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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

GEMINI X TECHNICAL DEBRIEFING

July 26, 1966

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HOUSTON, TEXAS

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PREFACE

This preliminary transcript was made from voice tape recordings of the Gemini X Flight Crew debriefing conducted July 22, 23, and 24, 1966 at the Crew Quarters, Cape Kennedy, Florida.

Although all the material contained in this transcript has been rough edited, the urgent need for preliminary transcript by mission analysis personnel precluded a final edit prior to its publication.

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1.0 COUNTDOWN

1.1 Crew Insertion

Young I don't recall that we had any problems whatsoever with crew insertion. It looked nominal to me in all respects. We were ahead of the count all the way.

Collins I certainly wouldn't insert any earlier. If anything, I think you could insert later.

Young Yes, I think we led it a little, but I would a lot rather be waiting on it than have it wait on me.

1.2 Communications

Young Communications were good with the exception of those cameras and those ... lights that they keep insisting on running and it appears to me like RF interference on the radio, when you don't really have any RF interference.

Do you remember that scratchiness and that "click, click, click?"

Collins Yes, I remember. I never heard it before and I thought it was a real comm. problem instead of a camera problem.

Young That's right. The thing is, if you had a comm. problem, you might lose it in all that racket. They ought not to do that, or they ought to get the thing fixed, so that it wouldn't be reflected in the comm. All the rest of the communications were perfect. Once we made them shut that stuff off, it cleared right up.

Collins And when the hatch is closed.

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Young No, they shut them off. They were through shooting pictures shortly after the hatch was closed.

1.3 ECS

Young I think the ECS was nominal. We were real cool laying there on the pad. The temperature I think was 48 degrees and I was happy as a clam. Were you warm?

Collins Well, I am always a little bit warmer than you are, I guess due to the cover layer, but we were on Suit Fans 1 and 2 and it was fairly comfortable for me. And we never had to use O₂ Hi Rate during the purge either. You know the suits sucked down quite a bit but I don't believe it was bad enough to use the O₂ Hi Rate.

1.4 Crew Station Controls and Displays

Young They were all set up right when we got there, and we didn't really have a lot to do, but sit there and wait. Did you notice any difference on yours?

Collins No, everything was set up as it should be, and I can't recommend anything in the way of any kind of changes to that.

1.5 Launch Azimuth Update

Young The T-Minus 15 update was good and so was the T-Minus 3 update.

Collins Surprise, surprise!

Young Yes, so we didn't really have any problems. I think it was a very nominal count. I think there was a little too much time in there, but it didn't bother us any.

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2.0 POWERED FLIGHT

2.1 Liftoff

Collins There is no doubt about it, within one second of liftoff, you know you are moving. There is a definite feeling of being booted from behind and a definite feeling of rising and a good feeling.

Young Yes, the engines light, and it is just like it always was.

2.2 Roll Program

The roll program was nominal in all respects.

2.3 Pitch Program

The pitch program was nominal in all respects. You could pick up the pitch gain changes on the ball.

2.4 ECS

What do you say about the ECS?

Collins It was fine. I think it was on the high side, if I remember right, the cabin sealed at 5.9 psi at 1 minute. Later on in the flight, it had dropped down below that to about 5.6 and stayed there most of the flight. It was 5.9 at 1 minute after takeoff. I wasn't aware of the suit, so it must have been comfortable. For powered flight, I'm telling you about.

2.5 DCS Updates

We got good DCS updates. We got them within 1 second of the nominal time, and I punched off the first one when I got it, and I punched off the second during staging.

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2.6 Engine 1 Operation

Young I think Engine 1 was great. The fuel and oxidizer pressures-- I never even had to pay any attention to them, they were so high. I don't remember what the exact values were, but they were about 20 psi above the pressures where you start sweating them, and they stayed there the whole time. The launch vehicle in Stage 1 just went exactly the way expected. There was a pretty good noise level until you went supersonic, and then everything quieted down, and then you went through max Q, and things picked up a little bit, but not much. Then we were at staging.

2.7 Engine 2 Status

Young It was just a quiet Engine 2. It was real good, I thought. The fuel and oxidizer pressure operation on it was the same. They were way up there; there was nothing to worry about; nothing really to monitor, it was so high. The way it ought to be.

2.8 BECO

Young What did you think about BECO, Mike?

Collins It happened a lot more quickly than I had expected. I thought there would be more of a pause between the first and second stage. The first stage shuts down, and the second stage lights up, and it all happens more rapidly than I expected. The thing that you see out the window is a flash

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of yellow; there is almost a sheet, not a sheet, but just a whole glow of fire, completely around the spacecraft. It completely surrounds the spacecraft and is clearly visible out in front of the spacecraft a short distance, but this happens, and then almost instantaneously you are through it, and it is a very quick thing.

2.9 Staging

Young BECO and staging are really the same event as near as I can figure. One shuts down and the other starts up and you are on your way.

Collins Yes, it is all one event. The shutting down of the first engine, the separation, the lighting of the second engine all follow one another so closely that it appears to be just one thing.

2.10 Engine 2 Ignition

Young Engine 2 ignition is the same way.

Collins It lights in a hurry.

Young Yes, those three are just lumped together; I don't see any difference. I agree with you, there is a little flash of yellow light and we are on our way.

2.11 RGS Initiate

I think RGS initiation was just exactly like they predicted it would be.

Collins When we got guidance initiate, we got a little bit of down

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and left on the needles and then later on it appeared as if we were lofting slightly.

2.12 Steering

The IGS said that we were just about on our yaw track, but we were riding just slightly high, although this steered out towards the end, and we were just about nominal at second stage cutoff. The steering was go all the way. It was very close. Then the ground of course said that they had us right down the pipe and just pretty much agreed with what we saw, although as I say, I thought we were lofting a little bit, the way the needles looked.

2.13 Go/No Go

Young There was no doubt-go all the way. That rascal really goes.

2.14 System Status

Young Systems were go. Did you have anything wrong on your side?

Collins No, everything I could see looked fine, we got Fuel Cell Delta P lights within 2 seconds of liftoff. This is considered to be normal and there wasn't anything to worry about. That's the only thing worth mentioning on the systems. The stack currents and the other gages in the cockpit were all nominal.

2.15 SECO

Young SECO was nominal. It was late, as I recall, 5:40.....

Collins It was supposed to be 5.39, but it was 5.41.

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2.16 Communications

Young Communications were go all the way through. We didn't have any trouble reading anybody that I know of during powered flight.

Collins No, the ground didn't acknowledge the things I called out like the DCS updates and address 95 right after burn out. None of those things got acknowledged. I am not sure but I think they probably should be acknowledged. It just prevents having to call a second time although I didn't bother to call the second time. Nonetheless, it would be nice if they did acknowledge what you say.

FCOD Rep Do you want to comment on the visibility? I would think it would be exceptionally good on your launch time.

Collins It was beautiful out the right hand window. There was a high cloud deck and this gave sort of a frame of reference. I could really get a sensation of speed and moving up towards the clouds and of course, I could see the pitch program relative to the clouds. It really looked good out the right hand window.

Young I bet that thing does roll over like that so that the guy that was supposed to be watching those engine gages on that side would be distracted, and you never would get anything monitored.

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Collins That's right. Really, the boost part of the flight was a very pleasant surprise, and I just enjoyed the heck out of it. In the simulator I don't particularly care for it. Over on the right hand side, you don't have enough gages really to know what's going on and you're always cringing there waiting for them to give you some abort or something. In the simulator, the boost phase is very pleasant I think, but during the real McCoy, I just enjoyed it. Just sitting up there watching the world go by. I thought that was great.

Young I told him to keep looking at those needles.

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3.0 INSERTION

3.1 Post SECO

- Young Attitudes and Rates and Damping. The booster pitch attitude was a little nose up, and the rate was a little nose up, but it was very insignificant. I don't know what it was, but it was a heck of a lot less than a degree per second. Do you remember what addresses 72 and 94 were?
- Collins 94 was + 7. Address 72 was 25,702. Nominal should have been 25, 720, so that says we were 18 ft/sec underspeed. Address 95 read out 27 so that said that we were 27 ft/sec underspeed and that's the number I called down to the ground 95, 27 underspeed. Okay, then after the burn - You burned a good IVAR because after the burn the number was 25 742.
- Young Right after SECO, 5 to 6 seconds, there was a couple of burps that came out of the engine, and I never experienced anything like that on Gemini III.
- Collins That's the "green man".
- Young I don't know, I never felt it before and I don't think anybody else has ever mentioned feeling the "green man" before, but it was definitely a couple of burps and some acceleration associated with them and some noise associated with them.
- Collins Well, anyway, those are the numbers. Within 2 seconds of SECO, I punched 72 and it said 25 702. Twenty seconds roughly after

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SECO, 95 said 27 ft/sec underspeed, and that is what I should have called to the ground, and I am sure I did.

3.2 SECO Plus 30 Seconds

Young Spacecraft Separation and Thrusting. A piece of cake. The turn around to 000 is simple, and when we got turned around the attitudes and rates and damping was no problem. Switched from DIRECT to RATE COMMAND and it steadied right out.

Fairing jettison, I did not do that for about 3 or 4 minutes and then I finally did it. What was Address 95?

Collins Just for the record, on Post SECO Address 72 read 25 702 and Address 95 read 27 feet per second underspeed. At SECO plus 30 seconds Address 94 read out 7, which is 7 feet per second up.

Young 7 feet per second up, and what this means is that we should have been 28 seconds early on our MC-1, if it was nominal. Debris? There was a lot but I didn't notice any debris at SECO plus 30.

Collins No, I noticed debris for a few seconds after SECO.

Young That stuff that went over the top.

Collins Yes, a bunch of stuff came from the rear to front and just disappeared out in front of the spacecraft.

Young That is normal.

Collins From then on I had my head in the cockpit. I don't have any idea what went on outside.

