

INTERVIEW

JOHN CONWAY

KENNEDY SPACE CENTER

2003
(no specific date stated)

DR. LIPARTITO: We're here at Kennedy Space Center with John Conway for an interview for the NASA KSC History Project. John, let me start by asking you a little bit about your background, where were you born, went to school, grew up, all that?

MR. CONWAY: Well Ken, I was born in Florida down here in Bradenton, Florida. My family has been in Florida for many generations. My father's side of the family came down here around Palaka in the 1830s. My Mother's side of the family came here from Georgia in the early 1900s. My grandfather built one of the first orange groves here and so I'm one of those real Florida natives that is pretty rare.

I was the son of a Methodist minister and so we moved all over the state when I was growing up so some people say because of the behavior of the preacher's kids, I don't know whether that's true or not. But at any rate, when I graduated from high school over in Inverness, Florida, I went to work to College at Florida State University and it was either Florida State or University of Florida because you know, I was very poor and had to work my way through school. I went to Florida State for four years and was planning to go on to graduate school and I wandered by, when they were doing the recruiting.

Toward the end of my senior year and NASA was there recruiting from Langley. The US Weather Service was recruiting and the National Security Agency was recruiting. I wandered in, I think it was up at Auburn, Virginia and I wandered in, more to see if I could just get a job and my intentions really were to go in the Air Force and I had everything kind of set up to do that. And NASA started talking to me about going to

the moon and this exciting program, and the fact that Langley had hired three hundred engineers the year before in 1957, and were hiring another three hundred engineers in 1958, and they wanted people who were going to graduate school, who could pursue advanced degrees to help go to the moon.

DR. LIPARTITO: So this was about 1959?

MR. CONWAY: This was in 1960. I'm sorry, I got that wrong, I was talking, I got it confused. Ok, It was in 1962. So in '61 they hired three hundred engineers and in '62 they hired, it was my class. I went to work in July, 1962. Okay, and they offered quite a bit of inducement in those days. Number One they were taking people out of the military to work for NASA.

DR. LIPARTITO: Right.

MR. CONWAY: They were pulling engineers out to be a part of the Apollo Program so they offered the draft deferment if you did this and they also offered to send you to graduate school if you'd go to work for 'em and they paid Two-Thousand dollars more a year than the Air Force. (laughter) And at Sixty Three Hundred and Forty-Five dollars a year, I thought I would be a wealthy man, compared to what I was living on in college.

So, to make a long story short, I said what the heck, and I went to work up at Langley Research Center Virginia. I was assigned to the computer department, which in my mind at the time, I thought was the most unglamorous job that one could get, because I wanted to, you know, I was offered opportunities like advanced structures, when you work as a team with engineers; trajectory analysis for figuring out how to go do the moon landing so forth and so on. I thought these were for more... but I took a

month off and when I got there in July, all the good jobs were taken and I had to go to the computer department. (laughter) That's a career emerged in computers. Unplanned, unthought of and really I explained all that to 'em, and they said, well work here for six months, and you know, if you do a good job we'll see if we can move you, you know to somewhere you will like better.

DR. LIPARTITO: Just curious, so your Bachelor's was in engineering?

MR. CONWAY: Mathematics. And I've had physics.

DR. LIPARTITO: Okay. So even at that time, computers were not considered particularly exciting technology?

MR. CONWAY: Well, you know yes, I think they were beginning to come into their own. I think my impression was a little bit of computer programming I'd done was very much like statistics. You did a lot of writing and got very little out of it, and I enjoyed the part of math where you did a lot more thinking and analysis and that sort of thing. So, I went up there to work. It was a great atmosphere in those days, and basically they were training us to be career employees of NASA. For the first year that I worked there they gave us a--- we were assigned a research project that we had to--and we were probationary employees the first year, started at GS 7 level, and they assigned you a research project that you had to do on the job, primarily in the last six months of the year. The first six months you went to class on everything -- all the mechanics and my being in the computer world -- everything having to do with computers -- every aspect that anybody did. NASA believed that if you were an engineer and you

had technicians working for you, you needed to walk in their shoes and do their job as part of your career development.

DR. LIPARTITO: Right.

MR. CONWAY: So all of us were assigned everything from the most menial job to the most, so that we could see exactly what was involved in all those aspects of the job. It was a great educational experience. You know, after about four or five months, I would have killed to sharpen pencils for somebody who was doing actual work. (laughter) Because, I mean, you know, we were going to school, but they had great people, very smart people. They offered an educational program that you were required to take, two courses on base, graduate level courses, and mine were taught by the University of Virginia. If you made an A or B in those two courses, you could request approval to go on to, in my case, William and Mary, and we got two afternoons a week off to go to class, and some of the others that went to the University of Virginia or BPI, or other schools.

We had a couple of gals that worked with us that went out to UCLA and got a masters degree, but basically you had to prove yourself locally, then they would send you to school and so your career development, your educational development, was very much a part of their program.

DR. LIPARTITO: Right.

MR. CONWAY: And because they were preparing for the long haul. So it was from that point of view, a fantastic experience. Okay, I was very happy there and in fact, after about three years I got my Masters from William and Mary and was planning to go to BPI, and work on my Doctorate program and was approved to

do that. People I knew down here in Florida that worked at the Cape said, Aw you need to come back to Florida, you need to go, you know. We got this neat fun stuff to do and so I retired and came to Florida. (laughter) at the age of twenty-six or so, like some people spent all their lives doing.

DR. LIPARTITO: Right, you got a jump start!

MR. CONWAY: So I came back to the Cape.

DR. LIPARTITO: Had you done any work down here?

MR. CONWAY: No, I never done any work down here. I

only knew some people from Langley that had come back down here and were working down here, who had transferred here. But my family was from here.

DR. LIPARTITO: Sure.

MR. CONWAY: So I had always kind of wanted to come back to Florida and so I could do that and I remember my division chief saying that was the end of a bright and promising career, that I was going down to Florida to be a Cape Plumber and here I was one of the rising stars and I was going down there. I talked to another, I really was very troubled, worried about this decision and I talked to one of the fellows who was a branch chief, who had left Langley, gone to Houston, come back after a few years to Langley. I went to him for advice, cause he had left the fold and come back. He said, this is a not an important decision. He said you're a good engineer, you're a good employee. He said if you go to Florida you'll do well. If you stay here you'll do well. It's a trivial decision in the career path process.

DR. LIPARTITO: Right.

MR. CONWAY: He said, good people do well wherever they

go. So he said, you'll do well down there, you'll do well if you stay here, why are you worrying? (laughter) And you know, I never forgot that.

DR. LIPARTITO: So, you mentioned something which I've heard from other people: it is still early years for NASA and their still entrenched, I guess, in a tradition, Langley is the oldest.

MR. CONWAY: Langley is the oldest and if you were not a member of NACA, you were one of the new kids on the block, and really needed to be taught as such, what the adults do who worked for NACA. In fact, in those days the desk and the file cabinet still had the NACA stickers on it. And somewhere the NACA people had the misconception that I actually worked, you know, for the NACA, before NASA, but I really didn't. I came along a couple years after that, so. But the NACA society sends me literature and stuff. Yeah.

DR. LIPARTITO: You worked at Langley.

MR. CONWAY: Right, I worked at Langley and so forth.

DR. LIPARTITO: And they thought the Cape was more operations and less theoretical?

MR. CONWAY: Well, the difference between the two Centers is that Langley was a Research Center and you could, if you were good enough, you could control your career path by developing a specialty area in a field that NASA had focused interest in.

