to the University of Nebraska and got my bachelor's degree in mechanical engineering there.

While I was at Nebraska, the space program was really blossoming. The Mercury Program, you know, some of the early problems in satellite launches and all of that were beginning to be behind us, and we had embarked on the Mercury Program. I just really thought I'd like to be a part of that. But I did take a job in Albuquerque, New Mexico, when I got out of the University of Nebraska, mainly because it was with probably the finest, I thought, national lab at that time, Sandia Laboratories there. It was a very good salary, and there was also the opportunity to go ahead and get my master's degree, which I did at the University of New Mexico.

But all this time I'm watching the space program develop and really thinking that I wanted to be part of it. What finally brought it to a head was when fellows I worked with at Sandia in Albuquerque came to work with the Manned Spacecraft Center, as it was called at that time, in Houston. Then they got in contact with me and convinced me that with the flying background and my interest in the space program it was time to join NASA. In the summer of 1963, we came to Houston, and I started to work with NASA.

BUTLER: Did a lot of what you had worked on at Sandia, did much of that experience translate over to what you were doing?

O'NEILL: Not so much the direct experience, because Sandia at that time worked strictly on nuclear weapons, very classified environment, very secretive environment, and, of course, that had no counterpart in NASA at all. But Sandia Laboratory was operated for the government by

Western Electric and Bell Labs. So they had a wonderful and very professional engineering environment, and the way they went about project engineering and tests and development, that was very valuable, and I think that carried over well into the work that we were doing when I got to the Johnson Space Center—excuse me, Manned Spacecraft Center, at that time.

BUTLER: Coming to Houston in summer of 1963 was—

O'NEILL: We thought we were going to die. We thought we were going to die with the heat, because I think the humidity in Albuquerque was something like 8 or 9 percent the day we left. We had four children, two of them quite small. But almost worst than the heat, we made arrangements to stay at a motel in Houston while we searched for a home. The first night in the motel, and it was a nice motel, but, wouldn't you know, my wife and children experienced for the first time a Houston roach crawling in the bathroom. I thought we were going to have to leave town. But anyhow, we got by that and found a home and have always been very happy we came here. We still haven't gotten used to the heat in the summer, but we've enjoyed the environment very much.

BUTLER: But certainly very different than, as you said, both Albuquerque and Nebraska, very different environment.

When you first came down to NASA, what position did you move into at that point? Actually, you were in the Thermo-Mechanical Section.

O'NEILL: Yes.

BUTLER: What were your responsibilities and duties there?

O'NEILL: JSC or the Manned Spacecraft Center was organized somewhat differently at that time. I was in the Thermo-Mechanical Section of the Flight Crew Support Division, which was a part of the Flight Crew Operations Directorate, but it was a very different directorate, with the exception of Aircraft Operations and the Astronaut Office. It was a very different directorate than FCOD is today.

At that time, Flight Crew Operations Directorate, you might say, had not only the astronauts and the aircraft at Ellington [Field], but they had all of the flight planning, all of the procedures for checklist development. All of the training, the simulators and trainers, as they were at that time, were a part of that directorate. So my immediate duties had to do with developing procedures for the Gemini spacecraft for operation of the systems that they classified as the thermo-mechanical systems.

So we were really in the checklist and, therefore, input to the flight-plans kind of business, working very closely with the flight crews. Donald K. "Deke" Slayton, by the way, was our directorate head. Warren [J.] North was our division chief. Both of them had, of course, tremendous backgrounds in aeronautical research, test flying, the whole thing, so that was of great benefit, too.

BUTLER: What did the thermo-mechanical systems consist of for the Gemini spacecraft?

O'NEILL: The environmental control system, the life support for the astronaut, and anything that had to do with thermal conditioning of the equipment in the spacecraft, to that total environment. Then later on as we got into Gemini, it also included mechanical systems, docking systems, for example, systems that fit in that category.

BUTLER: You said you worked very closely with the flight crews during this time.

O'NEILL: Yes.

BUTLER: Were you, on a daily basis, building these flight plans for each mission? Did you know the crews ahead of time as you were building these flight plans for the procedures they would be using?

O'NEILL: Yes, you worked very, very closely with the crew. In fact, the people that really have the primary flight planning and procedures development responsibilities still have that close interface today. They get a lot of input from the crew. But we were smaller organizations at that time, and so, yes, you saw the astronauts in the first and second and third class on a frequently, almost daily, basis. We were in the same building.

Quite often you worked on technical teams with the astronauts who were maybe not yet assigned to a crew but had technical assignments. Well, quite often you were teamed with some of those people. For example, I remember that Bill [William A.] Anders and I were responsible for the cockpit controls and displays development on certain of the systems in early Apollo. He had even broader responsibility, but, for example, he and I would travel to the West Coast to

review development of the spacecraft and the panels and the controls and displays. So, yes, you did work closely with them.

At that time, and on through the Apollo Program, the mission simulators for the final crew training were at the Kennedy Space Center in a building at Kennedy that was part of the Flight Crew Operations Directorate back here. It was part of our center but located down there.

A branch chief in our organization was responsible for those simulators and trainers. I bring that up because the final development of the checklist, the final refinement of the checklist and every mission had all kinds of totally new things. There weren't very many repeatable functions except for ascent and entry, but you would work on the final revisions to the flight plan and to the checklist at the Kennedy Space Center. We had small offices adjacent to the crew quarters area down there. They lived down there and went through about their last two months of training in Florida. So then you really worked closely with them. We took turns as the primary flight plan person and flight data file project manager going down to KSC with maybe a couple of other individuals from here. Then we'd make all those final revisions at KSC.

BUTLER: What went into putting together these procedures and doing the flight plans, the flight data file? How would you start from the beginning of the mission concepts and work up to those final revisions?

O'NEILL: Well, let's talk about the checklists and the procedures first. The really critical initial input came from the prime contractors building the spacecraft, from McDonnell Douglas [McDonnell Aircraft Corporation] in the Gemini Program and, of course, from North American Rockwell [Corporation] in the Apollo Program. So you took what they gave you as the proper

way to operate the systems and how to operate them in various modes including how to handle emergencies and all that. But that was just the starting point.

Then working with the flight crews and working with the simulators, you refined that. Your initial cut at the procedures tended to be system by system, but that's not how the spacecraft in the mission operates. You had to integrate all of the procedures. Then as you developed time lines, how long it took to accomplish certain of the procedures, and we also had a close interface. This was a huge team effort with the mission and planning and analysis people who did all the trajectory work. It had to fit the timing called for in the trajectory. It was a matter of bringing that all together.

So it was a tremendous integration job, really, bringing the flight plan, the procedures, the consideration of the workload on the crew, the interaction with the ground and with the flight control people. They, of course, were in a different directorate then. They were in the Flight Operations Directorate under Chris [Christopher C.] Kraft [Jr.]. So we had to deal with the interface with the ground with the flight controllers. So big, big team effort, with some occasional bumps in the road as we had differences of opinion about how things would be done. But it was a very constructive process, and everyone worked together very well, very constructively in the end.

I don't want to leave out the Engineering Directorate either. I mean they were very constructive in review and making initial inputs as to how systems should be operating and then reviewing procedures, reviewing the emergency procedures. So I can't stress too much what a team operation that was.

BUTLER: It certainly did take a lot of people to pull it all together. Nobody could have done this on their own.

O'NEILL: Yes, yes. And usually we were making changes right down to the wire. Of course, that was always a concern, too, in making late changes when you didn't have the information processing technology that we have today. I mean things were done on typewriters, and as you made revisions to masters of flight plans and checklists, you did it with Snopake [phonetic] and cut and paste. It was a very different environment. You literally worried that as you changed a page of procedures, a few lines that needed to be changed, that you didn't somehow affect other procedures that you didn't really mean to alter or that you hadn't given enough consideration to.

So that was why it was so important to have the checks and balances of the people in engineering, the people in the Flight Control Division, and FOD, the crews, and our other people looking at it, and then checking it out in the simulators besides.

BUTLER: How sophisticated were the simulators at this point in time for it, and how closely did they match up with the spacecraft?

O'NEILL: Well, when you consider the state of technology at that time, I really think they were quite impressive. It's more a matter of the level of fidelity with which they can depict the out-the-window view of the astronaut, the target if you're trying to accomplish a rendezvous. That had to all be done, I guess I'd call it mechanically, at that time, with actual physical models and cameras that ran up and down tracks to simulate the closure during rendezvous, that sort of thing.

But the simulators took off from the military aircraft simulators, which were becoming quite well developed at that time. A whole lot of my checkout, going all the way back to my Air Force days, when I, for example, flew the F-86D, there was no trainer version of that. You did not go up with an instructor. You, instead, flew so many hours in a simulator, which was really high fidelity. Then they punched your ticket, and you went down to the flight line and got an airplane.

Well, the simulators here were just a step above even the aircraft simulators, so I would classify them as really quite good. More difficult to load sophisticated failure sequences and all of that, but there were really bright, good people in the simulation and training area. They managed to create most situations that you wanted to train for.

BUTLER: How closely did you work with the people who were developing those simulations? Obviously, you mentioned you had to develop a lot of the emergency procedures as well.

O'NEILL: If we're talking about Gemini and Apollo, they were in our same division. They were just literally down the hall. So there was this constant interaction back and forth. Quite often they were the first ones to question new sets of procedures or plans, because they were trying to develop their training scenarios. So they would be back asking, "Is this really how this could best be done? Did you think about this?" So it was another one of those checks and balances, really positive interactions.

BUTLER: Were there several occasions where within a simulation itself after things had already progressed to that stage where they were running full mission simulations that people would come up with, "Oh, hey, wait a minute, this has to change?" Would that be?

O'NEILL: Oh, yes, yes, particularly with respect to the time lines. Is there enough time for that? Is the crew loaded too much to accomplish those steps? Have we spaced things out properly? Do they get the right information to make that decision at that point in time? So there were constant modifications as we went along.

BUTLER: How much time did you have from the start from when you first began working on the procedures for any one specific mission to flight day, and how much time did you have to finalize everything and firm it up? Or did that vary?

O'NEILL: That varied a great deal. Of course, the first flights of Gemini you had quite a bit of time to develop those initial, just basically getting it up and down and flying around a few orbits to get those procedures together.

What you did, in addition to trying it out in the simulator, we participated in the testing at the prime contractor's plant. We spent a lot of time in St. Louis [Missouri], as they were going through their thermal tests and hydraulic tests and every manner of test they could put the spacecraft through. So we used that knowledge. That increased the fidelity of the operating approach to the spacecraft. Then we started into the training and everything here, with the big step forward, too, in really wringing things out when you were ready to bring the Mission Control Center into the picture and you began to get their input.

Prior to that time, they'd been reviewing the procedures and, you know, they had a procedures trainer of their own that wasn't quite as sophisticated as the full-mission simulator. But in order for the flight controllers working for Gene Kranz and the people in that environment, for them to really come up to speed in that, they had their own cockpit trainer. They knew where the switches were. They knew what they were asking the crew to do. They would exercise the procedures also.

BUTLER: And as the missions would go, even though you said the missions were very different and a lot of the only things that were the same were the ascent and the entry, were there some phases of some of the missions that would be able to overlap that you'd be able to take that experience and apply it to later?

