

# NASA JOHNSON SPACE CENTER ORAL HISTORY PROJECT

## ORAL HISTORY TRANSCRIPT

JOE H. ENGLE  
INTERVIEWED BY REBECCA WRIGHT  
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WRIGHT: Today is June 24<sup>th</sup>, 2004. This oral history interview with Joe Engle is being conducted in Houston, Texas, for the NASA Johnson Space Center Oral History Project. The interviewer is Rebecca Wright, assisted by Sandra Johnson and Jennifer Ross-Nazzal.

At our last session we concluded talking about your second Shuttle mission, STS-51-I, that ended in September of 1985. Just four months later, the agency and the nation encountered the loss of the *Challenger*. Would you share with us where you were and how you learned about the accident?

ENGLE: [Steven A.] Steve Hawley and I are both from Kansas, and we had been invited by the governor of Kansas to take part in the annual Kansas Day festivities, which is a formal dinner and a banquet and a ball, and I believe there was a parade involved, too. Steve and I took a [Northrop] T-38 [Talon] up to Forbes Air Force Base in Topeka [Kansas]. We landed there the morning of the flight, actually. We had buttoned the airplane up and gone into base operations, and we landed about twenty minutes, as I recall, before the scheduled launch time, so by the time we got in, we were able to get all the post-flight activities done.

They had a television set up in the base operations waiting room or lounge area there. I think it's there all the time anyway, but they asked us if we wouldn't like to watch the launch and, of course, we were kind of hoping that there would be a place where we could watch it. So we went in there along with the people who were manning the base operations at the Air Force

base there and the folks from the governor's office who had come out to meet us and take us in town. Steve and I watched the last few minutes of countdown and watched the launch until the breakup; so we were there at base operations at Topeka.

I remember Steve being a little bit concerned about what we should do, and I remember telling him there's—in fact, I don't remember saying a whole lot of words. I think I told him, "You go file a flight plan back to Ellington [Field, Houston, Texas] and I'll call the governor's office and explain that we're not going to be there." So by the time I had finished the call, he had the flight plan ready and we turned right around and came back.

WRIGHT: What were your duties after the accident? So much was going on and people were trying to do all that they could. What were you trying to do after you landed and returned to Houston?

ENGLE: Of course, we didn't know what was going to be done. I think things were still not organized completely into focused groups. There was an Accident Investigation Board in the process of being formed. We were not part of that. As a matter of fact, I think [Robert L.] Bob Crippen was one of the few from the Astronaut Office who was on that board.

But I do recall immediately taking part in the almost continuous Shuttle mission simulator runs, which were attempting to duplicate all the conditions of the launch. At that time, the cause of the accident had not been determined. Nobody had any idea what it was. They suspected high-altitude wind sheers and, of course, they had gone back and gotten the wind profiles and fed that into the simulator. We were flying launch profiles, trying to determine if there were areas where structural stress or overload had happened during the boost.

So, as I say, we were not at that time assigned to anything specifically, because nobody knew where to focus specifically yet, but we were collecting data, mainly, of launch profiles in the simulator, and I was taking part in that.

WRIGHT: How were you able to determine some of the changes that were made for the Shuttle Program before the return to flight?

ENGLE: Well, the main change, of course, was purely mechanical and a design change at Thiokol [Corporation], a change in the geometry of the field joint that allowed the blow-by or the pass-through of the hot gas from the solid rocket. I remember sitting in on a number of those meetings where the design was being reviewed and approved, but I didn't have any active part in that.

As I recall, those of us in the Astronaut Office were most active in some of the other changes really didn't have anything to do with the cause of the accident, but had to do with additional improvements and changes. I recall the bail-out boom, which is the long boom that extends out the hatch if the crew has to get out over the water. It's not a good vehicle to ditch in the water with, so you can blow the side hatch, extend the boom, and everybody hook on with a parachute. The boom takes you down below the wing. It forces you to go below the wing before you get to the end of the boom, so you don't hit the leading edge of the wing as you bail out. That wouldn't have done any good at all in the *Challenger* scenario, but it was something that I think was done to make the safety folks feel that they'd made a contribution. It had very limited application.

We had stopped using pressure suits during the launch phase. They were cumbersome. In fact, I remember on 51-I, which was a couple flights before *Challenger*, we wore shirt-sleeve coveralls and it was a much more comfortable way to fly, and you had much more visibility and reach access without the cumbersome suit on. But after *Challenger*, it was determined to go back to a pressure suit. In case cabin integrity was lost, the crew would be able to survive. So the launch escape suit was developed further and we took part in those evaluations of that suit.

WRIGHT: Many had believed that until the *Challenger* accident that flight scheduling came before crew safety. Were there safety issues prior to or during your last Shuttle flight that concerned you and your crew, or had there been other safety issues that the astronaut corps had talked about?

ENGLE: There had not been any major safety issues, and there certainly wasn't any feeling that safety was being compromised in order to get the flights off. That may have been a misconception on our part; because we all wanted to fly so badly, we really were willing to accept the risk that was there and probably more. But in the Astronaut Office the discussions more were centered around somewhat of a relief that the thermal protection system, the tile separation issue, had been resolved. The tiles were not coming off or separating anymore and damage to the tiles was very minimal. There were a few dings, but that was normally resolved by having debris kicked up off the runway after landing, so that was not a problem at all for entry.

We were more concerned with the high-speed moving parts. By that I mean the turbines, the fuel turbines that pump the fuel the very high rate from the tank into the engines. They

turned at a tremendously high rpm [revolutions per minute], and just the thought of that rate of rotation and the turbines coming apart could very well have been a disastrous thing in the back end of the airplane. None ever have, but it's one that I think has always nagged not just the crews, but some of the engineers keep their eye on them pretty closely.

And hydraulic pumps. We had had failures of triple redundant systems, hydraulics and computers and things like that, all of which are mandatory for the vehicle to return to land. So we were keeping our eye on those kinds of failures more than the kind of thing that happened on *Challenger*.

WRIGHT: Did you have any indication that you might have another flight or were you expecting to command another flight?

