NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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Interview with

Mr. Cal Jarvis

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July 28, 1971

(TRANSCRIPT OF A TAPZ **RZCORDING)**

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PROCEEDINGS

(START OF TAPE ONE, SIDE TWO.)

MR. ERTEL: This is an interview with Cal Jarvis at RC July 28, 1971 and his participation in the RV. I'd just ike to have you, (Inaudible.) kind of reminisce about what ou did and whet was good and bad and the sweat, blood and ears, and laughs and --

MR. JAXVIS: O.K. Well --

MR. ERTEL: Try to give it a little humor besides hat so it will be believable to the public.

MR. JARVIS: Well it's kind of hard to talk with tha hing staring me in the face.

MR. ERTEL: Oh, don't worry about it (Inaudible.)

(Laughter.)

MR. ERTEL: And then you can spit it out.

MR, JAXVIS: Well, well I guess it's really been uite a while. I haven't had much time to think. Oh, some xperiences and problems we went through. Maybe it'd he bette f I just kind of started at the beginning --

MR, ERTEL: Yes.

MR, JARVIS: -- and kind of went through that, equence-wise. I guess the first -- really the first, oh, levelopment sequence involved in the program was the design nd fabrication stage which was more or less done hack at Bel nd involved most of the people here in liaison with the Bell

engineers. And up to the time we received the vehicle, I can't really, oh, remember the key things that happened. Some of the things that impressed me at the time, I think I was fairly impressed with the sophisticated nature of the vehicle, prior to the time we received it.

Probably not to the degree that -- probably not to the degree that it turned out being, I think in reality. As we went through the development phase I think it -- the complexity grew -- at least it grew in my mind. The key things, just to describe the vehicle very briefly, is, a very systems-oriented vehicle. It's a vehicle that was entirely dependent upon the electrical flight control system, which is kind of unique for an earth-oriented vehicle because there's not -- I can't think of another vehicle flying to where if you lose the electrical flight control system or electrical power completely, you essentially lose the vehicle.

So that kind of dictated a lot of the design philosophy and added to a lot of the sophistication itself. Of course when we received the vehicle, it was in a disassembled state and I suppose Wayne could probably fill you in much better than I can why we received it the way we did. There were contractual problems, tiae problems, schedule problems, same as any program.

When we received it, it wasn't completely put together right. We agreed to do a lot of the final assembly

work and essentially all the integrated flight control systems tests ourselves here with the contractor's support, So a lot of the systems hadn't really been proved out, like that jet engine ~~added to the~~ attitude control system, and ~~added to the~~ attitude control systems and electrical systems, and all these things really hadn't been -- really hadn't been -- integrated and run together, and it was really at a pretty green state.

So we went through a couple, three months, I can't remember what the time was, tying everything together and getting the system on, and continuity checks and de-bugging, and these sorts of things.

We finally got to the first real area of systems testing which was the running of what we call a closed-loop test on the jet engine attitude control system. This is the control system again and all the electrical system, and they position the engine vertically during the various modes of operation. A fairly complicated and sophisticated system in its own right.

I remember the first time we ran that, we tipped the vehicle and tied it down with big, half-inch steel cables, if I remember right (chuckle) to steel girders on the hangar floor, the calibration hangar. The idea was that because we were going to be cycling the engine, which is a pretty massive element, we didn't want the vehicle to bounce around all over the hangar floor and be damaged. So we tied it down pretty

tightly. And of course there were a lot of people around because it was the first really thing we were going to demonstrate -- in an operational manner.

So we had a lot of -- I remember Bellman was there, the project manager, (Inaudible.), and a lot of people -- a lot of interesting gawkers.

And we fired it up and, lo and behold, the first thing it did was, there was some type of structural mode, stability problem, and rather than just sitting there like it was supposed to do, it began oscillating in' such a manner as to just kind of bounce it up and down at a perfect rate of about two or three cycles per second.

And it was really a very funny thing to look at -- here's this big thing tacked down to the hangar floor and there's the engine just sitting there -- (Laughter.) bouncing up and down.

And then when I kind of looked over at Bellman about that time, and you know, you could see the concerned kind of grin upon his face.

That was our first systems try and of course our first major problem we had to deal with.

MR. ERTEL. You forgot the fact that the half-inch cable, or the tie-down cable, burned into --

MR. JARVIS: Yes. That's right, I was going to get into that. I forget exactly when that happened, that's right.

That was ancther --

MR. ~~ERTEL~~ Ottinger: That was a very early tie-down thing -- d d they get any polarity at all?

MR. JARVIS: Yes. What was happening was, we built up the ground power box,

MR. ~~ERTEL~~ Ottinger: Yes.

MR. JARVIS: O.K. It supplied 28 volts to the vehiel but nobody put a bottom on it, and all that wire was in there open and exposed, and some of the wires going to the breakers were close enough to the bottom of the box that they rubbed on the bottom of the ground.

So, sometime during those tie-down tests, somebody dragged that power cable on one of those steel girders running through the hangar floor, and the steel girder of course was what the tie-down cable was fastened to holding the vehicle down.

So you had a 28 volt circuit, you know, through the power box, through the vehicle, down through those steel girders and into the things on the floor, yes.

So everybody's standing there watching around, looking around, and this thing got dragged over there and nobody noticed it, and all of a sudden, there was a little puff of smoke, a flame, and those -- (Laughter.) steel girders just melted and fell right down on the floor.

And that -- I tell you, that really Impressed me,

you know. And what -- really the funny thing about it -- everybody couldn't understand it, you know, my gosh what's happened, you know.

And the most impressive thing was that everybody was afraid to touch the vehicle; everybody was afraid, gee whiz, if it did something like that to the steel cable, you know, what would it do to you -- blast a hole.

Everybody looked around and it was a long time before they really found what the problem was, a couple days, in I think. But that was pretty exciting.

MR. ~~ERTEL~~ Ottinger: Well didn't you initially, when you turned on that stable emission and hydraulic system, wind up with a bunch of hardovers, very, very early in the testing?

MR. JARVIS: Oh yes, yes.

MR. ~~ERTEL~~ Ottinger: (Inaudible.) with BOOM, BOOM, BOOM, full throttle on the gimbals, like 40 -- ah, what was that, 40 diegrees?

MR. JARVIS: 45 degrees, yes.

MR. ~~ERTEL~~ Ottinger: 40 degrees in pitch and 40 degrees in roll, and you can wipe that thing around those gimbals, hardovers, from center both ways. It was more dramatic, obviously.

MR. JARVIS: Yes, but that didn't, systems really, personally, those don't bug them too much because, you know, they're essentially basic problems, you go and

flip wires and get that squared away, but when you see something sitting there bouncing like that, you know you really have problems because --

MR. ~~ERTEL~~ Ollinger: Well, they beefed up the gimbal rating, as I recall --

MR. JARVIS: *Yes*, and changed those linkages, remember those linkages they had on the gimbal pots, YES, we had to square those away.