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- Young Okay, IVI readouts at 0 degree, 0 degree, 0 degree. They were 25 forward and 1 or 2 right and nothing up and down.
- Collins That is right, 25 forward and zero up-down and 2 right before the burn. After the burn, they were 1 aft, zero up-down and 1 right.
- Young We were done with the burn and in Prelaunch at about, I guess between 7 and 8 minutes. It was just as fast as we ever did in the simulator, which you would think would normally be slower in the actual case. In fact I didn't see anything different that we did in the Insertion checklist and that whole thing that followed than I did training in the simulator as far as the timeline was concerned. In fact we were ahead of it in a couple of ways.
- Collins We were really moving out; I was thrashing around and throwing switches and putting drogue pins in and the only thing that was different for me was getting the D-ring stowed. I stowed the D-ring, and then I would go to get the safety pin, and the D-ring would have floated loose by the time I got the safety pin. I couldn't get both hands and my eyeballs down there all three at the same time. I could get two hands and no eyeballs or one eyeball and one hand, and it took a long time to get the D-ring stowed. Other than that it was like the simulator.
- Young What were Addresses 72, 94, 80, 81, and 82?

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Collins Okay, 72 was 25 742, 94 was plus 7, 80 was minus 9/10ths, 81 was plus 9/10ths, and 82 was all zeros, and that agrees with what the IVI said.

FCOD Rep Did you load Module VI-A at this time?

Collins Yes, we loaded it and put in a 09001 in address 62. Of course, it didn't load instantaneously; it takes quite a few minutes, and we confirmed it at the end of insertion checklist, which we did, and it was loaded properly, and then we turned it to STANDBY and OFF.

Young We were caged and in PLAT Mode and then went to SEF at, I'd guess, about 8.5 minutes. Then I found out that I hadn't jettisoned in the fairings, so I went to RATE COMMAND and got rid of the fairings, and when the platform came back on, I went back to SEF and PLAT, and I guess that was around 10 minutes. So, we were, I guess, a way ahead on time, and you were loading Module VI about then too.

Collins Right, and we figured that I would start on Schedar, the horizon calibrate star, about 23 minutes after liftoff; and actually we beat that by, I would guess, about 5 minutes? By sundown I had the sextant in my hand and was ready to go to work on the orbit determination, although I am not convinced that that's a good way to do business John. We got a brand new vehicle airborne for the first time and we are....

Young I think it is stupid, and that is why I told them all off.

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Collins That's right

3.3 Insertion Checklist

Young The only thing we had any difficulty doing, and that we might have expected to have trouble, was stowing the D-ring; and both of us had trouble getting down in the footwell, because you just kept floating back out; and as you let go of one thing, the other came loose.

Collins Well anyway, here we are 18 minutes after take-off, a brand new vehicle airborne for the first time, the first time we've been in it or at least the first time I have been in it; and we're turning off all the cockpit lights and looking for stars.

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4.0 ORBITAL OPERATIONS

- Collins On the Horizon Calibration, we used Schedar. We got started on Schedar early.
- Young Yes, but we got the first star sighting on Schedar about 25:31 elapsed, according to the book here.
- Collins 25:31, well the reason is, I just sat there looking at things for a while and getting my eyes night adapted.
- Young That first sighting was to the air glow.
- Collins Yes, when I first looked out at the horizon, I could just see one horizon, which later turned out to be the top layer of the air glow, but at the time I didn't know that, and it just seemed like one horizon. So I just said to myself, that is the only horizon available, so that is the one that I'll use. I took a measurement from Schedar to that horizon, and the residual was on the order of 3 and one half degrees.
- Young I have minus 3.62.
- Collins Minus 3.62 is the residual, so, it became apparent pretty quickly that this number was unusable and at the same time I started noticing that down below this horizon, I could see stars. So, then of course I realized that I had taken this at the top of the air glow and that the real horizon must be somewhere below that. So, I started looking and I couldn't really see it, but I became aware of the dividing line between the bottom of the air glow and the top of the terrain by the

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Collins fact that there were stars on one side of this boundary and no stars on the other side but the dividing line was not clearly defined. As my eyes became a little bit more adjusted to it, I could see a very, very thin line dividing the two areas, but the contrast level was extremely low between the two. All subsequent star sightings, I took to that real horizon. However, it is an extremely marginal procedure when the moon is down and on more than one occasion, I would crank the star right on down through that real horizon looking through the sextant without ever knowing that I had gone through it. I was only aware of it three times. I was only aware of it when I realized that I was cranking a ridiculously large angle in, and then I would go back to zero and start again. So, I wasted a lot of time during this procedure in trying to locate that horizon. Furthermore, at other times I would get the star right down to where I knew the horizon was, as I could make out a dim outline, but I would waste time cranking a star back up and then back down to try to really isolate where the dividing line was. So I had great difficulty in using that horizon, under the no-moon condition.

Young You didn't seem to have any trouble with Schedar, and you got one, two, three, four, five, six, sightings on Schedar to the horizon, and the residuals on those measurements varied from minus 0.20 to minus 0.59. But there were only three good

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Young points in there, and when we plotted the residuals versus time, it looked to me like the best one to choose is the line that went across here at about 275 on the...so that's what we cranked into address 90, 00275. It was the best three out of five, is what it was, and I don't know how else to make a judgment on that, and even those weren't exactly solid line points. They seem to follow a trend right there and the last one you told me you didn't have much faith in nor the first one. So, I just took the middle three.

Collins O.K., well, again I emphasize the position of the moon, and under these lighting conditions this is very, very, marginal. You are straining your eyeballs, right to the limit trying to define that horizon. Now I used the big Coleman's sextant with the 80-20 light split. 80 percent of the light was on the horizon, 20 on the star; and I think that had I not used that I would have been out of luck in defining the horizon. On the other hand only having 20 percent of the light available to look at the star cost us, I think, the whole ball game later on, and we'll come to that.

Young O.K., go ahead--the First Orbit Determination Phase. The SEF star.

Collins O.K. here we are on Hamal, and we located Hamal without any trouble. John whipped the spacecraft around, and I knew where to look out the window relative to his reticle position. We

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Collins found Hamal, I put the sextant up to my eye with the angle on zero, I started cranking the sextant, and I couldn't get Hamal to split. So, I put it back on zero; I tried to crank it again, or I did crank it again, and I couldn't get Hamal to split. I took it away from my eye, I put it back up to my eye, I checked the sextant to make sure that one of the two filters had not inadvertently come across the sextant; and it was just no good. I just simply could not get Hamal to split. Finally it was about the fourth or fifth try that I got Hamal to split, and I finally got a good measurement on Hamal; we got a good residule on Hamal, but by this time I was way behind on the time line. The cutoff time for Hamal was supposed to be 37:30 and we..

Young And we got a star sighting on Hamal at 42:42.

Collins So, I spent five minutes fooling around, looking at Hamal. I got so desperate...

Young We got to Hamal early.

Collins I got so desperate that I even whipped the old sextant out of its box, the Ilon sextant, and I put that rascal up to my eye, and I got it to split, but I couldn't find the horizon. I whipped it on down there and couldn't even see the horizon and the field of view was limited. By that itme, I wasn't even sure I had Hamal any more, so I gave that up, and in desperation I went back to the original sextant and just tried all over

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Collins again and this is something I have great difficulty explaining; it is something that has happened to me in training and I always thought it is just the training equipment and it is not calibrated quite right, or it has been knocked out of adjustment a little bit or something like that; because I have been told that this can't happen. But it does happen and maybe it is a peculiarity in my eyeball.

Young Maybe it was the position of the spacecraft window...

Collins It could be the position of the spacecraft window; it could be the fact that Hamal is a fairly low intensity star; but what I think it is more apt to be is that my eyeball is just very sensitive to off axis errors. And unless I hold my eye up there exactly on center line and with exactly the correct amount of relief distance then I don't get a good image and I can't split the stars. I have difficulty with this all the way through in training and I don't know what to say about it. It seems to be a personal problem because others like C.C. Williams, have never had this trouble. So, I don't know what to say except my eyes are very sensitive to off axis errors or eye relief errors, and with the 80-20 split on the dimmer stars it's awful hard for me to split the image.

Young Well anyway when you finally got it split the residual was 200ths of a degree.

Collins .02? .

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Young Yes. Minus .02.

Collins O.K., minus 102 which we accepted that but the problem was that by the time that we accepted that, put in 99, 00006 and the 92 and 93 of the dummy, and pushed the START COMP instead of its being 39:30 it was like 40 something minutes. Forty two something wasn't it?

Young It was almost time for the BEF star.

Collins Yes, so, that I think is where the whole Orbit Determination scheme went down the drain. I think it would have been all right in retrospect if I could have split Hamal the first time and cranked it down to the horizon the first time without slipping through the horizon like I did sometimes, we would have been all right.

Young I don't know that it would have been all right, but it might have been better.

Collins O.K., the next star, we had our choice of either Altair or Vega. We chose to use Vega. We put in the 92 and 93 of Vega and we took that measurement. What was the residue on that?

Young It was unbelievable..It was unacceptable, I remember that.

Collins Oh, that's right.

Young That's the one where I think the right assension declination must have been wrong.

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Collins Oh, that's right the..it was a great, huge, log number wasn't it; did you write that one down?

Young Yes, we rejected it and went to Altair, remember?

Collins That's right, we rejected it. The residual on Vega was huge, it was 138 degrees or something like that.

Young We just put in the wrong 92 or 93.

Collins Well here is the 92 and 93 that I should have put in and I think that I did. 92 was 34360; 93 was 03875. At any rate, the residual was immense, we rejected that. 88 was 99999, and we went over to Altair, we put in 92 or 93 of Altair and acquired it and got a residual of what John did. You have that?

Young Well, I think it was minus 0.13.

Collins Minus .13 for Altair. Okay, then that completed the star sightings.

Young We switched the radiator to FLOW and evaporator to NORMAL a little late but this was due to the fact that we were riding around looking for these stars. The stuff over Carnarvon at 50 minutes was just what we planned all along to do. I felt they asked us a lot of questions that they didn't ask us in SIM-NET-SIMS. The digital clock was right on. The event timer was about a second and a half late according to their time hack, which I though was real good.

