INTERVIEW OF

DON BUCHANAN

by Kenneth Lipartito

APRIL 15, 2003

DR. LIPARTITO: This is an interview with Mr. Don Buchanan at his house on April 15, 2003. I'm just going to sit that there so you can talk and don't have to worry about anything It will pick everything up. Mr. Buchanan, why don't you tell me a little about your early years where you grew up in Georgia?

MR. BUCHANAN: No, I didn't grow up in Georgia.

DR. LIPARTITO: Okay, you better tell me the story.

MR. BUCHANAN: Went to Virginia when I was six months old and stayed there so I consider myself more a Virginian than Georgian. Well, when World War II started, shortly after I graduated high school and went into the service, into the Air Corp, Army Air Corp, and spent the last two and a half years of the four years over there in England. I was in the fighter squadron with first P47s, then the 51s. I was really in a technical squadron which supported the airplanes by doing the repair work on all kinds of things, but mostly the ones that were on base. They would get shot up and fixed. We converted a wrecked one into a two seater which provided, it was the only one in the ETO, and they used it mostly though for liquor runs to Paris. (laughter) I think it finally ran into a tree and didn't bother to fix it.

But after the service, I got out in December '45 and started college in February '46 at the University of Virginia majoring in machine design with somewhat a sideline instructor. I graduated in '49. Earlier that year jobs had been plentiful. By June, the bottom had fallen out and there weren't that many jobs around. I was fortunate enough to have several offers and in fact, I felt like I wanted to stay in Virginia and I went to work for NACA at Langely Field – National Advisory Committee for Aeronautics. My

thoughts along those times were that government workers were maybe a little bit inept and sluggish.

I found that the NACA had one heck of a lot of smart people and all hard working and dedicated, dedicated people. I was in the design area and designing all kind of things. We designed things you could hold in your hand, and things that you couldn't lift, but primarily along the lines of stands which support models, blow down tunnel, those types of things. Helicopter blades, helicopter rotors, a whole number of things. We did all the design yourself in house, and most of the equipment was manufactured right there at Langley. Occasionally they could send work out to different companies but not all that often. So we were watching all the stuff while it was being made and it was a great experience. From your initial design to completion may be six months or so, and then it may not even bother to go and make it. It depended. So, I thoroughly enjoyed the work but I could see that the job was somewhat dead ended.

Consequently one of the employees we worked with had already gone down to Redstone Arsenal in Huntsville and he kept trying to recruit me to join him there which I finally did go down in March of '56 and found that work was a little challenging and also was the beginning of a new program. They had launched the Redstone. I started working on Redstone with handling equipment and special transporters, things like that. Deflectors, launchers--all the handling equipment. Then Jupiter was just a step somewhat larger. If you look at the diameter you're going from seventy inches to a hundred and five inches. Not really all that much larger, but when we started with Saturn I, then it becomes much larger, cause it's now twenty-two feet in diameter or so. And one of the things that you have to do is, you have to think in the proportions of something that is not all that readily able, at the time that you start. If

you're starting with a leap of eight times the size of the other vehicle that you've done, and they had launchers that were quite larger, and the first one we built, was built out of concrete. The only concrete one that was built, but there was concern about the torsion loads which would tend to turn the weight of the vehicle. The code did not cover that: the American code concrete, they didn't cover it. Ended up designing it to a Yugoslavian code.

DR. LIPARTITO: Oh really.

MR. BUCHANAN: But they got concerned and put just a little bit more steel in it. You almost had to pour the concrete with a spoon. That's one of the reasons that that's the only thing that's left on Complex 34 today is the launcher because it would cost them more to tear it down and they won't realize any profit from it, because there's nothing there but concrete and reinforced steel. But I'm kind of glad because it is kind of a monument to an earlier complex that was very successful.

DR. LIPARTITO: You went directly from Huntsville to here. To Kennedy?

MR. BUCHANAN: Well after 10 years.

DR. LIPARTITO: After 10 years.

MR. BUCHANAN: But I was working all that time with things, we would send the equipment down. Primarily we were working towards getting a tactical vehicle for Redstone and for the Army and for Jupiter. For example they wanted a lightweight system to erect the vehicle. And if it's transported by plane, for example, you would not be able to have every crane, you'd have to have something that you could manually handle, and develop a system whereby you could come up and using an A-frame and a H-frame in vehicles and manually put the whole thing together. With the equipment, the pro type equipment that we had,

we could start from scratch and move the parts for a Redstone into a position that could be assembled and erected in forty-five minutes. We also could service it by using the H-frame II and disassemble it. We did the same thing for Jupiter. However, there wasn't, what you might want to call in our agency, fight for control for who did what, with the Air Force and the Army and ultimately the Air Force won out restricting the range of an Army missile to five hundred miles.

DR. LIPARTITO: Right.

MR. BUCHANAN: Which the IRBM, the intermediate range ballistic missiles such as Jupiter and Thor, were equal in fifteen hundred miles an hour. I mean fifteen hundred mile range. Now there was not all that much difference in size, but to do the same job, but because the Air Force got control of it, they ended up terminating Jupiter Program and they went ahead and did deploy over in Italy in Greece, I believe. But when they had the Cuban crisis, dismantled it anyway… The Army had the Jupiter base. Yes, they had that and it was one of the differences, and the vehicle would launch in fifteen minutes.

DR. LIPARTITO: Right.

MR. BUCHANAN: The Army took the position that the vehicle would be vertical and kept vertical. The Thor had it in a horizontal shelter. Move the shelter and erect it with a hydraulic rig, where I'm not sure they could have them in fifteen minutes, but we did demonstrate that we could beat the fifteen minute launch time. We had a shelter somewhat like a retracting rose bud around it. Had it protected to launch. Just launch right over it. That could work. There were some squabbles with respect to who was doing what.