ENGLE: I think expecting would have been a correct way to put it. I expected that I was going to fly again. I was not assigned to a specific flight. There were enough pilots, enough crews in queue that the foreseeable flights were already manned or announced when I returned from 51-I.

Then when *Challenger* happened, it was obvious that there was going to be an extended downtime for the Shuttle. There were an awful lot of really talented young pilots and engineers, mission specialists, who had not flown yet. I remember thinking very hard and trying to think unselfishly that it would be pretty vain for me to lobby to get back into the launch loop right away, while these other young kids were sitting around waiting, because they'd been waiting for quite some time.

The other thing was, I was coming up on mandatory Air Force retirement in March, so I had to make the decision of whether to retire from the military and hire on as a civil servant and

stay in the Astronaut Office. That would have been another decision to make, and I had not really forced myself to that decision. That was still a little ways off, so I was trying desperately to figure out some way to be able to keep flying airplanes, like the T-38s, because I knew once I retired from the astronaut program, I wouldn't have that access to the fun airplanes to fly.

I was really undecided, quite frankly, exactly what I was going to do, until *Challenger* happened and that kind of changed things.

WRIGHT: Take us through the next couple of years. You did leave NASA before return to flight and you did retire from the Air Force. Share with us how all fell in place for you and how you moved on to the next phase of your career.

ENGLE: I had given a couple of talks. I remember giving one major talk at an Air National Guard Symposium in Washington, D.C. It was prior to our flight, and I know we had taken a good many mementos from Guard squadrons around the country. When *Challenger* actually happened, [Edward C.] Pete Aldridge was the Secretary of the Air Force at that time. He had been down here at NASA, actually, training as a [payload] specialist to fly on the first Air Force flight out of Vandenberg Air Force Base [California], which, of course, never happened because of *Challenger*. But Pete was going to be a [payload] specialist on that flight.

He was at that time the Undersecretary of the Air Force and he was able to wrangle his name into the position of being the Air Force representative on it, which is a really good deal. Pete was a neat guy. His parents lived over on the west side of town, and I remember a number of times him coming in or needing a ride over, and I would drive over and spend some time with them and got to know them very well.

When *Challenger* happened, Pete contacted me pretty quickly afterwards and said that he had seen that my retirement papers were coming across his desk. He asked if I would agree to extend my retirement for a year so that it wouldn't be perceived by media and anyone else that Air Force guys were bailing out of the program because of the accident; they didn't want anything to do with it, and really, I think, from his perspective, from a standpoint of giving more confidence or shoring up the confidence that the Air Force was still committed to the Space Shuttle. So I was tickled silly about being able to do that, because it meant that I could still stay here and still fly T-38s. He had made arrangements with the NASA Administrator at the time, and that was all taken care of, so I extended.

I didn't serve on any official *Challenger* board or return-to-flight activity, but I did take part in the simulations. I remember working on simulations and working on other improvements to the Shuttle at the time. But that extended me from—let's see. I guess it was February until the next fall; October, I believe it was.

WRIGHT: When you retired from the Air Force, you were then appointed to the Kansas Air National Guard with the rank of brigadier general. Tell us about how that involvement occurred and why you decided to take that position.

ENGLE: That was one of the neatest recoveries that anyone's ever done for me. Again, I was coming up on the end of September, wondering what I was going to do to fly. I couldn't afford to go out and fly anything else on my own. During that period of time, during that extension that Pete had asked me to do, there was a position that was becoming vacant in the Air National Guard which was called the Air National Guard Advisor to Commander in Chief of Space

Command and—he wore two hats—the Commander in Chief of NORAD, North American Air Defense. The same gentleman was the Commander in Chief, the CinC, of both organizations.

The Guard, General [John B.] Conaway, who I knew personally, was trying to figure a way that the Air National Guard could integrate into space activities somehow, to get space into the Air National Guard repertoire.

During that same time, Gene [A.] Budig was the chancellor at the University of Kansas [Lawrence, Kansas]. He really wanted me to come back and take a position at Kansas. I had barely gotten a bachelor's degree at Kansas; didn't have a master's degree or anything. I was not a good student, and why they even thought they wanted me to come back and be on the faculty back there, but he wanted me to come back to Kansas.

[Senator Robert J.] Bob Dole was not a very close friend, but a friend, and he had approached me about running for a congressional seat in Kansas during this time period. I had, I thought fairly tactfully, declined Senator Dole. In fact, he has a great sense of humor, and I recall telling him what [Robert A.] Bob Rushworth told Margaret Chase Smith when she wanted Bob to come back—Bob was one of the X-15 pilots—come back and run for Congress or Senate in Maine. He had called me up there to his office in Washington and I told him, “Sir, I'm really honored that you'd ask, but I've been a professional test pilot now for twenty-five years, and I've become so accustomed to basing my decision on facts, that I don't think I could make the transition into politics.”

Bob said, “Well, I kind of knew you were going to give me that answer.”

But he and Gene Budig and John Conaway, who was Air National Guard, and Pete Aldridge, who was by then the Secretary of the Air Force, had decided that that would be an appropriate position for me to take and I could go back into the Kansas Air National Guard. I

could come back home to Kansas and serve the state and then do the appropriate assessment of how the Guard could get involved in the space program.

So they called me up to the Pentagon, and I was in General Conaway's office and he and Pete Aldridge were there. I suspected something. They approached me or they offered the job to me, and General Conaway broke in and said, "Now, this is not your normal cushy job. This is not your normal good-deal thing that you hear about guys getting. This is not just Space Command, it's NORAD, North American Air Defense, so I expect you to go out to the Guard squadrons that are flying air defense and check out in their fighters and fly with those guys and let me know where the problems are in the squadrons."

Boy, I could hardly believe what I heard him say, and I was trying to fight back a grin and jumping up and saying yes. I was sitting there trying to contain myself, and Pete Aldridge says, "Well, hell," he says, "I knew we wouldn't get you to take this unless we gave you an airplane to fly, so go do it." [Laughs]

I retired from the Air Force, I believe it was on the 30<sup>th</sup> of October, over at San Antonio [Texas]. They had a full-blown ramp retirement with a fly-by and all, and a flight of [McDonnell Douglas] F-4s [Phantom] had come down with Kansas to be part of the fly-by. The deal was, I retired that afternoon and the next morning I got in the back seat of one of those F-4s and flew up to Kansas and was sworn in, not as a general; I was sworn in as a colonel and held the rank of colonel for close to a year before being promoted to brigadier general.