DR. LIPARTITO: Right.

MR. CONWAY: And you could be, what would I say, you could sustain your whole career – assuming you were good enough.

DR. LIPARTITO: Right.

MR. CONWAY: Okay, and we had a lot of people... when I left there, I was in the Simulation Branch. We were just converting over to digital simulation and I was sent down there to help work the digital aspects of it, since I had worked on digital computers. Probably half of our branch had their Ph.Ds, the other half had their Masters or were working on it. So I mean, there were smart people.

Florida, you're right, it was an Operations Center but the difference, which I liked about Florida, you know--not on Day One--but in retrospect, what I liked about it is that you didn't have to worry about what to do down here. I mean there was, particularly in the early days, there were crises one right after the other. There were always issues. There was always, how in the world are we gonna do this, how are we gonna solve this problem, and it has remained true throughout my career at Kennedy. You're driven by launch schedules. Your work is a team effort tied together by an integrated schedule.

DR. LIPARTITO: Right.

MR. CONWAY: And the highest motivation is to not to let the team down with my part of the work not being done when I promised it. Your credibility is probably your most important asset and having the--I don't know what you'd call it--the intelligence when you saw a threat to you performing your part of the work, to give early notice to the team that I could have a problem, I may be in trouble, don't know yet. Kennedy relies on people raising their hand and saying, I'm worried about something -- it isn't yet a problem -- and the worst person in the Kennedy environment is the person who says, No, I can fix it, I don't need to tell anybody. I'll just

chug along and they'll never know I stumbled. Okay, it is not that environment. It's an environment where people challenge one another, from someone saying this is okay - two other people say, why, prove it to me? Where people argue violently over the best technical course of action and then go and have a beer afterwards.

DR. LIPARTITO: Right.

MR. CONWAY: Okay, I mean, it's that kind of environment but we're digressing, but... (laughter). So at any rate, I came to work here for a fellow named Brad Hughes and he had the computer support in the Central Instrumentation Facility, or the CIF building, as we called it back then. And before I left Langley, I was more into computer systems analysis computers. I was a software coder and a machine language coder for probably the first two years. The last year and a half we were attempting to go state-of-the-art with computer systems. We were attempting at Langley to replace our analog computing equipment, the OEAI- 231R analog computers with digital, high speed digital computing. We were developing math algebras to make that possible. And so, I ended up being up kind of a lead planner, analyst, designer, with programmers sort of working for me. When I came down here, I worked in kind of this general group. Here we had contractors writing software and civil service writing software in those days.

DR. LIPARTITO: Right.

MR. CONWAY: And so, what they needed was somebody to work with the contractor group and help make sure they had the right specs and critique the work they were doing, so I did that for awhile. Because all the other civil service wanted to keep on coding software and I kind of gotten out of that a little bit. And so, by

the way, when I came down here, I was very concerned about dropping my education you know cause I was ready to go on to work on my Doctorate degree. When I went down here I taught graduate school for seven and a half years at FIT, to keep my skills honed in math.

DR. LIPARTITO: Right.

MR. CONWAY: So that I could go on to school if I wanted to later. I was, by no means, sure of this career decision. It just seemed the thing to do at the time, okay.

DR. LIPARTITO: Did other people who you knew teach at FIT, as well?

MR. CONWAY: Yes, yes, we had a number of people that were a member of the adjunct faculty. And I did that for a number of years, and what I found is I was working weekends on the school work, preparing lessons – the book was always changing--the text--so you'd have to read – re-do your lectures and so finally one day, I came to the realization that if I put that same level of energy in my NASA career, I probably would come out ahead, and that's what I ended up doing. I said, Okay, so much, so much for being an educated man. I guess I'll just be a NASA guy.

But during Apollo, I ended up being a Section Chief, we called it. A manager of a small group of people that were responsible for the operating system software on what we call a G-635 computers, in those days. And GE--let me think about this-- that's right, GE designed and built that system and for their day, they had one of the most advanced operating systems that was in the industry. They were terrible marketing people, and they ended up selling out to Honeywell years later and so forth, but they

really, in those days had a more advanced operating system, in my opinion than IBM and some other people did with a much larger reputation. We could run real-time data through this system and do batch processing in the background, which was kind of new for that technology. I guess just to mention at Langley, the first projects I really worked on were the scout launch vehicle, that they were launching over at Wallops Island.

DR. LIPARTITO: Right.

MR. CONWAY: And I actually wrote the software to reduce the data for the first analog to digital transcriptions system. We didn't have real time telemetry data reduction other than analog strip recorders. And our data was all on analog strip recorders in those days, and so my project that first year, I was assigned to work with the senior engineer who had developed and is now up in Fort Lauderdale, I think they were called SSF Scientific Systems or something, built the actual hardware that this fellow had helped designed and I wrote all the software to go with it to validate the accuracy of the hardware, and we had PCM converters and analog to digital converters and PAM, PDM, FM, FM type signals and we converted that to digital data.

And then I wrote a software program that would run on a big computer and convert pressures, temperatures and so forth, rather than go through the laborious task of film rating film, with a ruler. So when they would then launch from Wallops, within about a minute or less, cause we would spool data off of this analog recorder, I would run down to the computer room, run it through my thing and the guys involved would call and say, okay, what do you think our pressure and temperatures are? We would build a telethon – we'd say, looked real good here, looked real good there, okay. So when I came here, the computers we used in Apollo basically were doing a similar

task. We were taking all the raw telemetry data and in real time, were going to, what we call a data course system, that was part of the telemetry ground station, that buffered this in data tables and we had two large machines – two 635's – that both were simultaneously reading this data core information, but only one of them would be putting the output to all the displays that were out at 39 and other industrial areas where people were monitoring temperatures and pressures and so forth.

DR. LIPARTITO: Right.

MR. CONWAY: And the way that system worked is, these systems were redundant, so that if this system had a problem with producing a data, this other computer would automatically start, you know, we've switched to its output and the customer would never know that his computer failed. So once, on one of the Apollo launches, there was one Apollo launch that I think we were having problems with our computer support. I didn't go home for four days. You know, I just slept in my office I laid four government chairs out and slept in those chairs. You no sooner get home and you'd be called back into work. I remember one time that our support was working well, and everything was running pretty good, and so I went out to the Cape to get supper or something and took a little break and I said, well, I'll drive back on the way home, I'll ride back through just to make sure everything's all right before I go home

DR. LIPARTITO: Right.

MR. CONWAY: And I went back and these computers were failing at five minute intervals. The firing machine would go down almost exactly in five minutes, just allowing the backup machine to get rebooted in time – so when it failed, the other one. And we failed like, fifteen or twenty times, but never lost support to

the customer because, you know, we had just enough time to get this one rebooted, and anyway, we got out software people back in. We found a coding error in the middle of the night, three or four a.m. and we fixed it and we didn't cause a problem.

But that was what we did, kind of, in Apollo. Again it was, you were part of a bigger team. We were kind of in a support group. We weren't, I mean, I wasn't out meeting and greeting astronauts. I mean we saw 'em and we knew who they were and so forth, but there was a great stance of, this is a difficult job, we don't know if we can pull it off or not, well, we're not gonna fail because of me. And I think that attitude prevailed in almost everybody out here.

DR. LIPARTITO: Your part of the software group for telemetry data, where did that fit in the organization?

MR. CONWAY: Okay, well it was part of the launch count down and launch testing portion, okay. And basically, the computers were actually in the Central Instrumentation Facility, the CIF building over in the industrial area.