O'NEILL: Oh, yes, yes, especially, you know, on the orbital missions and all that. Once we started into the Apollo Program and we were going out of orbit, you were in a whole new world. But there were just so many new things coming along. The early extra-vehicular activities [EVAs] and all that we had to learn there, the early approaches to rendezvous, where, you know, we stumbled a little bit here and there but refined those procedures. There were these constant changes in evolution because we were doing, usually, something quite different each mission; in Gemini, building the foundation for Apollo, and then the Apollo missions with the ambitious program that that was.

BUTLER: For Gemini, as we were doing some of our research, we came across the site on the Apollo lunar surface journal, written by Frank O'Brien, who I guess is your godson, and he had mentioned that you were involved, specifically with the Gemini EVAs.

O'NEILL: Yes.

BUTLER: What was your contribution there? And, as you mentioned, there were several difficulties that were experienced along the way with those.

O'NEILL: Just the general, again, development of the approach to donning the equipment in the spacecraft, stowage, what we would try to accomplish outside the vehicle. There was a lot of interaction with the engineering people. For example, no one was really, at that time, quite sure what would happen to the seals on the spacecraft door when you opened them and they were really exposed to deep space. I mean, we thought we understood enough about the thermal environment to do the job safely, but there certainly were a lot of unknowns.

So as they discovered more and more about the suits and just the whole process, then we'd try to crank that into the approach to the procedures and to the mission profile. But one of the really rough learning experiences that we had, and it was so obvious after the fact was that we did not provide adequate restraints and positioning aides outside the spacecraft in the Gemini Program. Gene [Eugene A.] Cernan and Dick [Richard F.] Gordon and others got in some amount of trouble because it was so hard to control and position their body. It was just a tremendous amount of work. Heart rates would go out of sight, and so learning how to provide

those translation aids and positions aids where you were held in place and you didn't have that action, reaction as you tried to torque the wrench it torqued you the other way.

We had so much to learn there that now seems so obvious, why didn't we think of that. But we thought of it to a degree, but didn't realize how pronounced those effects would be. So you were always updating, trying to make input to the equipment that would really help the crewmen and then the procedures that would go along and help them use that equipment and get the job done.

BUTLER: During—while the missions were flying, during real time, as they would experience some of these difficulties and maybe would have a need for change in procedures or an anomaly would occur and so they would need something like that, what was your role in providing that kind of assistance?

O'NEILL: Well, organizationally, I had mentioned before that we were separate from the Flight Operations Directorate and, in a sense, we were separate from the Flight Control Division, but we always had people on the flight control teams. The flight activity officer, the person who is responsible for the flight plans and then any changes to the flight plans and time lines during the mission in real time as events overtake you, and the procedures all came under the flight activity officer, too. Then we had a back room of experts in the time-lining, but also for the various phases of the mission, we had the people who were really knowledgeable about what was in checklists and how to go about the procedures.

It was our job to supply that information to the front room and keep things working as smoothly as we could. So that was our role. I took my turn at the various jobs that were part of that.

BUTLER: For Gemini, do you have any—and we've talked a little bit about some of the various missions and some of the aspects going into the planning for them, are there any events or incidents that stand out for you in memory?

O'NEILL: Oh, I can still remember how nervous we all were when, like I said, at that point in time you did all the final training at KSC. But it came down to not the actual launch, but it was a countdown demonstration type of test. I think it was [L. Gordon] Cooper and [Charles "Pete"] Conrad [Jr.] who were in the Gemini vehicle on top of the booster, and the tower couldn't be moved back over to bring them down. So there they are, sitting on top of this stack, and they literally had to get them off the top of the booster with a huge cherry picker. They had to crawl out the hatch of the spacecraft and into the bucket of this cherry picker and come down. Or, at least, that's how I remember it. Oh, we were so uptight about that.

But I also remember, you know, the concern when the Agena started to spin up on Dave [David R.] Scott [and Neil A. Armstrong]. They say you only remember the really good things, and I remember so many of the accomplishments. But I also remember how really concerned we were when that happened. I remember when we had the "angry alligator," the shroud didn't totally leave the vehicle, and we were evaluating every manner of thing to break it loose and let them get on with the mission. I wasn't working on the flight control team at that time, but we

were off in various facilities trying to work out solutions to the problem and bring that back over to the control center people.

So, yes, I remember those things very vividly from that program, but I also remember the success everyone felt when they did dock with Agena and the success everyone felt on the Gemini '76 mission where the two Gemini spacecraft came in sight of each other, you know, and pulled up. It was really laying the foundation, and you knew you were doing things and proving things that were going to be so absolutely necessary for Apollo to be a success. So it kind of felt like, well, we've got another building block in place there.

BUTLER: That was a very critical one, not just from establishing that foundation for Apollo, but it was also one of the first times, well, actually, the first time that America had pulled ahead of the Soviet program.

O'NEILL: Yes.

BUTLER: Were you much aware of what was going on with the Soviet program?

O'NEILL: Oh, yes, I don't really personally remember, or organizationally remember, being driven by the Soviet program, but you sure were aware of what they were doing. We were just trying to do everything as rapidly as you could do it safely and really understand what you were doing.

I can remember, for example, and it seems like such a small thing now, but on the mission where Ed [Edward H.] White [II] used the handheld maneuvering unit that was invented

by Harold [I.] Johnson, another older man, a senior engineer in the Flight Crew Support Division. There was so much concern about how is it going to behave when he really fires this thing? Will we get in trouble? I was not the project engineer for the maneuvering unit or that, but I was the operations project engineer; in other words, I was supposed to make sure that things were coming along, that we had the right procedures and that we wouldn't get tangled up in the umbilical and all that sort of thing, and how good it felt when it actually worked, and the astronaut was able to use it and move around a little bit. That laid a little bit of foundation, too, for the maneuvering units and pack that came along later that were so much more capable and effective.

BUTLER: You certainly did have the unique role, and you mentioned here how in that one particular incident that it was a personal thing for you because you had helped develop these plans and procedures and to watch it all come to fruition and happen successfully. That is sort of unique in the space program because you can't that have one—I mean if you have written this wrong or if it turns out to have a problem, I mean you can feel that personal connection to it.

O'NEILL: Yes. Well, I think the most acutely that I felt that vulnerability but also being excited about being part of it had to be on Apollo 11 because, again, I was the lead person at KSC putting together the final flight plan and the final version of the procedures. There were a good number of things to be concerned about in the procedures, not just because we were going to land on the Moon for the very first time, but systems that hadn't been fully exercised in the landing mode. There was a concern, even, that perhaps as the lunar module settled in on the lunar surface that the engine bell, the descent engine, could sink down in the dust and couldn't

properly get rid of the propellant vapors that would build up, and that there was a danger of explosion there.

So you had to work with all kinds of people, calling them on the phone. We didn't have a good system in place to methodically and in a real systematic way get everybody's input. We got everybody's input, but you got it by calling them and pointing this out. I remember that in the last two months that we were down there before we flew, we made 1100 changes to various parts of the flight data file and had to check all those things out and be assured that we were doing the right thing.

So even when we got into the mission, you think, "Oh, I hope we have everything right. I think we do. We've simulated it, we've tried it." But people in their zeal to make sure everything was as perfect as they could make it, just kept coming at you with changes to the point that, frankly, Neil Armstrong got kind of up-to-here with it and said, "Unless it is really, really an absolute crew safety issue, we've got to settle the procedures down so that we can be confident that we understand them and that we're going to go through them."

I can remember what a kick it really was to walk into the Smithsonian [Institute] and they had a display. This is years later. I was surprised that they still had any sort of display about Apollo or the first lunar landing, but they did have an area of the Air and Space Museum devoted to Apollo. They chose, of all things to display, cue cards. Not the real ones, because they stayed with the vehicle and all that, and some of them stayed on the Moon. But the cue cards are the astronauts' abbreviated version of the procedures to guide them through what they're doing. They stick them around the cockpit.

I've got to tell you an Apollo 8 story about that. But anyway, they stick them around the cockpit with Velcro, and they have to fit in the nooks and crannies between the instruments, the

gauges, and dials. There in the display was a set of the cue cards with the changes that I had negotiated with Neil Armstrong and [Edwin E.] "Buzz" Aldrin [Jr.], but because they were late in the game, they were carefully marked in pen on the cards. So it was neat to see them.

BUTLER: That is neat.

O'NEILL: The Apollo 8 story, by the time we got to Apollo 11, the Velcro business had really progressed, and there was sticky-back Velcro like everybody knows it today. That was not the case when we flew Apollo 8. The way that things worked in the launch preparation, the backup crew would go to the spacecraft and set all the switches, and they would put the checklists in right place to be available to the crew. They would put the launch cue cards in the place.

So the Apollo 8, and you can imagine the first people to be leaving Earth orbit altogether, everyone was really taking that one seriously. But when the backup crew went out to put the cue cards up, they started into the process. As they were getting the last ones in place, the first ones were falling off. That was because at that time, the Velcro didn't come with sticky stuff already on it and you just peeled it off. They had to mix a compound called RTV. Apparently, the shelf life had been exceeded on the RTV they gave us, and it was just plain not holding the cue card to the Velcro. So they had to peel off all these cue cards and bring them back.

There we are in the building where the crew quarters were located and where we had a flight data file area. Bill [William R.] Pogue, one of the astronauts, who was on the backup crew, and I are there in the middle of the night, trying to get all the old RTV scraped off and the new stuff applied. I remember that Bill Anders, who had a little trouble sleeping, I think, and I

honestly believe, and I think they've said this themselves, that they only thought there was a 50-50 chance that this was all going to work. I mean the mission, not the cue cards.

But anyhow, he couldn't sleep, and he saw us down there working. So he brought us a turkey sandwich in the middle of the night, and we took a break from trying to re-stick the Velcro on these cards and had a turkey sandwich with the guy that was going to go out of Earth orbit the next day and go to the Moon.

BUTLER: That's a pretty memorable event.

Well, Apollo 8 was a big challenge, as you said. At what point did you learn about that mission being a go, to go ahead and start planning for this mission? Were you involved from the beginning on that?

O'NEILL: No, I won't say the very beginning, but when the top managers of the agency were considering whether it was realistic to pursue this mission or not, but as soon as they thought, "Well, let's see if we could possibly put all the planning together," then we got involved and worked very closely with the development of the mission from there on.

BUTLER: What did you think about taking that step from going from just having one Apollo flight in Earth orbit, to putting your next one on a Saturn V and sending it to the Moon?

O'NEILL: Well, I think everyone was surprisingly confident. They really were. I think the trajectory planning people were the ones that had to carry the brunt of the questions and everything, mission planning and analysis, and they did just an excellent job.

You know, the [Howard W.] Bill Tindalls and all of those people were very much involved. So by the time we launched that mission, I think there was really pretty good confidence. Okay, you're going to say, "Well, that was naive," but there was pretty good confidence about the mission.

BUTLER: Certainly all did go very well.

O'NEILL: Yes, yes, very memorable.

BUTLER: Did you get a chance to hear the broadcast on Christmas Eve?

O'NEILL: Yes, yes. We not only heard that broadcast, but in order to be able to pass some information back and forth between mission control and the spacecraft, they took otherwise undesignated craters on the Moon that were prominent enough that they could use them for navigation, and, of course, the names don't stick. Only the astronomers and, you know, people who are really renowned in the field would ever really have a crater named after them, but it was kind of nice that on the Mission Control Center maps on the console and on the map in the spacecraft, they had given the craters the names of the people that had worked closely with the crew. So in the transcript somewhere it said, yes, "O'Neill Crater."