WRIGHT: If you've got to arrive in Kansas, you might as well go in style, I guess. [Laughter]

ENGLE: That's right.

WRIGHT: Maybe they wanted to make sure you didn't change your mind.

ENGLE: Well, it was one of the most enjoyable five or six years that I can recall, because it was getting to fly fighters again and get current in fighters and weapons delivery, and flying with young aggressive fighter pilots and hearing what their problems were and carrying those concerns back to where it made a difference.

WRIGHT: NASA was moving into somewhat of a new era. They were starting to develop some ideas for [Space] Station as well as possibly moving into partnerships with Russia. In [19]94, the NASA Advisory Council established a task force about the Shuttle-Mir [Program] and invited General [Thomas P.] Tom Stafford to chair that task force. Tell us how you became involved with this part of NASA's new era as a consultant and as part of that review team with General Tom Stafford.

ENGLE: I recall that General Stafford had been asked to chair a review team on the upcoming repair mission and he asked me if I would be on his review panel with him, along with a number of other people. Of course, I was happy to do that, and I think that preceded the Phase One, the Shuttle-Mir establishment.

I know that the two kind of went hand in hand, because when we had completed our assessment of the Hubble Telescope, which was a rather major impact to the planned EVA schedules. There were, I think, two EVAs at the time scheduled, and right away we saw that the EVAs were just terribly oversubscribed. I think it was a matter of people trying to keep the

number of EVAs from getting out of hand and make it look like not all that big of a deal to repair the Hubble.

But it turned out that there were five EVAs required and it was, I think, very fortuitous for Tom to identify and stand fast, make a very hard statement that it was going to be an unsuccessful mission and a disaster if they tried to do it in two EVAs. It turned out it took five full EVAs to do it and the repair was successful. So Tom gained a great deal of credibility there, which he already had, and as a result, I believe, was asked to review the upcoming Shuttle-Mir or Phase One missions, where the United States was going to begin to send people and experiments up to the *Mir* station to learn how to operate in space for an extended period of time.

So that was how the Phase One activity got started, and Tom took a number of the people who were on the Hubble repair team and put them on that Shuttle-Mir Phase One.

WRIGHT: Had you been in contact all this time? Had you worked on special projects with General Stafford while you were part of the Kansas Air National Guard?

ENGLE: No, not particularly, but I had been continually in contact with Tom. Tom was one of my instructors at the Test Pilot School, when I went through Test Pilot School, and we had kept in touch quite a bit. We flew together a lot at that time that Tom came down here to NASA, and I followed him down a number of years later, so we knew each other very well and we flew together down here some.

When Tom left NASA, he went back to the Air Force and ultimately was the Flight Test Center Commander at Edwards [Air Force Base, California] and happened to be the Center Commander at the time that we were preparing and flying the approach and landing tests. So we

worked very closely with Tom, both professionally and personally when we would go out there to fly. Tom made some very unique opportunities and assets available for us. I know Dick [Richard O. Covey] and I got to fly [Lockheed Martin] F-16 [Fighting Falcon] fighters while we were out there, and it was new and going through development, and learned some techniques from the flight control system on the F-16 that we were able to apply to the data-gathering flight that we flew during the approach and landing test program. So Tom and I had kept in touch. It was kind of a natural fit, a good fit, a good, comfortable fit.

WRIGHT: When you learned from him that he had been named the chair of this new task force to study the planning and development of Phase One, what were your first thoughts about NASA joining efforts with the Russians to do a space exploration?

ENGLE: I remember Mr. [George W.S.] Abbey was the Director here at the Johnson Space Center at the time, and he was the one that told me that he wanted me to work with Tom on establishing a joint commission with the Russians. I remember telling him that I was about as right-wing military as could be expected and I had spent a good deal of my professional career on the end of a runway sitting alert to go after them. I said, "I think I'm probably the last guy in the world that you want on that or that they want to see come and work with them."

He said, "Well," he said, "that's really kind of why I want you there, as a piece of litmus paper." He said, "I figure if you can make it work and if they can work with you, why, then anybody will work." [Laughs]

WRIGHT: What a compliment.

ENGLE: Mr. Abbey was full of those kinds of compliments.

As a matter of fact, the first contact with the Russians was very much that way. The Russians were not at all receptive to anyone else coming and sharing with them how to go into space, because they were convinced they knew how to do it. They'd been doing it longer than we had and, in their perspective, much better than we were doing it. It made it a little more difficult, because the boosters that they were using, the launch vehicles that they were using, were their intercontinental ballistic missile boosters and so there was a security element, too, that, from their perspective, made it a great deal more difficult to work with us. In fact, a lot of their space equipment was still being used for military purposes, and General Stafford knew that.

I remember in January, I believe, of 1995, I think it was—yes, I think it was 1995—he was going to go over in February to approach and formally set this thing up, and he told me to go over in January and kind of give them a heads-up as to what we were going to do and let them know that he'll be over in a month and sign this thing all up.

Well, I went over with a group of two or three people and we had scheduled visits with the deputy head of Rosaviacosmos, RSA [Russian Space Agency], and RSC [Sergei Pavlovich Korolev Rocket and Space Corporation], Energia. The gentleman who had been identified to be Tom's counterpart on the joint commission, who was Academician [Vladimir F.] Utkin, who is the most respected rocketeer that Russia's ever had—well, next to Korolev, but most respected living one, an old gentleman, just a big bear of a guy.

We were not doing well at all. Mr. [Boris D.] Ostroumov had essentially thrown us out of RSA and Mr. Semyanov did throw us out of Energia. He didn't want anything to do with us, didn't want any independent—they didn't know what an independent review group was. It was

an entirely foreign concept to the Russians. They were more prone to the stovepipe, of this enterprise has this task to do and you turn the finished product out and it will fit with this finished product, and you don't talk to each other. Everybody was very, very closed door about it. So they didn't want the idea of anybody looking over their shoulder, even their own people looking over each other's shoulder.