I remember that we made a trip out to California to McDonnell Douglas, who was the prime contractor for Thor, and they had a ground rule that what was common

equipment would be furnished by the Air Force, on the Thor part. Both were using the same propellant, RP1 – petroleum graded one propellant, so they had a tank and we figured that would be a common tank but they weren't even sure it's the drawing of the tank and come out and show us the drawing of the plan and says unless your flange meets this one, it's not a common equipment. Said we can make a flange fit anything, so to me I never understood why they took that position because they were going to get to build it. It wouldn't even use it as the size of the shelter. I found out in other ways where it was, but that's besides the point, but the whole meeting went to pot, so to speak, and we went back and had to tell the General, I forgotten which one it was, higher than McDerst who was the head of the one at Marshall, and then they got together and came up with a better arrangement which resulted in deployment of both.

The Army went with, they still had the Pershing system, and about 1960, around that time, they were formulating NASA and the ones that worked for ABMA could automatically transfer to NASA unless they wanted to stay with the Army or get another job. The Army did offer me a better job than NASA but I had no faith in them ever being able to develop into the size of organization they were talking about. I was more interested in the work that we were doing because it would be a continuation of the work that we had done on the Saturn I, cause separation basically for the long range exploratory vehicles that the Army was doing was gonna to get terminated and they said about Complex 34, don't put anymore money into it than it takes to launch four vehicles. They can all fall down as far as they were concerned. That's the reason I'm still happy to see that the launch pad is still there. Cause it was very difficult to try and design something like that.

DR. LIPARTITO: When did you start working on the Saturn vehicle?

MR. BUCHANAN: Right back in, I think in the late 50s.

DR. LIPARTITO: So this was gonna be an Army long range?

MR. BUCHANAN: Well Army was responsible for the… Cause it started Saturn I.

DR. LIPARTITO: Before they were told they couldn't do anything over 500 miles?

MR. BUCHANAN: No, that came.

DR. LIPARTITO: That came a few years later.

MR. BUCHANAN: So anyway, that continuation of the work kind of put a cramp in the organization somewhat. The little history that I gave you on it, I mentioned some of the reasons that we had to change. For example, Dr. Debus came up to Huntsville to see what part of our launching and handling laboratory that he wanted and at that time I had the launchers and special transporters and other things and he decided he did not want the special vehicle. Consequently, that meant that Marshall would have to take those over, which gave 'em to the test division. Test laboratory as they call it. And then the people that we had went with that design. Then subsequently there was a, I want to call it a, a situation whereby we had launch operation directly and was controlled by Marshall.

DR. LIPARTITO: Right.

MR. BUCHANAN: Okay, Debus was down at the firing center and they were trying to get a Launch Operation Center LOC. There were problems with who did what. For example, Marecek who was head of the construction and mechanics lab, he draws a line on the board and said that's the horizon, anything over that's mine, anything below it is not. Obviously that's no way to attack it. The skin of the bird was another interface. However at the time, we were designing both the flight part of the umbilical as well as the umbilical. So when

they chose to, let's see, they were going to design the flight part then they had to design the mating part. The swing arms and then it took the umbilical designers and the problem of getting all of the interfaces right. They weren't getting anywhere with respect to development of the center, the LOC, until Harry Gorman up in Marshall says, well how about turning over all the operational contract portions that they had to Kennedy, which wasn't Kennedy at the time, but it was still LOC.

DR. LIPARTITO: LOC, right.

MR. BUCHANAN: And that, well, quite frankly in the meeting, it was right after the launch of SA II that when we had the meeting, trying to solve whose gonna do what, that Werner Von Braun didn't agree to anything and Debus said, okay Werner what do you want me to do? When he said that then they got an agreement. But that was personalities.

DR. LIPARTITO: Right.

MR. BUCHANAN: That type of stuff, so their both gone now so. But it's just the way that meeting worked. For example they had Heinberg in the meeting as a neutral. Hell, he wasn't neutral. In ten minutes he was standing up and beating the table with both fists! (laughter) So that was the beginning of LOC. My office was up in Huntsville still, I don't know if that made it part of Kennedy but working on it, but we needed to be close to the vehicle designers, and they were just on the floor up above us. We were in the converted cotton mill, old Lincoln cotton mill called the Huntsville Industrial Center, but so, it was very easy just to go upstairs and try to work with them, and it paid off cause when you're designing the hold down arms, the tail, the service mass as well as all the umbilical and everything, you can't do that kind of work by phone.

DR. LIPARTITO: Right.

MR. BUCHANAN: Not all of it. And so, that worked very well, but then the more equipment and facilities that we got built for Saturn V, then I was spending more time down at the Cape. So then I moved down in July of '65, but others had come earlier. They weren't involved so much with the interface with the vehicle. Such as when you start construction, foundations and that, you don't need Marshall.

DR. LIPARTITO: Right, right.

MR. BUCHANAN: But, you know I give Marshall its due. It has got a lot of smart people and the engineering there was kind of outstanding.

DR. LIPARTITO: Right.

MR. BUCHANAN: You got to realize that we designed and built the vehicles.

DR. LIPARTITO: Right.

MR. BUCHANAN: We got to test the hardware and it wasn't like you could just write a criteria and send it out. That's the approach the Air Force takes. We had an arsenal concept for a long time, but it got eroded bit-by-bit, starting early. I guess the reason why is industry thought they could get more of it if you didn't have that concept and the government, in some respects, felt like that they could get a better deal when they didn't have somebody on the payroll from cradle to grave, and they would hire them for another job and they could get rid of them and so forth. But it started eroding pretty much.

The Air Force reached a position back during Apollo, for example, that they had Aerospace there--engineering in house--if you want to call it, but they may get one decision or recommendation from Aerospace. They may get another one from their prime contractor, whether it's Martin or Boeing. They come to NASA to get an opinion and try to get

voting, lodging, maybe two out of three. NASA reached a point where they don't have the expertise. They don't have it now. Been gone to the point where they contract stuff out and then serve as a contractor for the contractor.

DR. LIPARTITO: A contractor for the contractor?

MR. BUCHANAN: Well they give the work to the contractor, then the contractor subs it out to the government again, so, you know. That's happening.

DR. LIPARTITO: Is that right?

MR. BUCHANAN: So it may be something you want to look at.

DR. LIPARTITO: All right.

MR. BUCHANAN: I was gone before we did that. I didn't think we were that dumb but they are doing that. So right now, I see NASA as going very close to the Air Force type concept, where they just write a specification and send it out and boom.