DR. LIPARTITO: Right.

MR. CONWAY: But the displays were out here at 39.

DR. LIPARTITO: Right.

MR. CONWAY: And there were also, we had two other computer systems in those days that supported. We had the Ace computer system, that was derived from JFC and it did the Apollo space check out, and then we had, gosh, I can't think of the name of the other system, but it was a Marshall derived system that did vehicle check out. And then the systems that we had were large systems, compared to these being smaller systems, and they did basically the hundreds, thousands of

measurements that we took off off the vehicle in real time. They processed all this data and said the pressure, the temperatures, you know, but all those transducers were reading, and providing a real time display, on black and white, CRT, of course. Literally, probably a hundred or so display stations. I mean, unique CRT displays and these displays were then routed all over KSC.

DR. LIPARTITO: Oh I see.

MR. CONWAY: So that's how they fit in the overall computer check out world.

DR. LIPARTITO: Right.

MR. CONWAY: If you then transition in time to the shuttle processing system, the shuttle processing system was the first total vehicle check out system that was ever built at Kennedy. Always before, Marshall did all the development work related to the launch vehicle. Houston did all development related work related to the spacecraft.

DR. LIPARTITO: Right.

MR. CONWAY: They said when we came to the Shuttle Program...Okay, some say it's because they were looking desperately for something for Kennedy to do, and other things, okay, but needless to say that job was basically given to Kennedy and it's kind of fascinating how I came to be a part of it. I think it illustrates that it's the little things you do that you never expect to have any significance that turn out to be major career enablers, or whatever, versus doing a great job at your regular job which everybody expects. But during Apollo, I was one of the guys when the people out at 39, the spacecraft people or the vehicle people would need some data, or need some

analysis, or need a special analysis program developed to run, and they could try to go through the regular system and get work done and the bosses would tell 'em: we can't do that. There's not enough time or whatever. Then they would come to me and say, look we really need this. Can you figure out a way to do so and so...? I did a lot of just helping people just get their job done. You know, when they need things in the computer room.

DR. LIPARTITO: Right.

MR. CONWAY: And sort of became known, one of my bosses says well, let me tell you what the good news and the bad news. And I said, well what's that? Well, now you are a resident software computer expert, and with that goes the responsibility of never being wrong. (laughter) I said, well we are in a lot of trouble aren't we, and he said, well, I just thought you'd want to know. You're going to be asked your opinion on many subjects at many times and you're expected to always be right. And I said thank you for sharing that with me!

(THEREUPON THE TAPE WAS TURNED OVER)

MR. CONWAY: Let me talk a little about Dr. Kurt Debus in those days.

DR. LIPARTITO: Okay, that would be lovely.

MR. CONWAY: I had many, well not many, but a number of occasions to brief Dr. Kurt Debus in the early days and Dr. Debus was a man who had scientific curiosity. So if he read in *Scientific America* about a new bubble memory being developed in the computer industry or whatever, or how something works, some plasma process or whatever, a call would come down that says Dr. Debus would like to be

briefed on how this works. Or where the industry is relative to this process or this development.

DR. LIPARTITO: Right.

MR. CONWAY: And so on a few occasions, in the early days, I went up to brief Dr. Debus and Dr. Debus, in my mind, was more like an Emperor, than he was a Center Director. Dr. Debus had, you know, the big scar on his cheek, if you've seen the pictures, which of course came from his college days, where they had the sword fighting in Germany, you know, to establish honor. They actually got a cut that sometimes they would pull it open and pour wine in there, because, the ladies, the bigger the scar, the greater the, you know, whatever! Mark Twain wrote about that, so. You can read all about that by reading Mark Twain. And Dr. Debus would call us up there and you know, he would invariably...we had a lot of limited knowledge in those things, even though we did our homework before we got up there. He would soon empty our tank as it were of what we knew...

I remember one thing, well – it's like, it worked like a wave in the ocean and once I took a young engineer up there with me, a guy named Wayne Prince who's still works out here and we were trying to explain how this molecular system held together and worked. And I remember Wayne, in frustration, it's a wonder we didn't get killed, cause Dr. Debus did not tolerate fools, or people who talked down to him, okay. So Wayne said in frustration, Sir, it's held together the same way molecules hold this table together. (laughter) You know, because we were talking back at him, but Dr. Debus was a nice fellow, like I say. But he was a fellow who inspired both respect and little bit of fear. And in fact, once on one of these, I was explaining some software thing and we

went back and my boss said, don't ever do that again. And I said, well what do you mean. He said you were lecturing Dr. Debus, and I said, yeah but I'm supposed to know about computers. I don't know anything about managing Kennedy Space Center.

DR. LIPARTITO: Right.

MR. CONWAY: You know, I should know more about it. He said, no, Dr. Debus knows more about everything than any of us! I said, okay. He said I've seen people who did, you know, who spoke to him in that tone, who were never, ever invited back. Now, some years later, after Dr. Debus retired, he came out to one of these Christmas coffees, or something that we have, and I went up to him and spoke to him and he said, Vell, Mr. Conway, he said, I'll give you this, you came to see me many times and every time you were a little better than the last. I said Sir, that's the greatest compliment I've ever received!

But a very smart, very educated, very scientifically curious man.

DR. LIPARTITO: That's the impression I get. I've read some of his writings about the history of rockets.

MR. CONWAY: Right. I've worked for a German named Dr. Rudolph Broome [Hans Gruene?]and he worked for a guy named Karl Sandler who just died here a few months ago. And Karl was in a nursing home and he was just so frustrated cause there were no engineers around to talk to and he didn't like to watch TV. He liked to read, you know, technical journals.

DR. LIPARTITO: Right.

MR. CONWAY: I mean, they were very much like that.

DR. LIPARTITO: Right.

MR. CONWAY: One story about Dr. Broome [Gruene?] though is that the night the computers--that I told you about-- were going up and down, up and down. I called him at home and I said, Dr. Broome [Gruene?] we got a little problem out here. So far we haven't lost support, but I think you should come into work. This may be the night that we have the problem.

DR. LIPARTITO: Right

MR. CONWAY: So, he came into work. He said, come up to my office. Don't tell me anything about the problem. Come up to my office. So I go up to his office. He said, don't say a word. He said, okay, specifications, paper, pencil, slide rule. He said, now you may proceed and now you also understand how we lost the war! (laughter)

DR. LIPARTITO: That's good.

MR. CONWAY: But I mean, a great guy. I'm trying to think now, who was the Center Director after Kurt Debus.

DR. LIPARTITO: Is it Scherer?

MR. CONWAY: Might have been Lee Scherer.

DR. LIPARTITO: Yeah.

MR. CONWAY: He wasn't here that long. I mean he was a nice guy. One of my vivid recollections of the way he was, is that we were on a plane going to Washington. I was sitting in the back with the Center Director sitting over here and I was sitting there and they served coffee. And he says, Mr. Conway, if you spill that coffee on me it could be a career limiting decision! (laughter) So I never forgot that about Lee Scherer. But at any rate, let's go back to the LPS. I had mentioned

something about career decisions. When Kennedy was given the business about – you know, go develop a check out system for the Shuttle Program. This was in the early 70s. Early about 1972, I would guess. Dr. Debus was still here and I got this call and they said they wanted... There was thirty-five of us to show up in a conference room and we did, and this guy, Ted Sasseen was his name, he was a Spacecraft Engineering Division Chief in those days and Ted said, Gentlemen, we've been given the assignment to develop a check out system for the space station and you each have been recommended by your organization or whatever, I don't know. So what I'd like to do is, I'd like to go around the room and I'd like each of you to stand up, and in two minutes or less say what you think this job is that we've been asked to do and perhaps how you can contribute or whatever, and so we did. We went back home.