It was a difficult concept to sell, and we were just about to say, "This doesn't look like it's going to work." In fact, I had called Tom from over there and he said, "Well, pack it up and come home." He said, "We're not going to waste our time on this."

And I remember telling him, "Well, we got one more guy, the guy you're supposed to be the co-chair with, and I'll go see him, because we can't move the flight up anyway. It costs too much money to move the flight up."

So we went to Academician Utkin's, and he was pretty much the same way. I remember going in and being told to go in and sit in his office and wait for him. He walked in, and at that time, they didn't have phones with pushbuttons. Each line had a separate phone, so he had fourteen phones on his desk, I remember, and a big map, a wall map of the Soviet Union. It was still Soviet Union then to them. Finally he walked in, strutted in, and sat down at his desk and started making some phone calls. We were sitting there, [William] Bill Vantine was with me and there was an interpreter present.

Finally, after about, I think, about twenty minutes, he turned and he said, "So," through the interpreter, he said, "So, you are going to tell us how to go to space?"

I was trying to be as diplomatic as possible, but not wimpy about it, and I said, "No. No, sir. We're here to join with you and go to space together and see if we can combine our resources."

He reacted with a couple of things about, “But you want to use our space station? You don’t have a space station. You want to use ours.” Finally, he leaned back in his chair and he said, “Let me tell you. I was the head of the Intercontinental Ballistic Missile Program for the Soviet Union and I designed the SS-19,” which was a superb rocket, booster, and he went to the big map on the wall and he said, “We had—,” and he started going through the numbers of missiles that they had targeted for New York and Chicago [Illinois], all our major cities. After he’d completed, he walked over and he sat down and he folded his arms and looked at me.

I remember saying, “Well, sir, I know that you did exactly what you thought was the right thing to do for your country.” I said, “At the same time that you were doing that, I was sitting in a [Boeing] F-100 [Super Sabre] in Aviano, Italy, with a nuclear bomb strapped under the belly,” and I walked up and I pointed at Aviano, Italy, and I said, “I had one target, one bomb and one target only, but I felt I was doing the same thing for my country that you were.” I said, “My target was this airfield right here,” and it was back in Hungary; it was not in Russia, but it was in the Soviet Union. I said, “That was my target.” And it’s amazing, the intelligence that the Russians had on us at the time.

He said, “Yes, I know.” And he said, “You would not have made it.”

I said, “Well, I think I would have made it.” I said, “My route was to fly up this—.” We had memorized our routes so that we didn’t have to look at maps, so I followed the track up the river valleys and I said, “You had antiaircraft here and you had radar here, so my route was to go around these hills and on in.”

And he started to scowl and he said, “You would not have made it back.”

I said, “No, I would have run out of fuel before I got back, but I was going to bail out in Austria. I felt if I could get to Austria, why, I would make it back.”

And he sat there and he just scowled at me for a while, finally pushed his chair back and he got up and—he was a big guy—and he started to walk around his desk toward me, and I figured that—he wasn't smiling at all, and I thought he was going to cold-cock me, so I figured I'd stand up and take it like a man. [Laughs]

I stood up and hadn't really got my breath from standing up and he just grabbed me and gave me one of those big Russian bear hugs and he said, "It's better this way, isn't it?" [Laughs]

I recall just before he said that, when I finished I said, "This was what I was doing, but I really think that we have the opportunity to take off our gloves and do something together for the whole world." And that's when he didn't smile, but he walked around and he said, "It's better this way."

So he set the commission up. A month later, when Tom went over, it was all set up and ready to go, and it's been working for over—well, it'll be ten years coming up next year. And even Academician Utkin said, "We'll try this, but these things don't ever last more than a year or two." [Laughs]

WRIGHT: During the four years that Shuttle-Mir was happening, your commission had quite a number of challenges that you had to deal with, including a fire, collision, computer failures. Could you share some of the challenges and how you were able to find the mutual understanding and respect so that the two agencies could work as well as they did?

ENGLE: I think that the mutual respect and understanding was the key, and it only worked because it went both ways. We had to accept some of the Russian characteristics and some of their personalities and ways of doing things, and they had to do the same thing with us. We

never did, and probably never should, completely accept the way the other guy does things, because both sides had been doing things successfully, going into space successfully, and they weren't always the same way. And both sides were reluctant to let go of those ways and methods that they had been going into space.

Their concept is, as I'm sure you've probably heard, is much more dependant on ground control, and that follows their philosophy from the way they control their fighter aircraft. They control them from the ground. The pilots don't have much leeway as to what to do once they engage in combat, and that's what makes them very, very susceptible and predictable. They like to do things automated, and so we are more prone to let the pilots do all that they can, let the crew do all they can in the way of rendezvous, docking.

One of the instances was when the *Progress* vehicle collided with the *Mir* when we had crewmen onboard. Of course, our rationale was that we have Americans onboard, so we're very interested and we feel like we ought to be very much part of the accident. They didn't really want us to be involved with that, and I think, again, probably because some of their guidance equipment was still classified, still military, that they used to automatically guide the *Progress* in.

But they were attempting to transition in to where they had manual control of the vehicle coming in. The commander onboard the *Mir* station was going to fly it in remotely, using a camera that was on the *Progress*. The reason they were going to do it is they were becoming cash-strapped and the guidance system was being made in the Ukraine. It was very expensive and they wanted to avoid having to buy that automatic guidance and docking system. So it was an experiment, really, a demonstration that they could, in fact, do it.

They had set the rendezvous up. Unfortunately, it had some overburns in the *Progress* engine. So the *Progress* was coming in with too much energy, and the pilot onboard was trying desperately to make that rendezvous and docking happen, trying to force it, and it came in too fast and collided with the *Mir*.

The Russian traditional way to handle that is to blame the crew and to dock him of all of his bonuses and to send him off to Siberia and not have him around anymore. Tom was very quick to recognize this, and good for him, he really stood fast. Became very incensed that they were going to blame the crew for something that was really an experiment that was set up wrong by Energia and very poorly planned, and he made a very strong point of it.