DR. LIPARTITO: So it definitely wasn't that way.

MR. BUCHANAN: No, it wasn't that way. Now one of the things I do want to kind of stress with these complexes don't just come up like weeds and grow. You start with a blank piece of paper and you got it basically cradle to grave type.

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MR. BUCHANAN: Most people don't think of design but something but a piece of paper with drawings on it, but design engineering we had to let the contracts follow the contracts. Follow all the construction, get the equipment ready. Test it all out before we turned it over to the operator and so it's much more than design when you have to do that. And so we had, in essence, all of the facilities to contend with, we did not turn it over to

somebody else part way for something, we followed it from beginning to end. And there is a problem with design and getting your proportions right.

For example, starting with the Saturn V, it's a quantum leap from the Saturn I. Saturn I had a million and half pounds of thrust. Saturn V, seven and a half million. Other vehicles, some three hundred and sixty-three feet long. Now you draw it on a little piece of paper, 8½"by 11" and it doesn't look so big, but try to compare it to something. For example, the umbilical tower that's on top of the mobile platform for Saturn V, it's three hundred and eighty feet high, or so. The launcher is fifty feet thick. It sets off the ground twenty-five feet.

The relationship between the launcher, the vehicle nozzles and the deflector are critical. The thing that you have to do is to insure that you can contain the exhaust gases and plumes from the vehicle to prevent back pressures knocking out the base shield and the relationship for Saturn V to a deflector is almost on the order of a hundred feet. Different kinds of deflectors, more the one for test stand, usually is a J type deflector. If you use a wedge type deflector, you can cut the height down in half because you're exhausting the same gases in two directions, compared to one with the J type deflector. We needed to keep a lower profile for a couple of reasons. One is, the higher up you go, the higher the wind level, because the wind shears ran a power function on a curve like one-seventh of two-tenths that you can use, but now are considerable higher at 200 feet than they are at 30 feet.

DR. LIPARTITO: Right.

MR. BUCHANAN: The original concept for the Saturn V was to use barg. Barg has an advantage that it can take tremendous loads and you have to maybe control the ballasting of it by pumping water and get it to the proper relationship with respect to where the umbilical tower might be versus the vehicle. The vehicle for Saturn V is relatively light

compared to the rest of the steel because it's in the order of six hundred thousand pounds, but then you've got umbilical towers that weigh much more than that. Consequently whether its got the vehicle on it or not on it, is not all that critical. It's considerably different in some respects with the shuttle, but going back to the original design the deflector is the first thing you need to design, but it's the last thing you need to build. But the deflector determines the... The barg course did not fair as well when you examine all these pit falls and other things for example, the navigation of it is very tough.

DR. LIPARTITO: Right.

MR. BUCHANAN: The propulsion system is likewise, bad. Wind shears on it required to have a mechanical mule on a railroad tract and then you'd have to have drawbridges and everything else to cross over canals. Humidity problems, a lot of other things. But anyway the crawler went out on it and so to go, to keep the deflector on land and not underwater.

For example, you need to go up a ramp about 50 feet. And there are other underground storages there, cable systems and so forth go, but the width of the deflector determined the width of the crawler. The width of the crawler determines the width of the pedestals for the launcher and the width of the launcher determines the size of the doors of the VAB and so forth, so it starts with the deflector. But when you try to compare it to something, the tallest – like in Hunstville, it's still there, the tallest building there was the TAS building, seventeen stories high, but when you put that in juxtaposition with respect to a drawing of the Saturn V, that building didn't come up to the first knuckle joint on the umbilical tower.

DR. LIPARTITO: Right.

MR. BUCHANAN: So you go by that building and say, well gotta move something that's gonna be several hundred feet higher than that. It's not something that all people can do. I feel somewhat that designers are born, more so than made. You have to have a built-in sense of proportion to ever get it right. You can find guys fresh out of school that can analyze a truss real fast, but they may not know whether the truss is the thing to use or box beam or whatever. It's not all that automatic and especially when nothings been done before. One of the problems, it's a big problem to keep the weight and balances right so that when you start out that you can still get the end result. And getting requirements is kind of like pulling hens teeth. You can't get 'em early. Vehicle is not defined enough in some respects where you ever get where you want to go, so you set up the size of the structures. Like the size of the umbilical tower.

DR. LIPARTITO: Right.

MR. BUCHANAN: And you've got lots of people wanting space on it for different things and they can't, you can not have unlimited weight going on those or you reach a point where you can't get there.

DR. LIPARTITO: Right.

MR. BUCHANAN: And one example, that is when initially it started the Saturn V design, there was an arming tower that was outside of the VAB that the vehicle and mobile launcher passed through. And they put the ordinance on it there. The concept being that when it got to the pad they didn't have to have an entry from, other than the service arm, to get to the vehicle and do things. Spacecraft finally says, we cannot do all our servicing from inside, we need outside servicing. We didn't have anything to do that, and I remember Debus calling me and asking if we could transport something like the arming tower, to service it to pad. So I said,

ya know, we'll make a study to do that, which we did, and we all ended up with a mobile service structure. It's about 405 feet high, but I had put a limitation on the weight of that for ten and a half million pounds.

As they kept going with the design, I knew that it was heavier than ten and a half million pounds and your limited by how much you could lift with the crawler. You cannot have unlimited weight. So, I started in my office making kind of a – well, anyway I wasn't responsible for the mobile service structure at that time. Petrone wanted me to take it, but I said my plate was full. Carl Bidgood had it when it was a fixed structure. He thought he'd still have it, so he had it. They did their work through the Corp. The Corp had Rust Engineering doing the design. They were trying to design by computer. That was a fiasco, cause they even asked Engle Ironworks if they would do the design on it, and Engles turned them down.

The computer design, well, it's kind of complex. They didn't use the same type structures because when you run into a wide flange beam you either go with a pipe or some different kind of eye beam, the complication of joints gets bad. So they ended up in a total tubular structure, finally. And with the weight takeoff, by May they had thirteen million, seven hundred and fifty thousands pounds, which was considerable higher than ten and half millions pounds. I told Dr. Debus that you could not handle it with the crawler and it was too late to change all that crawler design. That they had just gotten out of hand with that because they hadn't made use of counter weights or anything else.