The next day I get a call to show up in Sasseen's office. I show up in his office and there were three other guys there, Tommy Walton, I think a guy named Terry Greenfield was there, and I forget, somebody else. And he said Gentlemen, this is the team that's gonna build the thing. Now is there anyone else we need on the team? And he said we got three weeks to put together a design and we got to brief Dr. Debus and then we got to go brief Houston. And we said, you're crazy, you know we can't do this. He said, oh yes we can and we will. We added a guy, I think named Frank Burns to the team and I don't remember who else, but certainly Tommy Walton was a key player in that.

At any rate we built the design. I mean we designed it on the blackboard and it was a combination of our heritage knowledge and the CIF computer, the Ace check out system and what was the name of that old vehicle computer system

we used back there in Apollo? It came from Huntsville. I just don't remember the name of it. They ran this goal engineering language thing on it, somehow or another.

DR. LIPARTITO: Right.

MR. CONWAY: It's one that Henry Paul was involved in.

He was a guy that worked out here in that area. Well, we put together this thing and I came up with how we could do things with a large computer to support the data base activities, the software initialization. We wanted real time simulation so that the guys at the consoles could check out. We came up with a number of consoles in the firing room. There was fifteen and put the disk name on each one and that's exactly what's up there today. They haven't changed a damn thing! (laughter) I like to tell people that they've tried twice now and spent Five Hundred Million dollars and still can't replace what we built in the 70's, so it must have been a pretty good system.

We absolutely worked as a team. We put together this system drawing with fifteen consoles, and then Franks Burns, who we got from a telemetry station, who's also passed away now, was the genius who designed a data core that allowed us to make all these consoles look like they were a lot faster than they were. A very high speed data storage device, where the large systems could deposit data that would be picked up by the small computers and where computers could talk to each other, so that we would have this big data library, if you will, and we were throwing data in just as fast as we can. It's ultra high speed and the different consoles were pulling out what they needed at any given point in time by address.

DR. LIPARTITO: Right.

MR. CONWAY: Okay. We took Apollo consoles and turned them upside down and put the displays on top because in the Apollo days we didn't have all the computer displays like we do now, so the part that was the foot became the top. Okay, and that's what we used for our prototype and the early design was based on that. The most significant thing they did in the firing room was, in Apollo, the engineers all faced away from the window and the managers set up in the back and they looked at these guys backs, and then fussed at them if they weren't paying attention or dozed off or whatever. And the first thing these engineers like Tommy Walton said was turn the damn consoles around, okay. So we turned the consoles around to face out the window. We had never been allowed to even look out the window at the damn launch! So we turned the consoles around – and said, by God, we're turning them consoles. Then we turned them upside down for Apollo.

DR. LIPARTITO: Did anyone ever say anything when they found out?

MR. CONWAY: Oh no, I mean we were, you know, this was the first big job. We really had the best and the brightest of the KSC engineers. This was after Apollo.

DR. LIPARTITO: Right.

MR. CONWAY: It was sort of a stand down period.

DR. LIPARTITO: Right.

MR. CONWAY: We had the advantage to pick and choose who supported us and in the end the development project was led by the design engineering director and it was led by a guy named, Henry Paul, and Tom Walton was

the guy who led the design of all the firing room equipment. And I led the design of all the large computer equipment and the interfaces between the large and the small computers. Tom and I became fast friends. We made sure that we resolved all the technical design issues before they went anywhere else. I mean, we said, our guys are gonna sit down, we're never going to not work as a team. When we have an interface issue we're gonna sit down and resolve it, you know because we've got the technical people here, let's get the technical solution. We're not gonna have any political solutions. We're just gonna build a technical system.

DR. LIPARTITO: Right.

MR. CONWAY: And that's what we did. That was the most challenging, most difficult job of my entire career. We didn't know if it would work. It did work. The first shuttle launch, we had those fifteen consoles up here and I don't think that we had ever... And after we got things all designed and everything, then I inherited the operations maintenance of the whole shooting match. The firing room, the RPF launching station, and the large computers, so I was responsible of all of that and then later on I became second level Director and I had that, plus pad instrumentation stuff and all the communications and operations PD stuff.

Okay. But at any rate, that first shuttle launch, prior to that and George Page was sort of our leader. George Page who became, who was the strongest leader that I ever worked for in NASA. George may not have been what I would call the most well-rounded manager, but George could lead you through the fires of hell and you would follow him. You know, we'd follow him through brick walls because George always

seemed, or pretended to work, harder than any of us. And we literally worked till we dropped.

I remember seeing Bob Sieck. Bob Sieck was working on the ground launch sequencing software and Bob would be out here for many hours and he'd be a little zombie. I mean we would have these meetings. We'd run these tests. George would get us all together and he'd say, damnit Conway, how many consoles did you keep running this time? And I'd say well we got eight running this time, you know, we had nine for awhile but one dropped out – well, when are you gonna get that fixed? Well, right away George. We're working on it. And Sieck would be up there and he'd say when are those ground launch sequences gonna work? How far did you get down this time? Well, I got this far George, but you know we think we're on top of it, and Bob would be just standing there, like he was so tired.

Norm Carlson was the NASA Test Director and Norm was responsible for all the procedures in the firing room and you know, okay Norm how many deviations did we have today? You know and so he just rained on us. I mean just rained on us, called us names and everything else, but we would kill for him. I mean, you know, we had such immense respect for George. And he brought us all together.

I never administratively worked for George in my career, but George didn't know that. (laughter) And I certainly never said anything about it. I mean, when George said jump, I said how high? He was one of the most really remarkable leaders in the history of this Kennedy Space Center, in my opinion. Later when I was doing all the communications and stuff, you know, I would get a call from George and he would say, Conway, now you know these computers and I'm holding you totally responsible for this.

You understand that? Yes, Sir, I understand that. Okay he says, now my guys keep bringing me these crazy requests and last minute changes for firing room reconfigurations stuff. He said, now I don't know enough to approve it or not. They tell a good story.

DR. LIPARTITO: Right.

MR. CONWAY: He said, don't you do a damn thing because I signed the paper. He said, you evaluate it and if it makes sense to you, do it. If it doesn't make sense, you pick up the phone and call me, cause I don't know what the hell I'm doing when I sign these things and I'm holding you totally responsible. And I got some crazy people out here to work for me and I'd say, yes Sir I understand. So, George was quite a character. But in George's leadership, digressing back, it being a hard job.

That first shuttle countdown with Crippen and John Young was the first time that we'd ever had fifteen consoles up and running for an extended period of time. And the system worked flawlessly throughout the two days of the first shuttle countdown when we scrubbed, at which point I thought I was going to die because I knew I could never get that thing working that well again as long as I lived. And sure enough, we recycled, we cranked up and we make the second, and it worked perfectly then too. But I mean, those were the longest, that first thing, you know sitting there... and what happened I think at that time, we quit making changes. We achieved a certain level of stability and we had worked our tails off to get both a test team, a support team to build a system, to have the procedures, to have the software, to have the hardware in a state that it was ready to support. Never have I worked so hard on anything in my life. I mean that had to be the greatest satisfaction from the point of a technical achievement that you didn't know how it was going to come out.

DR. LIPARTITO: Right.