We built up our own --

MR. ~~ERTEL~~ Ollinger: You strengthened that whole structure in that center frame, and put a cap on the box frame that they were on --

MR. JARVIS: Yes.

MR. ~~ERTEL~~ Ollinger's: -- added braces here and there.

MR. JARVIS: So it's quite a -- quite a reworked job

MR. ~~ERTEL~~ Ollinger: To get it to take the hydraulic system?

MR. JARVIS: Yes. Yes. Get rid of the stick in dark, get rid of the structural mode.

MR. ~~ERTEL~~ Ollinger: And you had the problem of the backrack too.

MR. JARVIS: Yes. Now that didn't develop until we got into the attitude control systems on Bienna.

MR. ~~ERTEL~~ Ollinger: The structural mode --

MR. JARVIS: Yes. We had the rate gyros located on the aft platform --

MR. ERTEL: You moved them up.

MR. JARVIS: Yes, we had to relocate those, beef those up.

MR. ERTEL: Mount then an the hard structure,

MR. JARVIS: Yes. And I guess thst was before we got into the next big srea of development, well tho next phase, which was the runs outside. The jet engine and the lift rockets,

And, boy, they really made an impression on me. I remember the first time we had the big lift rocket fire, you know. And Walker was In the cockpit, you know, and --

MR. ERTEL: Well, you know, Ray White was In the first one,

MR. JARVIS: Oh, was he?

MR. ERTEL: Yes. Ray White was the first pilot.

MR. JARVIS: He was, huh?

MR. ERTEL: First guy to fly, I should say.

MR. JARVIS: Because I remember the first one. I thought Walker was In the first one. Ray was in the first one

MR. ERTEL: We took the jet engine out and we put a nunk of concrete. We didn't have our tie-down sunk in the concret --

MR. JARVIS: I remember,yes.

MR. ERTEL: -- and we hung this big concrete to stimulate the jet engine and help tie it down because those things, you know, weren't sunk into the concrete to hold us do n.

And so then we fired the rockets and, it was great, we had the rocket firing, we didn't come up that much, but where we got i trouble was purging. And we had no suspicion whatsoever that we were going to get momentary thrust on a full purge, where you're really passing the high pressure helium through there.

It's all over with, but it's a knack that we got a couple feet off the ground.

MR. JARVIS: I think I remember that hangar.

MR. ERTEL: The concrete hangar?

MR. JARVIS: Well I remember the first time -- it really left an impression on me -- the first time I heard thos lift rockets go off.

MR. ERTEL: Oh, it's so noisy.

MR. JARVIS: Boy, I just, you know, I'd never associated that much noise -- the first time I heard them -- that much noise with that light --

MR. ERTEL: Well, we had the Munsies on too and you get 4000 pounds of peroxide rocket going at one time and I think that more than just the pounds of thrust, it's how many nozzles you got.

MR. JARVIS: Yes. It's a terrifying noise.

MR. ERTEL: Attitude systems blending in..

MR. JARVIS: I just couldn't visualize a guy flying through the air, honest to gosh I couldn't. You know, I think all the way through I think I really had it in the

back of my mind, I really didn't think we'd end up, you know - somewhere along the road something's going to occur that'll prevent us from flying this thing,

I mean, you know, I probably wouldn't admit it to myself. But boy, I really thought that when I heard those lift rockets fire.

Oh, I remember now, the first time Walker got in and flew -- or he was going to operate the lift rockets and also fire the attitude rockets with the stick, remember that?

MR. ~~ERMEL~~ Ottinger: Yes.

MR. JARVIS: And it so -- It just turns out on that day there was only two places where there was a possibility of getting two electrical plugs switched.

And there they were, they were using a key different so you can't put them in and screw them together. O.K. These two plugs were keyed the same, but nobody thought you'd ever get them together even though -- get them mixed up -- even though they were right next to each other because one was a male plug and one was a female connector, you know, so usually you could *look* and check, and then plug it in.

But lo and behold, they spent all this time checking out the attitude system in the hangar, finally they got it out and the first time the pilot was going to operate it pressurized.

And he got in and I guess he operated -- I can't

remember whether he operated the lift rockets first or second, anyway he got to the attitude rocket portion, and he energized everything and turned the system on and he moved the stick -- I think it was in pitch -- and nothing happened, you know.

Everybody's standing around waiting for the rockets to go up and they never went off, and of course Walker comes up with this big, blank expression, you know.

Then he lets the stick go and he cones back to neutral, and I'll be ~~gonnone~~ doggone, every one of those doggone rockets, it seemed like, went off. (Laughter)

Everybody looks around, you know, and gee, I didn't feel real good about that (laughter). That's when Leon was out here and he thought it was so funny. And I looked at him, and I looked over at Bellman again and he's kind of -- kind of nodding.

So Walker grabs it again and he pulls it back and again nothing happens and he lets it go, and gee, again all the rockets went ape wild. So I knew by that time, boy, you know, we really got a bad problem, because we checked the thing out, you know, and I couldn't imagine what it could be,

So he went through a few more tests, and he got down and we were kind of interviewing him, standing around the vehicle there. Somebody asked -- I don't know if it was me -- somebody asked -- well, no, I know I didn't ask, because I didn't even want to talk to him because I knew we had a bad

sroblem. Somebody asked him what he thought of it and he said "Well," he said, "It's not too bad except it seems like a little too much lag." (Laughter,)

He didn't even cetch the fact that they were all going off, and in fact he could sit back there and wait all day and nothing would happen until he turned it loose. To him that was lag, you know, a big *bad* problem.

So anyway, we got to looking, and it turned out that in the first place, Leon, who's the engineer from Bell who did most of the design work on this system. So he had ~~to make~~ a inkling ~~one (inaudible~~ of where) to go right off the bat.

Anyway, he went back and started checking on the plugs -- well, he went back to make some voltage measurements on those plugs on the gyro, the two plugs that you could switc .

He pulled them, got to checking and he looked at it. . And he realized that, doggone, the first time, th guys got those two plugs switched. So then he switched them back going the way they were supposed to go, and thought, well it wasn't but a half an hour, and the problem's squared away.

So, everybody felt good after that, and we went and played golf that afternoon. (Laughter.)

But that's really -- I really learned something fron that, you know, the only two plugs in the vehicle that could switch and that could carry down -- it affects other programs.

MR. ~~ERTEL~~ Ollinger: Yes.

MR. JARVIS: Because the guy that put that male plug in really had to Jam it to get it in because the pins wouldn't fit. He had to push them in until there was some hard rubber underneath it, he had to force them in...