Consequently when we went out to the pad the first time with five hundred F, there was no mobile service structure because they had to redesign and rebuild it. They went overboard, I think, the next time cause I told 'em ten and a half million is still okay. So they tried to do it for eight and a half million, but they couldn't, but the structure was a very, very bad

structure. When it was supposed to go one mile and hour, but that thing at three quarters of a mile an hour you had very, very large movements of beams that were a foot in diameter, or two feet in diameter were getting way out of proportion, so ended up that we limited to a half a mile an hour. It would get the job done but it didn't meet the criteria.

DR. LIPARTITO: So originally it was to go one mile an hour?

MR. BUCHANAN: Well the original design they carried their support mounts with the mobile service structure, rather than having some that they could sit down. And also they had completely not considered the weights of the gusset plates in there, and that was a million pounds of those. Anyway, it ended up working. I'll say that. But that's the problems that you have with trying to control the weight when everybody wants to put anything and everything on there. If you didn't have to lift it, you wouldn't care either, but when you gotta lift it far, you gotta kind of watch the stuff that goes on there. So that's a difficult task and a lot of the design was done the first time around and you don't have two bites at the apple, normally, you got to get it right the first time. You have an advantage in the facilities in some respects because you have maybe a little bit more weight won't hurt ya, but in say, a vehicle, that's even a more complicated design, because they have to fight for every pound.

I never could figure out how come they couldn't give me more weight on the vehicle to help. But we did get some attachment points. For example on the Saturn V it would allow us to actuate the hoods on the hold down arms to close those and protect 'em.

DR. LIPARTITO: So what you're sort of saying is that you've got really three different sorts of people: engineering, design, and people working the vehicle?

MR. BUCHANAN: You've got the facility people. And the vehicle designers and then you've got lots of other things that you don't even know about, which when

you're starting you got to plan for the number of people that are gonna be on the job. What happened in a lot of cases it's like even on shuttle, when you started with new facilities, like the OPF and so forth, then you have an influx of a whole lot of people. All those people weren't identified at the start. They kind of did it later on as they got more knowledgeable of the work to be done so, I mean we had box cars that we used to house the people, or we had a lot of house type trailers that we used as a temporary way because there was no way you could build the buildings all that fast and then you start with those. And you could have all the toilet facilities, and you gonna have the cafeteria facilities, and so forth. It's a growing thing with what goes on.

DR. LIPARTITO: In terms of either the shuttle or even with the Saturn vehicle, would you meet with the vehicle design people and the fixed structure design people. Would you all periodically get together and say, well, I need to do this and he's saying, well, you can't.

MR. BUCHANAN: I had to fix design.

DR. LIPARTITO: You had to fix design. That's right. That's the mobile.

MR. BUCHANAN: I had that and that was the mobile end of it and so you have your people that work on maybe one part of it, and so forth, but you need the compatibility with the vehicle designed because you can't occupy the same space.

DR. LIPARTITO: Right.

MR. BUCHANAN: You got to allow for that. If there's an intrusion somewhere when you start moving, you got to have it right. For example, the platforms in the VAB that retract, they have to retract enough to clear the vehicle and the mobile service – I mean the mobile launcher too. Now we originally didn't call it the LUT- launcher umbilical tower,

and the reason that got changed was Debus called me and asked if I could translate LUT into German, and I said if I could do that I'd be a helleva lot higher up in the organization than I am. (laughter)

He was making a speech in Germany and he needed to – but he was translating LUT to mobile launcher, so he came back from that and said he wanted to change – that he was going to officially change it to mobile launcher. I said well, it's kind of like if you have a dog named Rex, he's not gonna come if you call him Fido.

DR. LIPARTITO: Right.

MR. BUCHANAN: What do you mean by that? I said, well everybody knows that's a LUT. Nobody knows it's a mobile launcher. The documentation and we've got thousands and thousands of drawings with LUT on there, we're not gonna go back and change 'em cause it's too expensive to do that. So then he said, well, anything officially goes out from now on will be called Mobile Launcher – so it wouldn't go retroactive. So that's how the name Mobile Launcher came in, and then for shuttle to distinguish, it just became the launch platform cause we didn't have an umbilical tower on it. So there is an interface also with the brick and mortar part, but mistakes can be made in that too and sometimes you would pinch their heads off. (laughter)

DR. LIPARTITO: But that worked at least up to '65 or so. I mean that's being done by the Corp, right?

MR. BUCHANAN: None of my work was done by the Corp.

DR. LIPARTITO: Okay.

MR. BUCHANAN: I got disenchanted with the Corp on 37 when they would not give me drawings that I needed. I said, okay, I won't do anymore work. So we

started 39 and the Corp thought they were gonna get it all and I said, I've got mobile equipment, it's not gonna be fixed. So I kept mine out of the Corp.

DR. LIPARTITO: Okay.

MR. BUCHANAN: The part that was done with the Corp basically was the brick and mortar.

DR. LIPARTITO: Right.

MR. BUCHANAN: Although the Corp did have the wood mobiles service structure, but I had the launchers. I had the deflectors, the mount mechanisms for the pedestals, for example, and the mobile launchers, crawlers, basically everything that went on those structures was not done with the Corp. And pretty much did the same thing when we got it for shuttle.

DR. LIPARTITO: Right.

MR. BUCHANAN: And now I guess I think it worked out much better that way. So I had my problems with the Corp. Got 'em solved.

DR. LIPARTITO: When you came in '65 what was your title?

MR. BUCHANAN: I was Branch Chief for the… Launch and Transporter System Branch. Now that got changed fairly early though and I guess when I got down here, I was appointed a Launch Complex 39 Engineering Manager. And Launch Complex Engineering Manager embraced all the engineering on 39.

DR. LIPARTITO: Who would your supervisor, boss have been?

MR. BUCHANAN: Well, at the time it would have been Bagnulo but then he didn't last long.

DR. LIPARTITO: He gave a lot of speeches, I'll tell you that.

MR. BUCHANAN: Bagnulo?