MR. CONWAY: And it came out great. And all the people that were part of the LPS system went on to have great careers at Kennedy. A lot of people that did that. Tom Breakfield, was a guy who worked for me and a lot of other people ended up doing that.

DR. LIPARTITO: So this was basically eight or more years?

MR. CONWAY: Yes, oh yes, this thing, we launched in 1980 something. Yes, that shuttle got shipped to us in cardboard boxes and we had to assemble it. It was an erector kit when it arrived at the Space Center. And it was sent to the Space Center precisely because they couldn't finish it at the factory. And remember earlier how I talked about how Kennedy works as an integrated schedule to meet a deadline. That's the thing that Kennedy brings to the NASA table. It's the Operations – it's the ability to plan, integrate and schedule operations and perform them successfully. That operations scheduling integration mentality exists nowhere in the agency, in my opinion, except here. The same thing happened, the shuttle when they gave up and they could not hold schedule. They couldn't do anything, they shipped the shuttle to the Kennedy and said, let those guys finish it. Okay.

DR. LIPARTITO: Right.

MR. CONWAY: The same thing happened with a number of spacecraft in my payload experience. When they said, get it to the launch site. Okay. Get it on to the launch site. Let those guys get their hands around it. You know, with the factory team support.

DR. LIPARTITO: Right.

MR. CONWAY: Because they will drive to the finish line.

So, and I just can't think of the other examples, like where they get stuff to the launch site so we can get that operations mentality on it.

DR. LIPARTITO: Right.

MR. CONWAY: And the factory guys aren't... You know their designers, developers. They are not in that integrated schedule: What's the critical path, what are we doing about the critical paths, where's the risk in the process, how do we mitigate those risks?

DR. LIPARTITO: This is something that they developed fairly early on.

MR. CONWAY: I think so, yes.

DR. LIPARTITO: I mean, there were these ideas that there was going to be some factory system...

MR. CONWAY: Right, ship and shoot – we're gonna check it out at the factory – we gonna send a finished product. Never works that way.

DR. LIPARTITO: If anything it's gone more the other way.

MR. CONWAY: On complex payloads. Complex payloads always took a year longer than planned.

DR. LIPARTITO: Oh, is that right?

MR. CONWAY: One year. Okay, Space Lab, Tether Satellite, all these things always took about a year longer. The Shuttle took two years longer, at least than planned. I don't know whether it was optimistic planning or just what, but Space Station, same thing.

DR. LIPARTITO: Right.

MR. CONWAY: Space Station the same as the shuttle. Space Station was running behind with the labs and all this stuff, and George Abby, Center Director then said, ship it to the Cape, get those guys working it. So all the manufacturing work for the first Station elements, not all of them, but major portions of 'em, we' re shipped here. The wiring was done here. The integration was done here. The testing was done here. Again to get that Cape operations mentality on the problem. It happened in Station. It happened in Shuttle. It happened in times before that. So I mean, and I wouldn't portray that KSC is a great development center. I wouldn't portray it as a great engineering center in the capability of the analytical and so forth that exists at the other Centers. What they bring to the table is that you know, there's the objective, launch on a certain date.

DR. LIPARTITO: Right.

MR. CONWAY: Here's all the people that's involved in this problem. So let's build us an integrated schedule so we know where we all are. The lets work together as a team to achieve that objective.

DR. LIPARTITO: Right, right.

MR. CONWAY: And let's plan ahead and – what can go wrong, what are we gonna do when it goes wrong? And not ever hide behind a situation we think might occur--put it all on the table. Expose every weakness you got in your plan, so the whole team can be aware of it and can help you fix it.

DR. LIPARTITO: You think that has continued to the very present?

MR. CONWAY: You know I think it continues to the very present to a large degree. I mean I think that is the Kennedy heritage. I think that is what is different. I think the attempts to have turn Kennedy into a research center, it could be done. There are parts of KSC that are capable of doing some very good research, but I think what is brought is that OPP's mentality – what can go wrong. I think the events of recent years have impacted that to some degree. It's not maybe the priority it was in the more turn it over to the USA and some of the contractors, okay. I feel that, the Kennedy focus is, and the critique of the process, is an important factor in safety, risk and a lot of other things. It is quite an asset.

But at any rate, I continued to work for about ten years, I guess or so doing the shuttle, you know all the launch processing system stuff, the communications and instrumentations stuff. And then in, what was it, about 1985, something like that. Tommy Walton who was the guy who worked with me... And the heritage of the payloads office was George Page, was the first Director, okay. He came out of the ELV world. And the payloads director in those days had both the ELV Program and the Shuttle Payloads in it. George always claimed that was his first love. He had been taken out of his real job to go do this shuttle stuff, and in fact I was on a review team when we were reviewing candidates for who should be the director over that thing. Tommy Walton won out, but every director at Kennedy Space Center applied for it, including George.

DR. LIPARTITO: Oh, is that right?

MR. CONWAY: Even though he'd just been put in charge.
(laughter). Every single first level director applied for it.

DR. LIPARTITO: Because it was the most interesting?

MR. CONWAY: Well, I think, yeah. I think at first it had the LB Program , it had the Shuttle Payloads in it. It was all applied hardware except the shuttle.

DR. LIPARTITO: Right.

MR. CONWAY: And when I later came to find, what was fascinating about it were all the customer people that you worked with. Okay, now so in 1985 and I'll tell you a Dick Smith story about this time. So, Tommy Walton was leaving and Wally Williams, who was a second level Director in the organization was pretty much slated to get it. I was over in the shuttle organization.

(TAPE ONE ENDED) (TAPE TWO STARTS HERE)

MR. CONWAY: At any rate, I kind of threw my hat in the ring. Let people know I was interested in the job, although my good friend, Tommy Walton said you have not a chance in the world because Wally wants that job. I've worked the system so you couldn't get the job, and I said, well, I really need something else to do. I've been doing this for about ten years. You know things are fairly routine now and I said I really want to do something else. Not that I particularly wanted a payload job, but it was a job that was open so therefore, I kind of said I'd like to be considered.

So the time came for Dick Smith to talk to me about the job. He was Center Director. And Dick, by the way, was the one who was instrumental in me becoming an SES in the what we called, the Information Systems in those days. It was all of the LPS and so forth. He was the guy who'd actually, if you will, given me that

job, or selected me for that job, however you want to talk about it. And I managed for about a week to be in the initial class of SESers. Kennedy made a great mistake because I was only 39 years old and now they had an SES they had to deal with till he retired. (laughter) In those days, that was kind of young for a field center guy to do that. And I was very outspoken and some people felt that I was not mature enough to be in that job and others said, no he'll come though and so they prevailed and so...

Anyway, I went over to see Dick and he was sitting back, and he's having, as I later found out, he's having the time of his life. You know, he's walking me through – well what do you really think you'd like to do in the future and we're going through all this stuff. And he says, well I'm thinking that you'd be a good bet for Safety and Security, and I just came right out of the chair and I said, WHAT? And at the top of my leap I thought - God, he may be serious. You know, so I settled back in my chair and I said, well that job could have its advantages.

DR. LIPARTITO: Yeah.

MR. CONWAY: I could have a jeep. And he laughed and he said I'm putting you in the payload job, I just wanted to see what you'd say. He said, but don't tell anybody and I'm putting C. M. Geisler in the Space Station Program office and you two guys work great together, and he said I'm gonna put him over there. Wally had decided he wanted to retire early, so he said I'm gonna honor that, and I could make him happy and you happy both. So I decided to make two people happy and you'll be working with C. M., but you can't talk to him. Can't talk to him until we let him know about it.