At that, I think the people in O'Neill, Nebraska, no relatives of mine, all thought, "Hey, this is really neat. They've named something after our town."

BUTLER: That is pretty neat, though. That's nice recognition for you.

O'NEILL: Yes, that was.

BUTLER: Especially, having gone through all you did with the re-pasting and all that.

Jumping back a little bit, you did have a hiatus between Gemini and Apollo where you actually went to work for Bell Aerospace for a while. How did that opportunity come about for you?

O'NEILL: Well, financially, it was an opportunity I just couldn't pass up, I felt. It was a really interesting time. I was back in real hardware developments and working on proposals for NASA and the DOD [Department of Defense]. But frankly, that all came to an end when the Apollo fire happened. The Apollo fire caused a whole lot of activity to just go into a hold mode while the program recovered.

But far more important in my personal case, I got a call asking me if I would come back and get more into the flight-planning part of the business. Not that long after I came back, I took over the Flight Planning Branch. So I came back because I felt I really wanted to be part of trying to recover from the fire, not that procedures had anything to do with it. Although, we did have to embark on programs to see if we couldn't lessen the amount of flammable material in the cockpit.

So we were working with German paper companies, or a German paper company, that thought they had come up with a fireproof paper. That was an interesting development. It led not to fireproof paper in the cockpit, because it turned out when you exposed that paper to a vacuum it curled up and got brittle, but it did lead them to develop some products that were later

incorporated in far less flammable materials in commercial airline passenger compartments, the material that's used to form the basis for the forming of the fiberglass parts and all that. So like so many things in the space program, it had a spinoff effect there.

BUTLER: It certainly is interesting, the space program has had a lot of effects like that.

O'NEILL: But then, of course, we did have the additional systems and procedures development of coming up with dual gas systems to lessen the fire hazard and all of that. The program recovered and we went on.

BUTLER: While you were at Bell, what projects did you work on, if you could mention some of those before we move on further?

O'NEILL: Mainly on DOD projects. The Air Force, at that time, was very much involved in trying to develop maneuvering units that would be the second generation of the astronaut maneuvering unit, that Air Force unit that we flew during Gemini, mounting it in the back of the vehicle. They had a follow-on effort. It was going to be bigger and better. Various simulation and training concepts for working in lunar gravity. We were working with the Langley Research Center [Hampton, Virginia] on that.

It was a very innovative time at Bell. There isn't, I think, any use of this concept anymore, but that was the height of the jet belt development at Bell. I worked a little bit on that. But you probably remember the individual jet propulsion unit, the guy flying around the Astrodome and everything else. That was going on there. The basic development of what turned

out to be the V-22 Osprey concept, they were working on vertical takeoff and landing aircraft that could then, in flight, rotate the engines forward and fly as a normal aircraft. So interesting things, but, like I said, when NASA called, I really, really felt I wanted to go back, and we did.

BUTLER: Certainly, the Apollo Program was very exciting with people going to the Moon.

O'NEILL: Yes.

BUTLER: Well, you came back, and you talked a little bit about some of the changes that you had to go about after that fire, which was, obviously, a tragedy for everyone. But NASA was able to recovery very well with the whole team pulling together and making these changes.

O'NEILL: And, by the way, I think another very important aspect of that, and I'm afraid it's a little different now, but there was the support of the administration and the Congress and the whole country. That made so much difference, too. It wasn't a, "Well, you guys have screwed up. We'll have to look at your funding and all of that." It was a, "Hey, we're in sort of a race here, but we're trying to prove the technological abilities of this country, and we're going to keep pressing on, and we had the leadership." And we still have good leadership. But we had the leadership that could convince the people in Washington that the plans were going to work and we were going to recover and we were going to move on.

BUTLER: Good leadership certainly is a key to everything. There are some very unique individuals there.

O'NEILL: Yes, yes.

BUTLER: When you came in and you mention that you had quickly moved into being in charge of the flight planning area, too, for the flight-planning branch, when you came back to NASA, how much did this expand on what you had been doing before?

O'NEILL: Quite a bit. The relationships were there, but also there was tremendous talent in that branch. For example, one of the section heads was Tom [Tommy W.] Holloway, who is presently head of the International Space Station Program, outstanding individual, just very technically sound, and a very straight shooter. There were just very good people in all areas there. So it was a matter of developing some systems we would work within and just further refining our interaction with other organizations around the center.

So I think it was the project management more than some keen technical expertise that I'd picked up that I hadn't gotten here before. It was the management approach and the process of getting people to really work together and work in a team environment.

BUTLER: Now, we're obviously into the Apollo time frame here. As you mentioned before, Gemini really formed the basis for building a lot of the techniques needed for Apollo and for rendezvous, the EVAs. But Gemini also taught a lot about the planning stages. Apollo was a lot more complicated, as you mentioned, having to deal with leaving Earth orbit and all the lunar activity, so a whole another level there. What were some of the more complicated areas for planning important to the Apollo missions?

O'NEILL: Well, I think the entire, the whole spectrum of the development of the trajectory and how to adjust the trajectory, how to confidently navigate and program the burns, and all of that, and that wasn't so much our responsibility as it was, again, over with the trajectory planning people and all that, but also the engineering people working on the guidance and navigation platforms and all that. So I think that was the number one challenge in developing the confidence, particularly in the propulsion hardware, that it was always going to do the job.

Then on the operations side of it where we were, making sure that, okay, building on Gemini and all of that, that you could really carry out the rendezvous and docking procedures in lunar orbit, that you really understood the environment and the challenge and had solutions for that. Then the whole lunar landing thing, how to approach that, how to manage the fuel and stay on top of that. I think those were huge challenges in that program.

There were also background or environment challenges. I was on the—I forget the proper name for it now, but the panel trying to establish what was going to be the thermal environment for this mission. In other words, the deep space exposure going to the Moon, what was the thermal environment in orbit going to be around the Moon, what was the thermal environment going to be on the Moon.

Well, we had information from other probes and all that, but how did you adjust that so that it really fit the Apollo case? The people from the program and from engineering were really good, but we hoped what we were coming up with was appropriate and could guide, then, the development of the spacecraft, particularly the thermal control approach and how you would thermally condition the spacecraft as you went to and from the Moon, those kinds of things.

BUTLER: So that included then instigating the barbecue-roll, as you called it?

O'NEILL: Yes.

BUTLER: Certainly shows how many little things have to be taken into consideration for the entire thing to work.

O'NEILL: Oh, it's been a long time since I've worked on those things, but, anyway, yes.

BUTLER: As we talk, I'm sure that memories will—

O'NEILL: But they're the kind of things they're going to have to deal with on the Mars missions, even to a much greater degree of challenge and uncertainty. But there, again, that's the great thing about NASA. JPL [Jet Propulsion Laboratory, Pasadena, California] is laying the groundwork for that. When the country is ready to make that venture, I think the technical people can handle it.

BUTLER: They certainly have a lot to build off of, with all that's gone before.

You worked as a flight activities officer for several of the Apollo missions. We've talked about Apollo 8, and we've talked a little bit Apollo 11. We've talked about that. You were also involved in Apollo 9, 10, and up through the end with Apollo 17.

O'NEILL: Yes, yes.

BUTLER: As you were working on these various missions, what level of interaction here? You mentioned in the Gemini Program that you were working very closely with the astronauts, almost on a daily basis. It was a small-scale program at that time. Apollo was a lot bigger, and the missions were running, especially early on, so closely together. What level of involvement did you have with planning for each individual mission, or did you focus more on one mission than others? How much interaction did you have with the crews at that time?

O'NEILL: Well, as the branch chief, I was involved in every mission and in most of the meetings formulating the approach to the plans and all of that. But we did have a lead flight planner for each mission and a lead person on the flight data file. Then people like Tom Holloway or Ted Gillory [phonetic] or myself, we'd step in and go down with the crew to the Cape. So some of them I dealt on a very personal basis as their mission was coming together. Others, you interacted with them, but you had people that were handling the more detailed aspects of their mission.

But the astronaut corps was still a pretty limited size, and you tended to know just about everybody that was in the Astronaut Office. Working with them, for example, the backup crews and that as I mentioned, they would work with you in great detail on procedures and plans and what the primary crew that was really going to fly the mission would really like to see and want, because they didn't always have the prime crew at the time to follow up with you. So you tended to interact with everyone fairly closely.

I admit that it bothered me as we got into the Shuttle Program and the rapid pace of the missions coming at you and the expansion of the astronaut corps and the good number of mission

specialists and all great people, but I just didn't know them as well anymore. You knew the commanders and all that, but sometimes someone asks me something about a particular mission, and, you know, I've kind of forgotten who was involved on that one. It's too bad. It just means that the program has become a little more institutionalized or whatever. You hated to lose that personal contact and personal touch, but it happens.

BUTLER: Unfortunately, it does, especially as it grows, and there have been quite a few Shuttle missions now and all with large crews on them.

O'NEILL: Yes, yes.

BUTLER: Early on, actually, when we were talking about the Gemini stuff, you had talked about being involved with the crews, not just in building the flight plans and procedures, but also in the crew stations and displays. You did that and you mentioned it in conjunction with Apollo. Was that in your earlier time here at NASA, or was that also some still when you came back here?

O'NEILL: The involvement with the controls and displays, that kind of thing, that area was pretty well set, as I recall, on Gemini. Gemini was patterned largely on Mercury improvements and everything. But we didn't work as much on the controls and displays in my particular area, as we did later when we got into Apollo.

BUTLER: For Apollo, what considerations did have to be taken into account for those crew stations? You had obviously an additional crew member and many more systems to be taken into account, but were you able to build a lot on the Gemini and Mercury—

O'NEILL: Yes, and mostly it was situational awareness as it always is in the cockpit. Are the displays adequate and properly located and grouped in such a way that the crew, whoever at that point in time is responsible for monitoring the performance and status of those systems, are they being given enough situational information about that system that they're really on top of it and can anticipate problems or can see what's wrong if they do get an indication of a problem?

So a lot of attention to the caution and warning and all of that. There the interaction is very tight between the crew and the flight control people, because the flight controllers are monitoring the systems probably even in a little more depth than the crew, because you've got a control center full of people that are really expert on the systems. So that interaction needed to come into play also.

The guideline with respect to the crew was, more or less, give them the information that allows them to do something about the situation. You didn't worry so much if it was a display of something they couldn't really use to control or set up the system. But I'd say it mostly had to do with awareness of system status and grouping and all of that so it was logical for the tasks that the crewmen were facing.

By the way, some of it went all the way back to the aircraft days where we all said, "Who thought of putting this switch down here? That just doesn't make—or this over here? Who designed this thing, anyway?" So you were always trying to improve on that feeling on the part of pilots. You'll never quite get there, because there are a lot of different opinions on how things

ought to be displayed. But like in the cockpit upgrade of the orbiter right now, they're really trying to improve that situational awareness, that information available to the crew by very flexible electronic displays and all of that. So it's a never-ending challenge. How do you give the crew everything they need to manage the situation?

BUTLER: I'm sure there's some discrepancy between they'd like to have and what—

O'NEILL: And what you can afford to give them, yes.

BUTLER: Always a compromise situation, but hopefully it works out for everyone in the end.

