ORAL HISTORY TRANSCRIPT

DONALD D. ARABIAN
INTERVIEWED BY KEVIN M. RUSNAK
CAPE CANAVERAL, FLORIDA – 3 FEBRUARY 2000

[*Mr. Arabian reviewed, edited, annotated in detail, and approved this transcript for use.*]

RUSNAK: Today is February 3, 2000. This interview with Don Arabian is being conducted in his home in Cape Canaveral, Florida [for the Johnson Space Center Oral History Project]. The interviewer is Kevin Rusnak, and I'm assisted by Carol Butler.

I'd like to thank you for having us in your home today and agreeing to do the interview.

ARABIAN: My pleasure.

RUSNAK: Well, I'm glad you're excited about it, so if we could, just tell us a little bit about where you came from, the interest you might have had in aviation, engineering, that sort of thing, growing up.

ARABIAN: Well, let's see. I always liked airplanes, model airplanes. Airplanes always fascinated me, when I first saw there was such a thing that flies through the air and all. And so I spent a lot of my childhood building models and reading about airplanes and so forth, and that then got me to the point, I guess, where I was interested in building airplanes or working on them or designing them. I used to do a lot of drawing. I'm a bit artistic along those lines, and I used to draw all kinds of designs.

And anyway, so that's how I—I guess I was always involved with that, and bird flight. I used to like birds, and how they operated, you know, what the wings did and they did controlling and all this kind of stuff. Then there came a point where I thought I was going to build an airplane, and I probably was like about twelve or thirteen or somewhere in there.

RUSNAK: Really?

ARABIAN: Yes, I decided I was going to build an airplane, and the way I was going to build an airplane, I was going to get parts of airplanes that had crashed and kind of put them together. Of course, it would never work. So I got an old fuselage from a Travelair that I was using. I cut that down. I had a Model A Ford engine that I was going to use, that came out of a car. [Laughter] And then, let's see, I got a set of wings from an Aeronca C-3. I don't know if you've ever heard of that, a little two-cylinder Aeronca C-3. I got a set of wings. So those were going to be the wings.

Of course, anytime I had the opportunity, I was working on that. My idea, I was going to take off from the farm. There wasn't enough room to fly an airplane. Anyway, I was going to do that anyhow. That was my notion, see. But it's one thing to dream about all this stuff and build models, but then there's something else to know, engineering-wise, how you're going to do it, what the forces are, what the loads are, you know, and just the dynamics of the whole thing. When you start calculating numbers, you could find out different, but you've got to know how to do that, and of course I didn't know anything about that.

So things proceeded along that line, and then I got a job one summer. This was working for nothing at the airport, just working on airplanes. I told them I'd come there. The airport was like about ten miles away. I'd drive every day with my bike. But I worked in the summer, just working on airplanes. I was very fascinated by all that. And then that proceeded.

Of course, I lived on a farm and you had farm chores, like milking cows and things like that, taking care of chickens and hoeing gardens and things of that sort, but that was all what I thought was fun. It was work, but it was still fun. And anyway, it finally came to the point, I decided, well, I was going to be a mechanic, an aircraft mechanic. This was because of working at the airport and seeing what they did. You know, I figured that's what I wanted to do.

And so that proceeded until we finally got to the point where we got into the war, and then at that time I was in high school, and I was fascinated [with the idea of being a fighter pilot]. I [thought], "Oh, yes, well, I need to go fly." And prior to that time, I had not—I think my father took me up in an airplane once, in a Ford Trimotor. This was at the airport [in Rhode Island], for a ride one time. That was fascinating. Boy, that's really something. And I was fascinated by the idea, well, you were up there, but when you look down, it doesn't look like you were moving at all. I mean, everything was moving slow. But even that's all a relative sort of thing. It depends how big something is that determines truly what the size is. But that was really amazing to me, see.

But anyway, so this is how my mind got ingrained into the world of flying, or the world of aeronautics. Finally, the war having come along, I decided, well, oh, yes, I was very anxious to learn to fly then, see, and this was an opportunity to do that, but I wanted to go fly in the Navy. So at that time you needed two years of college still, and I was still going to high school. Their requirement was, you had to have at least two years of college in order to fly for the Navy, to start training. Well, then they were running low on pilots, so they came out with this program, where if you passed their test all right, they would go ahead and take you in. And so I did that. I passed, so I was going to be flying in the Navy. I was very excited about that, see.

Well, I come to find out, the first thing that they did when I was in, they sent me to Tufts College. This was to get the equivalent of two years of college in one year, under the Navy, see, but you were under uniform and all that, see, but they still had this rule, you had to have two years of college. That was very good. But this put me into engineering, see. All the courses I took in high school, by the way, were all physics and all the math stuff and all, that was all favorable to me and that was all interesting and all that, see. But this, all of a sudden, there I was, thrusted into college mathematics, which was very intriguing. I thought that was nice.

So anyway, so I got involved with that program and then we went on and I learned to fly in the Navy and so forth. And then, of course, the war was over and I had to make a decision, see, whether I was going to stay in, because I wasn't finished training yet, but they required, okay, we'd have to sign up for three years, to stay in the Navy for three years, if we're going to finish our training. Otherwise, we could get out, see.

So I was very unsettled about which one I should do. That was a tough decision to make, see. But I decided, well, I would [leave]. I know how to fly, they taught me all about that and all that kind of stuff. …There's no sense in staying in the Navy just for three years, and flying around, no war. [Laughter] That didn't sound very good, see.

So anyway, so then what I was going to do is go become a commercial artist. So I went to Rhode Island School of Design, [but] the credits that I had were all engineering credits, so none of it applied for commercial art. So I said, well, okay, if you feel that way about it. But I thought of aeronautical engineering. That was in the back of my head, but a lot of people that knew me said, "Well, you ought to go to art school," …because I'm reasonably talented along those lines.

But anyway, so I went down to the University of Rhode Island and I got into aeronautical engineering…and so that's how I started that. So I went through University of Rhode Island and got my degree there. …I had a job offer from Grumman [Aircraft Engineering Corp.] and another one from NACA [national Advisory Committee for Aeronautics] at Langley Field. So this is how I got tied into Langley Field, Virginia.

So the job at Grumman, in Long Island [New York], that paid a lot better than what NACA paid, but the idea was, you know, you were going to be—well, you could do research. "Aeronautical research scientist" was what the title was. But you could do research and you could continually go to school. Well, I thought that was great, see, so I took that job, and that's how come I went down to Langley Field.

And so in the process there, I was at the hydrodynamics division, which was messing around with seaplanes, designing of hulls and so forth. And then I got into sixteen-foot wind tunnel, doing transonic flow stuff. And about that time is when the Space Task Group started, Manned Space Task Group, at Langley Field, and they asked me if I wanted to come move into that, and I did, and so that's how come I got over there.

So that got me from—into NACA, which I thought was great. The people were fantastic, and the knowledge that they had. Then I did graduate work there, too. Of course, all the instructors were NACA people, see. They were very good. But anyway, so that was going fine, but once I got involved with the Space Task Group, all my time went into that. I mean, it was like twenty-four hours a day, ten days a week, and all this kind of stuff.

That was most intriguing, but the most shocking thing I think I found was when I was working on the Mercury spacecraft. I was [a] project engineer. McDonnell-Douglas [McDonnell Aircraft Co., St. Louis, Missouri] was the one that was going to build the [capsule], so I spent an awful lot of time there with the building of the thing… They were good people, they were good engineers, but it was the first time I ever found people who really didn't tell the truth, or they would distort things. They would try to slip things by. But you see, I could understand why that was, too, because, see, they're in the business to make money, and the Langley Research Center was not in the business of making money. The Langley Research Center was actually to find out things, you know, and how to make things better, or how to improve whatever it was you were messing with in aerodynamics.

There was two different worlds, and I understood those two different worlds, but it was a shock to me, see, because my experience coming up, you know, the world was just a wonderful, beautiful place and all this wonderful stuff, you know, but every time I learned something new about engineering in regards to what the field was, that was most fascinating.

But anyway, so there was an awful lot. The problems, there were always problems coming up, you know. Some stuff was heartening and some stuff was very disheartening. The people you could depend on. I mean, they did things per physics. You know, if the physics wasn't right, they were going to do whatever. See, there were good people like that, so I must tell you that, and because of those people, that's why we are where we are and we got where we are. But a lot of those people, they're not recognized anyplace, and it's hard to recognize them. You almost can't, see, the line is so long, and it would take forever, and for whatever purpose, well, it doesn't end up. You only see a point here and a point there and you think that's what it is. But if you haven't been involved with it, there's no way you can ever bring that out. The people were very, very—I should say most all of them were very trustworthy, see. Most all of them were very trustworthy, and they would try to do their best, and they would always do that.

And the other thing that was very interesting, too, was the number of people that were involved. Like in the Mercury, there were very few. I mean, there was no problem dealing with anybody. I mean, very, very few people. You could always have them on your hand, and there was no big deal about meetings and memos. In fact, I don't think I ever wrote a memo during the Mercury stuff. It was just one manual we put out, and that was it, and it was what that particular [mission] was going to be about and what was involved. It was very simple and straightaway. And there wasn't a lot of hullabaloo and whatnot. Pretty soon, as soon we got into Apollo, though, then that started to change.

Mercury was [relatively simple]. That was put together and designed by a [small group]. …You can design something way number one, way number two, way number three? The whole three of them will, in fact, do the job, if, in fact, everything's done per the physics. Let's assume it's done correctly. Some of them will be more efficient than others, some of them can do more than the others, and that's the difference [in designs], but there's almost like an infinite difference, see. So the Mercury [design was] such that…[it was very difficult to get to components]. Well, and time-wise, you could get into that situation, too.

Another big problem you end up with was when you had a lot of people designing something, I'm giving you a piece, I'm taking a piece and you're taking a piece. Let's say there's three pieces. Well, those three pieces have got to work together. I just tell you what I'm expecting from you, and vice versa, what you're expecting from me, and etc. But it's not necessarily the best design, okay, but you go do that because that's all the time you've got. The time constraints make you do that. [Then there's the weight constraint forever looming over you.]

You can't sit and forever improve something, get it better and better. You could, see, but it's almost like you take a shot at it, and then that shot determines you either end up luckily or not [so lucky from the manufacturing, reliability, and operational points of view], see. [And] luck comes in, [too]. I mean, providing you don't do anything [in error]. But the Mercury was not designed very good from that aspect. It work[ed]… It was [essentially a task] of throwing somebody up there and bringing them back [in good shape]. There was really nothing [for the crew] to do. You know, I mean, they threw a monkey up there. [Laughter] If there's a man, you know, manned thing and all that [emotional aspect comes into play].

Although the astronauts, I like the astronauts a lot. Some of them are what I would call "old women." Some of them were, you know, pretty good, [but] it took a lot of guts to do what they did! I'll have to pass that on. But the role that the astronaut was portrayed to be is not, in my mind, very important. From human pride thing, it is. The system [design] is the thing that made the thing work. The guy went along for the ride. [Albeit he was designed in as a component of the system by choice and not necessity.]

You can take, for example, take the Shuttle right now. You've got windows in the front. You could really block those windows off. The thing can fly itself. You don't need a crew. You're probably not familiar with that design, you know, but a man can't really fly that like an airplane. It's such the conditions you happen to go through, see.

First of all, for one thing, in order to go from here to hit the ground, and you don't have any power [to go around], you've got to make sure it comes out right [on the first and only attempt]. There's no way you can put your trust in man [to manipulate all the parameters involved with the correct response time]. That's just not going to do it. You need the computer to do it. So they show these guys flying these things [on TV]. Well, they're not really doing that, [the computer system is], which is all right.

See, the praise, in my mind, has to do with the design, and how do you praise a design? You talk about airplanes, you know, like an airplane will crash. The stabilizer problem they had in this one, whatever that. But that's one out of how many, you know, and it's almost like that's a very good design. Who are you going to praise for the design of the thing, to be able to fly that many flights, that many hours, and not have any problems? That has to do with the design, see.

Most times when airlines ever have trouble, it's because of the pilot. I mean, nothing wrong with the pilots, but the pilots are just human, and they make errors and they get the wrong notions and they get tired. They even want to commit suicide, see. You see, so that piece in there, [the man,] is a highly questionable part, if you want to look at all the other parts, how they function. See, what the pilot's supposed to function and what all these other things function as they're doing, you find out they're far superior than that thing that are people.

In fact, you look at computers right now. Look at all the stuff that computers are eliminating insofar as people go. Used to be bank clerks and all that. I mean, people.

Airline reservation was all done by hand. I mean, phone stuff. People screwed it up royally. A computer doesn't, see. Computers [have] very interesting [characteristics], see. It never gets tired, never gets irritated. It doesn't worry about [getting] a raise, it doesn't need sick leave or anything else under the sun. It will go do that. It does it forever, see. And our whole society is advancing tremendously because of that, not because of the talent of man. The man that discovered some of these things accidentally bumped across them, [because] he was inquisitive. As a result, he was able to bump across something, see, and these things that somebody bumped across, we say, "Oh, we could do this with that. Wow, look at this," and [as a result] eliminated the big problem, that's people, see.

So you can see, in some respects I don't have very high regard for the person in any system. The system should be designed such you don't need people. That's why I think that depending on people—then, what happens is, you'll see this happen, too. Like, well, you've seen this. Oh, look, man's important in space. He goes up and repairs something. Well, that's a hell of a note. The thing shouldn't have had to be repaired in the first place. That's not the problem. You don't want to have man going up and repairing something, and the cost involved in that. You ought to design that thing such that that's not necessary. That's a hell of a lot cheaper and a better way to do it. So I'm looking at the thing from a general overall picture. I'm trying to give you my perspective of what this is.

RUSNAK: So what do you think, with the Mercury capsule that worked particularly well, or did you not come across with a very favorable—

ARABIAN: Well, it was all right. The heat protection was all right. On the way out, they had this escape tower. See, look at that escape tower they had on there, for example. It was always, "Well, you can't lose a man." Man-rated. Always worrying about man. Well, what's man-rated? Man's damn cheap. I mean, he is. What's a man worth? They always say how much training I put into him. Well, that's all he's worth, see, how much money I spent on him. Other than that, you know, hell, they're a dime a dozen. You know, you can get all the men you want, or women, either one, see.

I thought, for the job it done, it was okay, just going up. The heat shield, worrying about coming back in and how you're going to do that. It was an ablative system, and that was perfectly okay. That worked all right. There were other ways to do it, which we know now, but that was perfectly okay. [Again, there are many different ways to design a system, any of which would do the trick.]

Well, the bad features about it, I guess—I wouldn't say bad. I would say the kind of an undesirable one was the fact the way the hatch came off. [“Somehow”] the hatch [blew] off [in the water] and one sunk and all that. Well, that shouldn't have been designed like that, but that's the way it was. It was designed like that, but it works. [It should be pointed out that every design has its limits for loads, power, electrical characteristics, etc.—if exceeded, you have a problem.]