DR. LIPARTITO: Right.

MR. CONWAY: And I said okay, so sure enough C. M. was told about three or four days later and Dick was amazed that I had not told him. And then he came over and got up and chewed me out for failing to tell him. (laughter) Why didn't you tell me, I could have been prepared. You know so I went into Payloads and in those days and still to this day, in the Shuttle, not in the ELV Program, cause the ELV Program the customer is paramount. The customer is buying the ride. It's the customer's mission. And it's usually just one customer, you know. Sometime two, sometimes a secondary payload, but by and large it's one customer. And so everything is built around that customer. He schedule, his plans, his desire.

Shuttle program is a little different. First of all, there is the astronaut culture and secondly, you're one of many customers flying, and the creed has long been that, if you're not ready we'll go without you. (laughter) And it was called, in those days, it was called Cargo Operations. I think, and this was seen by the payload people, as cargo – we're in the back. You know, we're in the back of the bus and we're not important.

DR. LIPARTITO: Right.

MR. CONWAY: So when I was doing that job, Dick Smith said to me, we have got a problem in the customer perception and we're talking now about people who build communication satellites for commercial in those days and the science customer that flew. We've got a significant problem in customer perception of the program.

DR. LIPARTITO: Right.

MR. CONWAY: They don't like the program. They don't want to fly on the program, because their treated second rate. Big deal. That's your number one objective, to fix the customer. He said, go up to Headquarters I want you to talk to a guy up there named Chet Lee who does all the commercial payload interface for NASA. I want you to talk to him and of course I went up there and Chet Lee rained all over me. I said, well what would you have me do and he said, the first damn thing I want you to do is change the name of that organization to Payload. I said, It's done. Soon as I get back I will talk to Dick Smith and we will get the name changed. And he said, and then I want you to start treating these customers like their important.

DR. LIPARTITO: Right.

MR. CONWAY: It's important to the agency that you do that. I want you to instill that attitude in your organization.

DR. LIPARTITO: Right.

MR. CONWAY: So we came home and that was our primary objective, to develop customer satisfaction, and at least from the point of view of the Cape, to support the customer in every way.

DR. LIPARTITO: Right.

MR. CONWAY: It was a fun and challenging thing to do. And I think the results were quite positive because I'm now in a reinvention team for ISS utilization for NASA. We surveyed all of the utilization customers throughout the agency and the one thing they talked about and praise over and over again, was the customer support that they received at the launch site at Kennedy. And it was remarkable. They said, well we used to get that in early Space Lab for Marshall but we

don't get it anymore. We never got it from JSC and we still don't get it. We are not Number One in those places, but you guys. One of them said if somebody says we're hungry, one of the NASA guys says we'll go get you a hamburger. Okay, he says it doesn't matter what it is, you guys try your best to support us.

DR. LIPARTITO: Right.

MR. CONWAY: And so that's what our mission was, if you will.

Now, along the way there were lots of fantastic missions. There was the opportunity to work with the international community. It's the precious job in KSC because you always got a new customer and a new mission. And the same is true for the extent of a launch vehicle. I mean you know, it never gets old because every mission is different.

DR. LIPARTITO: Right.

MR. CONWAY: And you're working the mission aspects of it.

DR. LIPARTITO: Right.

MR. CONWAY: It's the best job at Kennedy. Okay, I've never come back to work at Kennedy for a contractor because I had the best job and gave it up, so, I mean, I don't see the point, okay. So, it was great. We had a great team of people. And over the years the greatest satisfaction I got out of this thing was not these payloads. It was watching these young people come and make something of themselves and their career--what they were capable of. And a whole bunch of these folks that are now in KSC management, all came out of our organization. You know, probably half of them.

DR. LIPARTITO: If that, right?

MR. CONWAY: That's right. And so you know we had a great group of people. We had a great fun group. Every year we used to have a Christmas thing and we had this fellow who was the Scribe and who would get up and from his viewpoint, tell the story of the year. I got married one year, we had a mock wedding. (laughter) My new bride was invited and there was a great deal of, you know, she survived it. Let's say she survived it. The Center Director was always invited and poked fun at, along with everybody else. Particularly you know, all of my failings during the year, were put up for the public eye!

DR. LIPARTITO: Right.

MR. CONWAY: But we loved working together. We were a great group of people and I cared more about the people than I did the space program, frankly. I mean, the space program was an easy environment to be successful in, because we knew what we were working on, particularly Kennedy. We knew what the objective was. We knew what the problem was we're trying to, we knew what the launch was coming up, what the payload was that had these problems. And so, it's the easiest, motivational atmosphere. I mean you're not working abstractly – can I improve the Health program in the United States or can I do this? It was very specific, very right in front of your eyes, and you could go out and see a launch. Okay, and you say we did it or we screwed up.

DR. LIPARTITO: Right.

MR. CONWAY: So that was the payload thing. Perhaps, certainly the worst day was the Challenger accident.

DR. LIPARTITO: January '86.

MR. CONWAY: '86, well we were launching at a pretty good clip then.

DR. LIPARTITO: That's true.

MR. CONWAY: So we'd launched several missions, okay.

Several Space Labs missions and other things. I remember we were flying an IUF that day and of course, I think just like everyone else who was responsible for something on that mission, all I could think of is what could we have done to make this accident happen. Had the IUF come loose from its cradle – you know what did we fail to check? What did we overlook? And truthfully, it wasn't much fun watching launches after that.

DR. LIPARTITO: Really. Yeah.

MR. CONWAY: J.R. Thompson who is the head of Orbital Sciences was once asked, did he like to watch launches, and he was really talking about ELV launches and he said, no I really don't. He said three things can happen and two of them are bad. And I mean that sort of, the seriousness of the business came home. The risk of the business came home. And then it was the matter of success in spite of these risks that we're taking.

DR. LIPARTITO: Right.

MR. CONWAY: So it wasn't very easy to me.

DR. LIPARTITO: You had probably changed then?

MR. CONWAY: Oh yeah, I felt a change, I mean from my personal outlook. A lot of the fun went out of the business, with that accident.

DR. LIPARTITO: Really?

MR. CONWAY: I mean I really feel for the guys that are involved in the accident currently. I think before Challenger we kind of didn't know how good we were. I mean we didn't know. We had these margins and this, that and the other but everything seemed to work and so you didn't know. Your level of risk was somewhat, in my mind at least, we didn't know whether our flight system was more robust. Were we worrying too much or not worrying enough? We just didn't kind of know. I mean, you know, we didn't know and I think a lot of us felt that maybe we were more robust than we actually were. Okay, in an aggregate sense.

DR. LIPARTITO: Right.

MR. CONWAY: I mean because we weren't specialists in the SRBs, or the tank or the engine and we didn't know enough of that, but from a payload prospective, but you know it was certainly a thing in which we all failed. Failed in the worst kind of way. The first Delta launch we launched out there was also a failure. At which point I concluded we could do no right, and it was like we had launched, eighty, seventy something, eighty something successful Delta's in a row.

DR. LIPARTITO: Right.