We've talked a bit now, a lot about Gemini, and we've gotten into some of the Apollo as to the flight planning, building the procedures, building the flight data file. We haven't talked, specifically, about what the flight data file consists of. We've talked about how it's built and over the time, but is that just basically all of the procedures that the crew needs for the entire mission? Is that a good definition?

O'NEILL: Yes, yes, yes. Within the degree of what is practical and feasible, the procedures that allow them to handle the off-nominal situation, the malfunction procedures, the procedures for handling various anomalies and that sort of thing. Not only the nominal procedures related to ascent and entry, but also abort procedures and all that sort of thing. And then a certain level of just supplemental backup data on, oh, the flight software, a real complicated area in all that, but operating notes on the flight software, so, that, if necessary, they can dig a little deeper about what this really means or what is going on in this situation.

So it's the plans so that they have the reference to carry out the mission time line and it's the procedures to operate the systems in doing that and the procedures to handle off-nominal situations. It isn't just the spacecraft, it's the payloads. On the Shuttle, it's the remote manipulator arm. It's all of those things.

There's a whole new world of opportunity now. Now, I'm not talking about history, but using laptop computers and stored displays and all of that, it brings up wonderful opportunities where they can literally carry hundreds of procedures, maybe thousands, on disk and all that, that give them video presentation on this is where you go to do this, if you take this panel off, here's what the wiring bundles look like behind that. It's really amazing what they can do for them, which reminds me of a situation, too, that people do ask about, ever since the movie [*Apollo 13*].

But the Apollo 13 situation, when people say, "Well, what were you doing?" Well, we were running back and forth between the flight control team, who was coming up with various concepts for operating with the lunar module in the lifeboat mode and, you know, getting the command module into position that it could reenter safely after, of course, traversing around the Moon, and getting on the trajectory back to Earth. We were going back and forth and trying to refine the procedures and come up with instructions that could be passed to the crew about tearing covers off flight plans and using that to build ducting that would allow the LM [lunar module] to cleanse the atmosphere and get rid of the carbon dioxide and all of that.

Well, that's, yes, what had to be done. But what really made it tough, and what had us really scrambling was there were no teleprinters, there were no on-board displays where you could type something in on the ground and it would appear on board. We had to figure out ways to tell the crew how to take the present books and tear them apart and reassemble them and mark up certain sections and do things that had never been done before with those procedures, and

give them all those instructions by voice command. Then they had to figure it out and try to carry through on it. Of course, we were refining the procedures all the time, also.

But there was a lot of refining required. As we tried to simulate, people, other astronauts, of course, were helping us. Okay, now here's what we're going to tell them to do, and then they'd see if they could understand that before we voiced it up to the crew. It was a tremendous challenge to cut and paste a new set of procedures out of the on-board set of books and stuff that they had. But they, obviously got the job done. We got the job done, but that was a real challenging environment.

BUTLER: Absolutely. People do tend to be very visual. I mean that's a major input for us in our daily lives, and to do something like that and building something that they hadn't even seen before or conceived of before and not having an idea, and it did all work very well. You had to do it in a short time frame.

O'NEILL: Yes, yes, yes.

BUTLER: Certainly an amazing example of the teamwork and imagination that's required.

O'NEILL: Yes, yes, it really was.

BUTLER: What were your thoughts on the movie *Apollo 13*?

O'NEILL: I thought they did, with some poetic license, really quite a good job. They, obviously, had to take certain of the flight control team positions and all that and come up with a composite operator who did the things that three shifts' worth of people did, but, you know, in the movie they couldn't have three teams and a backup team coming and going. It would have been too many characters.

But I thought it was quite a realistic, theatrical depiction of what went on in that mission. I thought most people liked it. I think it gave a lot of credit to people who did do a great job. Maybe a lot of other people had kind of forgotten the job that they did, so I thought it was good. I thought it was very good.

BUTLER: It certainly did bring the space program into a little more awareness again for the country.

O'NEILL: Yes, yes.

BUTLER: In a positive way.

O'NEILL: Yes, yes, it was very good in that regard.

BUTLER: Well, talking about the various Apollo missions and building the flight data files that the various crews would use, for the lunar portions of the missions some of the astronauts used cuff checklists. Were you also involved in putting those together?

O'NEILL: Yes. And in the end, see, we had the fabrication people who had to figure out how to build this stuff, too, and modify it as it was constantly getting modified, yes.

BUTLER: Those were, obviously, quite useful for the crews in some ways, but some of them also had a little bit of fun with them. Were you in on any of the additions that were made on those?

O'NEILL: I take the fifth on that. I'm thinking of what the crew did with the flight data file. There were some good-humored additions to the flight data file, yes, yes.

BUTLER: It certainly shows even though serious missions were going, even though so much had to be done and so much had to go right, people still did have morale and good morale and good camaraderie between all the teams working, and probably because everyone had to work so closely together.

O'NEILL: Yes. Even some of the very positive things that happened that weren't absolutely in the script, you ended up not only having to deal with it in the mission but dealing with it afterwards, the reading from Genesis on Apollo 8. There were people in the country who don't share beliefs of that sort, and they very much questioned how it got on board and what the crew was doing. Of course, we, at the crew request, copied that on the proper materials with the proper ink and all that and put it on board for them. But, yes, we ended up answering a few questions for lawyers and people like that afterwards, but, fortunately, it went away.

BUTLER: Fortunately, the good things have been remembered now. A lot of people did take that in the spirit it was meant, and it did work well.

Are there any other incidents with Apollo that stand out for you? Obviously, there were a lot of different things that went on with a lot of different missions and various small anomalies and bigger ones.

O'NEILL: Oh, I think, you know, as the J missions unfolded and capabilities were added, the rover, and all of that, it just stayed exciting all the way through the program. I think we all felt, even at the completion of 17, there was so much more that could be done and should be done. But yes, it was fun working with the planning of the traverses and everything as they added capability that stretched the astronauts' range so much. So that was great.

And seeing the interaction with the science community, as the people worked with all the different ideas and proposals and that and tried to refine those ideas into plans that could really be safely executed where you knew you could get the crew back to the vehicle and all that, but trying to get as much good science as defined by the science community out of the mission as you possibly could, I thought that was really great.

Before that, it was mainly an exercise in proving that we had the machines and the capability to get there and back. But to watch that capability really applied to the science objectives, I thought, was great.

BUTLER: I'm glad you mentioned the scientists. You talked earlier of building the flight data files, you had worked very closely with the crews and the flight control teams. As they did move

into these missions, were the scientists integrated into the planning phases and the development of some of the procedures?

O'NEILL: You might say there was a bit of an organizational buffer there, because it was felt that people that were a lot closer to the science and had scientific backgrounds themselves and all that, they needed to take the wide world of inputs and ideas they were getting and refine it a little bit more. Then we tended to deal with the panels or the groups that would say, "Okay, here, evaluate these different approaches and all that."

So, no, we didn't work quite as directly with the science groups, but you sure knew who the primary scientists were before the mission flew. They had a very effective position in the program office, too. The mission staff engineer, who kind of put the mission requirements together, and we followed those requirements and tried to implement them. Generally, that person would have an interface with someone chairing the science panel and representing the science community. So that's how that worked.

BUTLER: Great. As the Apollo Program came to a close, you mentioned that many people thought that there was so much more that could be done, but, unfortunately, it did end with Apollo 17 being the last one. What were your thoughts at that time about what was coming up next as well as the—

O'NEILL: Even before we flew Apollo 17, I personally, even though I still had the same branch responsibility, had been directed to get involved in the Skylab Program and what was emerging as the Skylab capability and how we were going to handle the science. It was a difficult period

because Skylab was all about an early Space Station concept and providing a platform for research and development, technology and science in orbit. The science communities at large had been promised a great deal in the way of time on orbit, crew time, capability to carry out their science. A lot of very good people had devoted a good part of their career to come up with the things they would like to do in an orbiting laboratory.

It all started to come to a head, you might say, at the time I was getting involved when you just realized you couldn't do everything for everybody, and at least not as much of it as they wanted. That was a very difficult thing. I can remember having to go to a large Skylab science conference and tell people, "You're just going to have to work out a prioritization scheme because we cannot accommodate everybody in the airlocks. We can't, simultaneously, point in radically different directions. We have thermal constraints, but also we just can't satisfy everybody at the same time," that story over and over.

It was, frankly, difficult coming up with a prioritization scheme and difficult to satisfy everyone that they were getting a fair shake in the flight plan and how we were going to go about conducting those missions. So I went from Apollo 16. Tom Holloway took care of Apollo 17 and did just a fantastic job with a very small team, really did a great job. We were off trying to understand how we were going to go about Skylab.

BUTLER: Was there any driving factor that you could use, yourself, in trying to help form some of these priorities for Skylab? Or did you have to take a lot of input from the science community?

O'NEILL: Well, we wanted to take their input. You could say that in the progression of the programs, in Apollo, the approach was more or less you tell us what you want done, and we'll do it for you and we'll get you the data and give it to you after the mission is over. In Skylab, we truly had an attitude, the program did, and, of course, we were trying to implement the program requirements. The program had an attitude of, "We're going to provide this very flexible capability on orbit, and we're going to try to accommodate your research goals and objectives, and we're going to involve you in the Mission Control Center and there can be some interaction and changes in the science as it goes along. We'll send the commands and all of that, but you can be there and help guide the situation in real time."

Then by the time we got into Shuttle, truly the attitude was, "We're going to provide the environment in which you can achieve mission success. It's up to you." Well, I know we aren't always there, operating that way, but that's how things progressed. So there truly was an attempt to provide a lot of scientific flexibility. The problem was that the sponsors of this research and the science activity, operated sort of in stovepipe fashion. So that's how you ended up with a situation where, well, you have all these things to do, but they can't all be done in the time frame or with the number of hours or exposures or all of that that they want. Something's going to have to give, and we're going to have to have a prioritization system. That was very onerous to most scientists.

So when I addressed this group and tried to explain to them we'd have to have a priority scheme, it was not very well received. We were still trying to work that out. They did give us some priorities, but their priorities almost went to the third decimal place so you still had a lot of problems figuring out exactly what are we going to accommodate when.

But like so many things in NASA, it led to a very constructive process. That was the mission management team process that operates today. The science communities could represent themselves and their goals, not only at the beginning of the mission, but as the mission went on, to the mission management team and that team. I remember Bob Parker, for example, was one of the people leading one shift of that team. They would adjust the priorities and as the scientists got to know each other and got some amount of information and that under their belt, they were more willing to play into the process that determined what is the best thing to do tomorrow and the day after that. The real-time planning process evolved in a way that it really attempted to do the very best job for everybody involved and, I thought, worked quite well.

BUTLER: That's good. Again, an example of how all the people working together can make it work out, that team process.

O'NEILL: Yes.

BUTLER: Planning for Skylab was very different than planning—

O'NEILL: Now you can show that video to a Skylab investigator, and he'll probably say, "Well, that's just his opinion."

BUTLER: Well, it is hard, as you said, to accommodate everyone and their needs. People think that their project is highly important.

O'NEILL: Then at the very beginning of the mission, to have the thermal shield problem where it didn't deploy properly and immediately we lost one airlock altogether because it was part of how we went about solving the thermal cover issue. And yet a lot was accomplished in the three Skylab missions.