Well, anyway it happened, and I've sort of explained the whole problem.

But, okay, from then, those were the tie-down tests, then we went to the tests on the fixture, where the guy gets -- the pilot could actually get in and, you know, move the vehicle and pitch and roll, these sorts of things.

And we went through several months, I guess, of those types of testing. We tested the lunar simulation system, the weight and drag computer, which is all part of the jet engine attitude control system.

MR. ~~ERMER~~ Ottinger: We really didn't make -- we didn't do much on the lunar sim module after our first flights, as I recall. We were anxious to get in the air and --

MR. JARVIS: We did quite a bit, and they were -- well, with the auto-throttle system, remember those tests -- I remember one test we were running on the auto-throttle system with Willy in the cockpit; remember that?

They were running a frequency response test, Fie had the van pulled up there, and I guess I was kind of talkin with Billy, with Willy through the -- on the mike, there -- oh no, it wasn't Willy, it was Kick. Nick was at the cockpit

I didn't know Kick too well.

But he was running the Jet engine and what the test: were, were frequency-response tests on the throttle system where you automatically drove the throttfe at various frequencies and this kind of thing, to make sure it was working properly and all this sort of thing.

But it involved electrical control of the throttle, which the guy sitting in the cockpit had to relinquish to the guy running the test. So he had to sit there with his hands in his lap, and kind of watch the Jet engine throttle move back and forth.

We had a lot of problems with that throttle system initially, that's one thing we discovered because of the friction -- the cable friction. So we had to go to a hydraulic system, I remember that.

Anyway, these were all tests concerned with that. Anyway, we were cycling the engine and we put in a very large power-off input. And I didn't think you could drive the thin, past the idle stopper on the engine, because there were mechanical stops there.

It turned out that, even though the handle stopped, there was enough slop in the linkages that you could drive th arc control lever on the engine clean into the cutoff region. And that's what happened. The handle came back, stopped, but through the automatic throttle system, it drove the throttle

control lever on the engine *to* cutoff.

So the engine shut down, So everybody's sitting there watching the tests and they were going pretty good, and all of a sudden the handle comes back and the engine stops.

And I kind of looked up and I looked over at everybody else and Nick kind of looked up in the cockpit, you know, looks around. and, I didn't know what had happened, nobody else did either.

And then the throttle started going forward again. And I -- it didn't bother me, I thought well, the engine shut down, big deal, but I remember you kind of voiced your concern at that time, began to get concerned, and yelled to Nick to shut the throttle off, I guess.

I guess the problem was that when you pump fuel in a hot engine, it'll blow up on you.

MR. ~~ERTEL~~ Ottinger: Yes. (Inaudible) firing, and you have to pull it down into the hot section,

MR. JARVIS: But, I guess that kind of shook old Nick up quite a bit, because he wasn't real red-hot on these electrical systems.

MR. ~~ERTEL~~ Ottinger: Well during a lot of these tie-down tests, and even rocket tests, you would -- as well as jet engine testing from rocket tests -- you would cycle these things from your test card.

MR. JARVIS: Yes.

MR. ~~ERTEL~~ Ellington: You would cycle both the attitude rockets, various frequencies --

MR. JARVIS: And the engine.

MR. ~~ERTEL~~ Ellington: And you would cycle the engine on the gimbals. And you would cycle the solid ones.

You would do this all from a signal generator, I guess.

MR. JARVIS: Yes, Yes, the only way you really had of really doing a good evaluation and good analysis on these systems to make sure that all the integration is -- the interface -- is proper, was just the -- like you said before -- everything on it, if it was controlled by an electrical system

MR. ~~ERTEL~~ Ellington: You missed out on the -- on the stuff that they did on the T.V. done at Ellington, but there was a was a whole raft -- I would say months and months of testing that one fixture where those guys were cranking in all these frequencies, you know, and all these responses and all you were doing with the pilot up there was flipping switches and riding it , while the data's being...

MR. JARVIS: So anyway, we went through many, many, many tests, but I don't remember what their time sequence was, it was a long period of time.

We tested everything -- every test we could come up with we felt would be reasonable to run we conducted. I remember we even wanted to hang it on a pendulum, you know, swing it, so we could get the jet engine in the picture --

tie dropped that after quite a while, finally. We finally threw it out as probably creating more problems than it would help us, which I guess is probably true.

Then we went through the flight test phase...

MR. ERTEL: Well you got that when we made the combined picture, really.

MR. JARVIS: Yes. The only thing you didn't have, the only thing you could not test was the operation -- the closed loop operation -- of that lunar simulation system, the weight and drag.

MR. ERTEL: Yes. Yes.

MR. JARVTS: You couldn't, because you had to have translation -- translational motion on the vehicle itself.

MR. ERTEL: That and the yaw axis with attitude control, we never got.

MR. JARVIS: That's right, we never cheeked -- we didn't feel that would be a problem. Sure enough, that was one of our first problems. But --

MR. ERTEL: Well, it wasn't that bad.,.

MR. JARVIS: It wasn't real bad, but we had that mysterious -- well, in fact it was the attitude rockets compensating for it, but we didn't even notice it until we started looking for --

MR. ERTEL: Yes. I forgot all about that observance I think we finally attributed it to the exhaust gas swirl.

MR. JARVIS: Yes.

MR. ~~ERVIN~~ Oltrogge: In the jet engine. As the jet comes pumping air through, intended to give a rotational moment. And this is just set up to fire their rockets and we'd sit up there and burn fuel, compensating for that.

So we looked at several ways to stop it early in the flight test program ~~(inaudible)~~, with a minimum amount of work, and we wound up with a compressored bleed coming across the gimbals with swirl fade 4 and back to the back end at the rack, so we'd get the most moment ~~(inaudible)~~. Finally, we only had about eight pounds of pressure in that thing from the compressor, acting as a continuous bleed and pointed in the opposite direction from the exhaust gas moment. Cancelled it out! And it worked beautifully and we got it for nothing as far as fuel -- it didn't cost anything for fuel. It cost about ten pounds for plumbing ~~(inaudible)~~.

But you'd never notice it on the engine as far as gas loss.

So that solved a problem which was really going to eat up maybe 50 pounds of peroxide, which was damn critical.

MR. JARVIS: So really about the only system we really didn't run a complete test on was the weight and drag computer and the -- that part of the lunar sim system.

But that was actually really the key -- the key system -- the system really that the whole thing was built for

As far as it really put you in a lunar simulation mode, mood,

MR. ERTEL: Ottinger It's funny how that whole lunar sim mode progressed from the weighing -- initial weighing circuit that you had there -- and eventually you threw that out in th T.V. because you found that -- from experience you could, I guess, predict things fairly accurately within the tolerances (inaudible operational time that we could predict the weight that we're going to start sending this and this kind of stuff.