MR. CONWAY: And we launched this ELV and I'll never forget that either. We're all sitting there in the control room and here goes the rocket and all of a sudden, you know and powered flight during first stage, the engine shuts off. And the rocket just coasts for awhile and then it just starts flipping end over end. And it did like three-sixty's before it came apart. We concluded we had a very good structure.
(laughter)

Structural loads were in a lot letter shape than we thought, but what

happened is that the wiring harness had been replaced, seven or so flights earlier, with some Teflon coated wiring which was a lot hardier wiring, a lot more durable wiring, but was very susceptible--which nobody really realized--to chaffing. And this wiring ran up through this cable tunnel on the outside of the rocket and during the launch there's a lot of vibration and the wiring just rubbed off the rough edges and shorted out. It's almost as if that, or at least, many of the major problems that we have are, I want to say simple things. They are things that are not on the radar screen of things that we're all worried about. We're all worried about the complex things, like the engine, the computers, all the redundancy, all this that we built into those systems.

DR. LIPARTITO: Right.

MR. CONWAY: And then it seems like that sometimes we get to worrying about the complex parts of the thing so much that very simple things can get by us. I mean, the bottom line is you can't worry enough. I mean, you can't. And you can't have anything in this business but an attitude of, you have to feel, I'm not good enough. I may have overlooked something, what could it be? And a questioning attitude can never stop. You can never allow yourself the luxury of saying, Gee, we know what we're doing. In my case, in the last years of my career I had the ELV Program, the Shuttle Payloads and the International Space Station development at Kennedy, and between the three of them there were not many ball games tickets that I got to use. Let me put it to you that way. If it wasn't an ELV launch, there was a shuttle launch, or a station program review and it was pretty hectic. But I was smart enough to hire people smarter than me and I looked after them and they looked after me, and it worked out.

DR. LIPARTITO: Can I ask you a couple of specific questions?

MR. CONWAY: Sure.

DR. LIPARTITO: On Payloads, up until Challenger you're doing...

MR. CONWAY: Commercial payloads.

DR. LIPARTITO: Commercial payloads. After Challenger, just...

MR. CONWAY: Just NASA payloads.

DR. LIPARTITO: Anything.

MR. CONWAY: NASA and really DOD payloads after that. DOD fell off the program and went back to the Titan 4. Okay.

DR. LIPARTITO: So that changed the nature of the program?

MR. CONWAY: Yeah, it did, it did. What we were flying those days... we could fly three commercial payloads in the shuttle at a time. And these are basically huge communication satellites, okay. They actually had a McDonald Douglas booster. And those payloads you put 'em three at a time and you pull 'em and because they were commercial a lot of times we built 'em up and did some integrated testing over at the Aftertake Facility before they were brought on site. And then we basically integrated them, rotated them to the vertical and the canister and carried them out and put them in the vehicle at the launch pad. And we flew international customers. I could tell you one fun story about that. We were flying an Arab set mission, one of three satellites, and there were like seventeen, as I recall. That number may be off by

plus or minus three or four countries - Arab countries involved in that satellite. They each had their own engineering team assessing it because they weren't too sure about the other partners, and the integrated part of that, I think, was a British firm and I don't remember the fellow's name. At any rate we're in there one day and we're talking in my office, and we're talking about this thing and he said, let me tell you the significance of this. This is not about the payload, the significance of this he said, in the history of the world these countries have not worked as a team on a project like this for this long, without war breaking out. (laughter) He said, without hostility, he said, without hostility, okay. So he said, this is a monumental thing that we're doing, but doing this satellite and by working, you know as the United States with these countries.

DR. LIPARTITO: Right.

MR. CONWAY: Now, when we flew. Yeah, I think that was the one where we had the Saudi Arabian Prince flying as an astronaut. Okay. So now we're in the firing room and we're counting down for launch and the Saudi Ambassador is there, and Chet Lee from Washington had wandered in and he was sitting over in that little thing, and I'm up in the front with Bob Sieck, you know cause we're gonna give the payloads the go and do all that sort of stuff. And the Saudi Ambassador comes over to me and he said, how are things going or something to that effect and I said, oh, your satellite's in good shape and this, that and the other, and he said, forget the satellite - how's the Prince doing - the satellite is not important, the Prince is, and I said yes sir. And he said, I would like to speak to you, and I'm thinking, okay, I'm just a payload guy and he wants to talk to the crew and I don't remember whether the crew were already in the shuttle or not, but in a moment of inspiration I pointed at Chet Lee, and I said, you see

that guy right there – that’s the Headquarters guy, and he can arrange for this to happen. And I just took off back to the firing room, and I said I’m not going near this guy again, okay. So, there were lots of good times with lots of customers.

DR. LIPARTITO: I have never asked anyone this question.

Was it a good decision or bad decision to start flying commercial payloads?

MR. CONWAY: Well, you know, if it all depends on your perspective. In think in those days, we figured that the additive cost of a shuttle mission was about a Hundred and Ywenty Million dollars. We were getting about Ninety Million dollars to launch ‘em, so the government was subsidizing the flight to the point of about Thirty Million dollars. We were competitive with Ariane. They were subsidizing their vehicles and our pricing structures, and their pricing structure was based on each other.

DR. LIPARTITO: Okay.

MR. CONWAY: When payload customers bought their flight, if they had three satellites, they bought two from one of us and one from the other guy. They never flew all three on the same vehicle and we always felt that that was to keep our pricing honest.

DR. LIPARTITO: Uh-huh, right.

MR. CONWAY: Okay, so the real loser in the deal was, at that point in time, was probably the customer who lost the cost competition between the shuttle program and the Arian vehicle. Now after Challenger, shuttle became a lot more expensive, okay. And we were no longer allowed to fly commercial missions. In the place of the commercial missions – because in those days, you know, we were planning, or the thought was that the Shuttle Program would be the only US launch vehicle, okay.

And so the DOD was shutting down their assembly line. Well after that Challenger, they immediately said, we want to go back to our own vehicles, which is the Titan 4.

DR. LIPARTITO: Right.

MR. CONWAY: And that reinvigorated the old Delta and Atlas line.

DR. LIPARTITO: Right.

MR. CONWAY: Who now were back in business. So, from a big picture standpoint, if you were to ask me today, okay I would say NASA doesn't have any business flying commercial - payloads of that type. Commercial research in space, absolutely. You know in the space environment. But I think it's more important to have a competitive launch industry in the country.

DR. LIPARTITO: Right.

MR. CONWAY: And of course the problem now with the launch industry is all the payload projections haven't played out the way people thought they were. They were looking at all these lower orbit satellite constellations and stuff, and this hasn't panned out economically. And so for the last two or three years the satellite business and the satellites that have been built have turned out to be a lot more reliable than expected.

DR. LIPARTITO: Oh really.

MR. CONWAY: So they have a lot more in orbit life than earlier anticipated. Before it was like a seven year life and now its more like ten - twelve. So they aren't having to be replaced as often. So, I don't feel that was such a major setback. There were a lot of people, particularly from congressional staffers and

stuff , that came down and talked to us, who even then felt that we ought to be flying fewer shuttle missions, only when absolutely necessary and with a smaller number of crews. Because the risk, you couldn't get away from the risk.

DR. LIPARTITO: Right.

MR. CONWAY: That flying humans in space is a risky thing, and that you could never really overcome those risks. You know I suspect following this last accident that the Shuttle fleet will fly primarily to the Space Station. Which has an advantage that when you're at the Space Station, you can do things from there, like better check the tiles, things to make sure their in tact before reentering. But I would be surprised if we fly... In other words, that we would further narrow the use of the shuttle to the Station Program. Hopefully another Hubble repair mission or upgrade mission. Things that uniquely call for humans in space.

DR. LIPARTITO: Right.