And anything works, you can't complain against it, see. And if you make something per the drawing and it works, and if you make it every time exactly like the drawing says, it will always work. It will never not work [unless you exceed the design conditions]. It only does not work when somebody does something that's not per the drawing. Like if I don't connect something right. Or I make a joint, let's say, that it's going to go through a number of cycles and it'll break. But if I design [for a certain life], and I run through, let's say, a qualification test, [and] I go through the life of it, [i.e., how many cycles the] joint will last…[to verify my life expectancy, I know when to stop using the component then]. Everything will eventually fatigue. It's just a question of how I design it. So the more load I put on it, sooner [it] will break. When it breaks, okay, I've got a problem. Or you talk about corrosion or anything else. That's based on the environment that it's in, see. But if I use the right materials, I can prevent all that.

All that thinking—if that's the proper thinking [considering the physics of the design] that goes in there, I just need one. It will go the lifetime that I say, if I made it just like the way it was said to be made ["per the drawing"]. But if I make something wrong, I didn't machine it right, the thickness is wrong [or] the materials are wrong, or something like that, well, it's not going to work then.

And to have another one in place for one like that, to me, [redundancy] is stupid…and I don't think redundancy is [smart]. Now, let's look at the physics of it all, okay. Look at you. You're designed with what? A heart. One heart. That heart doesn't work, that's it. You don't have [a] redundant heart. You don't have redundant eyes. It happens you have two eyes not because of redundancy, in case something happens to one, but so you can have depth perception. You cannot have depth perception unless you have two. Like you can't add something unless you have two. You have to have a binary thing in order to add to that plus something else, otherwise I can't add or can't subtract. So I need two eyes for that, I need two ears for that.

You have two things because of control. I've got two arms for balance because of gravity [and to have a reaction, i.e. and opposing force mechanism]. I need that. I need a plus and a minus, so to speak, or a left or a right. But you never have two for a—nature's never done anything redundant, ever, so why is man, in his brilliance, all of a sudden decided what he needs to have is two or three of something? [Nowhere in this universe in all of the physics of things and systems of all things is there this idea or employment of redundancy.]

Take the Shuttle. How many computers have they got? I think they've got five computers on board, and it could even be more. I haven't been checking lately, but anyway, the number has been forever increasing. First they started with two. Well, the instant you have two, then you've got the problem of telling which one is saying the truth. Which one is correct? If they're both the same, then you're assuming that they're right, but that doesn't mean that they're right. But you assume. That's a reasonable assumption. But if they're different, you have no idea which one's wrong, so you need a third one.

So that's where three comes in. We need three because two can't tell which one's bad. So you have three. So if two says the same thing, you assume that this one's wrong, but that's not necessarily true either. But in general, you can say that's a reasonable assumption. But that's no redundancy. If all of a sudden the three of them are all saying the same, then you're pretty damn happy, and if one of them is wrong, well, now, I have one failure. If I have another failure, then they, see they always—flight control people are famous for this. Astronauts, I mean, the stupidity. It used to infuriate the hell out of me, some of the things that were done and some of the stuff that's on the Shuttle, this [thing of] redundancy. The cost of that, just the weight, the time, you name it. It's just [the] wrong [approach to].

Anyway, in order to tell if one of [two is] bad…[I need a third and so on]. So what happens if one of these computers goes down? Well, I need another one. Do you see? [Now] they've got five computers in there. But nature's never done that. [I have yet to see] man is [more clever] than nature. He never has, he never will be, and no way, he hardly perceive[s] how nature works. Nature, I'm talking about the physics of [the physical world].

But anyway, one big thing was redundancy in the Mercury. They had [redundant] wires, you know… Oh, in case something happens, you know, something blows up. Well, you've got to have two paths for the [action] to go. Well, this has caused us all kinds of problems… So that's one of the fundamental things that I really didn't like.

And some of the design stuff in the Shuttle, for example. I remember one area where they wanted to put dual actuators to control the control surfaces. I said, "You don't need two." Two or three. They said, "Well, the airlines have it." These are high-up people saying this, too. They look at things not from a numbers point of view, but from a probability point of view, almost. Like it's risk. They feel more secure, the more numbers. For some reason or other, you get that. The bigger the number, then they feel more secure. Well…you ain't going to go [if you] make it 100 percent secure. Yes, you'll have an infinite number of redundancy, but you'll never get off the ground, see. So you've got this paradox.

…[For example] in Mercury, they had wires running over here, but then another [parallel] path for the wires would go [another] way, too. But there were people who worried about that [continuously]. Now, if something was going to hit that vehicle, well, it's going to hit it, and…[you got bigger problems than a broken wire to worry about.] It's different than in a fighter plane…look[ing] at the military. It's a little different situation because you're being shot at. Okay, that's not like something you're not being shot at. I mean, being shot at, okay, it means I'm going to fracture [structures, wires, lines]… Give me as much as I can put in. You need redundancy in that and paths such that you can stand a lot of battle damage. [The other approach is to have a large number sufficient to allow a number of losses].

But things like an airline and things like a capsule in space stuff, you know, unless there's all kinds of meteorites out there or something like that, nobody's been hit with anything sizeable yet, so the risk of taking all this protection with you isn't worth it. There's a certain thing where you have to say, "Man is expendable," and the truth is, that's the way it should be.

But I was telling you about—I got off on a tangent there. I was talking about the actuators in the Shuttle. They only have one actuator in each control surface. They were saying, "Oh, [unclear]." I said, "Well, keep on increasing the strength of the thing, it's doesn't cost you anything, until you've got a safety factor big enough that you don't need another one." And it's finally ended up. There's only one [designed with plenty of margin].

But this is the type of thing, the problem you end up with. It's an emotional thing against what the numbers are, and when you put numbers down, you have to believe numbers. I shouldn't use the term "believe." A number is real. It could be big or it could be small. A number is a number. And if you think it isn't correct, well, you generally put in margin. This is where you put in margin. You know, safety margin. [Tolerance to operate under conditions beyond what is the design is expected to experience.]

Like, let's say you build a bridge. Okay, you determine how much load you can put on the bridge. In fact, there's a sign on it that says, "Do not overload this." So many tons, whatever it is. So the guy sits down and calculates all that. He can run that on a piece of paper, you know, figure all that out. Then you consider that the material maybe is not quite right. You're going to check all that.

But let's say the material doesn't have the strength it's supposed to have so it's going to be a little less. Well, maybe there's a flaw in there that you don't see, and maybe also that, maybe the load—somebody's going to drive a bigger truck over it than they're supposed to drive or something. Well, you put a factor in there for that. Maybe the winds are going to be stronger than what you think, and maybe the corrosion's going to happen, and this and that. So you keep on putting what they call safety factors, [added capability]. Those are factors above which you cannot conceive of a condition. In other words, I designed everything in there…then [I add] a safety factor. And [for] bridges…I think they're like a factor of ten or some high number like that.

But you can do that on a structure on the ground. You can't do that when you make an airplane, because it costs you [dearly] for that. That's weight. In…spacecraft, it's even worse, see, because you've got to get it up there. It takes, what is it, one pound, something like one pound of—to get one pound up there, it takes about eleven pounds of propellant. That's about the ratio on that. That's pretty severe. I mean, that's very expensive, the cost of doing something like that.

So to put in redundancy and all this kind of stuff, it costs you. It costs. There are costs, so you've got to do everything, and do it correct, and design it and make sure the design's right, check the design, and then you go make one and you make that one that's such a superior drawing, you only need one. Don't need two. If you want to build another one, fine. If that doesn't work, fine. You've got another one that only has one [system]. Fine, you let that one go and you send that one. That's how nature does [it]. She always has a flock of something. But they're all single [non-redundant systems]. There's none of them are redundant. But you'll increase the numbers a hell of a lot cheaper. I can build two. I could build, let's say, probably ten Shuttles for the price of one if there was no redundancy in there and you wasn't worrying about saving the guy's butt, which is an emotional thing, by the way. [But the guy's butt would not be in jeopardy if the design was right.]

Anytime you end up with manned space flight, it's all emotional. And as a result, it's a lot worse than unmanned. Unmanned stuff, you don't have to worry about that. The unmanned stuff, that's truly economics. Then you start figuring economics. But as soon as you've got a guy in it, well, it's, "Oh, we can't have a failure." [Well, look at the record.] But it's our way. We're brought up that way, unfortunately, so that's the thing that screws up engineering. It screws up design because of all that, see.

How did I get off on all that crap?

RUSNAK: We were talking about the Mercury capsule, is what got us off on that. You were talking about how costs affect these things, and so I was wondering, in Mercury, was cost much of a factor?

ARABIAN: In general, cost was not even an issue. Time was the issue. I mean, whatever it cost, it cost. There was no big—engineering-wise, there was no big effort in cost. There were people that worried about the price of stuff, but it was program control. You had a certain budget, you had to [try to] stay within the budget. That's what it really boiled down to. I don't recall any situation where that was an issue. In fact, Congress said to us, "Hey, yeah, you want to go the Moon? Very good." "Well, we need money." "Here's all the money. Go do it." Not a problem, see. So money wasn't the issue. In fact, when they were building Apollo, there was different designs, I mean, different companies making the same thing. In case this wouldn't work, well, they were putting money in that. Money wasn't an issue.

As a result, though, it screwed up all of NASA, okay, because NASA—when I'm talking about NASA, I'm talking about the people that were involved with the Apollo. They were coming along, there they are, and this thing got blown out of proportion because of man. Well, first of all, you were supposed to beat the Russians. Well, that means, you damn well made sure it had to work. Something had to work. So you go in two or three different avenues at one time. One could justify that. So money wasn't the issue. It wasn't that there wasn't enough money. "How much money do you need? Here's the money. Just go do that."

Well, as a result, the people started to have this feeling ingrained in them that nothing was too expensive, so to speak. Thrift was not an issue, and they became very unthrift and very highly protective, redundancy of probably—You keep on sticking [requirements] in there until either the weight or [some other factor prevents] you from doing it…

As a result, there was all this reliability [in the minds of some because of the redundancy]. I remember even after, what was it, after the fire or something, Boeing was brought in to [double check the progress]—I remember my organization…was assigned…maybe there was probably a dozen or more Boeing people just supposed to be kind of overlooking, that showed up. What a waste, stupidity that was. Okay? That was bureaucratic crap, and it served no purpose whatsoever. It served those in power that they were doing everything possible. They were showing the Congress, you know, they're making sure that the thing was done right. Well, you were training everybody wrong, all right? And I'm talking about the everybody. The people that were coming up, see. There was a certain group that was really doing the activity, influencing the activity highly, you know, like [Christopher C.] Kraft, [Maxime A.] Faget, and some of those. The guys from Langley Field, essentially, were the ones that were really driving the thing.

Then you had all these other people coming in, and they're observing all what's going on. You learn as you come in. They've got young guys coming in. You're seeing all this. Well, you learn that's the way you do stuff. Just like when you're brought up. Whatever your family, your mother and father, teaches you, you essentially pick up. I mean, this is the way you think the world should operate.

So as a result, when you come along on something like the Shuttle, it's going bananas, it's not working. I mean, it's a working function, but it's supposed to make money. Congress said, "Yes, yes, you guys want to do that, fine. By 1985, it's got to be paying for itself." You know what it costs you now every time they launch? It's like about a third of a billion dollars. I think it's even higher than that now. I think it's three billion dollars. I think it's up to that now. It's the number of flights per year that they make by whatever goes into that program. It used to be like fifteen billion dollars. I don't know what it is now. But you just take, divide the number of flights, that's how much it costs, per flight. It's not paying for itself. I mean, it's costing the taxpayers who are dumping money into it. And what are they doing? Nothing. Stupid experiments. I mean, what are they doing this flight? I don't know. I don't even pay attention to what it is that they're doing. I mean, I'd like to know.

Well, why has that happened like that? Well, so you get these guys from Langley Field who have retired. Now this other group now comes in, and they're taking over. Well, what have they learned? They've learned to spend and make sure you use up everything that you can get. You see what I'm saying? Not that they're not good engineers and all; they've been brought up wrong. [Laughter] And as a result, this is what you've got. You've got this thing called the Shuttle that's not worth the paper it's printed on, because it's supposed to make money. That was the only purpose for that. It was supposed to pay for itself. It was a method to make that happen.

Nothing commercial is going on. Nothing. I mean, they're still trying to hang onto the thing just to go ahead for the Space Station, which is another stupid thing. I mean, how dumb can you get? Because look, we started out. Look where we started out. We started out—remember Skylab, having a laboratory up there? Well, how long did that last? For a year or so? The reason we let it come back in because nothing else worthwhile doing there.

It's still true today. There's nothing worthwhile doing. That's a political thing now. So politics has gotten into the engineering, and you've got a group of people that has the wrong experience, to make space make money. Now, anybody commercial who's up there, hell, that had nothing to do with NASA. See, but they're making money. They don't have all this other baloney. That's strictly economics, what they're operating on.

But anyway, what am I getting off on that tangent for?

RUSNAK: Since you had mentioned Apollo, I wanted to ask, in '61, Kennedy says, "Let's send a man to the Moon by the end of the decade and return him safely." That brings in, too, the theme that you've been mentioning, (A), he wants a man to go there, and, (B), safely. So you've got to work within those two constraints.

ARABIAN: Oh, yes, that was all right. Like I'm saying, that's right. But unfortunately, you train the people, see. The next generation of people came along, they learned the wrong thing. The people that went and did all that came from a research background, so their bringing-up was different. They were really the right background to do what they did. But the method that was used and the techniques and the notions that were used was okay for that, make sure you brought the guy back and so forth, and you did it in such and such a time. But that's not appropriate for anything else coming along. That's what I'm trying to say.

So you can't say—what used to get me up, when they used to put these things out about experiences learned, lessons learned, and whatnot. Well, see, it was perpetuating the same thing, was the lessons learned. You know, if you read any of that stuff, it was all—you know, and you talk to some of the people—I mean, truly in their heart, they very strongly believe that, see, but it's just simply not right when you stand back and look at it. See, it's not appropriate, what they're doing. But you have to go through another generation or so in order for that to die out before that'll happen. You'll probably get back on an appropriate course, see, sooner or later. It'll oscillate. You know what a sine curve looks like, or a wave. Those plus and minus, plus and minus around the mean. What goes down, you know, what's going to go up, and this comes down, it'll oscillate. But things happen like that. That's the dynamics of nature.

RUSNAK: So what did you think of that announcement when he made it, about making the challenge to go to the Moon?

ARABIAN: First thing, I had no idea, I mean, all what was involved. I'm talking about, well, first of all, the navigation to get there, okay, and then to make something that wouldn't be so big that you couldn't get it there. You had to get the thing there and you had to get it back, and you had to do it within the constraints of being that far and how much you could lift up and all that. Yes, that was a horrendous thing.