DR. LIPARTITO: Yeah. I found quite a few.

MR. BUCHANAN: Oh yeah.

DR. LIPARTITO: He was a good talker.

MR. BUCHANAN: Bagnulo was somewhat of a typical Corp. Nice enough fellow but didn't fit in the environment with the real knife fighters.

DR. LIPARTITO: Uh okay.

MR. BUCHANAN: Anyway, I had a problem that I thought that he ought to make a decision on and I'd go to him and he'd say, let me know how you solve that. So I stopped going to him. Basically the one that I reported to mostly to was Petrone. Although Petrone was not in the line organization. He was in Program obviously. He'd steal around the damn center but he was… I'll give Petrone his due. He was the one that I felt, the main reason that we launched when we did, because without him we never would have made it in that time. We were pretty good friends. He wasn't running a popularity contest and so most people considered him a son-of-a-bitch, but he was job dedicated and he did a good job of doing it. He wasn't the kind of guy to do any design, for example.

DR. LIPARTITO: Right.

MR. BUCHANAN: What he would get from you is the details and the probing necessary for the design if that's what you were gonna discuss would be the best out or so. Petrone really was the glue that held the program together, and he had a computer mind – very, very detailed, smart as far a recall goes, and that type stuff or sorting out what maybe is best overall. Consequently, I don't think he got near the credit he ought to, whereas Debus got a lot of credit, but Debus went home at five o'clock. Petrone went home at a

eight or nine o'clock. So, I was 39 Engineering Manager so I'm looking at a whole lot of things which included all the brick and mortar.

DR. LIPARTITO: I see.

MR. BUCHANAN: And everything else but a lot of the details that I was doing before still was in my old organization, but I tried to let them alone to do that but I'm fighting budgets, contracts and all that type stuff. We had a Boeing contract that I had seventeen systems in, for example and a Hundred and Sixty-three Million. Big contract anyway. But in the grating of it, it was taking about twenty percent of my civil service people's time, so I told procurement that that was not the way to go and that sooner or later they were gonna meet all their objectives. And that it was gonna be a windfall profit. So sure enough, that's exactly what happened and then they said, well, we got to change that. So in the process of changing the in-center type contract, then they freed my civil service people up considerably.

(TAPE ONE, SIDE TWO ENDED)

MR. BUCHANAN: Later on I was...manager, which meant anything within site close to 39, whether it was a problem with any of the propellants or whatever. You know, we got it all to be responsible for it. It's a good focal point to say you're the guy, but you can't fix everything yourself. And back to Petrone, he's got site activation but he's also got all these outside contractors on all the stages coming in and all the requirements and everything that they have to have. Lots of stuff I was looking at considerably more technical with respect to you gotta have the hardware. The hardware's gotta be proven to be able to do the job. And a lot of things can happen that you can't do anything about. Took the mobile launcher with Saturn V test facility, 500 M to the pad, lightening hit the umbilical tower, released the brakes on the hammerhead crane and the blocks started coming down.

DR. LIPARTITO: Wow!

MR. BUCHANAN: I'm in my office nine miles away in the headquarters building and Petrone calls me wanting to know if I can stop it. (laughter) There's no way, but anyway it did hit the S 2 stage, made about a hundred and twenty-two dings in it, had to fix it but we had to fix it by using the hammerhead crane to provide the access cause we didn't have the mobile service structure to get there. Those things happen, but you got a lot of hardware there that hasn't really had a chance to be tried. The first launch, it's always a problem because you're not sure exactly how things are going to behave and you can get late requirements.

The one I considered very late was they said they needed a television camera to zero in on the cable mask and it had to be close by. Well, television cameras are not made for hurricanes, launch planes and that type stuff. You put it there, it's just gonna get ruined. So looking for a way to change it from the first launch to the second launch or something like that, put it over on the edge on the launcher, then when the wind would blow it, I mean, the blast would blow it over, caught it on a bungee cord down below and then the flame goes across and it saved the cameras. You can do that but you couldn't do it to begin with cause you wanted to get it right up close. Those requirements come late.

Another difficult thing as far as I was concerned with the Saturn V, was trying to get Marshall to agree whether or not you had to have a damper. Well, they waited and waited and waited and then said we made, they wanted to bring a ten thousand pound shaker down and put on the platform in the VAB to find out the damping in the vehicle. Said, you're out of your mind. The platform's not designed for that and you're not gonna do it. Well, I had a guy who was doing consulting work for me named Dr. Cox from Martin Company. A

pretty sharp guy. He said along the Titans that they had used a test to found out the damping of the Titan by pushing on it with manpower. A good strong man could push six hundred pounds or so. So we arranged what we called the Cox test or the tennis shoe test, cause you put on tennis shoes and on the platform, on the top part of the vehicle we get half a dozen men or so and pushed shoes against the vehicle. Pushing in the same direction. Well when you first push on it you know it's like pushing on this, it doesn't move, but eventually gets going and the frequency can go. Now we were doing this at two o'clock in the morning. Late.

And also had a rope tied up on the leg of the launch escape system which would kind of, a couple guys pulling on the rope. Had a rule, had to wear hardhats in the VAB for that but when you put it on your back you had to take your hard hat off. Got that thing going. It was moving, we used to push in either direction or so and all of a sudden hear this crashing noise. And most of the guys who were pushing anything, put the hard hats on and ran. One guy just anticipated and put the hard hat over his privates. (laughter) What happened was that the launch escape system fell off. Turned out the thing was made out of plywood and had sand in it to simulate the weight. But didn't know that.

DR. LIPARTITO: Oh really.

MR. BUCHANAN: And actually it turned out it was a good thing that we ran that test and had that thing fall off or you could have fallen off at the pad and really done a lot of damage. And we didn't know it was made out of plywood. Anyway what you do is you push on the vehicle and they use lineal potenialometers where it caves in along a rhythmic pattern, and then you can tell the structural damping on the vehicle. And I knew we were not going to meet what Marshall wanted, so this was kind of late in the game because see, we already got the vehicle down here and needed a damper.