MR. CONWAY: Because it's high risk business. I mean and it just is. I mean – we don't need anymore data. I mean surely we don't need anymore data for that. Sort of having been a part of all that, you know, it was more with sadness and surprise that you know, when we had the Columbia accident. I mean it was like Gee, you know, I never expected it to happen on reentry.

DR. LIPARTITO: Right.

MR. CONWAY: And that this seemed to be much more benign than in the launch environment. I mean, My Lord, we got the solid tied to that thing and for two minutes you're at the mercy of solid good behavior. And if anything

happens in the first two minutes our chances are very, very slim of survivability of any kind because you can't shut off the solid rocket motors.

DR. LIPARTITO: Right.

MR. CONWAY: It burns to completion, and it's going somewhere.

DR. LIPARTITO: Right.

MR. CONWAY: And your going with it. You know, they have a very high ISP and they can – their very powerful. But I mean their also, if something goes wrong, it's a bad day. So I think if you look at it... One of my greatest recollections looking back on the Apollo Program, and it was a great achievement. I mean we all, we just you know, we just watched that TV. We watched those instruments that had data back here. We were looking at that data the whole time and then you know, we're praying their gonna get out of there and come home in one piece. And then a lot of people wondered why we tried to do it again after we pulled it off the first time cause they knew how lucky, you could say lucky we were that we got away with that thing. I mean a lot of things had to go right.

DR. LIPARTITO: Right.

MR. CONWAY: And they did.

DR. LIPARTITO: Right.

MR. CONWAY: And we were very fortunate on Apollo 13 that we got those guys home. And in no small measure, due to their own ingenuity. And so... I had an old Uncle when I first started to work for NASA, working on this Apollo Program, you know Mercury –Gemini before that. He said, well I'll tell you one thing

you'll never land a man on the moon in my lifetime. (laughter) So it was with great pleasure that I went back and said, now Uncle Claude I believe we done it. And he said, I'm trying to accept that. (laughter) I said now you're not one of these people that believe we really didn't do it. That we all did it with lights and mirrors. But, you know.

(THEREUPON SIDE ONE OF TAPE TWO ENDED)

DR. LIPARTITO: About going back to the development of the data computer system of the shuttle. Let me understand, the difference is, you know with Apollo you're essentially doing three different systems.

MR. CONWAY: Three different systems. One doing a spacecraft, one doing the launch vehicle. And those systems, probably the most critical perimeters, you know, loading the software, and the system that I worked on was what I would call a monitoring system. A health monitoring system.

DR. LIPARTITO: Right.

MR. CONWAY: In which you're looking at all the telemetry data coming back. You're looking at pressures, at temperatures. Course once you lift off you're looking at acceleration. You're looking at all those kind of things. You're looking at your measurement system and you're looking to determine the health of the vehicle.

DR. LIPARTITO: This is all during count.

MR. CONWAY: All during count. All real time. That's right, that's right.

DR. LIPARTITO: So the system you developed for shuttle essentially mastered...

MR. CONWAY: Did the whole thing. It did the whole thing. It did that and a lot more. It provided a means, which is capability they got today, okay.

DR. LIPARTITO: Right.

MR. CONWAY: If we took, for example in the large computers. You now I told you back in Apollo we had these two redundant machines, that if one failed the other one did. Well we built these shared data base concept with the large machines. So that we could literally have this one working the real time support. This one over here doing something entirely different. It could be working the day-to-day, the preparing for the next launch.

DR. LIPARTITO: Right

MR. CONWAY: And we had one little module down there running that said, take over for this guy. And so with only a few seconds delay.

DR. LIPARTITO: Right.

MR. CONWAY: We could switch this guy out, switch this guy in and keep going. We could never have done that with the old system. We also had the capability that we could, using a special high speed interface that we built in-house, we could use that large computer as a simulator, so that the guys could check out their software in the control room, run simulated tests, okay. Using it as a simulator.

We also maintain all their data libraries, support functions for their systems, so it was a integrated system and then if you look at the fifteen consoles in the firing room, basically at about ten minutes, everybody up there is in monitor mode, with

the exception of the integration console running the ground launch sequencer software that is the active console. In other words all the command and control from those consoles – see we couldn't command that Apollo vehicle from our computers. The other guys could send commands to load data. It was command and control.

DR. LIPARTITO: Right.

MR. CONWAY: But in the firing room all the command and control functions: open a valve, close this, we're now getting ready to fuel this baby, you know, open this up, you know, chill down the lines, you know all this was kind of controlled with software but with human intervention also.

DR. LIPARTITO: Right.

MR. CONWAY: So, but once we get down to about ten minutes, everybody is out of the command and control loop except for just one integration console that's going through a program sequence of events without human intervention.

DR. LIPARTITO: Right.

MR. CONWAY: And all the operator can do is say, we need to stop and the computer says, not yet – my next stopping point is in thirty seconds. Okay, so it goes through all the things it needs to do to reach a safe stopping point.

DR. LIPARTITO: Right.

MR. CONWAY: Okay, so that's how that works. That's why that's the most critical software that's run up here. So these other consoles, were still monitoring things.

DR. LIPARTITO: Right.

MR. CONWAY: And they can monitor data that's either available off the large machine or off their own machines. They have a lot of flexibility.

DR. LIPARTITO: Right. So other big changes?

MR. CONWAY: We had color displays. We had color displays. Before, it was black and white and we had to overcome management objections. They said you don't need color, black and white works just fine. (laughter) I mean now you wouldn't even think of a CRT without color. Well in those days it was a big philosophical argument, about whether to spend the money for color or not, okay. So I mean strip recorders. We didn't have any strip recorders in the firing room. Whereas in Apollo we had gazillions of the analog strip recorders. We did have a few of the telemetry stations because the die-hards had to have 'em. Okay, we still do. I mean so far as I know we still do. I haven't checked in the last couple years, but when last seen the ELV Program certainly still has them.

DR. LIPARTITO: Oh, is that right?

MR. CONWAY: Absolutely. The old time boys are comforted. (laughter) Well when you look at the analog signal, it is true. With a digital signal you have a sampling rate. It can be a very high sampling rate. It can be a thousand times a second, but it's still a sampling rate. Some instruments are only sampled a hundred times, some only ten times, you know.

DR. LIPARTITO: Right.

MR. CONWAY: An event can occur in between samples, which you miss. And so by having the beauty of the analog recording is that I don't lose any data.

DR. LIPARTITO: Right.

MR. CONWAY: And so then, you know if a very small event occurs in a very small time duration, my sample rate isn't going to keep me from getting it, and that's always a worry with digital, your sample rate can mask the problem. But it was fun. I mean, you know.

DR. LIPARTITO: You went through some pretty amazing changes there. You came in right at the sort of...

MR. CONWAY: We came in, I remember when we were up in, when I started Langley, we were doing Mercury stuff.

DR. LIPARTITO: Oh okay.

MR. CONWAY: And were flying Mercury missions then. We flew some Geminis I think, after I came down here.

DR. LIPARTITO: Right.

MR. CONWAY: I remember we had this lady that worked for me, that when we were developing the Shuttle System and we had to move our office to some place else. In those days, the early days you kept all your computer programs on IBM cards, you know. IBM punch cards. We had these file cabinets full of these cards and she says to me one day, I don't know about this, but do you think I can get rid of those Gemini Programs, you know. I said Martha, I think you can throw away those cards. I said, first of all we don't have any capability to read 'em. I said, secondly I don't know what we could do with 'em. (laughter)

DR. LIPARTITO: Well, thank you very much.

Interview Concluded.