Now, to me, it was very impressive of the rocket, you know, the Saturn, that was made to do that. That was a very impressive thing. Huntsville, I think, deserves good credit for that. But there was a lot of experience going into that. That wasn't like the first time. You didn't make one that size before, but the physics of how you do the engines and everything else was there.

The spacecraft, the capsule, and landing on the Moon, that whole navigation—in fact, I thought that's a very weird way to do it, but you sit down and calculate out, that's the way you have to do it. That's really the only efficient way to do it, just the way they did it. And [John C.] Houbolt was the one that was responsible for pushing that notion, to make that happen. He wasn't even part of the program.

Yes, from there on, it was just simply making the stuff and making sure it worked. Okay, the numbers, you calculate the numbers. Okay, so that's it, and it's a question, okay, now how much mass do I need in order to land? And how many Gs am I going to do? And how heavy is the engine going to be? It's all that weight factor. Here again, it's get that down. I mean, one pound here means, well, it's eleven pounds here. You know, like I told you, that's just in orbit, not to the Moon, see.

Well, the equations, nobody had to invent anything. You did not have to invent the physics. You knew all that. That was all known. It was just a question of coming up with the mechanism that would come under the weight constraints. This is fundamentally it. It's the weight, your limitations in weight thing. For the weight that you can lift from here on Earth, you know, to go up there and come back, what that number is when they get back, can you squeeze that all within the physics that describes it all. Well, it ended up, yes, you could, so it was just a question of making that.

Yes, I thought that was—there was a good job done by [North American] Rockwell, there was a good job done by Rocketdyne and all the people at Grumman [Aircraft Engineering Corp.] that did the lunar module. They made that. That was all pretty well done. There were a lot of things that could have been done different, like I said, but it doesn't make any difference.

The thing looked miserable. I mean, it was not a very aesthetic-looking vehicle, but it's all you needed. You don't need anything streamlined. That was pretty good, see. But to me, having come up with that system to go to the Moon and the way it was, you know, this rendezvous [coming] back and that all works pretty straightaway…

I mean, rather than go into the Shuttle, you see, because—and you talk about the Space Station, well, I don't want to go off into this, but I might as well comment on it. The Moon's a space station. There it is, it's there, and it has everything there. You don't have to keep it up there and everything else, see, and it doesn't take too long to get there. It doesn't take too much god-forsaken amount of energy and you've got materials there that you can build things with. You can make stuff there if you want to go, if, in fact, it's worthwhile to go to Mars or some other place, because you're halfway there. Not halfway, but I mean, you're just limited—your big problem is getting away from the Earth. Well, it's one-sixth of getting away from the Moon. That's a lot easier [and] no atmosphere there. I mean, the Moon, my gosh, you've got everything there, except, I think, what do you need? Just hydrogen is the only thing that's lacking, but other than that, you know, you've got [the raw materials].

See, so that was cut off. But, see, something always has to happen in history in order to make an event or a new thing happen. It's almost like DNA and whatnot. You have to have a mutation somehow before something [different] happens. It has to be the right mutation, otherwise it won't happen. But it was cut off, well, because it was ahead of itself.

The society—I should say that the scientific society really wasn't in a place to swallow all that yet, but they messed around with all these other things that they shouldn't have. They should have just stood back. But you really need a leader to do that. You always have to have some leader. If you don't have a leader—right now, there isn't any leaders that I know of, I mean, that I would call leaders. There isn't. And you need a good leader. That's just part of the thing. Like you've got to have somebody who knows…[the laws of physics and] how to calculate [and develop]. [But], you've got to have a leader, too.

So all those pieces have got to be in place. If they're in place, then things will happen. If they're not, time is wrong and it ain't going to happen. But so we mumble on like we mumble on.

But anyway, what was I saying?

RUSNAK: We were talking about Kennedy, and you talked about the lunar orbit rendezvous and John Houbolt. Of course, doing lunar orbit rendezvous wouldn't have been possible without learning to rendezvous in the first place.

ARABIAN: Oh, yes, that's true. Yes, Gemini was very good. That was a block, see. That was not planned ahead of time, but that just ended up. One of the guys that I give a lot of credit for that, that I worked for, was [James A.] Chamberlain, Jim Chamberlin. I don't know if you knew him, I mean read about him.

RUSNAK: We are familiar with him, but unfortunately he's not around anymore.

ARABIAN: Yes, he's not around anymore. I worked for him on Gemini stuff, and I was responsible for the interfaces between the Titan and the spacecraft. I worked that aspect of the thing, and then also [the interfaces] between the Atlas and the Agena… Engineering-wise, I worked those parts and ran that stuff. That was the main function I did with the Gemini, was those designs, those interfaces.

RUSNAK: Did you think the Gemini program was a necessary step before Apollo?

ARABIAN: Oh, it was. It was a good thing. If it didn't happen, I don't think we'd have—I think things would have screwed up royally, because, see, nobody had any idea how you rendezvoused. I mean, the fact is, you can sit and look at the equations of motion and think certain things should happen, see, but if I see you over here on the ground and I want to go over to where you are, all I have to do is point myself that way and I go and I make it, see. But that's not the case when you're in orbit, see, because as soon as I put—well, let's say if we start out with a—here you are in an orbit, and if I put more velocity along—that's a tangent. You know what I'm talking about, a tangent vector there? I'm going around, see, so I have a certain velocity going around. If I increase the length of that vector, I no longer am on that circular path. I am now on the new circular path and I'm still going to go through this point, but this circle is going to go up and it's going to become elliptical.

I'm going towards you, see. When I'm going towards you, I start towards you, but I'll find out I start rising above you, so to speak. Our orbits aren't—we're not coincident any longer. So you have to know what to do, when to slow down and all that. So that notion, that had to be learned, and the crews really exhausted themselves doing that. But once you learned how to do that, that was all right.

So that was a very key thing. And also working in space. Not that you had to do that, but they found out, you know, going back and doing various things, because on the Moon you're going to be working in these suits and all that. Yes, they didn't have that right. I'm talking about—that's understanding what's there, see. Man's brain never understands. He goes and tries and he sees what happens, see. They found out, for example, the cooling wasn't right, and a whole bunch of stuff. You need to be able to brace yourself, things you needed to do. See, we're sitting here, we've got the chair pushing against me, I have something always to react against. Yes, all that was essential, and that was a good thing that happened. That was fortunate. But Jim Chamberlin, I give very high credit for pulling that off somehow. But now Houbolt, the people that were responsible for the rendezvous and all the equation of motion, how you do that and all that, that was key to that, too.

RUSNAK: In Gemini there were a couple of things different than in Mercury. Obviously, you have another person, but things like having ejection seats instead of the escape tower. I think you mentioned the escape tower before.

ARABIAN: Oh, yes. The ejection seats. And also the hatches opened up, and all the equipment was on the outside [where you could easily access equipment]. So we learned a lot from Mercury. It was the same people that did it, so they continued straight away, without having a whole new [program, which would have taken considerable time. Lessons learned did not have time to be transferred, so]…you just go do it….So that was very, very beneficial [time-wise, organizationally, and cost-wise.]

And the other thing, I think, was good for the Gemini thing, it showed that things weren't quite as easy as one thought, insofar as the body, how the body made out. The fact is, staying up there a long time, you start losing bone [mass and muscle mass]. There are a lot of things psychological—physiological, I should say, changes, happen to the body that is not quite clear, even today. I mean, they get motion sickness yet. [About] one-third and they get sick every time. It takes them, about what, three days [or so] to get over it. Some period of time, and they don't know who [will] and who [won't]…that's just the way it is.

The body's not made to go up there. Your body's designed to have loads on it, continuously, all your joints. I mean, if you don't, your bones start to disappear. Your bones are there just because your muscles are there because you're using them. If you don't use them, they [diminish]. You build them up, it's because you're using them more. So they're either going to be increasing or decreasing. And as soon as you change that, then they're going to change because they depend upon those loads for being there.

So all that was—like the doctors, oh, my gosh. The medical people. I shouldn't say this, but they're the most—I don't know if it was the particular medical people we had or just what, but I mean, to me, they were afraid of everything, measuring everything. They had to save all the urine. To me, they didn't understand physics, you know, the stuff that they did.

I [published] the mission report, and it always had a section in there for the medics. But the stuff, they just wanted to put [data] in there [without meaning and analysis], like, as a depository for data. I said, "This is not what that is. You're going to say what you found out or didn't find out. That's what this is all about. It's not about anything else."

But I used to have big problems with those guys, but, yes, they used to have instruments they stuck on guys, EKGs [electrocardiograms], you name it, you know. Used to save all the feces, you know. I mean, just dumb. All the urine. I don't know what the hell they did with it all, but they never found out anything, that I'm aware of. I don't know if they ever put a report out or anything else under the sun, but as far as I know, that was the biggest bunch of baloney.

Like, the other thing, going to the Moon and coming back from the Moon, and the quarantine of the spacecraft in case there were some bugs in there, you know, from the Moon. Ethylene [chloride], I think was used… Anyway, but everything had to be disinfected, so to speak. You know, I said, "Well, look, the damn spacecraft comes back into the atmosphere, and what the heck, you can't seal it off. So what's all this noise?" [The crew was quarantined for 21 days.] That finally dropped.

But you can see, emotionally, how some of these happened that had no sense. It's like flight safety. It's like reliability, and [it’s big] organization. Some medical aspect was needed. I mean, it's not zero, but the thing was way the hell out of proportion for what the situation was, that somehow the perspective was not handled right, in my opinion. The doctors were pretty much—start me off on another tangent.

RUSNAK: All right. Well, if we could get back on Gemini, I want to ask you about the paraglider and what you thought of that.

ARABIAN: Oh, the paraglider. Oh yes, that thing. Yes, I worked on that a little bit. Well, that was a notion. It was just like one of these things. You design something. Yes, that's one way you could do that. It wasn't needed, though. The program didn't need that. It'd be different. It was a good thing. It was always good to try something. There's nothing wrong with it. And I'll put it under the term of "research," because you never know what you're going to learn from it. You can't make a judgment ahead of time, this is a good thing to do or this is not a good thing to do. Anytime you do something that you had not done before, you ought to go do, and then you draw some conclusions from that. But to start out with making a conclusion, without knowing too much is not—I mean, that's the way you won't get ahead.

Yes, the paraglider. Never did use that thing. That was just like one of those—well, that was all right. It wasn't needed.

RUSNAK: And the idea, of course, a land landing would cost less because they wouldn't have to send all the ships out to try and recover it.

ARABIAN: That's true, but you see, here again is where in the program and who is in a position to call those kind of shots, you don't truly have a good setup for that. Where is wise to spend the effort and money? Okay, go try that. Like I said, being a research person, I'd say yes… That was just being fixed up for the Gemini because you could do that for the

Gemini. But something like a Shuttle, you wouldn't want to do that. It wants to be a vehicle that's part of the stuff, not something that has to stick out all of a sudden.

You've always got to have something that has dual function, if you can, that serves more than one purpose, and you're ahead of the game anytime you do that. In other words, something that's heat protection but also provides the strength and also provides whatever else you want, and the more ways to design things such that it's dual function, is better off. It's just a general principle, I guess. It's good to do.

Yes, parachutes. Interesting. I remember—oh, another thing I was talking to you about, the RCS [reaction control system]. You know, with the propellants coming out? Well, there was something else. I remember debriefing the crews. They came over to Building 45, you know, this was for mission evaluation. They'd come over and we'd have a day with them where they could ask us questions and we could ask them questions, if things had happened, you know, and such that, so we could explain what was or why, and whatever they did. So we'd go over all that. But I remember, several of the crews commented about when they were on the main chutes, and there was all this fire up there. They could never figure out what all this fire was. Well, didn't pay too much attention to it, as a matter of fact, until one time, and I forget what flight it was on, but anyway, we lost one of the chutes.

RUSNAK: It was Apollo 15, I believe.

ARABIAN: Apollo 15? Yes, that sounds probably about right, yes. …One of the [main] chutes [collapsed on that mission] What happened was, [the RCS ran out of fuel before the] oxidizer…Well, it ends up, this N_20_4, you know, which was being dumped [through the RCS nozzles is not compatible with the nylon chute risers]…

So sometimes…they'd run out of fuel [first]….This [was] one of the reasons why the RCS was [subsequently] shut…off before you deployed the [main] chutes….As long as it ran out of oxidizer first, there was no problem, but if it ran out of fuel first before the oxidizer, then the oxidizer came out. [That was a potentially serious problem.]

…[So that's] why the RCS procedure was changed [before the Apollo-Soyuz Test Project (ASTP). However, on ASTP the crew opted for manual chute deployment and failed to turn off the RCS. This resulted in N_2O_4 being sucked into the cabin and almost led to their demise.] I guess it happened to be just timed right, in the chute, and everything was [oriented] just right, see, so the riser was there [melted by the N_2O_4], and it caused the chute to collapse.

So [the] rule was [changed] to [stop dumping the] RCS [on the chutes]… But the crews [on earlier missions], not all of them, occasionally…mention[ed] about all this fire up there [while looking up through the windows.] What the fire was, was, as a matter of fact, was the fuel burning off…Fuel was burning, but there was no oxidizer there, okay, so this thing was just spewing out fuel…We could never figure out, what…they talking about [until Apollo 15]…

But that was…interesting—and then another time, I think on that same flight, 15, if I remember right, also a link broke one of the links that held the risers onto the spacecraft, the place it attached on was these, like U-bolts, as I recall, that pinned across it somehow. And that had some problem with hydrogen embrittlement, and if you get that happening, then they're weak, they [can] break, and one of those broke. See, that happened at the same time.

You never hear about that. But that ought to be in the report someplace, in one of the anomaly reports, and probably that anomaly report on the riser had that in it, too, because they happened in the same time.

The other thing funny about that, too, I remember that, because—see, the spacecraft went behind a cloud. There it was, coming down, three chutes, and there was a cloud and it went into the cloud and it came out of the cloud and one of the chutes was collapsed. So the first thought was that this—there's an adapter, what they call a shroud, that came off [before] the [main] chute first and it came down [on a small attached chute], and it went into the clouds the same time, you know, it was somewhere in there, and [we] thought somehow that made [one of the three] chutes collapse. See, there was no idea it was this RCS [dumping N_2O_4 after running out of fuel].

I was trying to think of who was very good at [helping] working that. Chet [Chester A.] Vaughn was…involved with it, too. But Henry [O.] Pohl probably was involved with that, and a couple of other guys I'll think of in a minute. But anyway, so here's this chute, you know, it goes into the clouds and comes out, and one of them is collapsed. [One would tend to jump to a conclusion] that's what it was. But that wasn't the case at all.