BUTLER: It certainly was. In fact, a lot of that information is still being used today on a regular basis because so much was returned.

You mentioned the launch and the problem with the shield being ripped off, that one solar array gone, the other one damaged. There was a very short time frame, again, as in Apollo 13, where there was still some time left to save it, but there was so much to be done in that time frame.

What was your involvement in helping come up with those solutions to solve the problem to save the workshop?

O'NEILL: We met constantly, every day. We had very specific meetings where we were taking all the inputs and all the ideas as to how we could jury-rig a thermal shield and make that work. We had the interaction with the Marshall Space Flight Center [Huntsville, Alabama] and all the ideas coming up there. Chris Kraft and Max [Maxime A.] Faget were the ones that were really guiding this whole thing, and we were providing planning and time line and actual procedure input to that process trying to figure out, well, what's the best way to go about solving this.

Had a great crew to work with, headed by Pete Conrad, a really resourceful, very good commander, very flexible, open-minded commander, so that really helped a lot, too. Again, between the centers, everyone got on it and came up with something that did the job fairly well,

and it was so much of a relief when we did deploy that shield that was put up and the temperature started dropping. You just really felt like, "Whoa, thank goodness, we may get something out of this yet," and NASA did.

BUTLER: I think we'll take a brief break here if we can and change the tape out.

O'NEILL: Okay. [Tape Change]

If we were leaving it [Apollo] one thing I should mention, people may wonder how this came about and you asked me a couple of times about, "Well, how detailed was your involvement?" After Apollo 11, there was a concern as to the number of changes that were made to the flight data file and to the procedures. I know I mentioned that we made about 1100. That concern reached George [M.] Low, who was the program manager and a super, super person.

You know, that's been the great thing working at JSC, the professionalism and the open-mindedness of the program managers and that that we've had. You just wonder how was NASA so lucky that we had the sequence of people that we did.

But to the point, George Low requested that we make a presentation to his program requirements control board, PRCB, about how we were going to make sure that we were disciplined and were properly verifying everything that went into the flight data file. What he was doing, he was creating an opportunity for us to come up with, I hate to call it a more rigid process, but it is a little more disciplined process and system, and so that was when we decided that what we needed, just as they have hardware control boards and software control boards, we needed a crew procedures control board. It operates to this day, CPCB.

From that time on, until jobs changed later, I always chaired the CPCB. That's where all proposed changes to the flight plan and the crew procedures, after everything was pretty well set, when you were in the early development stage you didn't want to review every change. But once you thought you had everything pretty well set, whether it was something coming from the flight control team, they actually saw a problem or something coming from the crew or the instructors in the simulation facility, whatever it was, we asked them to document what the problem was, what the change should be, the impact if you didn't make the change.

And we, on that same form, called a 482, and I know a lot of people hated it, "Oh, we have to fill one of those things out. It's obvious we need to make this change, and now I've got to fill out this paper." But on that form, we listed all the people who should look at that change to make sure it's proper: Flight Control Division, now the Systems Division, and the MOD [mission operations directorate], the trajectory people, how it affected them, the engineering people, on and on and on. Then when the Crew Procedures Control Board met, they had that kind of information. What is the change? Who's for it? Who questions it? Is there something else we need to do?

Anyhow, George Low really embraced that and asked us to put it in place. It's been a fixture in the system ever since, and it gives you a good way of tracking what's causing these changes, is there something we need to fix upstream to make the processes a little more airtight and less prone to need change later on. So anyhow, that's how all that came about.

BUTLER: It certainly sounds like it was a very needed part of the process, as you were saying.

O'NEILL: Yes.

BUTLER: You mentioned that part of that came from the 1100 changes before Apollo 11 and actually that reminded me that on Apollo 11, as they were landing, were experiencing their computer alarm problems, which ended up being traced back to radar problems and things that had been changed but not installed.

Can you tell us a little bit about that and what you recall as having been the problem there in that situation?

O'NEILL: Well, I remember more about who solved the problem than I do the exact nature of the problem. It wasn't truly a problem that should prevent landing. Steve [Stephen G.] Bales, who was the front room operator, and Jack [John R.] Garman, who was in his back room feeding him information, detected right away that it was an overloading problem due to a software glitch of some kind. I wish I remembered now exactly the details. I just read Kraft's book and I should remember, but a lot of things have happened.

But anyhow, yes, they were really on top of that. It was not, by the way, a procedures or a flight data file problem. It was more an inherent software sensor problem. So fortunately, yes, I ended up working with Steve Bales very closely through the years until he left NASA, and I still hear from him once in a while. Good young people at that time. We aren't so young and they aren't so young even anymore.

BUTLER: Unfortunately, that happens to all of us eventually.

Where you at the time of the landing of Apollo 11? Were you there at the control center?

O'NEILL: Yes, yes, yes. I was in the control center in the flight activity officer back room, yes, holding my breath like everyone else.

BUTLER: It must have been quite a moment when they did land and everything had worked so well and quite a time for everyone.

O'NEILL: I mentioned that we did the last round of planning and procedures development at the Cape, but our arrival back at JSC after launch was very much awaited because we would bring the backup flight data file back and with all the very last markings and little changes and that had been made, and that was really critical to the flight control team that they have the very latest, the exact thing that the crew had on board, so we'd bring that back and turn it over to the flight director and his team.

BUTLER: How soon would you be able to get back then after?

O'NEILL: We'd come back on the NASA Gulf Stream, the executive airplane. Believe me, we were the lowest-ranking people on the airplane, but, anyhow, it was understood that the flight data file needed to get back. So the top program people that had been down there for the launch would immediately go to the skid strip and board the NASA Gulf Stream, and we'd hop on it with them with the flight data file and bring it back.

BUTLER: I guess, at that point, the file was the highest-ranking person on the flight.

O'NEILL: Yes, yes. I'm sure if it came down to it, they would have brought the file back and left us down there. Yes, the pilot would have brought it to the control center.

A funny thing happened though. One time we came back, it was on a later Apollo mission. That time, we landed at Ellington, and I hadn't left my car there, but I'd called ahead and so my wife and children were waiting for me to rush me down to the control center and take the flight data file in. This is not exactly a technical story.

We go into the control center, and I'd really impressed on the family, "We can't fool around. You've just got to get right in the car, go right to the mission control center. Everyone is waiting for me and for this flight data file. We've got to get it back there, and it's really important." And that was pretty much true.

We get into the lobby of the Mission Control Center, and they had neglected to set my special control center badge up properly. So it must have been hot or cold or something, because my family came into the lobby, and here's Dad, so important, but they don't know who he is, and they aren't going to let him into the control center. About that time, the Monterey House guy shows up. The Monterey House guy has so many takeout dinners to deliver into the control center, that he has one of those little hand trucks. The guard doesn't ask him a thing, just waves him right on through to the control center. So Dad can't get in, but the Monterey House guy goes right in to the control center. Whoever that guard was, I'm sure he has long since retired, or anything, so it's not a hit on him. It was kind of funny.

BUTLER: That is pretty amusing how security can be a little nebulous there at times.

O'NEILL: And if you ask me for one of my negative memories about the Mission Control Center, it was the stale smoke and the Mexican dinner smell that set in after a few days over there. But anyway.

BUTLER: But it's interesting, because people before had commented on the smell of it.

O'NEILL: Oh, yes, the smoking just was. I just happened to never have smoked, but that stale smoke smell would really get bad.

BUTLER: All closed in like that. But that is interesting.

O'NEILL: What a change there's been in the Mission Control Center, though, too, and I think it's such a constructive thing, when you see the diversity, the number of women in every position over there, including flight director. Yes, that's really quite different than when we started out all those years ago. That's great.

BUTLER: It sure is. It's undergone a lot of changes up there.

We're definitely interested in the human interest stories as well as the technical stories. They add that personal touch to things. That's a good story there. I'm sure your kids, though, eventually, were able to realize that Dad really was that important. There was just a glitch in the system.

Are there any other memories from Apollo that you have before we move on?

O'NEILL: I may have a flashback as we keep talking, but it was just a great program. You know, I worried about the last mission, when it was clear that it was going to be the last mission. You just, "oh, golly, I hope this one goes all right." Even though other people were handling it, very good people, yes, you almost breathed a sigh of relief when it was all over and everyone was okay.

BUTLER: Certainly, because there were so many people that had to work right for it all to. The technology of the time though was great for the time, certainly looking back, it's amazing sometimes what was able to be done.

O'NEILL: Just relating a little bit to Kraft's book where he said that, you know, things have changed enough and there are so many levels of review and approval necessary for everything, he wonders if we could do Project Mercury now. You wonder, could you start from scratch and how quickly could you get it done. But that's kind of an aside. I wonder, though.

BUTLER: It is. It's something to speculate about. NASA has grown immensely and changed in a number of ways, including more paperwork and such. They did a lot. You all did a lot in those first ten years, an amazing job there.

O'NEILL: Yes, yes.

BUTLER: And certainly one that captured the whole world's attention. It is hard to move on from that. I mean a lot of people have commented, "What do you do after you've gone to the Moon?"

We started to talk about Skylab here and the early Space Station design. It had a lot of other considerations coming into it, a lot more focus on the science, the longer term. We started talking about how difficult that was building priorities for which ones would go up and then talking about that first mission.

During the Skylab Program, were the flight plans set in place for each of the missions before all three of them flew, or were the later ones developed after?

O'NEILL: A basic outline mainly based on the manifest or the complement of experiments and activities that you were going to try to conduct on those missions and then adjusted based on success or maybe some activities not being completed on a given mission. But we learned that it was better to have a rough outline than try to develop detailed plans for the whole thing.

But you needed to have the first few days of the mission planned and an idea of what you were going to try to accomplish in a broad sense and how resources were going to be utilized, but then let the mission management team process unfold and handle the detailed planning, always working on the day after. Not the very next day, but the day after that, because it took some time to put that plan in place and get the updates ready to go up to the crew and all of that. But by that mission, we did have a teleprinter kind of capability and that, so that made it a little better getting information up to the crew.

BUTLER: Skylab was, obviously, very different from Apollo in the long-duration time frame as you said, plan for a day ahead or so forth. But another thing that was learned, I guess, as the Skylab Program went along was that it wasn't as necessary to plan for a minute-by-minute for the

whole day of the crew. That actually came into play, I guess, with the last mission, where there were some troubles there.

O'NEILL: Yes, the crew really felt overworked and let the ground know they were feeling overworked. So things were adjusted from there. You know, that is a historical problem. As hard as you try to work out time lines and evaluate things in the simulators, in the water tank if we're talking about EVA activity, there still is a tendency for it to take longer, no matter how hard the crew is working, on orbit than it looks like it's going to take on the ground. So I think it's going to be so important in the Space Station Program that the crew's detailed activity is pretty much determined by the crew. They set broad objectives for them, and you give the crew the latitude to pursue those objectives at their pace. They are going to get everything done they can get done, but they shouldn't be pressured, especially on a long-duration mission like that.

BUTLER: They certainly are very dedicated individuals and are out to do a good job.

O'NEILL: Yes.

BUTLER: And, again, that, once again, comes back to that team concept of everybody having to work together to make the whole thing successful.

O'NEILL: Yes.

BUTLER: So a common theme here.