And we didn't really have to have these real refine

But then, the last thing that I heard from Dean [Gumm], when I was down there a year and a half ago, and I don't know if they ever did anything about it -- and that was eliminating the -- It may have been eliminating the auto-throttle.

MR. JARYIS: Oh?

MR. ERTEL: Ottinger And let the guy come back manually --

MR. JARYIS: So it would compensate for weight change?

MR. ERTEL: Ottinger Yes. Right. But there again, it's just one more step back to trying to eliminate complexity. Oh -- I know what it was -- I believe (Reiken) was telling me that this was something Houston had asked them to look into.

MR. JARVIS: Oh, I see.

MR. ERTEL: Ottinger To study it. And whether they -- I don' think they ever did it. I'm sure they probably got the thing he same as it was when it was essentially.

Ertel:
They've been doing it for two and a half million.

MR. JARVIS: That was a big -- led' to many problems, Well of course we didn't get into that when we were s!m testing until, well I forget how many flights we've made -- we've made quite a few flights.

Ollinger,
MR. ~~ERTEL~~: Well, when you consider the display system and the radar systea, the attitude control system of the vehicle, and the lunar sim mode and the Jet stabilization system, the emergency mode for all these things, the jet engine system, the rocket system -- It's a dam sophisticated piece of machinery to integrate all that stuff and to do that job with a limited weight --

MR. JARVIS: Actually it was a system with a seat on it for the pilot, a place for the engine, and a frame that holds them together.

(Laughter.)

Ollinger
~~MR. ERTEL: (Inaudible.)~~

Ertel: Either two or three guys up at Bell have mentioned something, and I haven't heard it out here yet But it was the effect of no visible means of support, because the machine had a built-in recovery factor.

Did you use much at Bell? I mean, I'm trying to figure some way that I can use it in a footnote --

Ollinger,
MR. ~~ERTEL~~: They often talked about, maybe -- we always had a problem, I think, in trying to fit in *all* of the

displays and switching and pilot -- a hell of a lot of concern really, on the pilot's ability to react to emergency -- to take his action -- to be able to have the right access to the switches and displays and so on.

And with the X-15, living along side of it and some of the problem they were going through -- their trials -- I think it only happened like maybe one flight they had a retro probe or something, but we always make an interesting proposition about, maybe we'll do this job with a retro probe independent of the bumper tension, or something like that, to key it off.

Really, we went from yaw pedals and center stick to the sidearm control. And we had that hydraulic -- as you said we replaced the throttle cable system across the gimbals because of friction in the hydraulic system, and then that had a back-up system, in case of a hydraulic leak.

So that meant another switch. These are things that you've got to have pretty good access to if you're going to ever have to use them. Throttle switch -- I think we had a foot-on switch, finally, because we got so busy with the hands, didn't we?

He had a gimbal lock switch on the hand control, on the right hand --

MR. JARVIS: And you had the jet stab switches, lunar sim switches...

MR. ~~ERTEL~~ Ottinger: Right. On the console. And the throttle over here and the lift handle somewhere else,

MR. JARVIS: Ad Attitude rocket switches.

MR. ~~ERTEL~~ Ottinger: What was the switch that got removed out l?ere late in th frdnt clutches, I was trying to remember it this morning. It was on the jet throttle handle, and [Don] ~~Mellick~~ Mallick inadvertently operated It. And it was decided -- was it ~~Mellick~~ Mallick you said that told then he inadvertently operated the switch on the jet throttle3

Ertel : Yes. They. changed the seat and It changed him so that when he did what he normally did, he touched the switch at the top and activated It. It had never been activated before.

MR. JARVIS: The switch that was on there was the emergency throttle switch,

Ertel : That's what I thought. And he said he was in a bad way for a little while.

MR. JARVIS: Well, I think he did inadvertently operate that on one flight. Got on the emergency throttle -- it seems like him, but I'm not sure.

MR. ~~ERTEL~~ Ottinger: But it seems like we still kept the emergency throttle system.

MR. JARVIS: Yes.

MR. ~~ERTEL~~ Ottinger: And I don't remember how that -- if that was still operated --

MR. JAKVIS: I think they moved the switch down to the left-hand console or something -- we didn't remove the switch, we just moved it to another location, I think.

One bad thing is once you activate an emergency throttle, you can't get back. Because you dump the hydraulic pressure.

MR. ERTEL: You've changed that with T.V. though.

MR. JARVIS: Yes. The one bad feature.

MR. ERTEL: I think we've fixed it in the T.V. set with two systems, with double return set-ups.

MR. JARVIS: Yes.

MR. ERTEL: But most of this stuff was just sort of one of a kind kind of a development. A few things you could run in and buy off the shelf, Some of the parts we dug out of work benches here -- guys had kept them for ten years -- that they used on X-1 aircraft or something -- I know the throttle system reminded me of it. We just grabbed some ten-year-old actuators out of the X-1 -- hydraulic -- and used them to fly these.

And come time to buy more and build them, then the. T.V., nobody would keep that stuff. Go out and design something new and get a bid on it and start fron scratch.

ERTEL: Well, I think this probably would run in to costing you so much, you know, you go out to subcontracting --

MR. ERTEL: I -- I told you before --

: -- four or five of those --

MR. ERTEL: -- MSA was footing the bill, you haw, and was going to pay us for all the stuff, but with the amount of shop work and effort and extra stuff that a center can throw into and R and D program and the pro shop arrangement, I would say just the general flight center money, wherever it comes from, and X-15 money, and things of this nature, that we were probably limiting, mainly at that time, a hell of a lot of that kind of support when you get around to it. You lose track, you don't count, and you don't add up, and so when a private contractor tries to get a job out, it makes a hell of a difference, when you get to counting properly..

: And people say then, why the hell should this cost so much more than the other;.

MR. ERTEL: You can walk down here into some of our pro shops, and you can take a whole crew of maybe eight or nine guys and throw on one project and make then work twelve hours a day, seven days a week, until you get a job done, and maybe in a week or two you're done, And you're over that hump and they're on something else.

And you just can't do that, either as fast or as cheap, in private industry as you can with, soldiers, where you've got all these experienced troops that work together

pretty good as a team.

MR. JARVIS: Yes. Well, you know, you find you h
to keep busy administrating their work; if you haven't got anything to follow up on with *that* bunch, you find you have lay then off. So you lose your team.

Here, they get paid regardless of working or not, you maintain your team.

MR. ~~ERTEL~~: Yes. YOU take a test ~~standard~~ with them. I daresay it would cost you a fortune in private industry.

MR. JARVIS: Oh yes.

MR. ~~ERTEL~~: Our guys'll do nothing but come out as look'at the thing:green, they'll size that thing, they'll fix it, cut and try, and If it doesn't work, maybe tomorrow the next day, they'll have it.