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Collins I copied down the updated state vector, and we had previously gone to Prelaunch and entered into 99, 90005. I put in address 13, 14, 15, 16, 17, 18 -

Young Everytime you got a chance during this thing, if you could turn on a light, Mike was checking the systems, which was good.

Collins We had that written into our checks, that if we had a breather we would turn on the cockpit lights and check that everything was hanging together in one piece.

Young We had to blip the MANUAL Mode of the heaters.

Collins Yes, the oxygen heaters.

Young This new system on X and subsequent, you are not able to operate in AUTO HEATER for the first day or two.

Collins Yes, for the first couple of days there is a constant fight with the manual heater.

Young Seems like that ought to be thermostatically controlled or something.

Collins From there we picked a convenient future G.E.T. We took 55 minutes. We subtracted that from 138 which was the G.E.T. the state vector, and we got address 12, 08300. We pushed ENTER at 55 minutes and went to Computer Predict NAV entered 99, 90004, and 99, 00005. Then I put the checklist away and got into the Rendezvous Book.

Young And all this time I was alining in SEF and Secondary Scanner

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Young to check out the secondary scanners while you were doing that so I could look over your shoulder.

Collins Okay, then we started to work on the Ascent vector and without reading this chart item by item, I got a Delta V N_{C1} of 58 feet per second, and a time of N_{C1} of 2:20:20. I wonder what the real number on that was? I wonder how much we were off on that thing?

Young 2:18:09 was the real number. But 2:20:20 wasn't really the number. Our number was 2:19:52, because you've got to subtract to get the midpoint of the thrust.

Collins Yes, that's right, I forgot that you make that last little correction.

Young 2:19:52 is what our number was.

Collins 2:19:52. Okay, and this is N_{C1} , and the Delta V that we said was 58; what did they say?

Young Wasn't much off 55.9, say 56.

Collins So we were 2 feet per second off, but we were nearly 2 minutes off in time. Then my second chart on the Ascent vector, I computed the Delta V of N_{SR} to be 46 feet per second. John computed the time of Delta V N_{SR} , at 3:49:13.

Young The ground said they had 3:47:34. They also had a Delta V of 47.9.

Collins 47.9 and we had 46. So we were off over a minute and a half. And I don't have any explanation for that. In working that

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Collins chart on the out of plane, I could not get the residual down below 0.1 in address 15. It just wouldn't get down there. So after 3 iterations I stopped trying and accepted what it told me for the plane change, which was 8 feet per second, spacecraft nose to the South. That was at a time 2:53:25. It was N_{PC} 2:53:25, Delta V of 8 feet per second, spacecraft nose South. Now John, what do they say for that plane change?

Young They said 2:30:49, 9.6 South.

Collins Spacecraft nose South?

Young Yes. Remember, that's the time you had all those problems iterating it back. The internal node just never showed up there.

Collins That's right.

Young I don't understand that.

Collins I don't even want to go into that now, I think it's just a waste of time. What we need to do is to get together with the McDonnell people and have them go over this chart.

Young Well you might expect that from the IVAR unless you had a big out-of-plane displacement, because the IVAR left/right was practically zero. So, if you didn't think you had any out-of-plane displacement, it's impossible to find the node because there really isn't one. 8 feet per second is only 820 foot per foot per second. Thats only a little over a mile out of plane.

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Collins Anyway, that's the story on the Ascent vector, then it was time to go into the second darkness. We had no trouble from then on with the Orbit Determination. I had no major trouble. Again I was having problems finding the horizon and I was wasting time trying to get the stars to split. On one of those two stars - the two stars we used the second night were Fomalhaut and Arcturus....

Young What did we do over the states? We missed all that.

Collins The states were clobbered in so we couldn't get any of those pictures.

Young We unstowed the camera box and took that stuff out and put it up.

Collins Yes, we unstowed the camera box as per the flight plan but the states were socked in so we didn't get any good pictures. I took some as I recall.

Young We didn't do a catch-up.

Collins I went back and fooled around with this plane change chart to try to make some sense out of that.

Young That's right, we went through that again one more time but it didn't do any good.

Collins I wasted a lot of that stateside pass looking back over my shoulder so to speak and fooling with that plane change chart. Okay, then we were into darkness again and on with the orbit determination. One of two stars Fomalhaut and Arcturus, I

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Collins had trouble splitting. I think it was Arcturus.

Young Yes, because Fomalhaut was only 9 degrees high and the residual on Fomalhaut was minus 0.15.

Collins That's right and that's when you said that you thought it might be a window angle problem and that makes sense. If I can look straight out that window at the star I don't seem to have this eyeball splitting problem. But when I have to look up, then the problem arises. I also tried this technique of holding my hand over the lower lens so that I look through the sextant and see the stars and the stars only. And that did not work. I saw nothing when I did that. The only explanation I can give for that is that perhaps with all this writing down and what not, and putting in 92 and 93, my eyes never had an opportunity to come..become night adapted. I think that's probably part of the problem. If you could stay in a dark room and take these star to horizon measurements and just call out to somebody else and have him do the computer work, it would be a lot better because that way you could keep your eyes dark adapted. Even though I was using red light inside the cockpit, the readout on the sextant is white light. And during these systems checks and what not, I was getting my eyes bathed in white light, and I think that probably had something to do with the visual problem. But the optics in general, I just had trouble with the optics. And the optics did not seem to be repeatable,

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- Collins they seemed to work one time and not the other. So that would lead me to believe that it is something like night-adaptation problem or maybe a looking-through-the-window-angle problem. We finally got an angle on Arcturus and I think again on Arcturus or Fomalhaut, one of them, I cranked it back down through the horizon a time or two and couldn't find the horizon.
- Young And that surprised me cause Arcturus is a real bright. Maybe that's what the problem was, Arcturus is so bright that it could obliterate the horizon maybe or something like that?
- Collins That's possible. The contrast is so low between the two sides of this horizon that it is almost indistinguishable. I'm sure it is in fact a fine line and the residuals are pretty good so sometimes I was successful in finding it, but it seems to be a function of night adaptation. It might also be a function of where the moon is relative to you or which way you are pointed or how close after sunset it is or whether there are clouds or whether there are not clouds or who knows what. Whether you are looking to the North or to the South, air glows or aurors.
- Young That is exactly what we told them 6 months ago.
- Collins All I know is your first impression when you look out there is there is absolutely nothing. You are just barely able to distinguish a hint of a dividing line.
- Young Unless you're night adapted, you see nothing. And that's a problem too. You've got to turn out every light in the cabin.

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Collins And I can't do that and work the computer simultaneously. So that's the story on orbit determination.

Young The residual on Arturus was plus 0.30. You really don't know after you get through all that stuff whether this is because we chose a bad horizon altitude or because those are in fact the residuals.

Collins I would like to emphasize that later on in the flight, when the moon was visible - during those periods of the third day when the moon was visible, this natural horizon appeared to be fairly clear but it also did not appear to be a smooth line. It was also jagged in places. There were scalloped out places in it which I don't know whether to attribute it to cloud formations or some kind of optical properties of the atmosphere or what. The smooth line of the horizon would be broken in places by what looked almost like jagged mountain tops. I am sure it couldn't have been mountains, but it could have been cloud formations, thunderheads and things of this nature. But I don't know what you would do if you measured the horizon to that particular spot. You would introduce a sizeable error, depending upon whether you were just a degree left or right of this thunderhead, assuming it is a thunderhead, or whether you measured it to the top of the thunderhead. What I am saying is, if you go up on a full moon, this Orbit Determination might be a piece of cake, I don't know. On Orbit Deter-

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Collins mination, as far as the charts go, the first chart, I put the values in, readout addresses 85 and 94, and they were off the chart. 94, which is a time, from which a Delta-T is supposed to be gotten, the chart goes from zero to 50, and my readout on 94 was 891. So that gives you some feel for how far off the chart I was. And again, I don't think there is any point in plowing through these charts. As a matter of fact, at this stage of the game, we had to abandon all the Orbit Determination charts because they obviously were not working, and we were off the charts. We told the ground that, and somewhere along the line, they told us our Ascent Vector was NO GO, so we pressed on with the ground solution from that point on. I have a note that I should have gotten out before, but I just jotted it down here, and that is -- during the Boost Phase, when we were building up into the high subsonic area, there was something loose on the nose of the spacecraft. John says he knows what it is. It looks like a shingle. It is right on the one o'clock position, right up exactly at the nose, and it is a patch about, oh, probably about 2 inches wide and about 5 inches long, which is attached on its leading edge, but not on its side or trailing edge. That thing flaps back and forth in the breeze all during the high subsonic area and acts like it is about to come off and come back through the glass, which of course is impossible. John says he has heard this in previous

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Collins debriefings. I don't ever recall hearing about it. I thought it was a shingle.

Young Phase adjust translation. Okay, Phase Adjust Translation was 55.9 Delta V. Their residuals, attitudes and rates; we did it in Rate Command, attitudes were 0 degree, 0 degree, 0 degree. As far as I know there were not any rates; it is a piece of cake. When we finished, 80 was minus 1/10th, 81 plus 4/10ths and 82 plus 1/10th and we had a little problem nulling residuals, but nothing like Neil had, and it was just a question of hitting addresses 80, 81 and 82 a couple of times and reading out and see what they stablized at and then firing a little Delta V. I don't remember what the propellant quantity was after that burn. In fact, I wasn't particularly worried about it.

Collins The residuals I have here were; 81 was plus 4/10ths, 82 was plus 1/10th and 80 was minus 1/10th, after we finished.

Young Did you end up saying that both the Ascent and the Orbit Determ Vectors were NO-GO?

Collins Yes, I said that.

Young Plane change was just a spacecraft plane change, nose south at 9.6 feet per second. I don't remember what the residuals were.

Collins I got them. Eighty was plus 1/10th, 81 was plus 1/10th and 82 was minus 5/10ths.

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Young Okay, we aligned the platform, of course, before both those burns. And it was at the plane change that we loaded module III, right? We didn't have a chance to do it before.

Collins Yes, we didn't have time to do it before then. We loaded module III in it, and it went right on out at 02:58 G.E.T., which is right about along in here, we had an intermittent radar lock, and at 03:05 we had a pretty good radar lock, and the range at that point was 240137.