O'NEILL: Yes. And it's so interesting, the makeup of the team anymore. I can't help but having spent, you know, five years in the military and all of that, I can't help but think about how times have changed as our cosmonaut friends and Russian planners and engineers are over here and the people from the European countries and Japan. I think the space program is doing a great thing for the world, and not just with respect to space, but people getting to know each other.

BUTLER: It certainly is building that international community.

O'NEILL: Yes.

BUTLER: That, in fact, started, in a sense, with the Apollo-Soyuz Project, which followed shortly after Skylab, although was in the planning stages while Skylab was flying. Were you involved with Apollo-Soyuz in planning for that?

O'NEILL: Yes. We were following the lead of [M. P.] Pete Frank [III]. I later worked for him in Flight Control Division. But Pete Frank was kind of the lead on the planning activity that we were involved in, so we interacted with our Russian counterpart when they would come over here. Then we put people in their control center and sent them over there. I did not journey to Russia during that program, but, yes, we had people working that program, and I was involved in that way.

BUTLER: From your viewpoint, what were some of the biggest challenges of that program? Was it building the connection between the different cultures and learning how to work together? Or were there the technical challenges as well?

O'NEILL: Well, there were technical challenges, but the cultures are sufficiently different that our way of doing business is, "Oh, here's a problem, let's get everybody in a room and work it and, you know, voices get raised and all that, but people kind of stay at it and get it resolved." You usually always know, and that person is usually present, who the decision-maker is going to be. That's it.

In their system, it isn't that they're indecisive, but they have a more hierarchical or at least at that time it sure seemed that way, have a more hierarchical decision process. So it was hard to get final closure on things you were trying to work out, and there were some big things to work out. Who's going to do what in the final closure on rendezvous, and how are we going to validate the module that joined the two vehicles? All of those things.

They were a more closed society at that time, didn't quite feel as free about exchanging information. So those were all things that made it a little more difficult. But as you got to know the people, and a little basis of trust developed, you know, everything got worked. The crew, themselves, carried a large burden of making things work, though. Tom [Thomas P.] Stafford and Deke Slayton and Vance [D.] Brand quickly developed a real good interface with their Russian counterparts. I think they're all pretty close friends to this day. That bridged a lot of the operational problems, so it came off rather well.

BUTLER: In fact, I think General Stafford's still been involved in the Shuttle-Mir, and Space Station because of some of those bonds that were built.

O'NEILL: Yes.

BUTLER: From Skylab, Apollo-Soyuz, and then into Shuttle, there was a transition time there when these programs were closing out, Shuttle was in the process of development, of building, but it did run a little bit behind schedule.

What was that transition time like for the agency as a whole, for the center here, and specifically for your area?

O'NEILL: Well, my area changed. It was, in that time frame that the center was reorganized again, and I went from being in the old FCOD all those years to being in the new Mission Operations Directorate. In the Missions Operations Directorate, I was initially the deputy to—no, excuse me. They called it assistant, because there were two of us, Jim [James E.] Hannigan and myself. We were the assistant division chiefs to Pete Frank. Immediately, I got involved in the strategic planning and the overall how are we going to approach it kind of things on Space Shuttle.

I never managed, totally, to get away from that the rest of my career, but I worked a lot on exactly how will we go about planning Shuttle missions, how often will we fly, what will the crew training challenges be, and then, very specifically, what changes do we need in the Mission Control Center. We were still operating out of the old Building 30 complex at that time. What changes do we need in the Mission Control Center to handle Shuttle? Frankly, as is so common

in the programs, there wasn't enough money. Because Shuttle had its problems, it had its overruns and delays and all that, there just wasn't enough budget to do everything you really wanted to do in the Mission Control Center to modernize it to be up to date with the Shuttle at that time.

So the initial missions were flown with a Gemini-Apollo-Skylab-based system and set of tools, just adjusted enough that they accommodated the systems and all of that of Shuttle. But I really spent a lot of time and a lot of trips back and forth to headquarters to try to justify some funding to modernize the control center.

It's interesting with the passing of John [F.] Yardley, recently. He was the program manager that we were going up and talking to. Usually, we were told, "Unless we apply most of the budget to the development of the Shuttle, you aren't going to need to worry about operations because you aren't going to have anything to operate. So we'll get to your problems later." Those were decisions that the program manager had to make. We made the necessary adjustments to handle the missions, obviously, and then built the new control center and that later on.

BUTLER: What sorts of changes were you able to make for the early Shuttle missions?

O'NEILL: Well, Shuttle was supposed to be autonomous. It was going to fly so frequently you hardly needed crew training after the initial training because they were going to fly so much they wouldn't have time to train. We were going to have a lot of DOD missions. I mean this was the era where they talked initially about sixty missions a year. Then that was downplayed, no, no,

they'll probably only fly forty missions a year. I mean that's how ambitious everything was at that time.

We were trying to figure out how a flight control team in that world, in the world of planning and all of that, how would we accommodate the payloads and everything that would be coming at us in Shuttle. So we were mainly defining the new processes in that to reflect a reusable, fly frequently kind of vehicle system.

BUTLER: Differences, obviously, planning for these types of missions, vastly different than what had been done for Apollo, for Skylab, especially if you were trying to figure out how to plan for missions up to even forty a year.

O'NEILL: Yes.

BUTLER: Were there discussions about the flight data file even being a regular thing? Were they going to continue with—

O'NEILL: Oh, no, it was just as important, but it was felt that the variability between missions would be greatly reduced. There would be a set of four or six Earth orbit missions as Shuttle flies that would be rather canned trajectories and canned approaches. So the flight data file, the trajectory plan, even the flight plan, would be developed, so there would just be a little insert to accomplish the specific goals of that mission on orbit. But everything else would be quite routine and quite standardized.

That hasn't come to pass, of course. We keep trying to expand the envelope and do very specific things with the vehicle, but it's a tremendously inflexible vehicle. But those standardized missions just never materialized. The world didn't turn out to be like that.

BUTLER: Yes, it certainly is, as well as a phenomenal vehicle in its performance, it is a very complex vehicle still, too.

O'NEILL: Yes.

BUTLER: And the missions, a lot of them have been very detailed.

O'NEILL: Yes, the amount of work required on the vehicle between missions was not fully anticipated. It wasn't part of the original plan to pull off the main engines and do maintenance on them and reinstall them and things of that type.

BUTLER: Again, some of those elements of so many things have to go in together to make it all possible that sometimes it is not easy to pinpoint all the details of it early on.

O'NEILL: Yes.

BUTLER: As this transition time progressed, and as you—

O'NEILL: By the way, the biggest thing I mentioned, and I didn't spend any time on that, was the Shuttle was going to be autonomous. It didn't need much ground support. I mean there would be a handful of people in the Mission Control Center, and that's all that would be required because the first-level problems would be satisfied by on-board redundancy and software management programs.

If things got stickier than that, you'd just come home and fix it and fly again another day. It would be as straightforward as that. That hasn't quite materialized either, and the flight control team approach and all of that has continued to be necessary to support everything you want to do and that could happen with the Shuttle.

BUTLER: Certainly, even with all the advances in technology and computer software and so forth, you still do need that human element participating in all aspects.

O'NEILL: Yes, but, of course, Shuttle and, now, Station have had a great deal of difficulty of even approaching keeping up with the latest computer technology. They just haven't. It's not possible in our system to upgrade every time the more powerful capability comes along.

BUTLER: Especially not when computers are advancing every few months.

O'NEILL: Yes. As I've talked about procedures and flight data file, that probably sounds like a sort of a bookish job. But for the people that handle it and make input to it, it's a really highly technical job, because the technology isn't going to help you on board if you don't know how to

employ it and handle it and direct the operation of the systems. So it requires the people that work in that field to be on top of almost all aspects of how the systems operate and function.

BUTLER: Would you have different people that would work on the procedures for certain aspects of it so that there were experts in those areas?

O'NEILL: Oh, yes. The powered flight experts handled the ascent procedures and how they'll approach the different abort modes and what the interaction with the ground will be, what you will do if you're faced with an abort situation. And then at the other end of the mission, the entry procedures and all that are very specialized area, too, and there are people who are really well versed in all of that. That's their technical area, and they're really on top of it.

On orbit, you have all the different activities there, the EVA specialists, the rendezvous and docking, and all of the visual aids and electronic aids that go along with that, those specialists. Yes, it's a very specialized sort of thing.

But in the Mission Operations Directorate, you can imagine the challenge of the flight directors, for example, because they have to be conversant with all of those areas and know how to bring their team together in addressing anything that comes up. Now, they have really good people to count on, but, still, they have to be able to interpret their inputs and make decisions on the basis of those inputs.

BUTLER: Well, that would be true, too, for the individual like yourself in charge of the flight planning branch at the time and you bring in all these different procedures from people that have specialized in them into the one coherent system.

O'NEILL: Yes, yes. But of course, once I moved over to MOD, I was oriented more toward the flight controller, flight control team part of the job.

BUTLER: Okay. You stayed in this position until shortly before the Shuttle actually flew, on STS-1. But right before then, you had moved to become chief of the Payload Operations Division. Was this still within the mission operations area?

O'NEILL: Yes, it was. That division had a strong partnership with the Marshall Space Flight Center, because they were going to have the Payload Operations Control Center, Payload Operations Integration Center, POIC, there. Together, we were going to work the payloads, including Spacelab. There again, what were their requirements, including their technical and engineering requirements, thermal, power, and all of that? Then we worked with the various Shuttle organizations inside and over in the Engineering Directorate and with the contractors to make sure that their needs could be accommodated or where they couldn't be, we made the necessary adjustments.

Then again, it came down to working with the people that understood the experiment systems and what time lines and procedures and that had to be put into place to handle their endeavor. So it was the same job as the overall vehicle, but it was really addressing the needs of, well, what the program was really supposed to be all about, the payloads.

BUTLER: How would you raise some of these things? Again, you're getting into some of what you touched on the Skylab having priorities for different payloads, some of them would have

certain needs, and maybe some of those needs would conflict with others. How would you balance all of that to bring it together and to make it all work for you?

O'NEILL: Because Shuttle was just basically about handling payloads, they recognized from previous experience and from the outset of the program that what went in the payload bay, where it went, when it got operated, and all that was basically what the mission was all about. So the program office set out to have payload integration managers, PIMs, and processes that really worked on how are we going to put these missions together. Maybe, initially, they didn't even know what. They hadn't determined yet what mission a given payload element was going to fly on, you know. They didn't promise people, we'll manifest you on this mission, initially. They just looked at the requirements and made the commitment that they would work them into the manifest.

Then in a series of reviews based on their requirements documentation that they put into the system, the payload requirements, they would hold cargo integration reviews and all of that so that we made input and recommendation to the program office. But between the program office and headquarters, it was determined what we were going to fly. The cargo integration review was an attempt to make sure that these payloads were compatible, that they wouldn't interfere with each other, that you could do the necessary things for all of them.

It didn't make life simple. That was quite a process to get that together. But once that was determined, then you could see that that was a little bit more systematic to go ahead and try to implement the requirements of that payload.

BUTLER: Certainly, Shuttle had carried quite a few payloads up over the years.

O'NEILL: Yes, they have, very varied payloads, at that.

BUTLER: They've been quite flexible with their abilities there.

O'NEILL: Yes.

BUTLER: You mentioned Marshall and Spacelab as some of their early considerations for payloads. You actually, later, received an exceptional service medal for Spacelab customer accommodation management and leadership.