But he might spend two months in design and --

MR. JARVIS: Right. Draw it up.

MR. ~~ERTEL~~: Right, And then find out he'll make i and get the part six months later, and it still won't fit.

MR. JARVIS: And he's got to go through the same thing (inaudible).

MR. ~~ERTEL~~: He's still got to go through the same thing.

: (Inaudible).

MR. ERTEL: Right. Right. Well, later on, we won't bother this discussion with it, but we've got to get into the aluminum welding problem with the T.V. Oh, that was a whole subject, there.

That's got to be covered because it was, I would say, the real milestone in a technical management quality triangle here, you know, I'm trying to -- it's all in the aftermath of the hpollo fire that this all happened. And it was a good -- it's a damned good example of the, oh, the after effects or where..

It's the influence in how far it gets out and reaches into the depths of any program that has anything to do with the lunar thing.

Even though we weren't going to the moon, we had something to do with those astronauts and that created an atmosphere where..

MR. JARVIS: Well, I can't --

MR. ERTEL: Let's talk about Leon a little bit. He -- I talked about (Baskim) earlier this morning, coming down, and actually, Leon -- between Leon and Baskim -- (Russna) sort of got in it too, but I'd say Leon and Baskim,..

Well Baskim was on it, I think, over the T.V. T.V. full-time as long as these programs were going. But Baskim was a factory man, you might say, in the pad part, mechanical --

MR. JARVIS: Mechanical engineer.

MR. ERTEL: -- by education -- which I hadn't realized for a long time. He'd been that for a long time.

MR. JARVIS: I didn't know that

MR. ERTEL: Yes. And he's a colored boy, and a cness champion.

MR. JARVIS: Yes. Chess champion?

MR. ERTEL: Yes. You never knew that? He's about second or third in the state of New York in the game of chess.

MR. JARVIS: On, is that right?

MR. ERTEL: Yes.

Ertel: What was his last name?

MR. ERTEL: Baskim. Bill Baskim.

Ertel: No, I meant Leon.

MR. ERTEL: Leon (Zwink).

Ertel: Zwink.

MR. ERTEL: Now, Zwink. He was more of a systems and test guy than what Baskim was and he didn't work on it all the time but he was on it a good share of the time in the RV.

And I think Leon spent the time with Edwards on the RV, whereas Baskim didn't.

MR. JARVIS: Yes.

MR. ERTEL: So, Leon was really -- we leaned on Leon in the test phase more than we did Baskim, even in the TV

MR. JARVIS: Yes, he'd go through all the problems.

MR. ~~KRIEL~~ Ohlinger: Yes, we had problens in Houston on the T.V. that Baskim didn't even ~~know that~~ though he was running the show If it wasn't for Leon Zwink, coming dawn and bailing us out in Houston, I don't think we would have made the schedules that eventually we made without Zwink's efforts.

He's a hell of a sharp troubleshooter, He could just come up with short cuts.on getting to the heart of the problem a lot faster than Bill -- and with no loss of credit to Bill at all, because as I say, hell, he was, for a mechanical engineer it was highly unusual that he was even in the spot he was.

Estel : Well, there's something that nobody has talked about yet, and I'd like to get... You guys have had the experience of working directly on the FRC job and the X-15, and you don't have all that many things to do.

But when you come to something like the RV which was basically approved at headquarters, and financed and co-managed by Houston, and FRC was doing the work between here and Buffalo.

Mow how much extra communication problem do you think there was that way for them, I mean -- that system compared to -- the difficulties of a system like that -- compared to something like the X-15, where'you just, you know, --

MR. ERTEL: One (mike making) one project set-u separate arrangements.

: Yes. It would seem to me that it woul be almost impossible on some occasions to ever get --

MR. ERTEL: 'Hell, I think it really, it never --

: How much does it slow it down?

MR. ERTEL: Okay. It never slowed it down as far as the day-today operations. MSC let us have our way, or ahead, you might say. And we ran with the ball.

They gave it to us and they didn't try to get it back, as far as the operations and the day-to-day program.

Now they kept in, I would say, very good -- in general, they kept up with the general thing we were trying to do. In otherwords, to get a monthly or semi-monthly review out here, somebody going down there.

There wasn't too much of it for the first couple of years.

That communication problem was not a very big one. It was done, and probably done adequately. But part of the - I'd say where the blitz came in that particular arrangement was that, in the two years or so of flying the RV, and all the changes that took place -- number one, you have (Happy Day) that was Dick Day, that was working for Warren, who started out with the RV coordination of the key men.

He hired Dean (Gremling) and put Dean on the program

fairly early. But Dick left, and Dean was left with it then, He got some other assignments, Dean did, and I would say, probably didn't get really close enough to the program during its two years of flying.

I don't think he came in right at the beginning. I think we were six months or a year down tfle stream before he came in.

MR. ~~JARVIS~~ Ertel: Yes. And then they handed it to him. Then they handed him that Gemini rendezvous problem in the meantime.

MR. ~~ERTEL~~ Gilruth: Yes. Right. So Dean was sort of sittin over here to one side, not really knowing all of our problems. Now then, and so, they're not going to bother us and we're not going to bother them type of thing, okay?

And so there was a gap in here. Then all of a sudden, the schedules began coming in, and people began lookin up, and there was this big push to get RV's wrapped up and down to Houston and T.V.'s ~~on their~~ under way, and all of a sudden we woke up, we didn't have our documentation -- we'd made all these changes and hadn't kept up with them, We got a lot, and money's tight, ...

We had all this work to do, and all of a sudden the big old mushroom cloud comes up, and not much researchers to back it with. And probably, a period of time for Dean getting up to speed again and realizing what we'd been going through,

So, I would say that that particular area was where the problems were. It didn't come with the day-to-day running of the flight test organization, but it was the start-up and the generation of the T.V. program, and the things that should have been done a year before they really got started in earnest, pushing it.

And another glitch ~~blitz~~, probably, was, by the time we got down toward the last half of the -- maybe it didn't take that long -- of the RV flight program, I think our technician, and ground crews, and our engineers, and all the support, was a pretty well-knit group who knew what they were doing, lots of confidence and operated pretty well. And I think the success, in general, of the program on a couple of these flights, was the little crap that went on. It speaks pretty well for it.

But the other glitch ~~blitz~~ was that not only -- and I would say most of the stuff I talked about Dean getting slow starting on -- it's in the operations area.

That thing had fixed-base simulator stuff, and they had a lot of other things in a supportive role, but it was the operations side that was so *slow* in coming and caused a lot of problems.

Joe Algranti ~~was a guy who~~ didn't have en engineering staff, to speak of, and it damned well had to be, to take that RV over. It was over-simplified by a lot of people in Houston.