Young Yes, and I have got here a solid lock at 03:06 at a range of 234.43, and that was fantastic. Really good. I didn't look at the needles until after N_{SR} , but when I did look at them, which was, I guess, about a hundred miles or so, they were solid, just like in the simulator. No needle movement whatsoever. We sent the commands like we talked about sending to those people, and

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- Young when Mike did the fuel cell purge at 03:10.
- Collins Yes, let's see 03:10, I don't recall whether I did that early or late. And we pumped up the O₂ pressure to 800 psi also at this point because we wanted it real high before the rendezvous. Then I got on over to this radar N_{SR} determination chart, and I worked that one out completely, and I got for radar N_{SR} 48 forward and 6 up.
- Young No, the ground solution was 47.9 which was close and 6.5 up.
- Collins Oh, that's right, it was 6.5 up, so I would say that our radar N_{SR} determination was a success.
- Young It was as good as the ground's, and that is why I said we burned ours, although we based it on their time, but what we are trying to check there was, will this thing in fact coelliptize you, and I think that it will. I will say one thing though, it should all be integrated into a computer. A guy shouldn't have to sit there and punch out numbers with such an unwieldy procedure, and I can say the same thing about module VI in general. That whole thing is an unwieldy, incompatible mess, and if anybody wanted to build a box and call it a "frustration", he would call it module VI. I can't understand how anybody could think that that is an operational thing that people ought to use in space flight.
- Collins I agree 100 percent.
- Young That thing is too darned unwieldy. We have a great computer

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there that could figure out all these stupid thing.

Collins We wasted more time in training on that thing than it was worth in my opinion.

Young And it is just an unsatisfactory math flow as far as I am concerned. Because we are either too lazy or didn't have the time or the money to go in there and do it right, we come up with that kluge and the results we got were about what we might have expected to get. But we tried, huh?

Collins Yes, we tried. Okay, we went to the Rendezvous Mode at N_{SR} plus 4 minutes. We put in all these addresses, 83 and 93, checked 54, 53, 24, 92, and 99, and they were all nominal except that....

Young Wait a minute, we didn't do N_{SR} yet.

Collins Yes, I am sorry.

Young That was the first funny that we got out of Module III. When you inserted the burn numbers in address 26 and when we went to to START COMP, instead of the original 6.5 that we entered back there, we got a 12.

Collins We got a 12.

Young So we went back and reentered it, punched START COMP again and got a 12 again. So by this time that whole N_{SR} radar determination scheme was a pretty time critical thing, and we were right on top of the burn. So what I did was let the IVI's run and just burn off 6 of that 12. And that kind of made me

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suspicious of those crazy numbers that we were getting out of that up-down correction. And then the ground came through with some big long fancy procedure to check all this after we had gone to Rendezvous Mode, and I didn't want to go through all that and go out of Rendezvous Mode, because I really don't think that was the way to handle that problem at that time. So we didn't do it.

Collins Okay, we pushed the Rendezvous Mode at K_{SR} plus 4 minutes and then I confirmed all these addresses, 54 read 72899, 53 read 53776, 24 read 13134, 92 read all zips, and 99 read 00004. I inserted 83, 13000 and 93, 04820.

Young And then I was down aligning the platform there for a while, and I had the platform totally aligned except for a brief period and platform...

Collins We started that platform alinement right on schedule too, just prior to 9 degrees. And that was at 10:40 after K_{SR} .

Young And we completed it on schedule, and as near as I could tell the platform was aligned perfectly. One thing we did notice was that on the polar plot before the platform alinement we were perfectly nominal on the line, and after the platform alinement we were 2 miles low. Isn't that right?

Collins That is right. I got six data points on the polar plot. They go from about 95 miles into about 79 miles, and their scatter is not more than, at the most, a half a mile. The first one

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is high, the second one is high, the third one is low, the fourth one is low, the fifth one is right on the line. Here is another one, the seventh data point is right on the line. Then after the platform alinement, all of a sudden bango! We are 2 miles low and...

Young And we stayed 2 miles low

Collins And we stayed 2 miles low on the polar plot, steady as a rock, 2 miles low from 67 miles, which was the first data point I have there, down to 48 miles.

Young Okay, that tells us right away that TPI should be 37 feet a second. No if, and, or buts. We were just as co-elliptic as we could be. We saw the Agena at 48 miles or so.

Collins Yes, I got it visual. We saw it at 48 miles.

Young Okay and that was in reflected sun-light. That wasn't with a light shining on it. We got to TPI and we were still in daylight. The computer seemed to be working properly. It would spit out a solution, but we reached point C, when the total Delta V-T was 93, which was a little higher than I would have liked for it to be, but I punched START COMP and up in the windows came 41, forward, 1 up and 16 left.

Collins Okay, my solution to that was 41 forward and 4 down. The ground solution was 34 forward, 6/10ths down, and 1 right, and the closed-loop was 41 forward, 1 up, 16 left; and the backup was 41 forward, 4 down. Of course, I don't get a left, right,

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Young Okay now, and what we applied was 41 forward.

Collins Used 41 forward, zero up-down, and zero left-right.

Young And that was my first error in judgment, I should have applied 37 forward, near as I can figure. And let it go at that, and seen what developed. It seemed to be pretty obvious that whatever this thing had picked the 16 foot per second left correction from was wrong. I wasn't really sure of the up-down, because I wasn't sure that the up-down numbers were taken properly after that funny on the Module III, N_{SR} maneuvers, but we will talk about that more later. Okay, so that's what we applied. But we were coming in there pretty good. What were the next two corrections you got?

Collins All right, the first correction that I got was 14 aft, and 9 down, and of course we did not apply that.

Young Because that was only a failure type of thing.

Collins Right, and the second correction, the closed-loop said, 15 aft 22 down, and one right this time, and the backup solution was 17 aft and 10 down.

Young We used 15 aft, which is the closed-loop solution, and 14 down, and the logic there was to be conservative, but considering that perhaps there was a funny with the up-down correction, to use half-way between the backup solution and the closed-loop solution. I didn't know whether there was a funny with the up-down or not. Trying to out psyche that thing, I failed miserably.

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That's what I did anyway.

Collins Okay the third correction was, of course, backup solution only 7 aft, and 10 down, and we applied none of that. The fourth correction was 1 forward, 25 down, and as this is a closed-loop solution, and 5 right, and my backup was 3 aft, and 14 down. And we applied 0 fore-aft, 25 down, and 5 right.

Young And this didn't leave us set up very good. Another thing that happened on that particular burn which I certainly don't understand was that the 25 down ended up coupling into 24 aft.

Collins Yes. When we finished making the 25 down burn we had 24 aft.

Young I don't understand that either.

Collins I don't understand that. You didn't burn out the 24 aft, did you?

Young Yes, I started braking shortly thereafter, but - that was a bad - the only thing I can think of that might have caused some of it, (and I hope the dickens it certainly wasn't, but we'd have to look at the traces to see whether the thrusters were firing or not) was the fact that I was cramped up in the seat, and I couldn't spread out my knees; I had a pocket on my pants that might have been forcing my hand up when I was putting in forward thrust and down thrust at the same time. That is the only thing I can think of. I had that big fat pocket and I might have been doing that. If that was, we are really in a bad way, I don't think so, but it could be. If it was

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it really would have fixed our wagon. It almost did. Okay, at that time I asked for inertial needles.

Collins That is right after the last closed-loop solution, we put in 99, 90002, and the needles took. I put those inertial needles in a total of three times.

Young I was going to give the system a good checkout. And here is my last error in judgment; I put in the inertial needles and I was checking them against the radar needles and out the window, a motion of the target and I decided that I would leave the cotton-picking range rate up high, to take a look at the braking schedule on the dual. I decided this before lift-off, but it was an error in judgment, I think. I know there was target motion against the stars, the moment I looked at it, so the last maneuver hadn't set me up well at all, to hit the thing.

FCSD REP Out of plane mostly, was it?

Young Yes, it was mostly out of plane. And I had an out-of-plane Whifferdill going on me. I started thrusting out of plane the moment that I looked up and saw the target and kept right on thrusting and we did a great huge Whifferdill. What I should have done was brake that son-of-a-gun on down, and not worried about the dual Rendezvous. I think it is an error to try to do more than one thing at a time; you've got to worry about one Rendezvous at a time. I think I made at least three errors

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in judgment on that Rendezvous. The first one was inability to distinguish between a correct closed-loop solution and a poor one. And the correct one was probably 37 feet a second forward, and no left-right, and no up-down. The second one was not applying all the first correction due to the fact that I suspected the up-down windows from that crazy thing that we got out on the N_{SR} up-down. The third one was not braking that thing down, because I decided to look at the dual braking schedule. And with all that out of plane, I just couldn't hack it.

Collins I don't believe it would have helped you to brake early.

Young Yes, it would. I could have gotten on the inside of it instead of coming back on it.

Collins I think there is something screwy with this out of plane. Look at this thing. The first closed-loop solution says 16 left, and you applied zero left, and then the first correction and the second correction are both to the right, closed-loop. That didn't make any sense. Does it?

Young No.

Collins See you applied zero left....

Young Yes, we applied the last right correction, but that didn't stop the out of plane.

Collins All right the, how could the closed-loop ask for 16 left, and you give it nothing, and the have its first and second

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correction be 1 right and 5 right? I don't understand that part.

Young That is where you are on the nose all right, but I don't think 16 left would have got it. Because if we had put in 16 left we really would have had a right out of plane. It was going like this, and even if it had been coming back like this and going like that, there is no way it could do a whole node from 35 miles on in.

Collins That is right. You can only do a small fraction of a node.

Young That is right, the first solution was just flat wrong, and I knew that because the target was on this side of the ball. Assuming the ball was right, the target was continuously on the right side of the ball, the whole way. And if I had applied the first one left, we would really have had the lick. So, I didn't do that. I only applied half that first up-down because of that funny at N_{SR} , where we got twice as much up-down as the thing really put in there.

REP Did you say there was a 37 in there some where, where was that?