So I got the job of coming up with the damper but I could not work out an interface with Marshall with a strong enough point to hook the damper to. So I went to Petrone and told him I couldn't work it because I couldn't get the interface out of 'em, so he immediately says, just sit tight. He called 'em up and says it's their problem because of the late requirement and they can just meet us at the tower. So then when Marshall got the job they cut two three foot square holes in the interstage up there to run the damper. Wouldn't give me any of this space, so they had to do it that way and of course was a non-flying vehicle. I'm sure they could do that.

Then when they get ready to go, and all this is happening, you know, real fast, and said well, we gotta have a cooling system for this damping system. I don't even think you even need the system, much less a cooling system. Gotta have a cooling system. So I got some of my guys to put, I think it was three, fifty gallon drums of water up with a garden hose. Ran the garden hose across the arm, had a hand valve and had the end pointed right to the cylinder. Okay, your job, if you see smoke, turn on the valve, (laughter) and that's how we went to the pad and the first time with the water cooling system.

Then we went to a permanent system. They had one that erected vertically and attached to the LES attaching point, not down at the lower stage, so it wasn't any holes cut in the vehicle or any of that. It got ready to go. They had a criteria that said you've gotta have a thing connected at all times until it gets filled or something. Anyway in the process of bringing the mobile service structure up it had an auxiliary damper that's supposed to clamp on so they could remove the permanent damper. There was interference with the structure. Rocco called me and I said, for that short distance they got to go, just forget it. He says well, okay, cause he was a little

nervous around hardware. Anyway we went ahead and got it attached by just ignoring the criteria that… didn't want to attach it all the time.

Anyway, it cost a quarter million dollars to fix the line on the mobile service structure. I said I don't want to spend a hundred, two hundred and fifty million... dollars for that, so I rigged up a rope system going over some caption head. It could play in and out if you had a problem cause you could. So Marshall agreed that it could do that but they wouldn't agree that it was a damping system. They called it a wind alleviation device and we had an ICD on it – Interface Control Document – and then said, well, suppose that rope gets hung up, so I had machetes furnished later. (laughter) If you get a rope hung up you swat it with a machete. Think about this. Course nobody's gonna be able to see it cause it's up in the air so far and all that but the mere fact that you got ropes and machetes is almost ludicrous in my mind. I don't think that we ever needed a damping system in the first place. But those are kind of the late type requirements that you get.

Another late one that we got, it was out in JPL in a meeting and Gilruth says he wants a slide warmer. Well, we'd gone through the whole thing with the astronauts and everything else, with the system they had. And they had one system you went down the chute to the underground rooms and all that stuff, which wasn't too good, so there wasn't any hope maybe of getting a good system for the time that was left. So, I didn't want to fool with the system so I just did an interface on them, the umbilical tower where they could hook the wiring. And they had to individually hook up to guys and go down, and they got to a certain point, where the wire would trip or break. That was a fiasco because you had to put, they were gonna put the wire in a position depending on if the wind was helping them or against them. It could happen to

be against them. It would be much closer to the ground and so forth. Said you're never gonna be able to manage that, cause you're not gonna have time to go out there, and the wind changes.

DR. LIPARTITO: Right.

MR. BUCHANAN: And my boss at that time was Preston. He got involved in it and I told him to stay out of it but… Called him inside to show him the demonstration. Hooked up a dummy out there that fell four hundred and five feet down on top of a LOX line and got him down at the bottom and a hold a hand together and leg a flows off, goes one way and a head goes another. One of my engineers says, looks like a Yugoslavian hanging. (laughter) So anyway, we ended up with the first one with the bar, like meat hooks and you hang on to that and the whole bar goes down, but it wasn't a good system. Said you'd be better off just to take an old Volkswagen bus type and go down there that way. They ended up designing one that was similar to that. Then going down for shuttle, I said I'd go with the baskets and put the baskets up in a, I think I had five of them down. I think you got ten, but that was 23 years ago or something.

DR. LIPARTITO: Moving into the shuttle, what sort of work did you do?

MR. BUCHANAN: Well in the shuttle I was high enough cause I had more control.

DR. LIPARTITO: Yeah.

MR. BUCHANAN: In my mind, it made it a lot easier. I started working on a shuttle in 1970, around there, doing some work. A lot of this stuff was preliminary. They were coming with all different kinds of concepts and you're supposed to come up with a facility to match it so they could cost it out. They had a lot more time to develop

the shuttle. Actually from '69 to '75 they only, they went through Skylab and the STP and so there was a five year hiatus there with nothing was really flying and the shuttle, in my opinion, over controlled the management.

They had three level boards of management. Our Center was number Three Level, program office. The one in Houston was Level Two and the one in Washington was Level Three, and you knew where to go. Luckily, Level Two manager was a friend of mine I knew up in NACA, we played badminton for a few years, so got to bypass a lot of Level Three. But the question was pretty much, when's the last time I got to make a decision and then how much is it gonna cost me. Well, the more you wait, it's gonna cost more and if you gonna wait for a guy to make a decision at the last minute then your compressed to do stuff that you may have to do in overtime and all that. So, to get a decision to do something was a rigorous routine by going through all these levels of management. Three would have to go to Two and Two would have to go to One and then you have lots of explaining to do to educate 'em and that kind of stuff.

So when it started the first configuration, if you recall, was a fly back booster, which was a tandem job and piggyback, whatever you want to call it. Then they reached a point and said, well we can't afford that. I never thought that they had the right configuration and I'm still convinced today that they had the wrong configuration. Boeing came in with, what I thought the best proposal of having the Saturn V booster stages with the orbiter up on top with the recovery of the Saturn Vs– it was a very doable thing. We already had all the platforms in the VAB. To do that you would have the orbiter then completely exposed for access. Not having to work through tanks and all the other stuff and not be bothered with falling ice. We

would have had an all liquid vehicle, which you could control. You wouldn't have had the O Ring trouble and wouldn't have had a lot of other trouble.

DR. LIPARTITO: Right.

MR. BUCHANAN: And we liked to gotten out. But they said well, it was too late. I figured it was - Houston was calling the shots on that. It was their tar baby and they didn't know how to let go of the damn thing, so it's a very, very tough configuration to process with all the assembly areas. If you could imagine you got – how difficult it is to get platforms to go in and keep from dropping everything. And so anyway we had to go with whatever they were gonna come up with. We had to come up with the airport.