And it took Dean's normal reaction time to get up to speed, and then after that he started battling, and he hsd one hell of a battle getting support down there, and getting that operations phase cranked up.

And Ed even went on, even when I was down there, (in the TV ground run), that was not --

MR. DAVIS: It hadn't really shaped up. You know, Neil's crash -- it opened a few eyes, but they seemed closed, And nothing was really done to really shake that operations punch up, and to put the kind of stiffening in it that it needed, until, I think, Joe lost number one T.V.

And I guess then it was like the difference between night and day. They over-killed the problem. And they put sn a bunch of Philco people, and they changed their whole organizational setup.

People previously running the operation -- flight snd ground runs and so on -- pulled them off entirely, put the new team in and got them trained up, and this old bunch now -- all they're to do is to keep the maintenance up and the procedures ~~new with the guide~~ and the design changes.

It's in that area -- it's a little sensitive, I guess, but that's the way the cookie crumbles and...

Eitel : Well, I don't know if it was (Mallick), or somebody, who said that they figured that in the iong run - well, the story on how the T.V.'s came about -- the story of

Ken ~~(Lamitge)~~ Levin. He was out near the Los Angeles area, AIAA.

. Talking a about the T.V., trying to peddle that to somebody who'd listen, He was pounding the halls, I think, over at MSFC, trying to sell it as a training vehicle

Then he came out and gave a paper on it to the AIAA.

Then he was interviewed by some reporters later, and the next morning it was in the Houston ~~Post~~, and Newport News, Virginia, and a couple other papers; said that NASA provides funds to buy ~~your~~ three vehicles,

And Ken said that he went back to Buffalo (and they re going to Houston; he ~~(illegible)~~ thought on the way down, ~~and then~~ that we're going to catch hell, you know, for saying it when it wasn't so.

And he said everybody in Houston was real happy about it, said, gee, we're glad this is finally approved, but nobody knew who approved it.

MR. ~~ERTEL:~~ Oltmge This was on the T.V., now?

Ertel : Yes.

MR. ~~ERTEL:~~ Oltmge Not the RV.

Ertel : On the T.V. And then I guess Leo Abernathy at headquarters --

MR. ~~ERTEL:~~ Oltmge Yes, I remember Leo,

M Ertel : -- got hot on the phone and called ~~(Dr. Ernmore)~~ Dale Slayton and Warren North and said, "Dammit you've got to have these things and what are you going to do about it?"

And then they cranked ~~Bruce and Lenny~~ loose the money at

headquarters to go ahead and give him verbal authority to let him sign.

That's really what did it. Well, I think it was in the paper that --

MR. ~~ERTEL~~: Ken kicked it off.

: -- Ken kicked it off out here, just saying that this thing -- what it was capable of doing. And then these reporters saying, "Well, what is the status of it? And he said, "Well, as of now, nothing, but... "

MR. ~~ERTEL~~: It's coming.

: No, he says he didn't even say that. He just said that we were just waiting until we get a contrac We're ready to go with it when we get a contract, and the nex morning ~~it said~~ in the paper --

MR. ~~ERTEL~~: That they had the contract.

: -- that MASB had decided to ~~fire~~ three of these things. In fact, two was all they wanted to ~~have~~

MR. ~~ERTEL~~: Did he say --

: Talked ~~him~~ into the third one, he sai if something happens to one -- if you get two and something happens to one, you've got one left; if something happens to two, you don't have any left. And that's the way they arrive at the figure three (laughter).

MR. ~~ERTEL~~: And as it is, they've lost the RV and two T.V.'s and --

MR. ~~JARVIS~~ Ottinger: Yes. One T.V. left.

~~MR. ERTEL:~~ One T.V.? Well, when was that AIAA meeting -- ~~(Inaudible)~~

Ertel: (Inaudible) I got a feeling it was April or June, maybe May. April.

MR. ~~ERTEL~~ Ottinger: What year?

Ertel: Well, it was sixty --

MR. ~~ERTEL~~ Ottinger: Five? Four?

Ertel: six, I guess. 1966, I guess. You didn't turn these other RV's in to Houston until when? 1967? I think they started -- well when did you go to Bell?

MR. ~~ERTEL~~ Ottinger: June of 1966.

Ertel: June of 1966. Well, it must have been right after that, then. No, it must have been --

MR. ~~ERTEL~~ Ottinger: It had to be before it, because I wouldn't have been at Bell had there not been a T.V. program.

Ertel: Right. That's right. I think it was around April -- it was that spring AIAA meeting -- that annual spring meeting we had,

MR. ~~ERTEL~~ Ottinger: Well, I think those of us real close to it and, of course, as far as Dean and some of us out here, always knew damned well, there had to be a T.V.

If I was sitting in Ken's seat, sitting back there with the contractor, and didn't see an RP come out -- and as I do remember, it was August or September-before the MSE RFP came out. It didn't come out until three months after

I left NASA.

Ertel: That's right.

MR. ~~ERTEL~~ Ottinger: But it nas the kind of a thing that: you just knew had to happen, and you recognize the kinds of --

Ertel: (The schedule was tightening up) Mel went out ~~(inaudible)~~ and started procuring the long lead-time items ~~Long~~ before they had the contract,

MR. ~~ERTEL~~ Ottinger: Oh yes. Well, I told you about the conversation with (Geezel) and (Phillips) at a cocktail party, and he turned around and Phillips said, "If you don't fly it by October of 196 -- "

MR. JARVIS: 1968.

MR. ~~ERTEL~~ Ottinger: -- was it 1968? "You're not going to -- "

. JARVIS: Make our program.

MR. ~~ERTEL~~ Ottinger: No -- they moved in in 1968. Then, October of 1967. "If you don't fly by October of '67, there isn't going to be a LLTV program, because If we don't get it for the first shot, we're not --" This was before the fire, see.

MR. JARVIS: That's right.

MR. ~~ERTEL~~ Ottinger. Before the fire, And there was just no way. That was like -- this was in August of 1966, and we had to fly in 13-14 months.

MR. JARVIS: Kind of tough, huh?

MR. ~~ERTEL~~ Ottinger: That was pretty damned tough.

Ertel: It took a year after that getting it to fly, didn't it?

MR. ~~ERTEL~~ Ottinger: It took a year after we got to Houston to get it flown. It really did.

MR. JARVIS: I think one thing that kind of plagued this program all along was that nobody up there really knew the complexity of the systems --

MR. ~~ERTEL~~ Ottinger: That's right.

MR. JARVIS: -- They had no conception.

MR. ~~ERTEL~~ Ottinger: We didn't know it -- we know it maybe better than anyone else -- but it was hard as hell to convince them, anywhere you went.

MR. JARVIS: Id just didn't look that complicated.