Collins No, he guessed that is what it should have been based on how low we were.

Young Yes, sure, that is what we should have applied. Two miles low and we got 41. If we had applied that 37 I bet we would have sailed in there like gangbusters. I guess you learn by experience, but that's sure a hard rock. And then not to brake it

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down, that was just dumb because I really had an out of plane going for me by the time I looked out the window. I did the last burn which was a pretty long burn, 25 down, so I was looking in the cockpit for a long time. It pretty well faded the up-down correction.

Collins We went by on the left, didn't we?

Young The Whifferdill was an out-of-plane Whifferdill at about 800 feet out, and then we came on back in and got it, at the cost of a lot of gas. The closed-loop was not correcting right for the out of plane. And where we got all the out of plane from I don't know either. We really had some motion here. I was thinking maybe when I took out this aft I didn't apply it properly. Another thing that happened there that I don't understand was the second closed-loop correction, which was 25 down; when I got through thrusting that 25 down, I had 24 aft.

Collins In the window, I don't understand that either.

Young Then I took that out, and so there I was in the cockpit another long time, and by the time I looked out of the darn cockpit the cotton-picking target is going out to the right like a bat out of hell. The only thing I can think of that might cause that is that I had unstrapped before to stow everything, and I had a pocket on my suit I might have been pushing down on it so that the position of that thing in floating up might have put us on

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forward thrust or something, but I don't think so. I really don't. If so, it was really a screw-up. Anyway, then we finally got in there and rendezvoused with it and it was right at dawn when we finally got up close enough to see what the heck was going on.

Collins Yes, all this was in the dark, too.

Young Yes, well, we were getting there a little early. I had a heck of a time getting stopped on that son-of-a-gun, but it didn't take a lot of gas to do it once we got in there. And I think that accounts for the fuel expenditure.

Collins Well, I think maybe it does too, except I am not at all convinced there is not a fuel quantity error in this system just because of what happened very late in the flight.

Young It wasn't much of one because the rate pressure was down so low it couldn't be very much.

Collins Yes, but we had at least 50 feet per second Delta V after they computed we ran out. We used 50 feet per second after they computed we ran out and we still had some left when we separated. So that is a sizeable amount of gas.

Young I don't know if we used that much.

Collins Well, they will have to see. Well, we used 25 feet per second in that 100 foot per second retrograde burn, more than they calculated we were going to use. Remember they said we were going to run out of the main tank at 75 feet per second.

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Young We stayed in PLATFORM for two orbits and that PLATFORM was just going like gangbusters the whole time.

Collins That is right and we separated with a reg pressure of 670 or 700 or something like that. I am not sure what it was.

Young And it was still there when we...

Collins That is right, the last time we saw the adapter we had around 700 pounds of source pressure.

Young Doing those kind of corrections you are not going to get in there cheap, and doing that kind of Whifferdill is going to cost you. There is no doubt about it because I had to thrust to do it, and they are just errors in judgment. I didn't understand the closed-loop solution, that is for sure.

Collins I don't think the closed-loop solution was right, do you?

Young Not for the out-of-plane, it wasn't, which was the problem right there. It sure wasn't.

Collins Well, even for forward.

Young It wasn't right for the forward either, but - In retrospect, what I should have done is null it against the stars and the heck with all the braking schedules. Just go ahead and get on in there. I probably would have saved a hundred pounds. But I really had to check those inertial needles because nobody had ever checked them before as near as I could tell. I didn't have any confidence that they were going to work right and knew dang well the needles wouldn't do it.

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I was using the inertial needles instead of the stars. They were working, I just wasn't applying enough thrust. I applied all I had. I just wasn't getting there. I wish I would have applied a 37 forward. That was a big mistake right there. Four lousy feet a second could have saved the whole ball game I am sure. It would have cost some gas because we were low, probably 120 to 130 pounds. I was so confident that I could do this on inertial needles and demonstrate this dual braking schedule.

Collins To continue, the Agena lights worked normally. The Agena commands all worked normally. (As soon as we got in the dark I could see the Agena.)

Young I compared the position of the Agena with the position of the boresight on the target and in pitch, the radar needles were perfect with the optical sight and in yaw, when the radar needles were centered, the Agena was one-half degree to the right. I think that is outstanding.

Collins I started taking pictures of the Agena with the Hasselblad and with the 16mm as we were coming in. We should have some good Agena pictures.

Young We alined the platform BEF.

Collins Yes, BEF, I think.

Young It was a BEF platform alinement and just a piece of cake flying that rascal. In fact, formation flying is just like in an

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airplane. It doesn't take any gas and it doesn't take any work either. Up to this time we had been out to the side of it BEEF and hadn't taken a look at the Status Display Panel. So, but that time it was time to go in and dock and we took a look at the Status Display Panel. Something I would like to say about this whole time was that a couple of times, that son-of-a-gun got in the sunlight and I couldn't see it. Just lost it.

Collins When was this?

Young When we were flying formation on the Agena.

Collins First time, huh.

Young Yes, when that sun came up.

Collins Oh, yes, I remember. I could see it one time and you couldn't, and I was telling you where it was.

Young Yes. I wasn't very far away from it, maybe 10 feet or so.

Collins It was over on my side.

Young Although we weren't closing on it at any great rate it was just uncomfortable. Man, the sun really bounces off that son-of-a-gun, you know. It really gets to you. The Status Display Panel, we did that, and then went on in and docked.

Collins Went on in and docked; it was a nice docking.

Young That son-of-a-gun just went --(slurping sound). I don't know how they will transmit that, but it really grabs a hold of you and just pulls you right in there. Looked like it knew what

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it wanted. Okay and when we got docked, we had 58 seconds on the main, 3 minutes and 27 seconds on the secondary and 85 percent attitude gas. All the lights were like they were supposed to be. After we docked, there was no dispersion between my attitude ball zero degree, zero degree and the alignment of the Agena, which was something everybody was worried about. I was convinced that it was okay to burn that thing in any direction they wanted to burn it in. It was just beautiful. It never was the same again, but that first time, after we got up a good alignment, it was just great.

Young We did the Bending Mode check, 3 seconds down immediately followed by 3 seconds pitch up. We alined the Agena stabilizer for 2 minutes, 3 seconds yaw left, 3 seconds yaw right and allowed the spacecraft and Agena to stabilize for 10 seconds. That was done over Hawaii and I couldn't tell that it was anything. We controlled the spacecraft attitude to zero degree, 180, zero degree, by applying a direct pulse and it didn't appear to me like..

Collins All we did was waste gas.

Young That is right. It didn't appear to me that we accomplished anything by that. We did it anyway and we tried to take pictures of it. I don't think they are going to show us anything. The rascal was solid as a rock. The rates that we experienced by the thrust that we gave it, was precisely the

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same as we had in the simulator. Mike sent commands to turn the ACS back on, after we got around to TDA4. We did an IVI and computer NAV MODE check to make sure we had the thruster logic right. Over RKV they gave us a VM load for the general purpose translation. Checked that out. We made sure that we were in FC7. Over Hawaii, the first burn was PPS burn which was forward and posigrade at 413.9 ft/sec. Have you got the residuals on that? The Dual Rendezvous General Purpose Translation.

Collins Yes, I got it all written down right here, but we made a practice of going into the FC7 anywhere from 3 to 6 minutes before the burn and I think that is a sound idea. I think if possible when you are going to do a PPS burn, you ought to let the station confirm that you are back in FC7 before you burn, because if you are not in FC7 and you burn that PPS, you are going to be in trouble. Of course, you can't do anything much about it. No, I don't think I have the residuals, John. Just a second, maybe I wrote them down in the experiments book - I have got them somewhere.

Young They are incidental anyway, who cares? Do you think it is necessary to have those residuals, Mike?

Collins No, I don't think so, but let me look one more place under Bending Mode Test. I don't think I wrote them down, John. Let's see, no, I don't have them.

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Young The burn was made at Hawaii.

Collins I did read them out.

Young Mike sent the 501 on my mark. Shortly after we sent it, 16 seconds after, we could see the unit ones fire. Could you see the unit ones? It was right at sunset when we lit this baby off. Address 80 has to be punched about three times to get a one digit change in it. At first, the sensation I got was that there was a pop back there, then there was a big explosion, and a clang. We were thrown forward in the seats. We had our shoulder harnesses fastened. Fire and sparks started coming out of the back end of that rascal. The light was something fierce, and the acceleration was pretty good. The vehicle yawed off, and I don't remember whether it was to the right or to the left, but it was the kind of response that the Lockheed people had predicted we would get; a yaw 2 or 3 degrees and then it yawed right back to center. This is the indication we got on the attitude ball.

Collins Did you notice this looking out of the window, the attitude change?

Young Yes....

Collins Well, I didn't notice it.

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Young Well, I wasn't looking out the window. I was looking at the ball, but I could feel it slide.

Collins Well, I was looking out the window and of course I am supposed to look at the status display panel, and I was supposed to monitor the rates on the rate needles inside, and I have to have one hand on the ARM STOP switch and all that. The way it turned out, you know, the only thing I really ended up doing was monitoring the time and shutting it down 2 seconds after the time was elapsed because when that thing lights off you can no longer see the status display panel.

Young I didn't think you could. There were plenty of sun angles where you couldn't see that display panel.

Collins That is right.

Young As a matter of fact, it was very rare in the daytime when 100 percent of the status display was visible. The shutdown on the PPS was just unbelievable. It was a quick jolt and it quit. The IVI's read out, the residuals on that first burn: 1.1 feet per second out of 413 feet and 113. 81 and 82 was 10.8 and I thought that was just pure fantastic. And at the end of the burn we had 45 and a half seconds left, main time; 3 minutes 20 seconds, secondary time; and 80 percent attitude gas. And the tailoff of that main PPS was -- I never saw anything like that before, sparks and fire and smoke and lights.

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Collins And we got some pictures out of that first one because we weren't expecting anything like that. I hope it took.