That particular trip, Academician Utkin had invited us down to Risan, to his hometown, for a celebration that weekend. So Tom and I rode back with him in a little van, and while we were riding back, about four-hour drive, with the interpreter, we explained to him the rendezvous techniques and why Gennady [Vasily Tsibliev] was set up for failure. It really was not his error at all; it was the people who had planned the thing.

And the next day, in our meeting, he had contacted all of the Russian people on the committee and they concurred that it was not pilot error; it was a bad test setup that had caused that accident. And that particular individual happens to be now the Commandant of the [Yuri] Gagarin [Cosmonaut] Training Center in [Star City] Russia, so it was a very effective scenario on that.

Yes, we reviewed the fire onboard the *Mir*. Moving on into the [International] Space Station, when [Dennis] Tito was taken up as a guest on one of the taxi missions, ferry missions, there was a misunderstanding or miscommunication that started that whole thing, got it off and polarized the two sides, and we were asked to go over and try and work something out, and were

able to do so, so everybody could walk away with a little bit of pride. So it's been a wide spectrum of activities that we've become involved in, but it's been interesting.

WRIGHT: When you first took the assignment, or decided to join up with General Stafford to do this task force, did you have any idea it would be lasting past the Shuttle-Mir phase and on in for another six, seven years?

ENGLE: No, I sure didn't. I think at the time we felt that it would be just Phase One, and then as Phase One started to ramp down and Phase Two of the Station started to ramp up, it was obvious that this line of communication, this alternate route of communication that had been established with the joint commission, was in fact very much value added to NASA and Rosaviacosmos, and particularly to the heads of the two agencies. There were a lot of times when things would come up that didn't lend themselves to a decision or to a public forum between the two heads of agencies to decide, and it obviously couldn't be decided down at the working level, because of, as I said, the way we do things differently. So a number of things we were asked to go work out and propose solution and give it to the managers and let them gnaw on it and come up with solutions. It really is more a good line of communications than it is a technical or even an operational asset to NASA and to Russia.

WRIGHT: Did your counterparts on the Russian side stay constant or did you have new people for these last years?

ENGLE: They stay constant much more than we do. Particularly the support staff people tend to be promoted up and, of course, the astronaut representative changes, but theirs does, too, because of flight schedules and flight scenarios. But the members of the Russian Advisory Expert Council, they tend to be very, very stable. They are the respected leaders and they don't change until either their health forces them to or they actually die. We've had a couple of them that have died while they were members.

WRIGHT: One of the changes, of course, is that *Mir* deorbited and the International Space Station is now in place and we are still working with the Russians. How did your tasks change, what kind of challenges did you encounter with the new program?

ENGLE: Well, the biggest hurdle, I think, was the mindset of people on our side and probably a carryover from what was perceived during the *Mir* flights. The *Mir* was a Russian vehicle and we were guests onboard. We were paying guests and we were learning how to operate. I think that within a lot of folks here they brewed the resentment that we were in a "Mother may I" situation, and the feeling was, "Boy, once we get our hardware up there, we're going to be the boss and they're going to do what we tell them to do," which was really not the right approach to take. And again, I think just the Russian culture is that they are more *stoic* is the word, serious, firm in what they say, whether they're sure of it or not. There was a little bit of an understanding that that goes on, that it was necessary.

But I think the biggest challenge was probably convincing both sides, our people as well as their people, that it was going to be a joint venture; it was going to be a joint Space Station and that the United States was responsible for it and would have to have the final say, but inputs

from all the partners were going to be necessary to make it work, and we still see times when that is a concern.

The technical rationale may not be totally complete when people take a very firm stance and they fill in what the holes are with just pride and experience, and that sometimes causes a problem.

WRIGHT: Out of all the meetings that you've had with the Russians in Russia and here, are there any that stand out in your mind?

ENGLE: Yes, there are a number of them, and I think the major ones that you touched on, the fire, the Tito mission. The Tito mission was really a very large hurdle because both sides had become so polarized. In fact, our Administrator had publicly stated very, very firmly that he was not going to fly, and their Administrator had very publicly and just as firmly said, "Yes, he is."

We honestly—I do recall that was one week where we were probably averaged maybe two or three hours of sleep a night because we would be in very, very hard negotiating meetings with them during the day, and then at the end of the day we would go back to the Volga apartments, the Volga apartments that NASA leases over there, and be on telecoms with the people back here, giving them the information we had learned and receiving information from this side and then trying blend the two together.

Of course, at the end of the day over there, five o'clock over there is eight o'clock here, so as we were just finishing up the day and getting back to the Volga at six o'clock or so, and normally hadn't eaten yet, the phones would be ringing and people here would be ready for a full

day's work. [Laughs] So it was good in a way that it was a very efficient way to get the job done, but I remember at the end of that week, we were all completely bushed.

WRIGHT: You didn't have to worry about forgetting while you slept.

ENGLE: No. [Laughter]

WRIGHT: You just didn't sleep.

ENGLE: That's right.

WRIGHT: Would you like to take a break for a few minutes?

ENGLE: Yes. That would be a good idea.

[Tape recorder turned off.]

ENGLE: ... Pilot In-flight Landing Operations Trainer. He had to force the words to make PILOT out of it. But it was essentially a laptop, but at that time, laptops didn't have enough capacity, so it was a workstation that we had to go out and buy. Essentially it was like a game, a little game that you buy now down at Target, to land, a landing simulator. We can talk about it or elaborate on it, but it was one of the things I had found I thought was maybe a deficiency or something that really taxed the commander on coming back and landing, that I felt would help

unload some of that task, if he could practice the landing onboard, and it's worked out well. It's gone on almost every flight now. Now the computers are small enough it can go into a little laptop, with very little overhead.

WRIGHT: That's interesting. What is the feedback from the commanders?

ENGLE: They really like it very much. In fact, Dick Covey had a unique situation on his flight. They had planned to land on Runway 1-5 down at the Cape [Canaveral, Florida], at the end of the flight, and the computer had the capability to put in a wind profile, and the winds during the duration of that flight, the winds had changed drastically, the jet stream had changed direction as well as speed of the winds at altitude. They were trying to maintain that same landing runway, because they knew he hadn't practiced very much going the other direction down at the Cape.