Did this come about through your work there at the Payload Operations Division and through your work that continued after that?

O'NEILL: Gee, I'm trying—I think it was probably while I was the Payload Operations Division chief. I think my career was based more on developing cooperation and finding the common ground between organizations than any other single thing. Some people are very good at really grabbing an idea and just driving it through the system and making it happen come hell or high water. I was usually handling something that I thought was a lot more valuable to have everyone's input. You can't do things by consensus, but you really need to hear everyone out and consider where they're coming from and have empathy for what they're trying to do within the program and see if you can't get everyone to work together.

That was really necessary in Spacelab, because they had their goals and objectives. They had Shuttles, interfaces were critical, and sometimes we weren't on the same page, but we

worked hard to get on the same page and developed some really good relationships with the other centers like Marshall. So that's really what that was all about.

BUTLER: That certainly would be a challenge building, because there had been some interagency rivalries going on between the different centers over the years.

O'NEILL: Yes.

BUTLER: I'm sure there's a lot of stories there that can be told, but it was important to build this—

O'NEILL: Frankly, I never had much time for that.

BUTLER: Yes, that's good. That's good—able to work beyond it and to make things work together. Then with Spacelab, you were even tying in the European concerns. So many different aspects to take into account there, and it all did come together very well. Spacelab had quite a successful series of missions there, actually.

O'NEILL: You know, I found in dealing in my last couple of jobs, especially the SOMO [Space Operations Management Office] job, I was really working across the agency trying to work with all the different centers. We're an interesting bunch in NASA. You know, you can go to any NASA center and there is no end to the help they will try to give you. If you present them with a problem you're encountering and you'd really like your help, they'll do anything they can to help

you. They won't accept any help from you under any conditions. We're all that way. We're getting over that, but it's a strange characteristic, and you can work around it. But it kind of tends to be that way.

BUTLER: It is interesting how that dynamic was grown and how the agency has formed over the years.

O'NEILL: Well, you're giving up turf, I guess, if you reach out too much for help, if you don't act independent and autonomous and all those things.

BUTLER: But the agency has certainly pulled together at times when it has been needed.

O'NEILL: Oh, yes, yes.

BUTLER: Yes. Well, you went on from your payload operations job to being chief of the Operations Division, which actually you held for a number of years in the early to mid eighties. How did your duties here change, and what was your—

O'NEILL: Well, in the Payload Operations Division, we were concerned with taking care of the payload. In Ops Division, we had all the rest of the flight planners. We didn't just have the payload officers in that. We had, it was back to the business of flight planning, flight data files. I became the chairman of the Shuttle Crew Procedures Control Board from the second flight on again. I also had the flight design and dynamics people. They were a branch in our division.

The people that—to contrast them with Mission Planning and Analysis, by that time, we had taken over what you might call production or all the mission specific flight design trajectory development work, and that was put in the Ops Division. So I had that.

BUTLER: Certainly a lot of factors to take into consideration.

O'NEILL: Yes, we had about everything involved in operational integration of the mission.

BUTLER: How would you, as you were beginning now to move up through the ranks and you continued to move up through the Missions Operations Directorate at this point, how did you build your management skills and techniques as you moved up? Did you learn a lot from those who had been above you before?

O'NEILL: I was going to say, listening, yes. Listening and observing, mainly, but NASA was also good enough to send me to the Harvard Business School Program, and earlier I'd gone to the Bechtel Research and Development management program. I think the contacts and the ideas that came out of the Wallops [Island] training were all valuable. But there were a lot of good mentors around, too, people you could talk to and learn from. So I think that was all part of it.

BUTLER: Your next position that you moved on to was assistant director for the operations. Actually, to kind of talk in general about some of these roles, as chief of Operations Division, as assistant director, what was your involvement with each of the individual missions? Did you

have a lot of specific involvement on them, or by now were you in a high-enough management role that you had a more general involvement?

O'NEILL: Well, when I was chief of the Ops Division, like I said, I was chairing the Crew Procedures Control Board, so I saw everything going in the flight plan and all that. I had to be familiar with the mission requirements and all that sort of thing. When I became the assistant director, I had to become more aware of and more concerned about the facilities and the resources in people and systems and what new technology we should be acquiring and all of that in a broader sense than I had before. I was really carrying out mission functions before, and then I moved into the bigger picture of, yes, we have to handle the missions coming up, but let's look even further downstream. I got a lot more involved in center strategic planning and organization planning and all of that kind of thing as the assistant director.

BUTLER: At this point, were you able to implement any of the changes to the control room that you had initially started to try and suggest back?

O'NEILL: We were laying the groundwork for selling the new Mission Control Center. And, yes, we did make a good number of trips to Washington [D.C.] to keep that in front of people, to try to move it through the facilities budgeting process and convince everyone that that was necessary and something we really needed for the future. I'm working for Gene [Eugene F.] Kranz at that time, who, of course, was really very good at looking forward on future requirements and all of that. So you could almost say it went from a function of trying to make

sure we were doing the right thing on the next mission and the mission after that to trying to make sure we were really looking out for the future. I'd make that the contrast between the jobs.

BUTLER: Good. During this time frame, up until about '80, '81, as you came into the Operations Division with a second mission as you mentioned, and then moving up through about '85, do you have any specific memories or moments either from any of the missions or any of the things going on at that time that you can recall?

O'NEILL: What was I doing then, again?

BUTLER: As you were the assistant director of operations, chief of the Operations Division?

O'NEILL: The memories I have of that period mostly have to do with trying to develop the rapport, not just interfaces, that sounds like just electrical power and software and all of that, but the rapport with what would be the customer community. That included the DOD at that time. Trying to figure out how we would best handle the total payload integration process. I have never felt we brought those processes to the point of streamlining that they could have been or should even be today. So we were working on those kinds of things.

The things that come to mind mostly are just the relationships and the people that I dealt with at Marshall or back at Goddard [Space Flight Center, Greenbelt, Maryland]. They were providing all the data and network support. I was kind of moving in that world where you weren't so responsible for what was happening in a specific mission and therefore you couldn't quite take the satisfaction that you did when you were really hands on with that.

But still, I was very concerned about how we were developing the people and what opportunities we were giving them, and so it kind of turns into more of a well, look at the people and how they developed and where they are now kinds of things.

BUTLER: You certainly do need those people for the program to work, and they have to have the right training, have the right knowledge to be able to make sure all of those steps come together.

O'NEILL: If you want to address that period and ask me what one of the toughest things that we had to handle would be, I was part of the payload safety panel or review. That was really tough. A whole lot of people had a hard time accepting what we thought were the necessary steps, the necessary system provisions, the necessary testing, all the things that we thought were absolutely required to feel safe and confident about those payloads. I also remember that payload customers would complain loudly about having to participate in all of those simulations, why do we need to do that, we know our stuff, we don't need to come down there and sit in on that.

I was always so impressed at the ability of our simulation people to figure out, not out of well, "we'll show you" kind of attitude, but, hey there are some serious considerations here having to do with mission success and how you'll handle a given situation, and you think you're really on top of your game, but there are other things that can affect you.

How are you going to handle the prioritization of what's left in the way of time for your experiment if we have to cut the mission short. Things like they just invented realistic but wonderful scenarios that taught people, hey, I think there are some things that we haven't thought through here and maybe the operations people's way of going about mission rules and priorities

and all that, maybe there's more to that than we thought. Then to see that once in a while come into play and help really save a mission, that was very satisfying.

BUTLER: It must have been challenging dealing with all the different customers that came in with the different payloads, because they were from so many different members of the industry, other nations, DOD, as you've mentioned, and all had different ideas, different experience, different priorities, and integrating all of that and making it all function as a whole would be quite a challenge.

O'NEILL: The important part of that that made it a whole lot easier was to do the best job you could, and I have to credit the program for that and managers within the program, but we did our part and held up our end of it, but was to have good clear requirements and processes. I think they're a little overdone, I think we could simplify it a little bit. But when you have something that you can point to and say, this is how we do business, this is how we've been successful, this is how we managed to avoid major problems, or be in a position to deal with problems, and this is how we're going to do it with you, I think that helps a great deal and it's not meant to be arrogant or dictatorial. It's sincere. Hey, it's worked. This is how we need to go about it.

BUTLER: We even have our own procedures for doing oral history work, which is certainly a lot less technical, so I can see where you're coming from there. It does help to have all that lined out and help resolve of those questions.

O'NEILL: Well, if it looks like you're applying requirements capriciously, it's going to bother people. But if it's this is how we do business, they can generally accept that.

BUTLER: Absolutely. You've mentioned the NASA-DOD arrangements, that early on the Shuttle Program that they were very closely working together. There were several DOD missions and the Shuttle was even—plans were being made to fly out of Vandenberg [AFB, California]. So there was a very close bond there.

O'NEILL: Major money was invested in the complex at Vandenberg, and they were going to control the orbit part of the flights from Colorado Springs [Colorado], yes.

BUTLER: How much involvement did you have with that partnership and working those missions through, working those agreements through, and how well did that partnership work?

O'NEILL: With respect to flight control interaction and that, we worked very closely with them and continued to work with them when they were dealing with missions out of the so-called blue cube on the West Coast. A few times we journeyed out to, they called it the SLIC-6 [Space Launch Complex 6] complex at Vandenberg, to give them suggestions about payload interfaces and handling and all of that. We participated at any opportunity they gave us to participate and tried to give them suggestions wherever we could.

I will credit them, too, that in dealing with Colorado Springs, they found holes in our definition of processes that we realized we needed to fill. Now, we didn't fail to do things, it's just that we counted on individuals and their knowledge and their relationship with other expert

individuals to get it done. It wasn't well-enough documented that you could hand it off to somebody else and they could understand it perfectly well without those same experts all sitting there telling them exactly what to do. So I think they pointed us toward some necessary process definition and all of that that we needed to do.

But of course, the *Challenger* accident came along, and for various reasons, probably a good many of them political and having to do with their desire to be able to operate quite independently, a whole lot of that kind of went by the wayside, unnecessarily. I think there were still people in the DOD who had payloads they would liked to have flown on Shuttle and all that, but they chose to go their own ELV [expendable launch vehicle] route.

BUTLER: In our research, actually, we came across a mention that you were a little bit involved in that phase-out of the partnership. Is that correct?

O'NEILL: Oh, yes, well, that's one of the tough experiences, but we worked with professional people there. What they're talking about is the fact that we considerably scarred our facilities in order to meet their security requirements, and it would be inappropriate to go into exactly what we did to the facilities. But they paid for it, yes.

But when they decided to not fly with Shuttle anymore and we wouldn't be operating in that classified mode anymore, it meant that we had elements in our systems that would continue to require maintenance and servicing and would finally become obsolete and everything else that we didn't need in those systems anymore. They had totally to do with the security requirements of the DOD. So we entered into a negotiation to try to recover from them the cost of removing

those things from our system that could be removed that were no longer necessary and represented a future complication.

You can imagine that the DOD wasn't real enthusiastic about doing that. It was complicated a bit by the fact that this wasn't exactly a prime assignment in the Air Force at Colorado Springs or the West Coast to be responsible for getting out of the business. So we'd tend to be dealing with bird colonels, who'd be in the job about three months, and then they'd go on to something else. But we recovered what I thought, and what I thought NASA was pleased to believe, was an appropriate amount of funding to remove the scar. They were good to recognize that that was necessary and all that. Just kind of the end to what could have been a good relationship, but at least it got wrapped up and taken care of.