Young Trouble is, by the time you can shut the thing down with the ARM STOP -- first of all, while it is burning you are plastered up against the windshield. You can't do anything. You are supposed to be looking at all these other good things anyhow. Then when you shut it down with the ARM STOP, you have to send 500 to recycle all the electronics in it, and then by that time you have to fish around and get the camera and start shooting. I think we probably lost the most spectacular part of the tailoff. That is really a sight to behold. Wasn't there stuff coming off the adapter?

Collins Our adapter section?

Young Yes during the Agena tailoff because it seems to me that stuff was coming from behind us too.

Collins I hope not. Might have been.

Young Yes, might have been. Little particles, maybe it was an accumulation of moisture...

Collins One thing that did happen during the burn, we got the Delta P light. Did we get it on all burns?

Young I didn't notice.

Collins I don't know, John.

Young We sure got them on the first one.

Collins We did? I don't know.

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Young And this bit about lithium hydroxide loose is certainly possible because of the jarring around.

Collins Yes, it is not a smooth ramp function. The first thing is a visual cue. You see the flame start trickling out of the back end of it, and the edge of it, and you think, "Oh, oh, it must be a hard fire or something because I don't believe it is going to light". Then just about that time it hits you, and when it hits you, you get one g almost instantaneously.

Young We had one g on the first start, and the last one was up to one and a quarter.

Collins If that thing started to go out of control, I think you would be hard pressed to get it shutdown before it broke up.

Young I think it would be pretty close. But I tell you we were watching it.

Collins I think the best thing to watch it on is those rate needles, watch those angle inside the cockpit.

Young I am not really sure the guy in the left seat shouldn't be watching the attitude needles with his hand on the ARM STOP switch.

Collins You don't have any ARM STOP switch.

Young I mean the guy in the right seat. Let the guy in the left seat watch the IVI and the main display hands or something like that.

Collins I tell you, I don't think it is even worth watching the Status Display Panel.

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- Young I don't either, that Status Display Panel is a real poor design. Who in the heck ever thought you would be able to watch it anyway?
- Collins Well, when that main engine lights up it just obscures the Status Display Panel. Whether you want to or not, your eyes just unconsciously stray off to see what is going on, to see that engine burning, and the whole sky lights up.
- Young I think originally we had the Status Display Panel inside the spacecraft, but we ran out of places to put it.
- Collins That is right. And as a matter of fact, it is not a very good cue as to what is going on in that Agena.
- Young Well, I guess it is, but the point is you just can't monitor it and watch that engine and watch everything else.
- Young Okay, we let that baby down and then they said we were not going to have any Phase Adjust Maneuver that night so we powered down, ate, and went through the Presleep checklist. By this time, we had gotten up to apogee and we took some pictures at apogee, which was essentially sunrise. I don't know where it was, but it shows the curvature of the earth. Through that night we took some pictures of an area coming down hill. I think it was the Red Sea area, I am not sure. It is on Magazine A. And then we took some more pictures and, I guess we gave them a crew status report at about this time, I don't know what that was for.

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Collins Wasn't it around 3/10ths, wasn't that what the first reading was? 2200, I think.

Young Yes, that sounds right .22 rads. Well, okay, we got a Flight Plan update along about that time. Have you got your Flight Plan updates? You have those.

Collins Yes, I have one. It starts with 17:30 gyro compass TDA south, 19 hours gyro compass TDA aft, Height Adjust at 20:20:57, 336 feet per second retrograde.

Young We changed all that stuff later.

Collins Yes, Plane Change 21:54:48; N_{SR} 22:37:53...and stayed docked for maneuvers. This was our first indication that we were really going after the old Agena (together)...hats off to those guys. They did a good job.

Young -We thought it wasn't going to go.

Collins Those guys did a good job down there. It wasn't too much longer after that you came on and said how about talking more. No, I guess that was the next day. But I felt like saying, oh, you don't want to hear what we have got to say. I am sorry about that, was that too bad other than talking?

Young The night I thought was pretty uneventful. I think we slept about like I expected to sleep on the first night. I was aware of being in a spacecraft the whole time and I just dozed. How did you sleep?

Collins I slept terrible the first night. And I say, I didn't sleep

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at all. Maybe I did sleep, but I was constantly aware of where I was, and my mind was much occupied with what had happened that day and what was going to happen in the next couple of days; and I wasn't really bone tired enough to fall off into sleep.

Young I was really down on me. I was really down.

Collins Well, I think we were both discouraged. The combination of being discouraged, and I don't really think we were bone tired like I say. The first night I didn't sleep well at all.

Young That is right. That first night I don't think we were very tired either.

Collins Well, somehow, I think you are emotionally tired, but not physically "poooped" enough to fall off into sleep. I don't know.

Young So the next morning was a new day. We got up and you gyro compassed the Agena to TDA, south. Yes, that was 17:30 and we spent a rev doing that until 18 hours.

Collins Nineteen hours. We went to TDA, south. Isn't that what you said? And then we went to TDA aft at 19 hours and went TDA.

Young We powered up after having powered down the night before. I really don't think you need a Power-up checklist, because if the things aren't on, you will know it. If you haven't turned the right switches it isn't going to work. We had a couple of cases there where we didn't turn the right ones.

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Collins Yes, but you don't want to turn the computer on and then discover you have the DC power off and then go back and turn the power on.

Young Very true. I think you ought to have a checklist. I really do. It doesn't hurt anything, but pretty soon it will become easy to do without one. And then we went to FC2 to Fine Aline the thing and cage the platform to it. And after that, everytime we went to a different cruise mode or control mode, the platform was always at some different angle; so from then on, everytime we went to a burn mode I caged the platform to the Agena. I don't see anything wrong with that, because I think the Agena knew pretty much where it was going. But we sure didn't know where it was going. That burn was a 300, and this was about the time of the dual Rendezvous Height Adjust Translation, which was 330 - 340 feet per second aft to bring that apogee back down, and 11 seconds. We configured it in FC6, forget where we were, I have got down here that when we fired it, we had a 2 degree left yaw that immediately cancelled out and went back to normal, and that thing overshot by 1.4 feet per second. I thought it was terrific, considering how much Delta V it had. Do you have any comments on that?

Collins No.

Young The way this thing would yaw off was just exactly like the contractor predicted. It would yaw off to the left and to the

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right; I think they were all to the left. They were all the same direction, I don't remember which way it was; they would yaw off and for 2 seconds and come right back on. Whatever the problem was with CG, they obviously got that fixed. And that was a good healthy burn; we took pictures of it and gave the same sparks, and the same hard light, and made the same racket. I don't really see that we did a heck of a lot in there. Okay, 15 U. S. pass purge cells powered up. During this time we had TDA south, we had the Agena recorder on to get the data for S-26. They dumped the tape on the Agena and checked the VM load, and sent up information to burn the PPS. The PPS burn wasn't normal; they changed our Standup EVA so that we were doing S-13 out the window at night, on a Southern constellation. From 20 hours and 21 minutes to 21:20, we were doing a Preliminary Standup EVA preparations.

Collins From when to when?

Young I don't know, why don't you do into all of that, because you were doing it?

Collins I really don't have any comments about the Preliminary EVA prep. We rehearsed it enough and we had the procedures down cold; it was just as we had practiced it. There were not any surprises.

Young I think you went through it just like nothing.

Collins It took a little bit longer than it did on the ground. The

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reason it did was that like everything else, on the ground we practiced one thing at a time. We practiced EVA prep, we did EVA prep, if we practiced Agena burns, we did Agena burns, but during flight all these things get intermixed; flight plan updates, conversation with the ground, encoder commands to the Agena, EVA prep and stowage all simultaneously.

Young We didn't allow for that in our time line.

Collins We had no idea that we would be given control of the Agena while we were doing everything else.

Young We weren't supposed to be anywhere near the Agena.

Collins That is the only reason it took longer.

Young I didn't expect to be working, I thought we would be resting about 50 percent of the time.

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Collins That's why it took longer, not because of those tests which we planned to do but....

Young Everytime we turned around, we got a call from the ground to do something, or check, or fix something, and we just couldn't do it.

Young Now for EVA Prep - I know you have to do a fuel cell purge. Okay, we got an eat period in there.

Collins Why don't we say something about eating.

Young Eating takes too long.

Collins Yes.

Young Too much time is wasted getting ready to eat. The eating doesn't actually take any time, but the getting ready to eat does. Now even the eating takes time, squishing that stuff out of the bags, and trying to get it all out of there. The necks of the bags, where the neck joins the bag itself, is a poor design because it lies flat and is impossible to -not impossible - but very difficult-to make it open up. I had at least four food packs that leaked. This was messy as the devil.

Collins I had, I think, two leaky packs.

Young You cut open a food pack one time, didn't you?

Collins Oh yes. That's a bad thing to do. I had my surgical scissors out, and I was cutting open the aluminum foil on this food pack, and as I am chopping along I felt a little resistance, so I just bore down a little bit harder with the scissors which

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Collins was a mistake. I cut open an orange juice container and little bits of orange juice started floating out and around the cockpit. You know these grains. I immediately went and snatched out a dry stowage bag and put the orange juice inside it and sealed it up, even though it was only a couple of minutes that it was out. For about an hour thereafter, we had little bits and pieces of particles all floating around, and I'm sneezing and coughing.

Young It didn't get over on my side, which is where it was supposed to come.

Collins But the food itself tastes alright. I don't have any complaints about that, but its just a darn unwielding procedure and on a short flight like this where there are a lot of other things to do, its just foolish to be required to waste time eating. Also about the food, the right-hand hatch pouch, we again had trouble getting this food out of there the first two meals. After we had the first two meals, then it was all right, but we had a lot of trouble getting the first two meals out.

Young I feel like they were trying to give us some exercise. Okay, I guess that takes us up to about the third PPS burn, which was a pretty good burn. Yes, all the burns were good. It was a short one; it was only 4 secs. We had a 14 second burn, and a 11 second burn; and this was at 22:36:51 with TFS forward to bring perigee up to 200. I guess it was a pretty good burn, I don't

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Young see anything different about it than the other. We still had the same amount of yaw that came back off, and it really wasn't enough. I didn't really last long enough to do anything. We got pictures of it, and this one instead of being like the first two were right at sunset, which is where perigee was. But this one was at sunrise, which was where apogee was, and it was to bring up perigee. I was afraid it was going to be in the dark, and I think making a PPS burn in the dark would be a very interesting experience.