MR. ~~ERTEL~~ Ottinger: When I went to Bell, I thought, oh, you know -- I sat and -- I didn't really realize it until the first two or three months had gone. I had -- I was sitting there waiting for that ~~RP~~ RFP [request for proposal] to come in on a MSA procurement.

But I spent a solid three months there, and I didn't have any problem staying busy at all because I could sit down and go through the drawings, and I had -- we'd already gotten a set from GE of the specially up-dated stuff -- and you wouldn't believe the crap that was left out.

It's hard to keep all the stuff from falling through the cracks -- and just things that had to be done. And I

didn't miss a day's work in that whole three months of just generating lists after list after list, system after system, o more changes that we'd forgotten, that we've made through this two or three years of R and D out here.

What was the toughest technical job, Cal, as far as the control system was concerned, do you think? Was it -- if you divided it up into -- well, you had all kinds of activities. You had your de-bugging, you had your basic design changes, you had your check-out procedures, and flight monitoring, and you pretty well saw all phases of it.

MR. JARVIS: Yes, I don't think I could really point at one and say -- I mean, there were various problems you went through.

I guess the biggest one was, well, the overall structural mode problem. Virtually every system you had to go in. And they said no way -- well, I guess they get a lot of analytical work...

You knew number one, in any initial design phase, that there were going to be structural mode problems -- you could look at the thing and see it. So we emphasize, boy, really do a good job on the analysis, so we don't have to worry about these things. And they analyzed it to death but it was still there.

It just sort of points up the fact that you just can't reliably predict what kind of structural mode problem

from the system dynamics standpoint, that you're going to run into with this. I guess the state of the order ofstructural mode predictions just isn't there or something,

Anyway, they missed it in virtually every one of these, and we had to go in and determine what the structural modes were, and add in compensation filtering and circuitry on each system, and it was a tough job.

MR. ~~ERTEL~~ Oltinger: So, after you got through that phase, then you began the problem of five, six, seven hour pre-fligh heck-out and you had to work on that.

JARVIS: Right.

MR. ~~ERTEL~~ Oltinger: Get it down to a reasonable --

MR. JARVIS: And then, of course there was -- the way the system was -- it was very -- it was sort of an early fly-by-wire prototype systen, you might say. (Inaudible). You'd fail into a backup and then, goodness knows what happen when the backup mode fails. You have no -- what is it -- a fail-safe scheme mechanization -- the backup system would fai hardover on you, Tnere was nothing to compensate for it except that the pilot would have to shut it off manually.

Which is kind of a risky way to operate. And one o the problems which you have is you try to set the trip levels on the primary (biliar) detection circuitry to work. If you do get a hardover primary mode failure, you transfer the

backup mode before you get any upsetting ~~movements~~ moments on the vehicle, you know, before he gets so tipped over he loses control.

We try to make them as short as possible, Of course that's where we run into all of our nuisance trip problems. I remember right at first you've got to get -- in fact our first flight was made with the backup.

I guess few people really realize the precarious position Walter was actually in, if he had had a backup mode failure. We would have lost the vehicle right there.

MR. ~~ERTEL~~ Ottinger: Had there been any problem in the backu system.

MR. JARVIS: That's right, yes. He'd have lost it, because he was flying around locked in -- he didn't get real high -- ten feet or so. He was translating and if it'd faile he would have creamed it.

MR. ~~ERTEL~~ Ottinger: I'd forgotten that not only were we in both sets of rockets, but I guess it automatically goes to backu

MR. JARVIS: Yes, the electronics would, yes. The primary electronics do. You switch on --

MR. ~~ERTEL~~ Ottinger: No -- but were we flying in backup?

MR. JARVIS: On the first flight?

MR. ~~ERTEL~~ Ottinger: Yes.

MR. JARVIS: Yes. Sure. (Inaudible)

MR. ~~ERTEL~~ Ottinger: Were we flying in both sets of rockets

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MR. JARVIS: Yes.

MR. ERTEL: -- because of that relay fitting --

MR. JARVIS: Well --

MR. ERTEL: -- thet weather cycling.

MR. JARVIS: Oh, the very first one, he just kind of came up on it; he barely even got off the pads.

MR. ERTEL: We went to ten feet.

MR. JARVIS: On the very first one?

MR. ERTEL: Yes.

MR. JARYIS: Oh.

MR. ERTEL: He sure did.

MR. JARVIS: Okay. I *guess* that wasn't the one he went into the backup on. It was the ant? where he got up and he actually did translations -- I think the casters -- I don' even know if the casters were an.

MR. ERTEL: Well, didn't we -- we really gat him down any time we had a backup mode, actually, trip, I think.

MR. JARVIS: Yes.

MR. ERTEL: I know we did later, but, you know --

MR. JARVIS: Well, I know this was one *case,* he jus did it an his own, you know, (did) what was out there and looked at it and --

MR. ERTEL: And he was flying around on backup.

MR. JARVIS: And he just said, "Oh, the heck with it," (Inaudible) Didn't feel like doing it.

MR. ~~ERTEL~~ Ottinger: Before we (inaudible).

MR. JARVIS: Prerogative of the test pilot, I guess.

MR. ~~ERTEL~~ Ottinger: Well, we -- you didn't have those prerogatives, though, after we got the teams back.

MR. JARVIS: That's right.

MR. ~~ERTEL~~ Ottinger: And we flew, I don't know how many flights, until we got that team in there. But, even though we had TM or real time telephony available, it's hard as hell to coordinate on the com line.

You can do it better nowadays, maybe, than you could in those days, but too much room for glitches in the ~~V/STOL~~ VSTOL program.

— — You came here from the south base

Ertel : (Inaudible).

MR. ERTEL: Yes. But -- we had a -- that first flight -- that was October 30 -- we didn't fly again for a month or two, and the reason was, as I recall, the stick -- the center stick -- number one, the dead bands were so narrow that he was -- it was a very sensitive stick.

MR. JARVIS: Yes. Mechanical dead hands.

MR. ~~ERTEL~~ Ottinger: Wow. The fact that we were flying with both sets of rockets and a limit cycle added to that problem, but even in ground runs, and after that first flight he said, "Look, get me wider dead bands." And these dead bands, (inaudible) were shifting on us and the mechanisms which --

MR. JARVIS: Yes, mechanical problems.

MR. ~~ERTEL~~ Ottinger: -- operated the synchros, and to control synchros off of the center stick, were real gimpy.

MR. JARVIS: Right.

MR. ~~ERTEL~~ Ottinger: And we had to go in and redesign that whole thing and rebuild it and check it out and it took us one or two months.

MR. JARVIS: Yes. That was a tough one.

MR. ~~ERTEL~~ Ottinger: Before we flew again. And we did it both on the yaw pedals and the center stick. Threw all that out and put in new stuff after the first flight.