But I remember that, because I went out to Hawaii because there were helicopters out. There were three helicopters, that I recall, and, of course, I had to find out all that data for that because I worked on all these anomalies, you know. And so I…flew out there to Hawaii right away, so that I could get with the helicopter people and see exactly what they saw from their position and all that, and try to figure out what was going on… I had no idea what the problem was or anything else. It was just, "Well, [a] chute collapsed." Well, that's a very bad situation. So immediately you want to get every piece of data you can and see all what things say, but the first thing you do is make sure you collect all the data. You don't jump to any conclusions or anything else…whatever happens has to satisfy all the data. Can't satisfy 99 percent of the data and one thing you can't satisfy, that's it. Then you don't have it. So it has to make sure it satisfies everything. [Frequently you make a setup to demonstrate that the events and sequence does in fact show you have the problem defined.] But I remember going and talking to the crew on that. That was most startling when that happened. But then all these things pieced together… That was funny.

RUSNAK: Well, of course, the RCS also caused a little bit of a problem on Gemini 8, but that was on orbit rather than coming in, where the thruster stuck open.

ARABIAN: Yes, that was an electrical problem. Yes, well, those things, see, something like that happened, that was very good that Neil [A.] Armstrong did what he did on that one. That was very close to a catastrophe. I mean, he was on the verge of tearing that thing up [because of the rate of tumbling]. Yes, the anglular velocity he had was pretty high.

Yes, one thing, now that you mentioned about that, on the Gemini, the design is very interesting. Remember I told you I was responsible for this design between the Agena and the spacecraft. Well, it started out, this is the way that the McDonnell and the Lockheed people were working [the design], and they had come up with the concept. What they were going to do is bring [a lot of instrument data] across [the interface] so they knew what was going on with the Agena. It was going to have a display inside the capsule, such that they could see what the status of the Agena was, because they wanted to dock with this thing and then they were going to fire it and then undock with it. Well, they didn't have any data, so they had to connect to there, and all this information was going to come across, and that was a big problem to try to do that.

Then I start to think to myself, this is kind of dumb. I said, "Why the hell do you want to even do that?" I mean, just have an instrument panel right on the Agena, right out there [looking through the window]. There's all the data [on an instrument panel on the Agena in line of sight]. Before you even dock, you can see what's okay, what's not…

So that's what we ended up doing. And the design of a connector, too…[that was simple and mechanically happened at docking]. I eliminated most all the functions, see, because there was nothing hardly coming across then. Yes, [I thought] that was very clever…In general, the Agena was pretty good. The Atlas was a good vehicle.

[The Titan was used to launch the Gemini spacecraft. I remember how I wanted to eliminate the coolant umbilical disconnects from the ground (another device which could go wrong) – at the time, Martin had 57 successful umbilical disconnects. On the very next flight, the coolant umbilicals did not disconnect at liftoff—and ripped the side of the vehicle—they immediately changed to my breakaway design, simple, no umbilicals.]

RUSNAK: Early on, the Atlas had a lot of problems. You had mentioned that in Mercury, you were also involved in the same sort of thing. Were you working with it when it wasn't quite as reliable?

ARABIAN: Let me say this. As far as reliability goes, see, it was a big thing on wires and switches, because one big thing that happened on switches was that there was some little particle in there. Now if you're under 1G, the thing always stays down, just like in the capsule, if you have debris in there. Well, you don't know it when you're on the ground, but as soon as you get up there in orbit, everything floats. Everything's floating around.

So you've got a little different situation there, so that was a big thing on the switches. People used to worry about switches and cleanliness, for that reason. But that wasn't the big problem. The big problem, people would drop drills, [tools, etc.]. They even do it right now. They go up there, there's all kinds of stuff. They tumble the thing and try to clean it up [on the ground]. You know, wrenches, [scraps, etc.]. Well, they even had a ladder found in one of the vehicles. What was it? Was it Titan? I don't remember. It was Atlas or Titan, there was a ladder left in there. But they're people things again, you see what I'm saying. They're all people things. They're not design things, because you didn't make the design to put up with people, right? Well, then they say, "Well, it's designed wrong."

Just like the fire, for example. Remember the fire they had in Apollo? Well, that's when I just was transferred over into [Apollo]—we just got through with the Gemini, and I was assigned to…the Test Division [in the Program Office], and I was really to evaluate the data and all that, you know, essentially doing what I did. And of course, I had to come down [to the Cape] right away, and a lot of it, I didn't know about the details [of the systems and the design] of the Apollo because I was just working on Mercury and the Gemini. [However, the fundamental operations and techniques were similar and more extensive.]

But anyway, it went to a very fundamental principle again, about testing, that I have a big aversion against, in some cases [except for tests to qualify the design]. I have a great desire to test something to know what the design is and what the design can take. In other words, once I design something, now I want to find out what the heck it can do, truly do, [performance]-wise…[and know its limits]. And then I'm going to make every one like that and I don't need any more [tests] of them then, [but inspections (once)]. I just need to make them right…[i.e. per the drawings. For one thing, testing can screw up a system unknowingly.]

See, one of the big problems was, there were two different centers. There was the Kennedy Space Center [KSC]. They always wanted to test stuff [again after it’s been already accepted]. It shouldn't have been allowed to be set up like that [by the design center (JSC)]. I think another error was to have the thing organized like it was organized. The Kennedy Space Center ought to have been a place just to provide [the] needs to [service and load the vehicles] provided, but they have no responsibility for testing or anything else under the sun. But it ended up, okay, they wanted to test everything. [Of noteworthy – the fire and Apollo 13.]

It started in Mercury, by the way. They felt like the Mercury spacecraft…[which had been tested at the factory prior to shipping could have been] screwed up…[while being transported The Program Office] allowed [taking] the thing all apart and inspect everything and put it all back together and test[ing] it again…[Why not a third time or a fourth—where is the logic? An emotional situation which was and still plagues the system today. Today there is more life taken out of the systems than is in flight!]

…So here they are, in Apollo and the crew wanted to run this test. Well, KSC wanted to run this test, too, and that was an all-up test to make sure everything works. [Like a light switch, how do you know it still works? You can test it, but that does not say it’s going to work the next time. So you keep on cycling the switch, taking life out of it—sooner or later it will fail! Logical?] This is with the crew in and everything else. So the crew gets in there, and the crew wanted to do this, too…The idea was to go through a complete launch [simulation], and there was all this…[sequencing of the events, but most parameters are static, no dynamics, laods, temperatures, vacuum, etc., so the merits of doing such a test are arguable.]

Well, they get in there. The only thing that's different when you did that and you go up in orbit, the pressure you get in orbit is different than the pressure you get on the ground. See, up there it was like, [the cabin pressure] was about 5 psi… And on the ground, it's 15 psi, pressure.

See, so I get the regulators in there. They always regulated the cabin pressure to be 5 psi above a [reference outside pressure] point…On the ground, the regulators will have 15 psi in the cabin. In fact, even a little higher than 15 psi, but up there it will be down to the 5 psi you want. Well, that's fine, [except the gas] you're using [is] pure oxygen…

But anyway, so the thing was designed for oxygen and so here's pure oxygen in there. Well, the instant—I don't know if you know much about the rate of burning of things [and the ease of ignition], but it has to do with the partial pressure of [the] oxygen, you know, that combines with it. If I've got 15 psi here, okay, [with air since] there's about one-fifth of the pressure, of that pressure of the 15, is oxygen pressure and [about] four-fifths is nitrogen pressure…plus some other gases thrown in, CO_2 and some methane and hydrogen and all that.

So the number of molecules that are there [i.e. the partial pressure], oxygen molecules, will…[determine] burn…rate…[The higher the pressure the easier to burn stuff. In pure O_2 at a high enough pressure, metals will burn!] Now, if I had pure oxygen [at 15 psi] here, [anything flammable] will burn like hell [because of the concentration of the]…oxygen molecules…

So here they are, in an environment that's not right…trying to prove [what]. You're just saying, "Well, everything works the way it's supposed to work." …[but] that environment is wrong…I think probably what happened was caused by—and this is not in the literature anyplace. See, I was responsible for the evaluation of the data. I [managed] all the data [evaluation] down there…[with the NASA and Rockwell engineers]. This was analyzed for the [investigation] committee…[The data showed] there was a glycol leak, very, very small leak [per the quantity measurement and if] glycol [leaked] on silver [it could] start a fire [with pure O_2]… There's silver on [the] wire [but it's not conclusive].

…There [was] no reason to prove that…[the problem was the pure O_2 gas and material that was highly flammable inside the cabin. Both had to be eliminated regardless exactly how the initiation occurred.] It wouldn't [have] change[d] anything…[So we] don't know [exactly] what [started it]. All of a sudden there was a fire…Those guys [died. Design changes were in order].

Well, as a result, all this stuff was changed, as you're familiar with. So the hatch could open quick, let the nitrogen and oxygen in, you know, which was a very good thing, by the way. But it's just one of those things. But, yes, it should have been designed not like it was. But here is a case where you find something out because something happened. But it happened because somebody wanted to do something I didn't think they should have done in the first place. See, but that's all right. But it was worthwhile that it happened like it happened [however sad].

But here, that's a luck thing, too, see, because it could have been that that didn't happen, okay, and although pure oxygen…but nitrogen and oxygen, you're better off, see…Something like that could have happened on the way up there or something, so having pure oxygen wasn't a good idea design-wise. But it made it a lot simpler, see, because you didn't have to take nitrogen along, you didn't have to regulate it and all that stuff.

Like Apollo 13, you know, that was an interesting thing. See, Apollo 13 was—you're familiar with that, I guess, are you, what happened?

RUSNAK: Why don't you go ahead and tell us about it. [brief pause] [Brief interruption; tape recorder turned off.]

Why don't we talk about the Mission Evaluation Room [MER], where the concept came from, and all of that?

ARABIAN: Okay. [Organized] mission evaluation really started after Mercury…[For] the Mercury flights…[the data necessary to monitor the safety of the flight was displayed in the Mercury Control Center by the people controlling the mission. After the mission the guys responsible for the design examined all the data at another location.] They didn't watch it real time. Later on I'll get into that.

So that data was looked at to find out, for example, if pressures in the cabin did what it was supposed to do, or the accelerations did what it's supposed to do, and temperatures were what they were supposed to have been, and the events happened when they were supposed to happen. So you have to take a look at all the data that came down, telemetry, you know, and you look at that to find out if everything was [doing what was expected per the design].

If everything did what it was supposed to do, you said, "Okay, everything's fine. [A-Okay.]" If something wasn't right, then you had to determine what that meant, whether it was, something had to be fixed, or it was okay, just didn't understand the design, or whatever, but it had to be assessed. And who were the right people to assess that but the designers, the guy who made the thing, nobody else. So who were those people? Well, those people were spread all over the place. For example, well, it happened to be in the case of Mercury, it was just the McDonnell engineers, plus the NACA [National Advisory Committee for Aeronautics] engineers that were involved with it.

So, me being the project engineer, and one of the capsules, my capsule, well, I was responsible, first of all, putting a report out, saying what the mission was going to be, but then after the thing was all done, something that said, "Okay, this is all right, that's all right, and [the objectives that were] met…"

So this started…in a room where…[all the data was printed out and graphed on strip charts for evaluation. For] Gemini, it got a little bit more elaborate, but essentially [the same]—somewhere along the line, I forget [just] when flight control really got involved, because I was involved in Mercury control center out here [but the mission evaluation guys started to watch real time to watch what was going on with the crew]. I was the system monitor, also. There was me and Walt [Walter J.] Kapryan was the other one. We were each project engineers. He was project engineer in one capsule, I'd be on another one and so forth, so we were most, system-wise, familiar, overall, with the vehicle, from that aspect, so as a result, got the job also of being the system monitor in the Mission Control Center, which was under Chris Kraft, the flight operation director. And so I had those two jobs then.

But during real time, see, in the Mercury control center, you watch what went on. There's not too much you could do, although there was one of the flights, I remember having to call the spacecraft back in early. We only made one orbit, we came in, dropped it in early because one of the thrusters was not firing or acting up. I've forgotten. Yes, I think it was either leaking or not firing when it was supposed to fire…something [like that].

But anyway…I remember that Kraft was flight director in the Mission Control Center down there and he said, "Okay, Arabian, what are you going to do?" I said, "Well, I'm going to wait till the next station," and the next station was Hawaii. But then I had to make a decision very quick because they had to fire the retros [retrorockets] over California in order for it to land where it landed in the Atlantic Ocean, in order to pick it up.

But there was like, I remember [about] a three-second time period where the data would come into view and then I could see the data and make an assessment. They had to fire the rockets, and I had to tell them right then. I said, "Well, three seconds is all I'm going to need. Don't worry about it." I remember that. Then the activity was…showing signs they were not firing right…and I told them, "Bring them back in." I remember that.

But that was real-time flight control. See, that's looking at data real time. But see, in order to say whether something was all right or not, you had to make a decision on that. I remember, now that I think of it, another situation with John [H.] Glenn's [Jr.] flight, when I was the flight controller on that. On his flight, the heat shield limit switches, there were three switches which would tell whether the heat shield was deployed or not… The reason the heat shield was deployed is to act as a cushion. There was a bag that held it [on], so that when it landed in the water, it took some of the shock so the crewmen would not get as severe a bang as they would otherwise.

So there's this heat shield that was held on [by the retro package], and it was released [when the retrorocket package was released] and there were three switches to indicate that…it was released. You really didn't need them. I mean, if they released… There was nothing they could do about it anyway. …You had to rig those switches [during installation]. Now, I was aware of that [and exactly how it was done]. I was completely familiar with all what was there, and they had set them up with feeler gauges and all that.

But there was an indication that that had happened, that there was a switch that indicated [release], and that was a big trauma [for everyone] on that, and I was not in favor of letting them come in without the—well, first of all, I need to tell you, there was a retro rocket packet that held the system on, and so the decision was, since that switch was indicated, and the retro rocket package was still strapped to [the capsule], see, that was blown off by pyrotechnics that cut the straps to release that.

Now, first of all, the heat shield couldn't very well release itself with the thing being strapped on… And secondly, they get quite emotional, and not to mention any names…you know, but the higher-ups decided they were going to leave it on. And I remember Max saying, well, it was all right to leave it on. Well, I thought it was a [not smart] thing to do, for two reasons. Number one is, the system is such that, you know, it will not deploy unless there's—it doesn't indicate "deploy." Any one switch will not indicate. Secondly, there are switches that are set up. And thirdly, there's no way that thing could be deployed with the thing still strapped on, having the retro package on it. You see what I'm saying? And to come in like that, never having done that before, was kind of a dumb thing to do, but luck had it that it was okay, you see.