I was over in Mission Control at the time, so I would send up on the message train what the forecast winds for landing were, and I'd put a little explanation code that we used on our flight when something was—you know, "Pay attention to this," without raising other people's concern. And the winds clearly showed and the trend showed and the forecast, I'd send the forecast winds up with this explanation marks on them.

Dick saw that and he realized that the winds were going to be such he was going to have to land the other way, plus come into the heading alignment circle with—it seems to me they were almost 200-knot winds at altitude that day—and that he would need to turn early and anticipate it, otherwise get blown way downstream and way down below the hack and then be energy short coming back in. He could make it all right, but it would be a terse thing.

So on that little trainer he had onboard, he started practicing landings the other way. Even though they were still sending up to him that he planned landing runway was 1-5, he was practicing to land on 3-3. Then that morning, the flight controller finally decided that they were going to have to land the other way, so they changed the runway on him, and they were expecting him to get blown way downstream and told him he might have to turn early. He said, "Okay," and he was ready. And he did, he knew exactly when to lead the turn; he'd been practicing it. So he just nailed the heading alignment circle. He was right on all the way down, energy all the way down. Afterwards he said that that was one of the biggest gratifying things to him was to be able to know ahead of time that the landing situation was different and to be able to practice it. He said he'd screwed it up the first few times. He went and got blown on by.

Anyway, that was PILOT. It started out, I was up in Washington with Mike Mott and we were going to serve on some review, and I can't recall exactly what it was right now. It had something to do with a new vehicle review. But we were both disqualified for some reason. Oh, I know. It was because neither of us were NASA employees and the meeting was going to be just NASA employees.

So Mike and I got thrown out of the meeting and we went downstairs to get some coffee while they were discussing whatever they were going to discuss, and we were talking about things and I told him that on my flight, on my second flight particularly, when I came back admittedly dehydrated and no sleep the night before, but even on the other flight, that after being in zero gravity for a long while, your motion cues are altogether different. One-G [gravity] is not your calibration point anymore; zero-G is. So when you get in the pattern to fly, you've got this force on you, the 1-G force, that's strange and it kind of diverts your attention.

The visual cues should completely dominate your attention and you should try to divorce the motion cues as much as possible in order to keep up with the cross check, because it seemed like it was tough to keep up with the cross check. You knew something was wrong and you'd be looking around trying to figure out what it was was wrong, so you needed to really divorce yourself from everything but the visual cues, and that a way to practice doing that would be with a little landing game, if you will. I remember drawing it out with a computer and a stick.

And Mike said, "You know, that's a good idea. Let's go talk to—," the guy who was the head of what is now Code M [Office of Space Flight]. [Jeremiah W.] Jed Pearson was his name. So he set up a time to go talk to him about it, and George Abbey was there and came in—he was in Washington for some reason—and we sat and talked with Jed.

Jed was a fighter pilot and he said, "That looks like it might be a good idea."

And George mumbled and he said, "Yes, Joe Henry, that's pretty good. Why don't you find out what you need to make that happen." This was on a Monday, and I was going to fly back Tuesday, and George said, "Why don't you come on back and come up to my office on Tuesday."

I said, "Well, George, I'm not going to get back Tuesday. I won't be back till Wednesday and I won't have time to do anything with this."

"Okay. Wednesday will be okay. Come on up to my office." [Laughs] So it was not much more than that scribbled cartoon literally on the back of an envelope. George said, "See what you need to do to make that happen." And as I mentioned before, it turned out that laptop computers didn't have enough capacity then. The one thing that I was going to be insistent on was that the response that you see on the screen would be accurate to what the Shuttle is and not

have any delays. The resolution was not as important. Whether you looked at boxes or filled in buildings didn't make any difference, but the horizon and your response was very important.

So one of the guys here, Bob Henson [phonetic], said, "You know, if we had a little more capacity, we could take the actual updated Shuttle flight dynamics out of the engineering simulator and just use one string of that, put it into the computer, and we'll get some guys out in California to draw the scene for us, keep the load down. So we did that, and the idea initially was to tie it in with the Shuttle hand controller so you could just use that and practice on orbit.

But to penetrate into this orbiter flight control system would have required a whole new certification from Rockwell [International Corporation] at the time, and we didn't want to do that. So we got a little hand controller built by a company that builds them for games and got them to make one that looked like the Shuttle hand controller, and got it all put together and it really worked well. And as I say, then as computers got more and more capability, more capacity, they were able to put them into the standard onboard laptop that's carried now, and it's used over in the Pilots Office over here in Building 4 now.

A lot of guys, before they go out to fly the STA, the Shuttle Training Aircraft, they would go in and practice some landings just to freshen up and to make their training more efficient when they go out. New astronaut candidates spend a lot of time in there, flying and getting familiar with the characteristics, because the characteristics that you see on the screen are duplicated; they're replicated from the Shuttle engineering simulator. In fact, all of the operational interims, OIs, that are put in and developed, feed right into the SES [Shuttle Engineering Simulator], then they're ported into this PILOT simulator so every change that's made in the flight control system is updated automatically.

WRIGHT: That must have been pretty rewarding for you to be able to take that concept and see it work so well.

ENGLE: Very rewarding, yes. It really was, yes. It was neat. And fortunately, a lot of guys had made the same comment, that “I thought that I was the only one that was having trouble with—,” that the perceptory cues, the acceleration cues are really distracting, that normally they’ll help you out in the pattern. You can tell when you’re pulling 1 G or 1.5 Gs in the pattern, but that’s deceptive and it takes away from your concentration, because everything is strange and different after coming back. You just have to concentrate on the visual cues and the hand-eye coordination between what’s going to happen.

WRIGHT: Quite a confidence-builder.

ENGLE: It is, yes. And it really turns out, I think, it’s not much different than video games. If you play video games a long time, you get pretty good at them. [Laughter]

WRIGHT: Some of us. [Laughter]

You also were involved with the STS FCS [Space Transportation System Flight Control System] and guidance improvements.