Collins I don't think it makes an awful lot of difference, personally.

Young I just don't look out the window.

Collins You can't see anything out the window anyway.

Young Yes, but it would sure be good to see it.

Collins But you ought to turn the cockpit lights up Full Bright at night.

Young Yes, I agree.

Okay, I guess we've come to the Standup EVA. We yawed the TDA immediately after we did that burn. We did the Final Standup EVA Prep which included the suit integrity check, and this was at 21:20. Okay, at 21:20 we gyro-compassed the TDA forward, the spacecraft 0, 180, 0; and at 23:00 we gyro-compassed the TDA North and got it in FC-2. They made us go to FC-6 so we wouldn't use so much gas. At 23:26 it was sunset, and right at sunset, we opened the hatch. The suit integrity checks were

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Young nominal, and we depressed it to 3 psi, and everything looked normal. We opened the hatch, and Mike stood up. To me the hatch opened very easily. I didn't think there was any pressure on it at all that first time.

Collins No, the hatch worked beautifully throughout. The closing and opening forces were very low, I'd guess on the order of 10 to 15 lbs, and the adjustment on the sawtooth and all the other adjustments were just perfect.

Young Yes, they were really great.

Collins So, I opened the hatch, and I started standing up and turned in toward John, about as we planned. It turned out about 45 degrees angle inboard was just about right. I put the S-13 camera up on the bracket and went to advance the film.

Young Tell them about breaking the timer.

Collins The timer on the S-13 broke during the last Agena burn. We'd done the Preliminary Standup EVA Prep, which included putting all the S-13 rig together, so I had my timer...

Young We had a lot of stuff in the cockpit. We had junk all over the place.

Collins I had the S-13 all assembled, and I had the timer screwed into the camera, and I had the whole assembly put down in the right-hand footwell because the g load is forward. After the burn, I noticed that the S-13 extended timer had come loose, the little end of it. The part that fits down inside the shutter

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Collins opening thing on the camera was bent off at about a 45 degree angle, and a little piece of it was broken off inside the camera. So, I did all the S-13's manually, and I think that's a good procedure. As a matter of fact, I think all you really need to do to that S-13 is to enlarge the shutter opener, or the button that you push to open the shutter. And what seemed to me to be the best thing to do was screw something in there which is about flat and about the size of a silver dollar, so that with your gloved hand you could just bag down on that thing and find it without looking for it in the dark.

REP Think it held steady and everything?

Collins I think it did. I would advance the film and then I would hold the camera with my right hand which I used to advance the film, and I would come along holding it in my right hand. I would come along with my left hand and push the shutter down. The only trouble was that the little button was hard to find in the dark, and sometimes I would take two or three stabs at it before I found it. That is why I recommended the silver dollar thing.

Young And I was counting you down by seconds.

Collins Yes, John was giving me marks. I'd tell him when I started, and then he would tell me when to stop. We made..We were supposed to make 20 exposures at 20 seconds each, and I actually figured that was the last time we were going to use that gear,

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Collins so I made more on the order of 25 exposures. There was supposed to be 24 on the camera. I think there were 24. No there are more than that, John.

Young There are 40.

Collins. Forty, that's right. That's right. The maximum that we were supposed to use, leaving some for calibration was 10 exposures on four star fields. That was preflight. So the way it worked out, I took about 25 of the 40 exposures. It worked real good; we could see the stars. The only disappointing thing was that left hand visor does knock out enough of the light intensity that you can't see the faint stars that I expected you would be able to. As a matter of fact I could only count...

Young I was seeing a lot more stars than you.

Collins I could only count seven stars in the Pleiades while I was EVA. But none the less it is a beautiful view. The body position was no problem at all. I was wedged in there, and the S-13 camera was easy to operate. I did have one false go at putting it in that bracket. I thought it was in the bracket, and then when I advanced the film, it just flew right out. The whole camera came loose from the bracket, so I must not have had it all the way in. The second time, I did finally get it in. That bracket is a poor design. I don't know how to improve the design because the problem is that the piece which is attached to the spacecraft must, of necessity, lie flush

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with the surface so that it doesn't interfere with the hatch closing. So if you are unable to bring it out three dimensionally, I don't know how you are going to improve the design. But it is of a poor design, and it is very difficult in the pressurized suit to do anything in the dark, especially to get that camera in that bracket. I would recommend on Gemini XI, if they use that experiment, do that in the daytime; I mean to erect the equipment in the daytime. Of course you can't perform the experiment in the daytime.

Young Okay, we went through the whole night pass, and it looked to me like we were always on the same star field the whole night.

Collins It did look pretty much that way. I could see those four that we were looking for.

Young Gamma Velorum, Zeta Puppis, Miaplacidus.

Collins Yes.

Young He's got them in that field because it has got to be in there.

Collins Yes, Miaplacidus, Gamma Velorum, and Zeta Puppis. They came up and that's where I got the extra exposures. It was on that. Just as the sun came up, I passed this equipment, S-13, back in to John and he gave me the MSC-8. I erected the extension rod and got everything ready to go, and I took two exposures of that color plate at F-8 and 1/250ths.

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The spacecraft was small and to the South and I was turned so that my body was pointed East-Southeast so that when the sun came up I was pointed toward I held the color plate back over my shoulder, so to speak, and upward slightly so that I guess the sun was hitting it at about a 10 degree angle. I took two exposures at F-8. By this time, I was having so much trouble with my eyes that I decided the best thing to do was to hand the camera back in to John and let him change the setting on it. I couldn't see the camera. I had to go from F-8 to F-16 to F-11, for MSC-8, and I was unable to do that; so I handed the camera back in to John.

Young Things were so bad that I should have known something was wrong because at that time, he said that he was going to get rid of the color plate and take the S-5 and S-6 pictures.

Collins That's right. I figured that we had limited time left, and the best thing to do was take some decent pictures instead of the plates.

Young He wanted to put on 1/250ths at F-11, and I looked down through the camera and my eyes were tearing so bad that I couldn't see the index to change the exposure settings. So, I kept squinting at it and trying to change them, and I

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couldn't see to change them. I guess, I don't know how long we sat there, but it seemed like a long time, and it didn't seem to be improving any. In fact it was getting worse. I was tearing so bad that I couldn't see to read the instruments, so I said why don't you come back inside and let's terminate this thing.

Collins It sounded like a good idea to me. I got back inside about half in the blind. I mean I couldn't make out any details. But on the other hand, I could see the general form of everything. So, it wasn't really a problem, I was sure that there was nothing fouled in the hatch because I didn't have that much gear out there with me, so, I made a normal ingress, which was very easy. I popped right in and had lots of hatch clearance and pulled the old hatch closed, and I don't remember whether you helped me or not, but it came right on down that last sawtooth--I think, in fact, I brought it down to the next to the last sawtooth and then you gave one little tweak on the --

Young It was about 10 pounds, I guess like....

Collins --hatch closing device and it fell in the last sawtooth and we had already put the hatch close to lock-lock and we cranked her on down.

Young And we repressurized. I don't know whether it was going to

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clear up or not, I was beginning to wonder if we weren't in a bad situation.

Collins Yes, for a while there, I thought we probably would be looking for a reentry.

Young Reentry?

Collins Yes.

Young If you can't see the instruments, I don't know what you are going to do. That was a peculiar thing, I didn't ever have anything like that happen.

Collins We should have thought of O₂ High rate, but we didn't. I tell you what threw me off on this thing was that it was timed with the sun. It struck the instant the sun came up over the horizon. I thought that the only new element in this whole rig was the wet wipe on the outside of the visor.

Young That is what I thought about.

Collins So I thought- - -

Young It was the sun.

Collins That's right, I thought it was the sun impinging on the wet wipe and causing some sort of gas which was irritating my eyes. I don't think that is so, though.

Young I don't know, it may have something to do with it, because when I opened the --- I mean when you gave me the camera just about that time the

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sun was starting to come in my window and that's about the time my eyes started tearing too. So, maybe it is sort of psychological. ---

Collins Well, I think if you look at the sun, everything else being good and normal, it tends to make your eyes water. So if your eyes are probably very close to watering because of lithium hydroxide, or some other factor, and then you look at the sun, it is just enough aggravation to act as a catalyst and the whole thing starts.

Young So, we had to repressurize the spacecraft, which was unfortunate because we sure had a lot to do and a lot of interesting things to do.

Collins Anyway, that completes the standup EVA. We restowed and --.

Young Well, that was at 24 hrs? Did you get the update at 24 hours? That was when they wanted us to do the docked D-5 operation wasn't it?

Collins Okay, yes, they wanted us to do the docked D-5. They said to put the Agena to Flight Control Mode-6, go TDA forward, then they gave us these commands.

Young Well, we had a long talk about it.

Collins Yes.

Young We had a long talk about this problem, and then went to O₂ high rate and ----.

Collins Yes, they were going back to the oxygen....

Young And when we got the cabin up, we repressed it, and had some discussion with the ground on this thing, and went to the single fan

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set up that we stayed on the rest of the time. It worked okay with single fan and normal flow after we got off O₂ High Rate, which cleared up everything.

Young Except it was hot the rest of the flight.

Collins For the rest of the flight it was hot. It was hot from the beginning of the flight. The whole flight was hot.

Young As far as you were concerned, that was for sure. We set up this TDA forward thing and tried it out a couple of times, and couldn't get it to stop yawing. We would go off, and we couldn't get it to stop yawing, and then somebody told us that we had to turn the gyro compassing off. I hadn't thought of that. That wasn't in the original instruction as to what to do either, since this was a new fancy thing that they were pulling off, but anyway, it was really a gas burner, and we finished one rev. of doing D-5. We looked at our attitude gas and we almost didn't have any. I think that it was down to 18 or 19 percent or something. What was it? It must have been above 40 or something before we started, maybe 37.

Collins We really burned up the gas, the Agena attitude control fuel that is.