But here again, see, luck can play against you, the throw of the dice can be—but, to me, that sticks in my head as not a very smart thing to have done. There was no reason. The logic was not there. The logic was not there to have done what they did, but it was all right…

And another time, at the—see, I was busy doing a bunch of other stuff…with the capsule, and they were having all these simulations going on over at mission control, and I was over at Hangar S, with [one of the capsules]. I forget which capsule… Walt [Walter C.] Williams was the head of that Operations and he was the director of…[the flight operation]. Anyway, he called me up and said, "Arabian, how come you're not over here? Get over here." "What the hell do I have to go over there for?" They sit there and simulate stuff. What a waste of time, I thought…

Anyway, I've got to do that, so I went over there, I remember, and I sat down at the console and there was a strip chart aside of me, and this strip chart, I had, I've forgotten all the parameters I had on it, but one of the indicators I had on it was [the] thruster firings I was telling you about, the RCS thrusters, which controls the attitude. [That data was] on the chart, so if it would fire…I would know, I would see that…

So I came walking in and sat down and turned my strip chart on, and [during] this… simulation, so anytime you do a simulation, anything happens, well, you do that. If something's not working right, and where you bought it, and they were getting ready for a liftoff. Everybody was, you know, be calm, medics, guidance, all go, go, and the systems. I said, "Now, if this was a real flight, I would have scrubbed. Now let me explain to you why I wouldn't have scrubbed for this, because the thruster is firing." Well, it ends up, it wasn't. It was the timing mark I was looking at. I thought it was a thruster. I was looking at the wrong channel. So if that was a real flight, and I had come in and just sat down, and that was a true launch, I would have scrubbed [the launch or called for an abort]. "No, this is not a launch…"

But this goes to show you my notion of what should be and shouldn't be is something else, but a simulation really makes—it's important practice to see something like that. But anyway, that was an interesting activity that's not recorded anyplace, I don't think. No, I guess that would be on the video, I mean the audios. If they had all that taped, if they taped that, that would be still on that conversation.

Okay, where are we at now? We're talking about—that was some of the Mercury control stuff. The evaluation. Okay. But anyway, so I gave you real time, I was giving you a real-time assessment of what you do, and it's only to see what's not all right and then what you do about it. Well, eventually, they had [all] flight control [permanent] people. A flight wanted their own systems people… They didn't want other people… [For Apollo a new Control Center was created] in Houston, under Kraft…who was the Flight Operations Director. Then they'd sit and simulate all kinds of things…[to train the Flight Operations team for all kinds of failure situations.]

…[Mission evaluation was needed during] Apollo [as the mission was happening] …to put a report out on the flight [which was required for real time evaluation]. Well, there was a big flap in one of the first flights…about who was saying what was [working] all right and what was not all right…what was [anomalous] and what wasn't… Oh, that went around and around, and finally, it ended up, George [M.] Low said, "Okay…it's Building 45 [the Mission Evaluation Team's responsibility]. We're the ones to call…"

So you had to have that, because you had all these different [groups, the] flight crew…, FOD [Flight Operations Directorate] [and others]. So we were the ones that called that out [and solve any issue]. Well, it ended up, also, that we had to evaluate the flight. Had to say, okay, what was okay, what wasn't all right on the flight [design wise].

Well, that started to get organized into a cohesive mechanism, and then of all the people that would be assigned to that, see, I still had all the designers. I had the designers, regardless of where they came from. For example, Eagle-Picher [Co.] was the one that designed the batteries for both the command module and the lunar module. Well, I had them down there. I had some from the companies themselves, the guys that did the stuff, okay, because we were assessing what the design was doing, you see what I'm saying, so…[they constituted the mission evaluation team].

…There were guys that were involved in the design, in the evaluation, you know, qualification testing of it and…[these aspects of a system]. So it was a question of how good was that design, not what the crew did or anything else. Although the only thing, like the medical part was, like I said, whatever the doctors' part, they had their input to that, and I cut the hell out of all what they were doing.

But basically that's how that started. So, for every flight. Now, the other thing, in the meantime, so here's FOD going on, doing all their simulations. Well, they figured—well, the other thing that happened, when flights would come up, too, right in the beginning, when something happened they hadn't figured out what to do about it, well…they'd have to ask the designers. So then they'd call over to [Building 45]. Of course, then we needed all the data… [and] we were supporting the FOD people, in case something happened, you know. They only trained to whatever they simulate. It goes out of that, then they have to come and ask [for input].

So a lot of times that was very sensitive, but you can see, there's a difference then between the design and knowing what the heck he has and what the other flight operations people—it's almost—okay, I guess you understand that then. So as a result, we also asked to help support FOD on their simulations, so we'd have simulations with them sometimes. Not many, but a couple times before flight or something like that, where they'd throw [simulated] problems at us…

But that was the reason for the Mission Evaluation Room. That's why it was a different entity than the FOD. It was the designers evaluating the system. As a result, when something happened, they were the ones that came up with what to do. For example, like Apollo 13, the first thing that happened in Apollo 13, when that situation was, the question was immediately, "Well, what can be done?"

I remember getting up on the board with the…guidance system designer, …the ECS [Environmental Control System], [the power system], there were five of them. I said, "Okay, let's [ballpark what we [possibly] can do" We knew what we had left power-wise. The question is, can we get that thing in the configuration that we can get them back [energy wise]? Forget anything else, forget all this other stuff. If the energy wasn't there, there's no way you could do it [back]. That was the first thing [to determine].

I remember getting on the board immediately with that, and we figured out, yes, it's possible to get them back. Now, the only reason we could do that is because the designers knew at what voltage, how low a voltage they could get on to the system, because we had to cut power all the way down. The further you drop the voltage, the less energy you use, because the voltage times the current is the watts, so if the voltage goes down, see, there's less—so anyway, so the question was, could you get them back? Yes, it was possible to do, but this is what you had to turn off. [Next were the details.]

So [we] went over to FOD, I remember going over there. "Okay, you guys, this is what you're going to have turn off [and the limitations]. Forget anything else, or else you ain't going to get them back. Forget all your rules and everything else under the sun." So that's how that started off, and then we figured out various stuff to do. Different groups did various things, but that was a continuous thing. But the question is, yes, that's what you had. It was a doable thing, that was the first thing. Because if it wasn't doable, forget it.

You know, there were a lot of situations [on many of the missions]. I remember, for example, we had a direct line in to George Low, who was the program manager, who was down for the launches, had a direct hotline to him and he had to give the go for launch. So where did he get all the data? Well, he got the mission evaluation room, all my guys were all in there, see, and we're all looking at it from the design aspect.

I remember one of the times when the battery voltages were not up to red line. I mean, it wasn't above red line yet, because when you turn them on, see, what happens is, the voltage increases as the [battery] temperature goes [up], and you have to start using energy to do that, so internal resistance increases the temperature, and as a result, the voltage starts going up. There's a certain minimum voltage [(redline)].

Well, when you turn it on, there's generally not enough—you know, it depends on the outside conditions and temperatures and all that, but it can be that it's not quite there yet, but by the time you're going to launch, you proceed with the launch. You know, I remember it wasn't up to snuff. I told him, "No, it's fine… It's okay to go launch." And, of course, yes, by the time it was flying, then it came up.

But this was knowing what the system was, you see what I'm saying. You've got to know how the thing works. You can't assume that's going to happen. There's all kinds of things you can't assume. But FOD tries to do that. They try to assume certain reasonable things, you know, and failures, and they go through various exercises. But this is how the two played together.

Mission Evaluation Room is not concerned at all about the operation of the flight [as such]. It's just…the operation of the systems, and how you can use the systems, and that was fundamentally what the thing was [about]. And that had existed on up until the—when we got into the Shuttle, I wanted to knock that off completely [because the nature of the missions and the capability of the systems to take care of themselves (by design)], when Glynn [S.] Lunney—he was head of the Shuttle Program Office—you know, I told him, in very short order, "We want to get so that you don't need a Mission Evaluation [activity]. You shouldn't have to have it." I mean, no longer does an airlines have mission evaluation rooms. They got rid of all that. It was [necessary] for going to the Moon…[however].

I remember one time there was one big meeting and George Low was in there, and the administrator was down, and they were talking about one of the flights. I don't remember which one. I remember walking into the room, though, and the big issue was how much of the data that we're looking at. I mean, this is people again. To think, here we're going to the Moon. Now, how much of the data that we're looking at? [Laughter] I walked into the room. I said, "Well, maybe 10 percent or something like that." And it kind of shocked the people. I said, "Well, you can't sit there and just look at the data all the time. I mean, you just take a snapshot [every now and then]. If it's okay, everything's all right… [Essentially] everything's steady state. You're on the way to the Moon, nothing, you know, what the heck." What are you going to do, spend all your time reducing data, looking at all this data? It's kind of dumb [but all is recorded in the event there is a problem and you have to review back data]. But yes, I remember that little episode.

Here again, there were those that thought you should be looking at everything. You know, this is the everyone, everything. Well, you don't. You don't have to do that. You only look at it if, in fact, something has happened, and you say, "Well, I wonder why that happened." Well, then you go back, try to figure out what happened. Otherwise, you just—it's almost like driving your car. You don't keep your eye on the instruments all the time…[Normally parameters change gradually].

Yes, so that's how the mission evaluation started and proceeded. Then all the anomalies, by the way, which was [a most] interesting thing, too, because they then had to be solved. The question was, so the various designers would be working on it, and lots of times it was very complex. It wasn't simple, but most of the things the designer themselves was able to take care of, but we had to determine, okay, whether we're going to fly with the condition like it was, or we're going to have to fix the condition before you make the next flight, and that type of thing.

So we had these anomaly reports come out. The main report came out whenever it did, but it was the anomalies that were really the things, the ones that were not closed, that you had to do something about. Then whoever the program manager was had to go do something about those, so that was the [mechanism] that kept a view of what was going on.

There weren't all these different people, everybody saying, "This is a problem, that wasn't a problem…" There was only one place that said, "These are problems, and if it's not here, it ain't a problem." And it says not only it's a problem, okay, now what's done about it, what the changes, if anything. And so each one had its own report, if it didn't get in the main report.

It was essentially, what, flying two-month centers or thereabouts, and that worked very well, by the way. That was a very good system. But it was not something that you wanted to continue, like into the Shuttle or even like Skylab. There was no need for it. But it's still going on today, as far as I know.

Another thing, I tried to stop that, but I had retired by then, so the bureaucracy blew the thing out of proportion. The last I knew, [Building 45 even] got new equipment… I remember [during Apollo] people used to come through there to see what we were doing. They went over to FOD with all these fancy consoles. We had nothing but plain gray tables and stuff on there with the TV up. You know, nothing fancy… "Well, that's all we need. What do we need this fancy stuff for? It's in the guys' heads. It's not what they're wearing or anything else, that is the thing."

But that was the big difference between the two places. It was very shocking, by the way, when people would come and see the operation real time, what we were doing, what they were doing over at FOD. FOD, unfortunately, that got blown way out of proportion. That, to me, well, it's a design, it's a mechanism that was used. There's all kinds of mechanisms, like I said before, you can use that would work. But what's best is another point. Anyway, so those are those discussions on mission evaluation. Yes, they were on twenty-four hours [during a mission].

RUSNAK: Besides Apollo 13, which you had mentioned, there were a couple other of the Apollo flights that had problems, that I was curious what was going on.

ARABIAN: Oh, lightning. Lightning. That was an interesting one. [Laughter] That was Apollo 12. Prior to that event, the addressing of even a possibility of lightning did not exist. Nothing [was] designed for that condition. There are certain standards one uses for where you put shields for electromagnetic effects and how you ground things, that was followed, but lightning is a little different character. It's still electromagnetic, but the field strength that you get from it, the electric fields and the magnetic fields, are tremendous, and the currents can be very high.

But anyway, so, and I would say NASA essentially knew nothing about lightning, and there they were at the launch and it was raining. I think it was drizzly, whatever, there were clouds, and they launched. This was Apollo 12. It was going with—who was—

RUSNAK: [Charles C.] Pete Conrad?

ARABIAN: Conrad, yes. I remember Conrad said, "Here we go, we've got [panel warning] lights in here and [alarms]." So anyway, [Apollo 12] launched and at about 6,000 feet they got struck by lightning. At about 14,000 feet they got struck by lightning again. The first time, I think, it knocked out all lights in the cabin, you know, alarms came on and everything else under the sun. They didn't know what was going on [and neither did we!]

Anyhow, they continued…[there was no evidence to] stop. You know, there it was, vroom, vroom. Nobody knew from beans what was going on. "Hey, we got this kind of alarm, all these lights are on, ‘this’ kicked off the line, [etc.]." So the notion was, okay, looks like we got hit by lightning, and the only data that showed any problem was some temperatures and the platform being tumbled and things of that sort. Everything had to be reset, you know, a lot of things tripped off.

So we decided, yes, well, no reason why not to go on. The systems look all right. And they redirected everything and so forth, and they continued on to the Moon, which is a very daring thing. [Laughter] I mean, knowing what we know today about lightning… that was okay to do, but I mean, to me, that was kind of a risk, but at the time… But after looking into it further, it was [a bit] risky.

And anyway, in fact, the guidance system on the Saturn came one bit from being screwed up completely, but there was a redundancy [in the bit stream] in that it didn't fail, the signals weren't right, but it had to get two that were bad, as I recall. Oh, it was three had to be bad, I think, in order for it to not function right, and it got two signals that were erroneous because of the lightning. But anyway, so that was fine, went to the Moon, you know, and all what happened. That worked out pretty well. [There is luck, too.]

But then I got this call from George Low [who was at his console at the Cape], and he says, "Oh, a professor from New York University—" What was his name? I'll think of his name in a minute [Dr. Dick Orville]. But anyway, he says, "He's going to come [see] me. He wants to come down to give you a quick course about lightning," since I'm supposed to be responsible for all these anomalies, see. Well, we had nobody that knew anything about lightning, see, so anyway, so he came down to JSC… and I spent a couple hours with him, and I got a [fast course on] lightning… [Laughter]

And anyway, so as a result of that, we did a bunch of tests on [one of] the spacecraft… and simulated lightning into it, and measured what the effects were on the circuits. Fortunately, just from [other] design [considerations], that one was [pretty well] designed [in]…a secondary effect, because the [spacecraft] is shielded…with metal like it is, and all the circuits are on the inside… There's something that you call—have you ever heard of Faraday cage? You ever heard of that? Okay. So what happens is, see, if I've got two wires, or let me have a cage, and I'll make it four wires, all right. Any number of wires. And if I have current flowing down them, as soon as you have current flowing, you know you get magnetic fields created [around them], but the magnetic fields…cancel one another in the center, so you have no effect from them [on the center wire], although you get tremendous currents going, [and] the electric fields are tremendous. I mean, the magnetic fields, I should say, are tremendous. They're canceling one another…[creating a so-called] Faraday cage [effect]… In effect, anything on the inside is protected [from the magnetic fields]. That's how a shield works… Well, that's what those shieldings are. Any kind of electromagnetic interference gets canceled that way. The current flows through the shield. As a result, inside is protected because the fields cancel one another.

So anyway, but that's how come [the Apollo vehicles] were [essentially] okay, except the signals that acted up, and I think we burned a couple of temperatures sensing circuits… but the wires actually came out and went into the service module. There was a disconnect, you know, when you separated the two, there was a place where those wires came out and they weren't [shielded] very well, and they got induction that way, and as a result, they caused damage, but it was not significant. But that was just luck. …We found out [after the fact]. Okay, so now, as a result of that, then we said, "Well, we'd better do something about all this, because it's not a very good idea to be [hit] by lightning…"

First of all, there is a… Society of Atmospheric [Scientists. They are a group that studies the physics of lightning. For the most part they came from the academic world] and they got involved. I got involved with them, and that was very interesting, because I learned an awful lot [about lightning] and they learned an awful lot [about spacecraft]… Between…us, we ended up with a set of [launch] rules that would…[enable flying in weather conditions that should not trigger lightning.]