So right away -- right at the very beginning -- we started pulling in stuff, going back, redesigning, and, you know, and then 'the whole history of the flight.

But then we finally got down to where we were no longer in between configuration changes, and maybe by the time we got halfway through, we'd pretty well gotten through all the configuration changes. And anything else done -- the last half of the flight test program was done for LEM up-dating or -- we're just to that phase of the program -- we're testing this part of the trajectory or something else,

It's constantly the product improvements until we got at least halfway through the flight program.

But, again -- those procedures again, because that was a hell of a burden in the pre-flighting of the vehicle, th (tense'ear) problem, trying to get off early in the morning

with no wind, and cranking up the (inaudible) at 2:00 in the morning, in the early days.

MR. JARVIS: Yes, it was a real problem because, mainly, one thing you were quite with is, you have all this sophisticated electronic gear, and there was a batch of It, and you had to make sure -- and one key thing you had to make sure of is -- if you got it off the ground without a failure, and you were pretty well insured that the probabilities of having one failure in here are pretty remote, and two failure:, we were saying, were not going to occur.

We could live with one failure in the air, but not two. If we had two. we'd lose the vehicle.

MR. ~~ERTEL:~~ Ottinger If they were in the right system.

MR. JARVIS: Yes. Well, two in the attitude system, you lost it. Two in the jet engine (stands)-- if you lose the jet (stands) as you go to gimbal lock, you lose the gimbal lock,

MR. ~~ERTEL:~~ Ottinger Yes.

MR. JARVIS: You lose the vehicle. So, the whole thing was designed on this one fail-operant philosophy. But you really had to make sure, then, that you didn't have a failure in a backup system somewhere, or anywhere on the vehicle prior to takeoff.

So that really means you really had to go through a good, thorough, detailed systems check-out preflight --

MR. ~~ERTEL~~ Ottinger: Very early we applied the ground rule that you don't -- that we don't fly with a ~~fire trap~~ transient any more than you absolutely have to.

We had the one when we went on internal power.

MR. JARVIS: Yes.

MR. ~~ERTEL~~ Ottinger: But we couldn't very well do away with that. But we wouldn't allow power to come on after sim pre-flight, and then turn around and turn it on again and fly.

MR. JARVIS: Because you could have had -- the most likely chance to have a failure is during a power-on orpower-off cycle. You get a big transient. You'd have a ~~hit~~ hidden failure. You'd be taking off with a ~~hit~~ hidden failure and you have one failure in the air, and you're gone.

There's all this continual concern about that. So that resulted in a very detailed systems specs and tests, pre-flight procedures.

And then again, we tried to come up with a situation where you just wouldn't have one guy zipping through the spec, you know. We could visualize problems -- say, you've got the guy, he does it fifty times, and come time fifty-one, and you overlook something because he's checked it so many times before.

So we tried to arrange them so that we use the inspection to sign off, and various key elements and that kind of thing.

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In fact, as you had to, we found a way our spectators operated before, too was -- it's kind of hard to get them involved in the tests -- you know, they stand there with their hands in their coat pockets, and there's the guy doing all the work, and when he gets through, you know, if there's no smoke, he'll sign it off.

But, we tried to get around that by each -- what we thought was a key test -- the guy had to witness it and sign off that test. So, it kind of forced everyone to get involved -- we had checks and double-checks on the procedures. It really worked out quite well,

I think we've really come up with a good set of procedures, and I don't think there's ever a time where we had a problem -- where we had a problem and we didn't catch it.

Ertel : They ran into -- at NASA -- the same kind of problems -- the fire down at the Cape.

MR. JARVIS: Yes.

Ertel : Because so many guys down there working on spacecraft so long never check any procedures books And, boy, I had just, many complaints.

Real old guys that said, "Well, gee, you know, it's all right, bub, this is yours." But when it got to the place where I had to take it over, it says, "Stick the head of the screwdriverinto the screw and turn it two and a half

clockwise," I was about ready to quit.

But they had to check it. They checked it but they still didn't --

MR. JARVIS: Yes, that's a problem. That's really why you end up with procedures like that, is you're trying to get rid of the lackadaisical attitude that's very easy to develop when you do the same thing over and over and over again --

Ertel: Sooner or later you forget something.

MR. JARYIS: That's right.

MR. ~~ERTEL~~ Ottinger: That's detailed check lists, but then versus requiring as -- Williams was talking a couple months ago down there about the number of signatures that it takes to get a change to a procedure'.'

Where it goes like something ten or twelve to get any details changed.

Well, then it works the opposite way. You get so many guys signing off that everyone assumes the other guy's going to look at it; and nobody looks at it. They just automatically sign it off.

So you've got approvals and approvals and --

MR. JARVIS: Yes. It's certainly up to the project manager and the project engineer to understand that and to know those kind of problems, And you always have to have a sharp guy somewhere that you know is going to do that.

Regardless of how many guys sign it, you've got to have one guy that you have confidence in, that you know is going to give you a good summary of the problem.

You'll find most project managers, I guess, realize that, and have a key guy,

The sane thing here. Sure, you could end up with a lot of unnecessary steps and procedures, but it's really up to the guy writing that thing down there.

It sort of has to be written to go along with the type of people. You have to understand what this guy -- how he's going to react to that -- the points you can skip, and the points you have to really, you know, they have to be caught.

And if you don't catch them, if he overlooks them, you could cream them sometimes.

I really think we did a good job. After all is said and done. Like you said, we have a lot of problems,

Operations kept trying to get research, and research kept trying to get operations.

MR. ERTEL: Well, it finally boiled down to -- as we got to know the vehicle better, we were able to develop -- and maybe eliminate -- some of the work that initially we overkilled the thing with and, in checking out extra things that we could drop off' because it wasn't, maybe, flight

safety, in the final analysis.

MR. JARVIS: Oh yes. As you get confidence on certain aspects, you, yes. We did that,

MR. ERTEL: It's a growth process.

MR. JARVIS: Of course, then we sort of went to the automatic check-out with the TVs, which is -- a good idea now I guess maybe they'll be automatic check-outs.

MR. ERTEL: Yes.

: Who was responsible out here for getting the GSE on line.

MR. ERTEL: Me.

: (Inaudible) maybe somebody else might have --

MR. ERTEL: Well, when I had a problem with a piece GSE, I'd turn it in if it was like a (fuel trailer) or a (safety unit), you know, crap like this. We had a series of shops, and we'd take it to the shop -- there'd be several people.

: (Inaudible). You probably got a better handle on data reduction --

END OF TAPE: ONE, SIDE TWO,

C E R T I F I C A T E

I hereby certify that the tape recording represented by the foregoing pages was transcribed by me, or under my direction; that this transcript is a true and accurate record to the best of my ability.

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