ENGLE: That was a fallout of the simulator. In realizing that at high winds at altitude, the guidance system does not have any way to anticipate what winds are or the displays that you have are so much after the fact that your trajectory has been affected ahead of time.

So what we did was to take the cues that were on the eight ball, the guidance system, the attitude reference system, both roll, pitch cues, and actually the yaw and yaw rate cues, which are vertical and horizontal bars across the bottom with a little needle that tracks across. Those are not used in aerodynamic flight; they're used in space flight. So we took those functions and put in, as you approach the heading alignment circle, an error that shows that you're coming up on the alignment and gives you some anticipation of when to roll into the turn and what Gs to pull, and what's necessary to track the heading alignment circle and to fly the approach more accurately. So it was a matter, really, of just taking some functions that were already on the display, giving them new meaning, differentiating or defining what they told you in the pattern. The idea, really, was to be able to keep the errors at a minimum all around the track to landing in case the pilot had to come back at low clouds, low-visibility conditions.

At the time, there was a big push to go ahead and qualify the automatic landing system on the Space Shuttle. We had kind of tried that on STS-3, with Jack [R.] Lousma, and the Shuttle doesn't really lend itself very good to that, because if the automatic pilot is flying the airplane, the stick doesn't move any, because it just stays still. So you don't have any feedback; you're not communicating with the airplane all the way down. So if you do have to take over with an error at the end, you really are at a disadvantage of not having flown the airplane and not knowing how much deflection is needed for the delayed response of the Orbiter.

So an additional thing that we put on that was a little box that even if the pilot had been up for a long-duration mission, which was a concern that he might not be capable of flying it back in the pattern if he was up there for two, three, four weeks, that he would at least start flying it and try to keep the guidance symbol, or to keep the velocity vector inside this guidance box and fly it around and keep communicating with the airplane and acquire this transition that was

necessary for the landing. And if he was not able to, if he wasn't able to keep the velocity vector in this guidance box, then the automatic system would take over, fly it back and center it up, and then he could take over and fly it again on in. That didn't have to be used, because the automatic landing system push finally went away, and I think that won't ever happen. But developing those kinds of pilot interface displays was a lot of fun, very rewarding.

WRIGHT: Another one you mentioned was the glass cockpit development.

ENGLE: The glass cockpit, the transition from the old—well, we called them steam gauges, but the old round dials that the Space Shuttle initially had to the CRTs, cathode ray tube displays, where it's multifunctional display system. You can call up different functions on the same screen, if you like, and the development of the layout, the format, of displays that should go on those CRT screens to replace the old gauges, was, again, an interesting pilot interface task.

WRIGHT: You did that, again, as part of working with General Stafford, as part of his review, or was that an independent consulting?

ENGLE: That was an independent consulting tasking that I was doing then, yes. That really preceded the time that I was working with General Stafford. I started to work with General Stafford on the review group, on the Hubble review. In fact, the PILOT and the flight control system and the MEDS [Multifunction Electronic Display Subsystem], the glass cockpit, all preceded the time that I started to work with him.

WRIGHT: What other types of projects have you done, either independently or with General Stafford, for NASA that we haven't discussed?

ENGLE: I think that working with him, they've all been as a result of being on the Stafford Task Force or the ISS [International Space Station] Operations Review Task Force, but the particular nature of the tasks have been pretty varied. I mean, they varied everything from reviewing the Russian budgetary system to see if they were going to be able to hold their end of the agreement up, which was entirely foreign to me. I'm still not really sure what all we did over there. All I know is that General Tom had forced his way—not forced, but talked his way into the Bureau of Budget, which was a very restricted area over there, and they brought out what they called grafiques [phonetic], which at the time, they didn't print things up; they just would have these big wall charts of numbers and things that they would put up for briefings, and at the end of the briefing, they would be taken down and rolled up and nobody could see them.

So they had this grafique up there which laid out their expenditures over the next few years, and we'd asked for a copy of that and they'd said, no, it's not available. So we sat down and I just told guys, "Okay, you take this section up to here. You take this one, I'll take this one, and you take this one here, and we'll get this thing copied down."

So we were copying the charts down and Mr. Ostroumov, the guy who threw us out initially, I know he came up and he said, "Is this all American generals have to do is to copy down numbers?" [Laughs]

And I said, "Well, sir, American generals do whatever they have to do to get the job done." And he let me alone after that. [Laughs]

And then the interesting thing was, we had copied all these numbers down and gotten together at the hotel and combined them, and the next day, very, very magically, a handout appeared with all the numbers on it. [Laughs] But again, I have no idea what they meant or what they were or anything; we had the budget report there that we brought back.

WRIGHT: You were there to gather information.

ENGLE: We gathered the information.

WRIGHT: In February of 2003, NASA and the nation lost another Orbiter when *Columbia* disintegrated on its way back home. Share with us where you were when you heard that news and then how you've become involved with some of the return-to-flight activities.

ENGLE: I was in Reno, Nevada, when we lost *Columbia*. I was at a wildlife conservation convention and saw it on the news very early in the morning, and wasn't able to get out of there before being captured by some media types who wanted interviews. Of course, I had no idea what had happened then. There was a lot of speculation, but I really had no idea what had happened until, well, I guess it was a day or two later when I learned what the source was.

WRIGHT: Are you now involved with some of the return-to-flight activities?

ENGLE: I am. I am now and, again, because of General Stafford, who keeps me off the street and keeps me from my hunting trips and flying as much as I want to. He had been asked by the

Administrator to set up an independent review group of how NASA was responding to the recommendations of the *Columbia* Accident Investigation Board. We were not involved at all with the Accident Board or with their findings, but because of the commitment by Mr. [Sean] O’Keefe that NASA would in fact comply with all the recommendations, and NASA’s statement that they would raise the bar and do even more, he asked General Stafford to form a committee of experts, of expertise in various areas, the management areas and the technical areas and the operation areas, to review NASA’s responses and to assess whether they had complied with the intent of the Accident Board recommendation, and that’s what we’re doing now. That’s what I’m involved with right now and will be up until return to flight.

WRIGHT: Anything you can share with us at this point, or are you still collecting information?