… [Applicable for a vehicle that was not designed for lightning,] I mean, it was very, kind of a risky thing, the thing is, you want to try to eliminate the possibility of that happening… [The rules encompassed a] discussion of clouds [and] the charge in the clouds, and how close can [one] get…without triggering lightning?

So this, by the way, was not that lightning struck us; [the vehicle] triggered the lightning. The lightning would not have happened if it wasn't for [the presence of] the vehicle. It ends up this vehicle flying all of a sudden enhances the electric field, okay, to the point where the electrons will start to go, [lightning].

This is what…happens with airplanes. Airplanes end up triggering lightning, [which] goes into them and it comes out of them. In other words, it doesn't terminate on an airplane, it goes through it, [since] an airplane doesn't have enough [electrical] capacity, it can't store enough electrons in there. See, so the capacity is almost nothing. It takes a tremendous area to…[store enough] of electrons…[to create lightning].

But anyway, that was a big thing… These atmospheric electricity guys…[were eleated] over that. "Oh, look, they triggered lightning." They'd been [studying] trigger lightning…[and here’s] an actual case. [It was a] big deal, and all that. So that became…famous in that world, [and] I was making presentations and talks on it… But the fact was, as a result of that, we [learned] how close you could get to certain [weather] conditions [and not trigger lightning again].

And then it ended up also, okay, now measuring those conditions on the ground. We had electric field mills all around, looking at what the electric fields were. And then things came in like clear air lightning, you know, lightning doesn't have to come from a cloud, and various aspects of…this had to be addressed.

But anyway, to make a long story short, we ended up with a set of rules, how far you had to be from this or that. The idea was to not let that happen, if we could, although it looked like the Apollo was…reasonably okay, you know, but still not 100 percent. See, the question is always how much current could you get [induced in the circuits]. Anytime you have windows, you've got places where fields can get in, and it's a question of how much [lightning] current you have flowing through the [structure].

Lightning, for example, can have as much as 200,000 amps flowing, 200,000 amps. That's a lot of amperage. [It] can be that high. Most of them aren't that high. See, 100,000 or 80,000, you know, something like that, but they can be as high as that. That's a lot of energies being dumped all at one time. So the question [was], what to do about that [with the vehicle on the pad].

Okay… ASTP was coming along and we had the [weather launch] rules set up for Apollo's next flight, you know, when we wouldn't fly. But there's also a possibility of being struck on a pad, and the question is then—there was an Atlas that got struck, for example, and the question is, okay, now what do you do when the vehicle gets struck on a pad? How do you know you hadn't damaged some solid state electronics, which is very sensitive? Now, if everything's shielded right, that's fine, but how do you know it? Since it hadn't been designed for lightning, how do you know that's the case? See, how do you know you're okay? Here again, you're playing Russian roulette. This is about luck again. Well, what do you do?

Well, the only thing I do is test everything [again]. [But], you can only test it to a certain degree. There are certain things you really can't test, and you can go change all the [black] boxes [and] put in new electronics if you want [but that takes time]. That's one thing you could do. …This is the type of thing you're up against.

Anyway, so here we are with ASTP coming along, so the question was, the Russians are going to be up there, already in orbit, and we would have to launch at a certain time, and if the weather was bad then, the argument I was making then, first of all, before I got to that argument, it was, now what do we do to make sure that we don't get [struck] on the [pad]… which we'd have to, you know, the question is, now what did we damage, and have to be re-test and all this. The Russians are already up there. In other words, it's not like I can wait two weeks later or another month. Well, no, they are already [in orbit] and waiting for us, see, so we'd better not be the ones [to terminate the mission]. So I was very strong on doing something [to give us the best chance].

So I came down here [and had a session] with the KSC people [and] the center director… and I said, "Now, you need to [provide lightning] protection on that pad, because we cannot have that vehicle hit, because if it does, it's going to be your damn fault, because you didn't do something about it." And…suggested is…[ways to protect the vehicle on the pad]. Well… the center director decided he'd better go do that. So that tower is still on there now, on the launch pad, so if it gets struck by lightning, the vehicle doesn't get… [affected].

Now…[the issue was] if it's possible to go, we should go. We had these [weather launch] rules, you know. If you're this far away from thunderstorm and this and that, we won't go. Well, I said, "It would be a hell of a damn note because if they're already up there, it's not like I can wait for tomorrow or the next day or whatever, see. I have to go." And if there's any possibility of going, we should go. We should know that.

And the only way we could do that was to measure what the [real time] electric fields [were]. If the electric fields [were] not high enough, then this vehicle flying into that field would not trigger the lightning. But if it's to that threshold where it could, then you wouldn't go…

Now, in order to pull that off, I ended up getting a number of airplanes flying at different altitudes [measuring the electric field]. The Air Force sent me a couple of fighters [especially equipped], and… one plane from the Navy and there were a couple of research aircraft that were used, and even the Schweizer power glider was in amongst it. There were [assigned] different altitudes [along the launch flight path].

They had…field mills to measure what the electric field was, so if the electric field was [in limits], okay, then we [could] launch. Forget where the clouds were or anything else, see, we were going to go. You didn't have to have a clear sky. It was just a question of the [electric] fields being okay, and if the fields weren't all right, we wasn't going to go, and this is what was going to be used. I mean, this "Air Force," so to speak, was put together to do that [before launch]. But the day was fine. It was a clear day, a nice day, and there was no problem…

Then as a consequence of all that, then here we [were] designing the Shuttle, so one of the big things I [pushed] for the Shuttle…to…design [it] for lightning…[It would be safe to fly through lightning conditions.] You [may have to] come back into the atmosphere and have to go through [electrified] clouds. You might not have a choice… [For this reason the orbiter was] designed for lightning.

Well, that started the big activity off on that, so I had a certain amount of weight to allot to that, and part of the group that I had, you know, I had a couple of guys, a couple of the engineers were very good on electromagnetic stuff. Bob [Robert L.] Blount, he was one of my division chiefs… He and his group did a lot of the [analysis] on what you do for the Shuttle to design it that way… [But today,] except bureaucrats, you know, when I left there and all that, they start going back to the rules that you don't fly…[unless the weather was clear].

Well anyway, but that was how we got to the Shuttle, such that it could be okay for being hit by lightning. Tested a whole bunch of stuff, too, including the tank. We had things on there special for that. But that…episode…started [by] Apollo 12. That's how it ended up.

RUSNAK: We've gone from 13 to 12, and while we're going backwards, I want to ask you about 11. Do you remember where you were when it landed and when they did the first EVA?

ARABIAN: Oh, yes, I was in the mission control room. Mission Evaluation Room…[in] Building 45. Yes, that was [exciting], you know, because, yes, I thought that was an exciting moment, but probably not as exciting as a lot of people have portrayed it. I've been asked a couple times. Now, the guy that wrote *Apollo: Race to the Moon*, he asked me the question a couple of times. Essentially, it was like that. Different times, like two years apart. Maybe three times he asked me the question, how did I feel [at that time]. And I said, "Well, yes, it was all right. It should have worked [per the physics and per the design], unless something went wrong and it was just luck. It's not surprising that everything worked." I'm talking about that it was a doable thing. And I said, to me, the most surprising thing to me in all the space stuff that I was involved with, believe it or not, is the first time we sent a capsule around the Earth, and you lost the signal, and there was no data, and then when it came on the other side, and it came the right time and the signal was there, which said…the physics is correct. To me, that was more impressive than landing on the Moon. Landing on the Moon is supposed to have worked. Now, if it didn't work, that would have been a tragedy, if something went wrong or whatever, but it should work. It's not a question, should it work? But to me, I probably had not shown as much excitement as a lot of the people had shown about it.

One thing I certainly was doing while that was all going on, I think I was putting myself in the minds of the crew, of what they were seeing and what they were feeling during that—I don't know if you can transfer one mind into another. I mean, I think I was doing that. Yes, in the comments that I made to you, on that thing I showed you, about [seven] times they went to the Moon…and [all were] successful, and they didn't have anybody there, they launched themselves, they landed in a strange place, they didn't have white suits on, they didn't have all these people and entourages, like they land the Shuttle right now and all this baloney and fanfare, and for what? For nothing. And look what they did there. And you have to raise the question of, if they can do that there…the physics [is] the same, why are you doing what you're doing here? A very significant thing to address, okay, and it's a very fundamental thing. And then you say to yourself, some of the things I've been trying to explain to you all along, is, the thinking gets screwed up, and once a person gets taught wrong, unfortunately, you can't re-teach them. [It's very difficult to change.]

But to me, one of the most profound things I would say is that of all this activity that happened, is why, okay, why can just two guys do all that, and you get on this end of the line, [that is, for launching at the Cape,] you can't? By the way, the proposals I have, where the crew gets in, launching the Shuttle…[themselves when] they're ready to go… get in there, and they go. They don't need all these people… just like an airline…

There's a lot of stuff that's done wrong, and I think it's one of the things I'm trying to point out here, is the general way that we think of things gets single direction. I mean, in other words, everybody jumps on that bandwagon. There's no way you can turn it, and that's the way it's going. You can't stop it that way. You cannot see if that's the best path or not the best path. It's just going to happen like that, until the thing terminates. I guess that's what I'm trying to say about that. [In that regard the shuttle is a basket case.]

RUSNAK: Were you any more excited about Apollo 8? I know a lot of people have mentioned that they find that to be a more significant event than even Apollo 11.

ARABIAN: Oh, yes. Oh, yes. Yes, I thought that was fantastic. The fact that we had management [had] the guts to go do that… That, to me, was first class, and I think the people responsible for that—I guess Borman probably wanted to do it. I don't know who first proposed it, whether he proposed it or not. Do you remember? I'm not sure where that first came from.

BUTLER: I believe it might have been George Low.

ARABIAN: George Low, maybe, yes. George Low, it could have been. Yes, George Low, by the way, of all the people that I have known in the program, I admired him more than anybody else, for several reasons. One is, [he’s an] excellent technical guy. He knew; he didn't do things on emotions. He did it on, and I'll use the term, "engineering evidence," or physics, the evidence of physics… He was a very perceptive individual. He listened to…you—and he depended on you. You knew he depended on you. And he was a very hard worker. He knew what was worthwhile doing and what was not worthwhile doing.

The thing is, there are people who do things—you've seen managers in positions where they create unnecessary activity. You know, meetings of this, meetings of—I mean, you know, or forms of papers. None of that. I was under him. I was head of the test division, and then I reported directly to him… But I admire him more than anybody that I can think of. He also was very fair. And you can depend on—it's almost like, the equation F is equal to MA. I mean, that thing, you know, that relationship was always there and it had soundness to it. Yes, he was just a peach of an individual. I mean, he wasn't like a boss, so to speak, but he wasn't ever doing things that are unnecessary to do. Yes, to me, he was probably the most key person in the whole [Apollo] activity, in my opinion.

Most of the astronauts were all right. It's a different world, though. It's not an engineering world. That's a pomp type of thing, almost like, and it was a separate thing. I saw it as a separate package. It was a peripheral type. What they did was very gutsy, I'll tell you that, without any question, but some of which was not necessary.

Well, you've talked to Max Faget, haven't you? Have you talked to him yet? He had the position, and I agree with him. A lot of stuff I didn't agree with him on. Yes, Max was pretty good, in general, but he didn't think that they should have had test pilots. That was one thing that was probably—it was okay. It worked out all right, so I shouldn't complain about it.

RUSNAK: What was he preferring?

ARABIAN: Like he said, you could board up all the windows, which is right. I mean, they wanted it like for an airplane. See, it's made like an airplane, you know, they're flying it. You don't need any—I mean, you can not even have windows like an airline or anything else. I mean, you don't take off, you don't fly the thing on the way up. The thing flies itself. I'm talking about, well, talking about any of the spacecraft. You're on the booster, you're on the booster. Nobody does anything. FOD doesn't—nobody does anything. What starts the whole activity? People don't even start activity. I don't know if you know that at T minus twenty-seven seconds [control] goes [to the] on board computers. They do everything. [The people] sits and watch. If they don't like something, the computer doesn't let it go. They said, "Oh, why'd it scrub? I don't know, it shut down for some reason or the other." Then they've got all these people watching. Doesn't make any difference. It's all handled that way. Landing, everything's handled by the computer. You cannot put it into the hands of a man. He's not capable of doing it.

I remember looking at the data one time on some simulations that were run in Ames [Research Center, Mountain View, California] on flying the Shuttle through a standard turbulent model. That's…the turbulency air is, they design airplanes for. You know, you've got to have some design condition and what kind of turbulency. But anyway, so they were flying the Shuttle through turbulent air [on] the simulator… It had all the characteristics of the Shuttle there. And you let the computer fly it.

Well, first of all, let me say this to you. There are three hydraulic systems that they have on board, and so there are three APUs [auxiliary power units], you know, that have the hydraulic pressure, so the work is a factor of three, and then that's the maximum amount of work you put in them, and all the hydraulic systems are operating, you actuate it. And if you take and have the crew fly it, doing the best they… [could do required] the three hydraulic systems to put out the work… On automatic [so] that it's all done…by computer… you need [only] one [hydraulic] system operating. This gives you comparison.

That, to me, was very [surprising]. I remember when I found that out and I saw that data and I said, "Look at this. Gee, what the hell have they got men in there for?" I mean, that's all wasted energy… Man has to have something happen, then he responds. The computer can do it [almost immediately], the quantity that they can detect is so quick and so fast, nothing happens, see, so the thing's essentially right there.

Well, it's true of airlines. I mean, airlines now—pilots don't generally, I don't think, I don't know if any airline lets the pilot land it now. I think the computers basically do that. They can take over if they want, but I think because it comes in such that it saves them money-wise. It has to do with cost of tires and the smoothness of the landing, and all that. Computer just is beyond the capability of man. But anyway, yes, so this is why the thought that the crew was there, and I kind of go along with that pretty much, that you don't need [them].

RUSNAK: I want to ask you about another what I think was a bold move for Apollo, and that was the all-up testing idea, where you send the Saturn V, you know, with all the working stages rather than going one on one.

ARABIAN: No, I don't think that's right either. That's another thing with testing. You don't need all-up testing. You can piecemeal stuff together, but you've got to know what you're doing. I mean, you've got to make sure the pieces—here again, if you don't know what you're doing, then something like an all-up test is okay. I mean, it's a costly thing, but what I'm saying is—well, let me take those stairs over there. I can go ahead and design that railing to take a certain load, and I can test that by itself and load it and make sure that's okay. Then I can design the stairs to take a certain load, you know, and test it separately. Then I can put the whole together and say, okay, now that will go and take this load, plus that load. I don't have to, now they've got it all assembled, to go ahead and load the two things simultaneously and then see what happens. You see what I'm saying?