So with the shuttle, then George Low was the acting Administrator, at that time. His position was you didn't have to go in to touch the payloads after they left the OPF, which in essence all the payloads are gonna be put in the OPF. So I told him, I said, look, you've got all these experimenters, people with Petrone are gonna go over there and get their rat test or whatever they need. They need access up there to the last minute. So then, you won't have a firm criteria of what the requirement is. So then we said, okay we provide access to get in there and then I got to hand it to the Air Force. I think the Air Force did one heck of a lot better job with respect to payloads than NASA ever did. Cause they got more realistic as to what the requirements for the payloads were gonna be. And finally reached the point I felt like the payloads would be processed at the pad more so than they would be in the OPF, which caused a complete change in the design. Cause this change came at thirty percent at the time they were already through. So I came up with the rotating service structure and so, Bob Gray had written a letter that said it would be more than just routine to have to process payload at the pad. So now

you got to be able to take payloads out, put 'em in and that type stuff. Let me see if I can find something here in my memoirs…

So anyway, the rotating service structure I came up with about five o'clock in the morning out in California - but not anything but a sketch here of it. But looking on to the umbilical tower and here it is, and it rotates out, but then I'm giving reasons here for the advantages and disadvantages for different things. So anyway, to do that I had to build a pedestal in the middle of the flame deflector trench and with the rails going around. We took part of the extensible column, I mean it was the VAB column, a pedestal columns to use on the trucks. When you followed down the structure which was about seventy-five feet high or so, but on the legs of that to the truck, you get to the bottom, if you put universal joints, things get complicated. Putting the ball there, changes all that. But the thing really has grown. It grew to the extent that we had to put bigger ones in since I left.

DR. LIPARTITO: Right.

MR. BUCHANAN: Anyway that made a big change in the complex. Another thing that was a big change was that you might ask, why don't we have a separate mobile service structure. One of the problems that you run into is anytime you disconnect something that's already been checked, you put it back together, you gotta go through a check again, which is reason for the mobile concept for Apollo, for example we had the swing arms all checked out and could make a swing test in the VAB with those so we did not have to make or break connections. The connections that we had to make were at the electrical interface up on pedestals by the side of the launcher which you still had to plug in a lot of these sixty plug connectors and so forth.

DR. LIPARTITO: Right.

MR. BUCHANAN: So with the rotating service structure we would not have to disconnect those because they were, just have to be designed for the flexibility to go through a ninety degree swing. Which is a big, big relief of not having to handle those cables, ducts and those type of stuff. And moved it on the east side because that's where all the connections were in the first place. Not much went on the west side. There is a bridge-- we had it cross over on the north side of the -- to carry over the LOX line, you know, water lines, that type of stuff, but the shuttle was able to use just one deflector then change out. We had to put side deflectors because of the solids. But in the initial design of 39, I had considered solids, but I didn't tell 'em, because they would have made me make it smaller, (laughter) and that's the reason we were able to make it convert to that. See one of the things you don't want to hem yourself into. I mean of the things that I hated that was on 34, the umbilical tower for example, was...

TAPE TWO – SIDE ONE ENDED.

MR. BUCHANAN: I had an artist drawing of a bird looking down at the complex with the launcher service structure in the background and the umbilical up there. Von Braun says, what is that? Umbilical tower. You don't need that, all you need is a two foot diameter and a water pipe. He says, it's what he used for Redstone and Jupiter. We had six inch aluminum tubes which ran, supported a long cable mask – disconnected – just fell to the ground and that was it. And so he was not in the mind set for anything like an above tower. So all this talk about providing elevators in the vehicle to go up and down – you're not gonna do it because they are too heavy. When you fuel 'em you're not gonna run the pipes up from the bottom because you got extra lengths of pipe and all that weight, you're gonna have to fuel up on the top

and you're gonna have to have propellant sleds and all that's gonna have to have an umbilical tower.

After the meeting my boss says, how could you propose such a thing. I said, you can't do it without it. So he said, well it ought to be retractable. I said, no it shouldn't. The vehicle ought to fly and he said well, it could miss it. So he let contract to Adico for an umbilical tower and they came up with one of these radio towers with guide wires running and it had an elevator going up that you had to grip to handles for it to run. Idiotic, we're not gonna do that and their gonna get the thing up there anyway. He said it's not retractable to start with.

Then he went to Structures and Mechanics and up there says, they ought to retract and they ought to come down in sections, at the time and then fall on a fiberglass bag that's full of air and breathe it to a stop without a scratch. Now can you imagine a two hundred and forty foot tower coming to rest on a fiberglass bag in the time it takes to light up and launch one? Idiotic. So anyway, then he goes to Hughes Aircraft. They said, yeah you can make it retractable but the first hundred and fifty feet ought to be fixed. So then he says, then he says, well, how small can you make it. I said well it ought to have an aspect ratio of at least ten to one, more like twelve to one or so. You can make it by with twenty feet. Let's start that twenty feet for the base. I made it twenty-two feet. Next, I made it twenty-four feet. He never did know the difference. It's still too small on thirty-seven and made it thirty-five feet.

Anyway Von Braun would only let us build a first part of just above the launcher, pretty much with the umbilical tower. Then he wanted to use a long cable mast. Well, I wasn't designing the long cable mast. I was designing the tower. That thing going up there is an aluminum truss type structure. Said that thing would never work, gonna fall and break. Sure enough it did and then for the second launch, they look at the redesign they said, that's not going

to last either. Well, it's nine time stronger. Said still not strong enough. Sure enough that broke off just like the first one. So since it flew twice without deviation, says okay you can build the rest of the umbilical tower.

By that time I was still working for Von Braun anyway, but the problem was the upper part was furnished by a different contractor and so the parts and pieces don't necessarily fit all that well and you also end of having to do it while you're still doing work on the complex and it becomes very complicated because you got to have time to work on it, and all that. So I didn't want to get caught in that kind of environment. So I was determined on Saturn V not to get caught in that environment so I kept looking at all the vehicles we had and they had one called NOVA, which was a nuclear powered thing. That was a little longer, made it accommodate the longest one.