BUTLER: You did mention briefly here that the *Challenger* had happened in the interim, between this, and was part of the discussion between DOD. Obviously, *Challenger* shook NASA up as a whole, the country, and there was a lot of time that needed for healing and for recovery after *Challenger*. What was your involvement in that process?

O'NEILL: Well, I took on a very specific responsibility given to me by Gene Kranz. Our procedures and processes had nothing to do, of course, with the terrible accident. But we were going to be down for a while. We were probably down longer than we really should have been. I mentioned that the dealings with the DOD told us that we didn't have our processes as well documented as we should, and we had addressed that and were satisfied that we had fairly well caught up there.

But we decided to use that downtime to go through a total process review, what do we do from the time we start interacting with the requirements and the payload of a Shuttle mission, how do we do it, who does it, what are the quality assurance points in the process, how can we improve that, but first it was a definition of all those processes. So organization by organization, we went through this fairly disciplined review against a set of requirements that defined what information they should bring to us and how we'd discuss that.

So we took everything apart, looked at all the processes, and put it back together again in the most bulletproof, sound way we could, but the really important thing was where were we going to introduce checks and balances, quality assurance points in the process. So that took quite a while, and that was my specific responsibility. Yes, that filled file cabinets, but it didn't fill file cabinets and get forgotten, we tried to improve the process as a direct outcome, and it really did help a lot. Things are quite well-defined now.

That also was, I think, effective in allowing United Space Alliance [USA], who was just coming into the picture then—well, excuse me. They weren't the United Space Alliance then. They were RSOC, Rockwell Space Operations Company, and they were taking over about fourteen previous contracts, I may not have that number right, and servicing all the operations support of MOD and the program. Well, that process review involved them and allowed them to be able to put together a definition of how they went about doing the job for us that gave them confidence and gave us confidence that they were prepared to do the right things. It defined where we would step into their processes to make sure everything that was doing was being done right and all of that. That has fed on with the United Space Alliance and is still a basic part of how they do business. They have their way of going about business quite well defined.

BUTLER: Was this was resulted in the ten-year plan for mission operation? We came across an article in *The [Space News] Roundup* [JSC newspaper], actually, that talked about it.

O'NEILL: No, that was a belief on the part of Gene Kranz and center management at that time that we really needed to look at how we were going to evolve and that certainly the Shuttle Program represented a growth opportunity, but if we were going to ever play a role in programs beyond that, we'd better think about how we were doing Shuttle and having a way of evolving to a more streamlined efficient state as we went along. So that's what prompted the ten-year plan. We worked on MOD plans, and center strategic plans, and all that. I really kind of got that "other duties as assigned" job there for a while.

BUTLER: I think that falls to many of us from time to time, and it certainly seems like you were able to roll with it very well and to make it an efficient concept.

O'NEILL: Whether the plans really got implemented the way they finally were issued is not as important, I don't think, as the positive interaction between the organizations and the establishment of common, near-term goals, and then kind of an attitude of cooperation for the future. I think that was the really important part of it.

BUTLER: Absolutely. Reinforcing the team, reinforcing even the morale of the center after, in this recovery period, was a very important phase.

Did you have any direct involvement with the return to flight of STS-26?

O'NEILL: Well, of course, in my directorate job, yes, participating in the readiness reviews and all of that. But not in a hands-on, you know, specific product way, no.

BUTLER: The Shuttle was able to come back on line, and, as you said, it did take a bit of time. But all different parts of the agency had gone through their own reviews, such as yours, with operations. Shuttle came back on line, has been working well since then. We touched on talking about the plan for the future and what was going to happen next, building up to Space Station. Several ideas had been tossed about now for Space Station, the *Freedom* design, and some other iterations of the design.

O'NEILL: I served my time in Crystal City as part of the redesign team and as part of the synthesis group before that, yes.

BUTLER: The Station certainly did go through a long period before it was able to be finalized and flown.

What was your contribution to Space Station through the years as from an operations standpoint like this? You mentioned serving on these groups. But how was the operations side of things affected by all of this?

O'NEILL: Well, we dedicated a part of our MOD organization to Space Station. Chuck [Charles R.] Lewis and, as I recall later on, Larry Bourgeois directed that part of the organization. Gene Kranz, himself, got involved, too. So my involvement was trying to tie an overall strategy for the directorate and everything back to what these groups were doing trying to come up with the

more specific command and control and planning approaches and that for Station and that back and forth. So I was really in the directorate mode at that time in the forward-looking kinds of things.

BUTLER: Were you able to contribute some of your experiences from Skylab at this point, or was it still too early in the process for that?

O'NEILL: No, we all did. We would get together in reviews of their plans and have an interaction on not only how they were going to set up the processes, but the organization structure, and so it was a constant back-and-forth kind of thing. You know, the advise-and-consent or review-and-comment kind of mode, where not only I was drawing on all my experience in the other programs, but that was what everyone was trying to do to shape our approach to Space Station.

BUTLER: As Space Station reached closer to its final form, as we see it now, you were involved in the transition back here to JSC of the Station management.

At that point, was Russia involved as a partner, the Europeans, and how did that transition go?

O'NEILL: I'm trying to remember. I think, yes, I think Russia was involved. The program had already moved from the Space Station *Freedom*, Reston [Virginia] mode, and they may have just been in the process of moving the program down here, but we went through this lengthy redesign team exercise in Crystal City where we had three major concepts that were being pursued and

then coming, sort of out of the blue, but people at high levels in the agency had been thinking about it and working with it, the Russian involvement came along. Then the last part of the redesign team activity was dedicated to figuring out, well, what role can they and should they play. Then the real impetus all moved down here to JSC to try to work out an implementation of that.

BUTLER: During this time frame—

O'NEILL: By the way, I was the one that carried the story on why we needed Building 4 South up through the facilities and congressional reviews and all that. I only mention that because we sold that building on the basis of the needs of the Mission Operations Directorate and the flight crew office. When it was decided that JSC really wanted the Space Station Program management job, Aaron Cohen, the center director at that time, gave me the function of figuring out the accommodations for all the Space Station people at the center. They were to be accommodated in Building 4 South.

So anyway, we, much to the displeasure of a lot of people, we displaced a lot of folks or didn't let them move where they thought they were going to move and shoe-horned the Station Program into 4 South. So yes, I had that role, too, the move coordinator or accommodations coordinator. I forget what it was.

BUTLER: Certainly a lot of different hats you would have to put on.

O'NEILL: Yes, that was a very different hat for me.

BUTLER: Housing still tends to be a hot issue on site. It's not always easy to find a place to put everyone.

O'NEILL: Yes, yes. One group that had to be displaced from Building 4 South made sure that as they moved over to their new facilities that, apart from the furniture and that, they all walked at one time past our office windows with the French Foreign Legion or displaced person kind of clothing on, with their stuff on poles over their shoulders, and all that like, you know, we had really moved them out to the boonies.

BUTLER: Well, sometimes, unfortunately, there's not much you can do to accommodate everyone.

O'NEILL: No, no. There's never enough room on site.

BUTLER: Yes, yes. During this time frame, as Space Station was going through its various iterations—do we need to take a break?

O'NEILL: No, I don't have to go as yet. I don't mean to overtalk this whole thing.

BUTLER: Oh, no, we're certainly fine. I'm enjoying it, and this is the kind of information we're looking for. But certainly, if you do need to go, just let us know.

O'NEILL: I am going to have to go at four.

BUTLER: Okay, okay. We'll make sure that we stop then.

As all of this was going on, the new Mission Control Center was being built at the same time as well in this time frame. What were the major changes that you were putting into effect for that center? It's obviously very different from the original design.

O'NEILL: Well, the big factor was that the old control center had approached the point that it was almost not maintainable. We wanted to step up to new computer concepts, a workstation based control center where we weren't dependent on big mainframe computers and then just kind of dumb consoles tied into that.

Where we had a huge reconfiguration challenge, every time you wanted to change any displays or anything else, you couldn't do it by software entries through the individual workstations. You had to go through a big rebuild, driving things from the main computers, and the voice system had become particularly obsolete. It required literally soldering and wire changes to change the loops from mission to mission. Why would they change? Because you're dealing with different people. So you had to configure the voice loops differently. So we wanted to go to the new available technology that allowed us, through software reconfiguration, to set up the new control center.

It gave us a whole lot of redundancy, too, in that each workstation is standalone in the sense that it can become anybody's console. They just bring their software, load it in that console, or they call it up from a central server and sign on, and then immediately that console becomes whatever console it needs to be for that particular operator.

We also needed the ability to control a Shuttle flight and at the same time have people in a very capable control room handling the Station, or vice versa, training for the next mission in one small control room, and operating the ongoing station activity from another control room. So just a whole lot of things came together, and that's how we managed to sell it. People realized we really did need to step up to additional capability and the new technology.

BUTLER: That certainly has had a lot of benefits to it and it must have involved a lot of retraining, too, for the individuals using the systems.

O'NEILL: Well, the people that worked that, the NASA people overseeing it and directing the activity and the contractors, really did a number of wise things. That is, with all this new computing power and everything, initially what they programmed into the workstations looked a lot like the consoles they came from. Then the operators started improving on that. But it made the transition easier.

You know, there was some concern on the part of some operators. I'm going to go to this new place, how's it going to work? It was actually handled quite well, I thought. I thought.

BUTLER: Good. Certainly very important that it did go smoothly for the mission's sake.

Talking about software improvements and the new control center, and you touched on it earlier when you were talking about the flight data file, and now with Station and Shuttle so much can be on the computers themselves that it doesn't have to be a hard copy that they have, that they can call up hundreds of procedures.

O'NEILL: Yes, which still bothers people, because they can't make notes in the margin that stay there. I mean, seriously.

BUTLER: True. Was that beginning to come into place at this time as well?

O'NEILL: Yes, yes, it really was. I'd say most of the innovations on Station, they had in mind right from the outset. It's just too bad it isn't easier to upgrade the capability. I mean they have 386s, and they ought to have the latest. But that's not easily done.

BUTLER: Certainly a lot of factors to have to be taken into place, qualifying the hardware even for space flight, and then getting the software ready and all. It is growing as the years do go by.

O'NEILL: Well, I can remember when we very first wanted to just bring a laptop on board the Shuttle, and that was such a foreign idea. It's good that the program is conservative and cautious, but they were very much concerned about what they thought could be a lack of discipline and careful determination of what would work okay by having it in a laptop that was so easily reconfigurable. It took quite a while for people to get confident enough about what could be done with that hardware to embrace the laptops.

BUTLER: That's interesting since here we are talking about the space program, which most people think of as cutting-edge technology and, as we've mentioned, so many different improvements have come from the space program. But yet, there is that need for the conservative side, too.

O'NEILL: We were very, very resistant to change in areas that we were afraid could hurt you, and that's probably proper, but it does make us a little too resistant to change.

BUTLER: Yes, certainly safety is a very important consideration when you're talking at this level. Space flight is still not a routine thing.

O'NEILL: No.

BUTLER: And won't be for many years to come, I expect.

I think at this point, we're probably at a good point to stop, so that we can let you get on with your day. I want to thank you for joining us today.

O'NEILL: My pleasure.

[End of Interview]