ENGLE: Yes, we’re still collecting information and it’s going to be, I think, much more of a task for the task group than was initially planned. I think initially folks thought it was going to be a black-and-white yes or no; yes, NASA has complied with this recommendation, and no—the recommendations themselves leave some flexibility on what can and should be done and the practicality, actually what you can do, practicality, whether you can do it or not requires some flexibility. It’s not a matter of looking at each recommendation individually; it’s almost necessary to look across the board where if one recommendation is not quite completely satisfied, is it covered by the ability to revert to another direction by another recommendation.

So, for example, the foam shedding off the tank, the liberation of foam off the tank, ideally, the intention was to say, well, we just won’t have any more foam coming off the tank at all, and that’s not really a reasonable or a practical thing to try and do. The foam is necessary for

the purpose it serves, which is insulation and to keep ice from forming, and by its very nature, some of it is going to flake off. But the size or the mass of the piece that breaks off and the velocity that it will hit the vehicle then determines whether there is any damage or how much damage could be done, and if a enough damage is done to require repair, then the ability to go out and repair is necessary. And in the very, very remote event that something catastrophic happens and you can't repair it, then the last fallback is to be able to dock to the Station, the crew transfer into the Station, and then wait for a recovery vehicle to come up for them. So it's a very complex scenario that has to go together to make the complete and the correct story, the correct response.

WRIGHT: So much history has passed with NASA since the first time you flew the *Columbia* and then, of course, now to the loss of it, it's quite a mix of your expertise that you're offering at this point, to help them return to flight.

ENGLE: Well, I feel lucky to still get to be considered useful to have around. [Laughs]

WRIGHT: Looking back over these many years that you have been connected with NASA in so many different ways, is there a time that you feel is the most memorable one for you, if you had to pick a highlight, that you would consider to be the most significant moment of your NASA career?

ENGLE: The most significant, the most exciting—I hope neither one of those have happened yet. I'm still hoping to get a lot more thrills out of this job before I quit. But up to now, I think that

some of the more significant ones, I can remember very well both STS-2 and 51-I and, in fact, all the flights, getting the feeling that you really were representing the country. When you walked out to the pad, you were representing the whole nation; everyone who worked at NASA and on the vehicle and worked so hard, but not just them, the whole nation pointed with pride to the space flights.

So I remember very distinctly consciously thinking that when I walk out there, this is like putting on the USA jersey at the Olympics. The whole world is watching you and particularly your country is watching you and you just don't want to screw it up. You want to make it happen right and do it good, and you want to have trained as completely and thoroughly as you can, and you want to keep focused and concentrated on what's going on and not pay attention to the flashbulbs going off and things like that.

Probably the next tier down is that same kind of feeling during the approach and landing tests and during the reentry on STS-2, when having been such a proponent and pushed hard to get the flight test data and to incorporate the flight test inputs into the controls, to get that data for the engineers on the ground, I do recall thinking that I had an unique opportunity to represent the whole test pilot community, and that's a very proud community in itself, and feeling kind of the same way. "I just don't want to mess this up. I want to do as good a job as I can to make everybody feel proud."

WRIGHT: I think you have. It's only fitting that we started out these sessions with talking about your flying days, that we end the sessions with you talking about your flying days. You've flown more than 185 different types of aircraft, logged more than 14,000 flying hours during your lifetime. You're continuing to fly today, is that correct?

ENGLE: I am. Not nearly as much as I would like to, but more than I deserve, I'm sure. But I do get to fly [Boeing] F-15s [Eagles] and [Lockheed Martin] F-16s [Fighting Falcons] at Edwards Air Force Base, I think largely because [Charles E.] Chuck Yeager helped vector me into that position. He and I enjoy the status of test pilot emeritus at the Flight Test Center out there, which I looked up and it means "old guy," really; an old guy that you really want to retire, but you hate to hurt his feelings. So we both enjoy being test pilot emeritus at Edwards, and as such, we are asked periodically to come out to talk to enlisted people on the flight line or in the support roles as well as the Test Pilot School. We both are asked to—out of courtesy—to review the curriculum at the Test Pilot School, both the academic and the flying curriculum, which is really neat. And they always make an airplane available for us to fly.

Then each fall, each October, during the annual Edwards Open House and Air Show, we get to go out and fly for—well, we get to open the Air Show with a Mach 2 sonic boom early in the morning to start it out with, and we fly that in formation with two F-15s. General Yeager is quick to point out to the center commander out there that I have a very short memory and I forget everything I knew about formation flying in a year, so it's going to take him a week to get me back in shape, so we get to fly all week long out there in fighters.

He was one of my idols and mentors, and I admire him so much. He's such an awesome pilot, stick-and-rudder pilot. I first flew with him at George Air Force Base [Victorville, California] in 1958, when I first got to fly with him, flying [Boeing] F-100s [Super Sabres], and I have soaked up as much as I could, how he flies, how well he flies, and enjoyed flying with him. And we've gotten to fly together continuously almost all these years, and we still get to fly these

fighters together, and it's just one of the biggest thrills of my life is to take off, join up on his wing, and fly a mission with him.

WRIGHT: Well, there's no way that we could have covered everything through our questions. Are there other stories, anecdotes, memories that you would like to share with us about any of the things that we've covered before we get off? I always think maybe you're walking out the door, you think, "Gosh, I would have told them this." So I'd like for you to take a second and think if there's some more, and if you don't mind, I was going to ask Jennifer and Sandra if they had a question for you as well.

ENGLE: Why don't you go ahead and ask them. I can think of a few anecdotes, but I don't think I ought to tell them. [Laughs] If I can think of anything more, I'll follow up in an e-mail.

WRIGHT: We thank you for all the time that you've given us for the project.

ENGLE: Well, I sure thank you guys. You have done this whole thing so professionally and you've been so patient, and you've been so patient in that you let me keep coming back. I know you normally get through with somebody in one session, and I know I start ambling and babbling on and I've taken up an awful lot of your time. I don't know how you're going to justify this.

WRIGHT: It's all good. That's how we justify it. [Laughter] Thanks again.

[End of interview]