They finally settled on the hook height in the VAB was four hundred and fifty-six feet, but it's the umbilical tower with the hammerhead crane that went through the door, there's only about eighteen inches clearance. So I said, if I can make mine as tall, I'll have to go with another contract to extend it, cause that's just ridiculous to do that. And on shuttle I wanted to make sure that we at least had the thing as high as we needed cause we weren't gonna get any other configurations. I didn't see any that were going for that.

We tried another thing that happened with the shuttle that galled the hell out of me, and I blame most of that on Chris Kraft down in Houston, because his insistence that you could launch it anywhere. He even talked about launching it at Ellington Air Force base, but then every time a senator had a piece of land somewhere that was suitable, we had to go, I think it was Kansas, Utah, Arizona and everywhere you go, then you go though the whole thing of designing out the cost of a complex to do it there.

DR. LIPARTITO: Right.

MR. BUCHANAN: Including transportation of all the stages and all that stuff. And to me it didn't make sense cause it's gonna end of launching it here, but he was a pain as far as that was concerned. It took a lot of manpower to do that. And it just – totally uncalled for. Oh, he didn't like KSC and KSC didn't like him.

DR. LIPARTITO: I got that sense. Heard that before. You think, I mean part of it though is also what you're saying is that really he didn't appreciate the difficulties of launch. Let's shoot this thing off.

MR. BUCHANAN: Everything is concerned with what's flying and that I felt was always one of the things that was not that good a philosophy. For example, on Saturn I, had a very, very complex hold down system, release system. We had retractable arms as well as fixed arms and they were very complicated in as much as they had to pull back while it's still ignited but if they had to have a shut off, it had to go back underneath it. And you're talking milliseconds and your moving five thousand pound pieces.

And so I wanted to get fixed arms instead of retractable arms and Von Braun asked how much would it cost in the vehicle weight to do that. It was something like twenty-five hundred pounds. And they related to, I don't know, two hundred and fifty pounds of payload. So, he asked one of his futuristic guys. Looks at me and says, well on a trip to Mars, says we could use that two hundred fifty pounds. Says, okay well, just stay with this. Now we're not going to Mars with that thing. One of them had water, one of them had sand and I forgotten what the other two had, but they could have had a much better, safer complex as far as I'm concerned, cause this thing had to go right by a locks line when it went back in. So for the next Lock Two, we went to eight fixed arms instead of that, so that's a case where you need to work

the facility and the vehicle to the other and you're gonna have some things on the vehicle, I think, to accommodate facilities and that is just common sense.

DR. LIPARTITO: Right.

MR. BUCHANAN: But we did do some things different on the shuttle and one of the things we had was a much better lightening system. On Skylab we had put a fiberglass mask on the vehicle as it left the VAB and some sixty-three feet high or so and went in transition across the threshold of the VAB, we'd place this fiberglass mask on the top of the hammerhead and it had wires out on each side to protect it from lightening. So we did that for shuttle. We put it on the permanent tower when it goes out. You can see it on that picture there. Fifteen hundred feet on either side, and then it goes down through a coil to measure the intensity of the strike and it goes over the top here.

So it's basic to save the vehicle anything within a cone of forty-five degrees. They found out through the years, particularly looking at things in Europe that got struck by lightening if they were within a cone of forty-five degrees, like a church steeple or so, it was protected.

On Apollo when we got a strike, it went down through the umbilical tower but it also created havoc with some of the more sensitive features cause you got stray voltage and so forth, when you got struck by lightening. And when you get struck by lightening, now the question is, how far back do you retest. And there is no good answer to that. It may knock out a fuse but did it do other damage or whatever? So the induced voltage is what would, kind of what could cause you all kinds of problems. So we didn't want to do that. I know this, I think that we've been very, very successful.

You may notice on the Air Force, they have gone with much more expensive lightening systems. They have towers with mask and they got Seventeen Million Dollars invested in lightening towers where we just use that. That's worked. It's a hollow mask – five feet in diameter. It's got spiral strakes on it to keep the thing from going into a natural frequency and in a horizontal wind, it can cause the shedding of it to induce occultations sideways, but if you put spiral streaks going around two-thirds of the distance, that'll protect it. That ones up by itself but has spiral streak. We had some concerns of some of the members. As a matter of fact, we did have some members on the umbilical tower itself that we had to do, because it was, maybe sixty-feet long or so and we just took, about 3/8 inch welding rod and went into position and stopped it. Just like that. And those are the things you got to worry about, but based on the experience we had with the Skylab, that's the reason I said we'd go straight to that and we won't worry about launches. There's also a big teleport system throughout the whole complex. Use to drag chains with a crawler on it to ground it, but I guess they came to the conclusion that the shoes themselves were enough of a ground they needed - and they didn't need much else. But a simple thing like getting on and off a crawler, you have a fiberglass ladder. You dare don't have metal or you'd get shocked good.

DR. LIPARTITO: Right.

MR. BUCHANAN: Or you could get killed. You could get a lightening strike easily going back and forth which is one of the problems we had with shuttle was that solid protected against a lightening strike. Well, that bothered me, but shuttle had all kind of other faults too, in my opinion. This is opinion only, and that is that we probably could have saved money if we hadn't ever recovered one of their solids. I wanted to pour 'em here because didn't

make sense to go back to Utah and then come back, cause your passing through populated areas where you got potential danger and still have it. Politics gets involved in a lot of decisions.

DR. LIPARTITO: Oh yeah.

DR. BUCHANAN: Because it would not have been that expensive for me to go up around Wilson's Corner somewhere and pour those things and they got the railroad tracks there anyway. Would have been a lot less of a hassle. Now you got a Navy recovering them, you got to refurbish them here, send 'em out there, get 'em back. All that processing. For example, Challenger flew, for two years nobody got laid off, so you got a Navy you're supporting. Two years doing nothing. That's gonna be costly.

DR. LIPARTITO: Yeah.

MR. BUCHANAN: So, anyway the…

(TAPE TWO, SIDE TWO, ENDED ABRUPTLY)