So it's simply that, and most people say, "I don't know what the interfaces are." Well, you shouldn't be designing it if you don't know the interfaces. Now, if it's easy to do, fine, but it's not necessary to do. It's necessary to make sure. There's one thing that I used to advocate all the time. I was head of the test division… I didn't do the tests just because they were tests.

I wouldn't have had that division called "test." I wouldn't have called it "test division." It shouldn't have been called that. It was the wrong name. It should have been, what do you do to show that your design is okay. I would use that. It means, okay, it can take all what it's been designed for, and you demonstrate that it can do that, and that's what I call a qualification test, so to speak. It means I put the loads on it's been designed to take, plus I go beyond that to find out what's going to break, so I know what the limits are. Now that is how you should go about doing something, and once you've done that, see, I no longer have to go ahead and redo that for every one that I make. The only thing I've got to do is make sure every one…is made the same way, and I don't have to test it to do that, although they turn on. People go around like kicking tires… Well, that doesn't tell you whether this is okay or not. Kicking tires is not the way to test tires. I put a tire on, I better know that it's been manufactured and inspected, such that it's manufactured [correctly]. I don't have to load it to show. That's one way I can do that. That is certainly a case, but that's a very expensive way to take every article and put it through the loads it's been designed for, to make sure it's okay. See, I should be able to, along the way, be able to inspect.

I'll use the word "test" if you wish, but the best thing, if you could physically be an electron—you know my little buddies, the electrons? If you could physically be an electron, and walk over, I mean, just work my way through all the wires, and look at all the installation, look at everything physically, because it's only physically something's wrong, and if it is, I can see it. If something's broken, or it's the wrong material, or something like that, it's that simple. It's not some complicated fancy thing. I need to look and see it's made the way the drawing says it's made. The dimensions are right, the materials are right, etc., and it's torqued right. It will work then. You don't have to have two, and you don't have to test it. It's okay. [You thoroughly inspect.]

Yes, my notion of testing and the testing—now, there's other people. I remember at the Cape, when [I] came down here and…went to work for Rockwell, I told Rockwell I needed to come down and try to make this thing [(the shuttle)] pay for itself, because it wasn't. So I went and saw the president of Rockwell, you know, and he said, "Yes, okay, very good." So he sent me [home]… Well, the Cape was of the opinion [that] everything…[had to be tested]. These are the Rockwell people and NASA people both. This is the old school, and [I was] trying to break that out [so] that the Shuttle pays for itself so my…object was to do…that.

One other thing had to do with testing. A lot of the testing was unnecessary that they do, [when] they come back… See, they were knocking all this stuff out. So I had it all figured out, where, in fact, you [could] make [about] sixty flights a year, by the way. It wasn't a question of just—but it was a lot of stuff that you would not do, what's unnecessary to do. You're wearing stuff out. The CRTs [cathode ray tubes], for example, inside the Orbiter, they were wearing out just testing them on the ground, putting too many hours on them in the flight. They had to replace them. I mean, leaving this on all the time.

The whole group of people down here was of the notion you have to test them. They were responsible, the tests that they performed. Their notion of what a test was was even wrong, but because they tested it, they knew it was okay for flight. And they were qualifying it, too. I came down here and I was making talks to groups and all this kind of stuff, you know, trying to get this whole thing changed around differently. Those people thought that they were the ones that are responsible for making sure that that thing's okay, qualified to fly, and they didn't have the foggiest idea of how you qualify something or what it meant.

See, but it was just set into them… during Apollo, but nothing was fought then, you see, it was just left that way. And as a result, it was ingrained into them, and it was almost impossible to change anything here. But that was all this test notion type of stuff. To me, that needs to be digested more, but I don't know of any group that's appropriate to do that.

I mean, like FOD, the way FOD operates, you know, and the Mission Evaluation Room operates, and all that, that's a way they're doing it, but that's not—it's like Apollo works, but as a result of what happened in Apollo, there's a lot of bad things that have happened consequent to that. I mean, bad habits, habits that were bad. They weren't bad insofar as Apollo goes, because of the conditions, but they ended up being detrimental to [the Shuttle] programs, where it's kind of screwed everything up, in my mind.

RUSNAK: Your last job with NASA was as a Program Operations Manager, is that right?

ARABIAN: Yes.

RUSNAK: And you left in '79?

ARABIAN: 1979, yes, and then I came down here and went to Rockwell, told them what I wanted to do, and the president, fortunately the president wanted to do that. In fact, I went and talked in front of the board, you know, made this whole proposal what to do and how to simplify this whole thing, and they were all in favor of all doing that kind of thing. I was proceeding pretty good. I got the Air Force on board and all this kind of stuff.

But somebody had the notion they're going to have a single contractor down here. This is another dumb thing, and that all started, so that stopped after that, see, so that was all out. So anyway, so I terminated.

RUSNAK: You mentioned the Air Force. What involvement did you have with them and the Shuttle?

ARABIAN: Oh, see, that was interesting, because in order for NASA to get money from Congress, it was necessary that the Air Force use the Shuttle, too. So NASA had to convince the Air Force that this was a very good thing for them, because they needed the funds. The Air Force had to put in, I've forgotten what the amount of money is. Some other charts I have show that, in cartoon form. But anyway, I showed them my little coyote, by the way. There he is, talking to all the brass of the Air Force. They had their sunglasses on and whatnot, and they're all convinced, oh boy, this is just the thing. You're going to have this, that, and the other thing. He was really selling them a bill of goods, see, so he gets them on board. This was fine with the Air Force. So the Air Force wanted to have their own operation, out there at Vandenberg [Air Force Base, California], so the Shuttle then was going to go out to Vandenberg anytime that they had one of their launches. Now, why in God's creation they wanted to do that, you know, is another argument.

But anyway, so Rockwell, in all their glory, was in favor of that, because that meant people going out there, it was another activity going on. Well, here I am down here, trying to straighten this whole thing out, even with the Air Force. So I'm getting involved with the thing, too.

And so I went—this was very good because I went—George [Jeffs]—what's his name, from Rockwell? Who was the president then? Can't think of his name. Anyway, so after making a pitch to him and all their people, see, a lot of the good engineers, you know, they were behind me out there at Rockwell, too [except those who would lose their jobs]. A lot of companies were behind me, like they would give me data that I needed, and they all knew what I was doing. It was just not me getting up saying that; I had to have substantiation behind it all, people [like engineers] from RCA and [others], you name it. I mean, all of them were under the table, telling me all this stuff. They were agreeing with it. They'd give me the evidence that I needed and all that. So this was all being put together, so here I am.

Jeffs, George [W.] Jeffs, he decides—well, first of all, I went and talked to the Air Force one time. Somehow I pulled that off. Rockwell didn't know I was doing this, because they're very controlling. I was a free cannon, kind of like, see. So I went and talked to the Air Force. Oh, they liked it. They called up Rockwell. "We like what Arabian's doing." What? They didn't know all this stuff. So they couldn't say nothing, so I really had my foot in the door properly.

…Anyway, so George Jeffs decided, okay, we're going to go see them and we're going to make a pitch to the general out there about Vandenberg and all that. So I'm making this whole pitch, and it's just me and Jeffs…[the General and his] entourage of military. Nobody else is there.

…The general was [intrigued], boy, he says—I remember there were pictures all over. He says, "Boy…you have to have balls to do something like that." And George Jeffs says to him, "Well, that's how you make a one-star general a two-star general." [Laughter] I remember that plain as could be.

And then the activity continued on from that, see, but then there were vice presidents out there at Rockwell who saw that as a big threat to them because a lot of this stuff would not be done, and their money that they make was based on—their bonus that they get is based on how much money they're taking in, see, so I'm just eliminating this like mad. But the president of the company [Jeffs] is behind me, see, so there's a big problem.

But anyway, like Vandenberg, I remember going up there one time to them, and this was when Rocco Petrone was hired at Rockwell, and he did not let me do this. I'm going out there and making this pitch to the Air Force about how we could go ahead and take a group from [the Cape], two weeks, and I've forgotten the number of people, just a handful of people, had everything all [figured] out and all the people here all agreed to it. A whole team would go out there to Vandenberg when they're ready to launch there, service, do everything that needed to be done to the Orbiter, and launch it and then come back and do it in two weeks. I've forgotten the number of people, maybe three hundred at most, something like that.

And oh, my gosh, so Rocco Petrone, he's out there working for Rockwell [at Downey] then. Well, I had to show that to him before we…[presented it to the Air Force]. He said, "We can't tell them that! Boy, we'll look terrible." Well, that's exactly right. [Laughter] And they had, I've forgotten the number of people they had working out there, like 1,700 people, I think, already out there at Rockwell, at Vandenberg, but, you see, this is contractors just bleeding the situation, because the way the contractors are set up, it's wrong. [But it was equally wrong for the government to contract the way they did.] It's cost-plus. In other words, whatever it costs. See, and the more people you have, then the more…you have to make on it. So you don't try to keep everything down. It's designed to expand. Just like this place…[KSC]. I have no idea how they're contracting right now, but that's the thing that's wrong, fundamentally wrong. In fact, I remember doing some flights with—I'm going to go off on a tangent and I'll come back again. I'll tell you about the tape recorder, which is very good, that we used in the Shuttle. That comes to mind [talking about contracts].

But anyway…back to Vandenberg… For example, there was one facility they had… for testing the OMS [Orbital Maneuvering System] system… Special facility out there. Why have a special facility here? Well, you couldn't [get to] use this [KSC] facility [full time], even making sixty flights a year… I said, "What do you guys need that out there for?"

There's George Jeffs with me. He's backing me up, the president of Rockwell, too, see, and they liked that. They liked all this stuff. You don't need all this crap. Cut this out, cut this out, boom, boom, boom, boom. In fact, [you] didn't need the place out there [at Vandenberg]… And eventually that all got screwed up. Why did they get screwed up with the Air Force? Well, first of all, you couldn't depend on a launch [schedule, not even close. Supposed to make dozens of slights a year—well you were lucky to make a half dozen or so.]… When the Air Force wants to go, they had to go. They can't sit around and say, "No, we're going two months from now." I mean, that's it, see. So they said, "Forget you guys." That's right. Everybody [(the commercial guys)] else said "Forget you," too. But, yes, so there was a lot of trauma.

I remember going out there [to Vandenberg] and making a whole pitch to the [Rockwell] group… and they just saw what I was doing. They would be out of a job. Most people saw I'd be eliminating them… Put it…this way. I said, "It's very simple to calculate what it costs to [turn around] something. It's the number of people…[on the payroll] that's the big expense." Whether you do [fly] or not, you're paying that out all the time. [Laughter] The cost for the vehicle is [minor]. Don't talk about the fuel and saving this and saving a few hours here. That's peanuts. I said, "If you don't knock somebody off the payroll, you've done nothing [to reduce costs]." Or if you want to keep all those people, then get the flights up to the point where it's damn well cheap enough. [This meant stopping all the unnecessary retesting.] But those are the two things, and you chip away with that. So I had all kinds of schemes…[to do that].

But anyway, back to this—I'm going to tell you about this tape recorder. Odetics. There are a lot of [other] stories coming to mind, I think. But anyway, Odetics was making a tape recorder. NASA had something called low-cost office, out of Washington. This was one of these Washington crappy things that they thought that rather than having each program developing a tape recorder for their use, I mean, whether it was unmanned or whoever it was in NASA, Goddard [Space Flight Center, Greenbelt, Maryland] people, or on and on and on, they figured, oh, the low-cost office, which is a dumb thing. High-up management doesn't know what the hell [they're] doing.

But anyway, so they're going to have this low-cost office. Well, this low-cost office was going to operate. Each one of the programs was going to use this thing, but put money into it, and then the low-cost office would go ahead and make this recorder that all of NASA could use. It had the capability to take analog stuff, digital stuff, voice, you name it. It could do, I've forgotten how many channels was in there, but it could do anything. Anything you could imagine…you could do it on that recorder.

Odetics gets the contract to go make it. Odetics is out there in Orange County out there near Los Angeles…a little outfit, [but a] good outfit. So I'm still back in Houston. So they're having, it looked like, a little trouble with that recorder. They might not have it in time for the flights that we had coming up, you know, it was getting squeezed. So Aaron Cohen was program manager for the orbit…so he needed that thing and he was putting in, I think already put in two and a half million dollars or something like that into the—but he sends it to the low-cost office and then they pay Odetics. But they're the ones who are controlling what the configuration of this thing…[and managing the activity with Goddard help.]

So I get asked by Aaron Cohen to go out and see what I thought of the whole situation, so I go out there, have a [session] with…[them, Odetics, the Low Cost office, and Goddard]. So I'm going over [the design of the recorder]. I can't believe what they're saying, and we only needed a small portion of [its capability]. I said, "Okay, you guys. Hey, we don't need all this stuff. We just need this part. We can't hold up this Shuttle thing just because you guys haven't finished this other stuff."

So anyway, so I didn't say too much more to them, and I came back and I wrote this letter to Chris Kraft telling him about the situation. This dumb, low-cost office ought to be hung from the yardarm… How stupid to come up with this thing? It's going to cost us, not only cost us, you're not going to have [the] recorder [in time]. This thing needs to be taken the hell away from them. And that's what I wanted to do.

So anyway, so, yes, at the time I was working for Kraft then. I was Program Operations Manager then. So anyway, so Kraft…sends this letter up to the administrator, and immediately, this thing ended up in pretty good shape then, see, because it showed it was very stupid and we couldn't put up with that, so immediately, somehow I got control of the whole thing, see. So I then took the thing away from the low-cost office. I just told them I was going to do that. "You're no longer involved with this thing. I don't know who your boss is, don't worry about it. But this is the way it's going to be."

And then our contract people said, "You can't do that." I said, "What do you mean, I can't do that? You come on out there [to Odetics]. I'm going to do this." So I took the thing away from them and [simplified] the whole…design, set it all up, made a deal with Odetics. I told them what the price—I made them think there was another company [wanting to take it over] I was thinking of having. I worked them down to a [fixed] price and that was the way it was going to be. There wasn't going to be any cost-plus or anything else. It was going to be a flat-time thing. The cost-plus thing made me think of that.

And that's what we ended up doing. Took it away from them, changed the whole damn design, eliminated all this stuff, just eliminated stuff, and we got what we needed, the price and everything else. The contract people said, "You can't do that." I said, "Why not? Come on, you watch me." [Laughter] Yes, that was quite an interesting little activity, a little side issue. I used to do those things every now and then, get involved with problems.

RUSNAK: After you worked at Rockwell, did you have any other jobs?

ARABIAN: Yes, I went to China for a while, for a little bit. There was a satellite that was put up by the Orbiter. In fact, there were two satellites that were put up [the same time] that didn't work… They were Hughes [communications] satellites. One was for Indonesia, I think, and the other one was for Western Union, and neither of them worked. I think it was the stage [PAM – Payload Assist Module] that they were on…[that was the problem].

But anyway, the Shuttle went and recovered them after about two, three years. They were up there some period of time. They recovered them and brought them back. Well, it ends up they were insured, and one of them was insured by an outfit in England, I think

Meredith, Meredith [Insurance Company], it was called. And so they had insured the thing, so Western Union was getting a brand-new satellite, because they weren't going to use this satellite over. Well, this insurance company had this satellite, they didn't know what the hell to do with it, so this guy by the name of Michael Johnson, who was an entrepreneur in New York, a wheeler and dealer, and he went over there and somehow got a hold of this satellite for about a million bucks. Now, I mean, having a satellite's one thing, but you need some place to put the satellite, see. So somehow or other, he wangled and got a position he could put that satellite…over in the Pacific Basin, okay, in the China area… I don't know how he pulled that off.

But anyway, and how I got involved, there was this one guy [Bill Hussonica] that knew me, and he called me up one night and he said, "Hey, Arabian, I need you over in China." I said, "What do you mean?" "We've got to leave tomorrow," or something like that, or the day after. And I said, "What's going on?" And I thought he was drunk or something, so I didn't pay him much attention, but he called me the next day during the day and he said, "Oh, yes, we got to go," and it was Martin Luther King's birthday. It was on a Monday, it was a holiday, and I didn't even have a passport, and we were leaving on Tuesday. [Laughter]

That was an interesting story in itself, but anyway, I ended up having to go to Hong Kong and whatnot, and from there I went to China. But this guy got this position and then he needed somebody that knew what the hell to do with this thing, you know, who was going to interface it with their launch vehicle. Oh, he gave it to the Chinese somehow to use their launch vehicle, I think, somehow is how he got the position, was the Chinese position, and I think he was going to use the Chinese to launch it. Somehow he got that involvement, where it was some kind of a deal. I don't know [exactly] what the deal was. In fact, there was a vice president, one of the vice presidents who worked for Pan American was a Chinese guy that was involved with it somehow, too. And there were a couple of other people that put money into it.

But anyway, so that was the deal, so he got this guy that worked for Pan Am, this engineer [Bill Hussonica] who was with NASA, who knew me, all the stuff that I was involved with and…so he called me up and he says, "We're going to go do that," and he was going to be the one handling…the engineering stuff. So he said he needed me for that…

That's a story, just how I got…[a] passport in San Francisco and almost didn't make it…but did it in [about two hours]. They said, "Never done that before." But anyway, pulled that off. That was very interesting, because all these concepts that I talk about, what you need to do [for testing] and not need to do, okay, so you got that, you don't need to test this and that, so you got that in mind.

Now, the next thing was that Western Union, by the way, who now has got a new satellite from Hughes. See, Hughes is the one that made this particular satellite and then they made this other one, and they made a whole bunch of them, as a matter of fact. Well, they were going to make a new one for Western Union, so Western Union is over with the Chinese, too [because] they're going to use the Chinese to launch it [on the Long March vehicle].

The reason they're going to use the Chinese to launch it, first of all, the Shuttle's not launching anymore [commercial stuff], but, secondly… it's cheaper to go with the Chinese than it is with anybody else…[in the world]. The Chinese [charged] $30 million to launch.

The Delta is $60 million to launch. This is a Hughes satellite, you know, one of these communications satellites, that size.

So that was the deal, and so the question was, what to do with this whole set-up. I mean, here we've got a [second hand] satellite. The first thing we do is…go talk to Hughes, so here's me and this other guy coming into Hughes, you know, and saying, "Oh, yes, we're going to do with this satellite." So Hughes said, "Oh, you need to do this, you need to do that and the other thing," and come to find out, well, they are also, Hughes is working with the Chinese to launch this new satellite that they're going to build for them, which is identical to the one that we had. [The insurance company paid Western Union for the failure.] It's just a Hughes—I forget what the number was, a certain configuration.

So they have been already working with the Chinese, so the Chinese had a notion about what's going to be involved. Well, they didn't have any facilities over there for doing any testing of this satellite [like they do at the Cape], so they were going to build all what was needed, because the Chinese hadn't done this before, commercially, for anybody but now they're going to do this. So we're the first two [outfits to use the Long March launch vehicle]. There's the old Western Union plus this old—you've got old Western Union one, plus the new Western Union one, so to speak. But this new outfit which I was a part of had the old one.

Anyway, so they met with the Chinese already, the Western Union people with the Hughes people and the new satellite, and they had a big meeting, you know, all documents…and there were twenty-five people there [for Western Union]. And they had all laid out what they needed. …[The] kinds of facilities, and the Chinese were just going to build…[what they wanted] to check this out, [to] check [that] out, do the spinning stuff, you know, and on and on and all this stuff [like what was normally done at KSC]. Special buildings, making them, didn't have them there. Everything was just, whatever you needed, okay, we're going to do that [and] thirty million dollars, we'll launch it for you.

So anyway, so we're about maybe three or four weeks later, something like that, so we're over there meeting with the Chinese. So we come walking into this meeting, here's all these Chinese in there, big hall, and it's cold, wintertime, and the Chinese look around, they're wondering. We have an interpreter, you know, and they've got an interpreter and all that. They're wondering, where's Hughes? Well, Hughes, what do we need Hughes for? Only you guys? There's just three of us here. Yes, that's all. They couldn't figure that out. [Laughter] What's going on? Well, we don't need them. How are you going to make out without Hughes?

As a matter of fact, one of the funniest things was, when we had a meeting with Hughes, I got the diagrams, I got the manual from it to see what the…[systems were like] in the satellite, because I didn't even know what the heck was in the satellite, you know. So anyway, so I'm looking at the whole thing, and come to find out, this is funny, because there's an error that they have in the electrical drawings. I'm looking at this circuit that they have that charges the batteries up and all, and I said, "Well, hell, this damn thing, if this is the way they designed the thing, it ain't going to work. It won't work right."

So I got there, and they were—I mean, here is these two guys coming in to Hughes, who have been all in this business all along. So we come in there and sit down. Oh, yes, I'm going over the design, you know, what that is. I'm saying, "Yes, this isn't right what you've got here." They were aghast, that their manuals weren't even right, you know, in this one place, which is really strange, see, but normally somebody doesn't pick up something like that…

But anyway, so here we are. You get the set-up now. So the Chinese, you know, we told the Chinese, I said, "Look, we don't need anything. The only one thing we need to know, when you're ready to launch, you give us a call. We're going to fly the satellite out there on Tiger Airlines." You know, Tiger Freight Airlines? You ever heard of Tiger Freight? I don't know who bought them out. Somebody must have bought them out. But anyway, it used to be an airline, just freight airline. They just flew freight, called Tiger.

Anyway, so we were going to fly it out there. We had a place to land right in Xichang [phonetic]. There was an airstrip there, and we were going to trailer the thing over to where the launch site was, which was like twenty miles away or something like that, and we're going to put it on and we're going to go launch it. We're not going to come out there before then.

Well, here's Hughes, they're going to be there two months ahead of time. They're going to need facilities and cooks that can cook American food and Chinese food. They had all these requirements. Blow your mind. TV. You name it. They had all these facilities they were going to build for them. All these guys were going to go out there with this satellite and test it. And I explained to the Chinese, I said, "This damn satellite, I mean, Western Union is not going to buy it unless the damn thing's okay. What the hell are we going to go out there and test it for?"

Then I had made a whole presentation that I have—I think it's still up there someplace—to the Chinese that showed them how things are blown out of proportion in this [space] world, that if you want to do that, you're wasting your time and money because you don't need that, because you're going to be done out of business if you're going to do all this stuff. In order for you to stay in business, you just need to do what you need to do. So they couldn't [unclear]. So we did all our stuff and that's the way we're going to work and get all the things straightened out, but they were just…[amazed].

…I remember going through some of the [Long March] circuits. They had [a circuit] that would blow the [launch vehicle] up if the [angular] rates got [above] a certain value… And also, if the attitude got into a certain position, it would blow itself, so there were two signals that came in that [could] automatically blow itself up. Then they [also] had a manual way of blowing it up. So I couldn't figure out, you know, I said, "What the hell do they need that for?"

…So one of the things I wanted to eliminate is the fact that inadvertently get the thing blown up, you know, from the rate gyro output or gyro output, but the signal wasn't legitimate. See, one of those things again. I said, "There's a manual thing there. If the thing's manually going off, and you can see that, fine, you push the button, and if you've got any problems, I'll push the button for you." [Laughter]

And that was a big problem with the Chinese, because they did not want to have anybody—I don't know why they even had the button there, because the Chinese do not like to be a failure, [or make a mistake] doing something. They do not want to be wrong. So they wanted [the automatic destruct] in there, and that was a big bloody battle to eliminate that.

But anyway, so the involvement with China was associated with that interface, that whole activity, you know, and how the heck to do that. But that was using a lot of these things I was talking about. But here in the real world, where money mattered, all the Chinese were saying, "What the heck? Why are you doing this, and why are they doing that?"

RUSNAK: Well, if we can pause here to change the tape. [Tape change.]

Looking back on your career as a whole, what do you think the biggest challenge for you was?

ARABIAN: Solving some of these anomalies. Some were fairly straightaway, some were very complex and complicated. Like, for example, I remember working with the SLA [Spacecraft Lunar module Adapter] panels that came off as a result of rain at the pad, and there were holes where they structured the SLA. You know what SLA panels are, right? They have vent holes in them, to vent, because they're a honeycomb structure, okay, so they vent the pressure out as you go up. But it ended up, rain got in there and as a result, there was water in there and on the way up, the heating on the sides increased the pressure enough to actually fail one of the panels, and to determine what that was and how that happened, that took a lot of time. I had some very good people working on that.

But yes, there were a lot of—challenges always had to do with problems, [like when a] battery blowing up [on the LM]. You know, even to say [a] battery blew up in a flight, like one of them did, but it didn't affect anything…[it still functioned] but that was very traumatic for some people. Those were the challenges, really, because if everything was all right, fine. When something wasn't all right, and there were many of them, many of those anomalies took a lot of effort [to solve. But it was all very enjoyable—not like work].

Like the Apollo 13, that was fairly straightaway, because you could demonstrate very easily…what happened, although it was traumatic. News-wise, it was traumatic and all that, and a lot of people involved, but it was not too complex a problem. To me, those were the challenges, to straighten out when something was wrong, find out why it was wrong.

All kinds of interesting things happened, you know, like in ASTP, I remember. Not only in flight, these are other than flight ones, too. I'm talking about things, design-wise, that were happening, things like solder joints breaking, and why they broke.

I remember, and I got involved with that, this one outfit in California that was making this amplifier for the communications system, and it was S-Band amplifier. But in the qual test, they kept on getting breaks in the solder, and they tried everything under the sun, you know, specs for the solder and on and on [but] there was a very simple solution. It was a question of just in the way they were manufacturing it.

The expansion and contraction was such, they were heating one part up and the other wasn't heated up also, and when they were joined and then cooled, [the solder] was overstressed, and it actually broke the thing, but it was a design problem, see what I'm saying? So the design problems, to me, well, most all of them were design problems, when something goes wrong. I mean, crews screwing up or something, that's straightaway, but I'm talking about when something doesn't work design-wise, why is it doing like it is?

All kinds of problems I've had like that, lots of them, you know, that I found very intriguing, very educational, and it makes you think differently of things. In fact, a lot of the things I've been telling you about, testing and how you design something, you make sure it's designed right, you know what the design is, and if you've done that right, you've done it, and you've accomplished something.

That, to me, is the biggest challenge, I think. It's not going to the Moon. I mean, that got you to the Moon. See, those are the things that got you to the Moon. Going to the Moon's not a challenge. You'll get to the Moon if you've got the right design. It will get you there. To me, those type of things, when something was not designed right, why wasn't it designed right? Not why, but how do you make something such that you solve whatever that problem is? I guess most of my efforts have been on that, in solving problems and eliminating them, and do what you need to do design-wise such that you don't have problems. That's what I would say.

RUSNAK: I also wanted to ask you about some of the people you worked with and anyone you really felt maybe was a mentor for you or you felt you learned a lot from, and if you could characterize some of the people for us.

ARABIAN: George Low. I told you about him. To a certain degree, Max Faget, but his thinking, in my mind, I wasn't always in agreement with a lot of his thinking. Chris Kraft, he was a reasonably good manager. I thought he was pretty good. I enjoyed him.

RUSNAK: Any thoughts on Bob [Robert R.] Gilruth?

ARABIAN: Yes, Bob Gilruth was pretty good. Jim [James A.] Chamberlin. Yes, Jim Chamberlin's thinking was, he had a very peculiar way of thinking of things, but I enjoyed his method of thinking. He was quite straightforward. He wasn't too political. He would have been better off if he was more political, but engineering-wise, he was very good, very perceptive engineering-wise.

See, it's hard to sort—it depends what you're talking about on people, see, what you're talking about when you say a "mentor." A mentor, insofar as a leader goes or a mentor insofar as a technical guy goes, normally they're not the same. You know, they're different individuals. Lots of them are different individuals.

Gilruth, he was a good leader and whatnot, and Kraft was a pretty good leader, but the best was George Low, in my opinion. Let's see, others. I tell you one thing, there was instructors that affected me, that stuck with me, other than people that I worked with, that I learned things from. It might have to do with the subject matter, I'm not sure. It's hard to sort that out, not personally knowing them very well. I mean, how well do you know an instructor or a professor, or whatever? You only knew them to a certain degree. It's more or less of the thoughts that they put out.

There was one in particular I can think of, a guy by the name of Howarth [phonetic], Dr. Howarth from England, who taught theoretical aerodynamics, and he impressed me. I learned an awful lot from him, how you think about things. There was a Dr. Katzoff [phonetic] in Langley Field who taught one of the classes I guess I took in graduate school, and he was very impressive to me, his method of thinking, so he had an effect on me. I had great regard for his method of thinking and his thinking [(analytical)].

But insofar as looking at people like administrators, of course, their job is different. Here again, it's a different type of thing you're talking about. There were a few of those that I thought were reasonable. I mean, they didn't inspire me or whatnot, you know, but I had respect for them. And there were little engineers I had good respect for, a lot of them, I mean guys that really had a good understanding of the physics of it all and knew how to apply it, and there were a lot of those.

But here again, see, then you've got the other problem of politically being able to sell something like that, too, see, so it's a difficult region that you mess with, but you end up across with a lot of good people. Like I said, in the beginning when I told you about one of the biggest shocks to me was with McDonnell-Douglas in the beginning, how some of those people were, particularly the people in managerial positions, how they would distort. And that, to me, was very shocking. That was a negative mentor, is how not to be. You know, there's how to be and then how not to be. How could anybody be like that? Let's see. I'm trying to think of others that kind of come into mind, but that's probably it.

RUSNAK: That was all the questions I had, so I'd like to thank you for participating in the project.

ARABIAN: Oh, very nice, very nice. I enjoyed it.

[End of interview]