Young So, we decided that wasn't a good thing to do, but the D-5 worked out pretty well that way, and it should be possible to do it that way.

Collins Yes, I think it would have been possible to do it that way,

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and I think it....

Young You did some of it that way. The only trouble was we didn't get the whole sequence because of the gyro compassing trouble.

Collins So, of the 6 or 7 stars we were programmed for, I think we got 4 or 5, the last 4 or 5. It seemed to work all right.

Young We had Module 6 loaded for that, and that loaded okay. We went from Module 3 to Module 6 and at 26:29:43, we started on the D-5, Mode A, but this procedure they gave us which was: set up 420, then yaw right, which is yaw rate low; and then yaw right and yaw left 411 and 410; and then start at 441 and stay at 442- - -

Collins They had gyro compass on. That's what they told us to do first.

Young Okay.

Collins See, this is what they called up. They said to go to Flight Control Mode 6, TDA forward, send 420. When said send 411 or 410, depending on which way you want to yaw, and put your gyro compass on and Flight Control Mode 1 on. So we did what they said, I think.

Young Well, whatever it was it didn't stay. We finally got it to stay in the right place, but it cost us a lot of gas. I don't understand what kind of setup we had there. Things were coming up so fast.

Collins That's right, they were really moving out about this time.

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Young Okay, and then we got the spacecraft vector for D-5 Mode B, but that's the one we didn't get a chance to do on the second night pass. Then we got an update for KC-1, the Catch up Manuever, and there was an SPS burn. We did that at 7.7 feet per second, and on that one the SPS burn was like burning the IVI's. We played that one conservatively, and you shut that one down on 2 seconds over.

Collins Yes, we shut it down late, and even so, the thing had an overshoot tailoff that- - -

Young What did we have at 80?

Collins 2.3

Young 2.3 over at 7.7 feet per second, we actually had- - -

Collins We had a 9 second burn. I gave it, I think, 11 seconds, as near as I could judge. Then I shut it down. 80 was 00023, 81 was minus 0005, 82 was minus 0007. That was at 27:45:36.

Young At this time we are down to about 17 percent on the attitude gas, so they told us not to do any more of those good things they said to go ahead and power down, go to sleep, and purge the fuel cells. He purged Section 1 and Section 2 at 28:40, and then we powered down.

Collins And what I did on that purge, I left the Section 2 oxygen switch on for a lot longer than 2 minutes. Personally, I don't like those rollers. If I had it all to do over again,

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I'd go without those rollers because this was coming right up on a sleep period, and I could very easily have just conked off to sleep and left that oxygen running, and that would have been disasterous.

Young I think we had to almost continually, those first few days, bring the manual O₂ heater to beat that pressure back up to 800, and when we forgot to do it the ground would tell us at practically every station. I guess that is all right. 28:40 and another eat period at 29:40, 28:40 to 29:40. Then 29:00, over CSQ, we got the updates, and at 29:20, over Hawaii we gave them a crew status report. 39:30, we went to sleep.

Collins 29:10 to 39:30, I think, was supposed to be the sleep period.

Young We did a lot of cleaning up and stowage.

Collins Boy, I really got a good night's sleep that night.

Young I did too I think that is probably the reason.

Collins The only one of the three nights that I got a good night's sleep was the middle night, and I think that is something for flight planning. It seems to me that the second day of these flights should be a light day, an easy day, because I don't believe, as a general rule, many people are going to get much sleep the first night. If you have a three day flight plan in general, I think you should make the first day and the third day heavy, and the middle day light.

Young I think so. They are going to need that second day to

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catch up - - -

Collins That was the way our Flight Plan was supposed to work. Now being attached to that Agena kept us busy up to the second day, and I'd say by the end of the second day both of us were pretty darned tired.

Young Yes. I don't know how busy it was, but it seemed like everytime we turned around we were giving commands to that Agena.

Collins Everytime I turned around you had another half dozen commands that I had to send to the Agena. If I sent that thing one command, I sent it 500.

Young Well, there was just no way out of it. We were running out of gas and we had to get it configured, so and we -- --

Collins I realize that, but it is just an awful time waster to be attached to that thing when you have to talk to it all the time.

Young Well, that is mighty poor. Next time we design one of those interfaces, we will make sure we get a better method of control. I mean if you want to go to Control Mode, you ought to be able to punch an FC-6 and have it 'zap' in there without sending a hundred more commands.

Collins Well, that is true. Another thing is, I trust the ground to talk to that Agena. I mean -- -- we had them load the VM for us, and then we did everything else ourselves. That

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worked fine.

Young I'm not sure we shouldn't have done that the second day.

Just tell them to conduct -- --

Collins That's what I'm leading up to. It wouldn't

worry me a bit to have the ground do all that Agena stuff.

I think as long as they can verify their loads and make

sure they are getting it in right before they burn them,

I think they can do it. I think it is a good procedure.

I realize we give up some element of control.

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Young The third morning, over the Canaries we got a velocity meter load. We caged to the North, we caged the Agena, we set up the FC2 then we went to FC6, then FC1. We had to send 460 on FC1 when the gyro compasses around to get us out of this deadband problem which nobody told us about. So we lost some gas that way. At 41:02:26 we did the plane change, in SPS which was 14.8 ft/sec. to the North. On that one, I made an error in that I gave Mike the gyro compassing to the South. The only way I caught it was about 10 minutes before the burn, I looked out the window and instead of looking at the southern constellations which I would if I was TDA North, but I was looking at the Northern constellations. So we gyro compassed it through 180 degrees. Rather swiftly I might say. I don't think it used very much gas. We got on station and went to FC2 and had 5 minutes to aline before the burn. We then went to FC6 and then to whatever configuration it is that you burn SPS in. And we went ahead and burned SPS on time. On that one the residual was 2/10ths of a foot per second. Got to remember that all these burns we're doing now, are strictly off the cuff. We didn't have any flight plan to go by or any information. It is pretty sketchy to keep this thing in a proper configuration, and a proper control mode, and play it by ear.

Collins I don't have the residuals on it, on plane change, John. Do you have them?

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Young No, but I remember it was an overshoot. I think it was on the order of 7 or 8/10ths of a foot per second. We resolved to do a little bit better on that. Then we gyro compassed to TDA aft, and we got a GO over Carnarvon for 44-1. And all systems were go. And we're still in FCl, the crew's configuration to save gasoline. We were practically using no gas at all that I could tell. I don't know if this is the exact time or not, but at 41:35, or some number, we did a 3 1/2 foot per second retro-grade SPS burn. I guess that was the last of the SPS burns. We did 3 PPS and 3 SPS burns. Pretty good check out of the Agena. We did all kinds of gyro compassings, to the North, to the South, East and West 90 degrees and 180 degrees. I thought the ability to control that vehicle attached to the spacecraft was pretty good. The big drawback of having the Agena up there, is that you can't see the outside world. The view out of the window with the Agena on there, is just practically zilch.

Collins We wanted to get some good pictures of the horizon. All we could do was just shoot the sliver of the horizon out of the corner of the window.

Young Just like backing down the railroad in a diesel engine looking at a big boxcar in front of you. It's really a frustrating thing to be up that high and not be able to look out of the spacecraft and look down. I was tempted to turn the ACS off, and

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just let it drift and just see what we could see.

Collins Then we figured we better not do that, and besides we didn't really have time. It seemed like these burns and things were coming up pretty consistantly.

Young On the question of the status display panel. Of course, at night, we're sleeping with the status display lights on bright, but of course we're asleep ...

Collins On dim

Young On dim yes, but we're asleep. So we couldn't see them. So, we didn't know whether things were going wrong or not. When it came time to take these S-13 pictures, we just turned the lights off. If it is really as dangerous to be operating with that thing as they say it is, it's not the kind of thing you should be doing all the time. But we did it anyway.

Collins You could see that the Arm Safe switch worked and you could make sure that you were rigidized. I think that that is an important thing. It's probably the most important thing we got out of the display panel.

Young Well, it wouldn't be if one of those other lights went out. Every time I looked out there they were on. But I think what is going to happen is the ground is going to tell you one of them is out. There are certain lighting conditions where the main red could come on and shine for 20 minutes, and you would never know it. If it came on during a PPS burr I don't think

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you'd ever know it either.

Young I don't think you'd see it. I think any of those other lights could go out or.... There's four lights that go out, and one that comes on during a burn and you're supposed to get out of there. I don't think you'd ever see them. You know you're supposed to shut it down. I think it is a waste of time.

Collins Yes, I agree.

Young I think they should re-evaluate that position, I don't think you'd see any of it until after the burn was over. I don't think it is a system where you can monitor the operation of it. But my guess is if it lights off the first time and doesn't blow up or something, it's going to work right the rest of the time. That first one was the one I was really sweating.

Collins And if that's a soft light, I'd hate to see a hard light.

Young That's the way I feel. That was a good kick. Then we moved the gyro compass to TDA 4 and FC1. Then you purged sections 1 and 2, and then they gave us an ECS test to perform. This was the height adjust, 3 1/2 foot per second retrograde. The procedure for that was to open the Flow Control, close the Recirculation valves, go to suit fan 1, decompress the cabin to 3.0 - 3.4 and after 1 hour repress the cabin. If we had any problems we were to go to O₂ Hi Rate.

Collins You know that was the first breather in the whole flight plan.

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This is 43 hours after take off and this is the first time that I can recall just sitting there with nothing to do.

Young We got some pictures out the window. We sat there with nothing to do for a whole hour. It's pretty nice.

Collins Yes, it was. Nobody to bug us because we were working, doing the ECS test.

Young My eyes smarted a little during that test, but I didn't say anything. As long as they didn't smart so bad that I couldn't see the instrument panel I was not going to say anything.

Collins Mine felt okay.

Young We never did go to O₂ Hi Rate. I never considered the situation to be such to even check O₂ Hi Rate. But it would have cleaned it right out, so I knew we had an out there.

Collins The next thing after the ECS test was Preliminary EVA prep.

Young Yes, that's where you missed lunch.

Collins Yes, that's where I missed lunch. What happened was I had part of breakfast left over, and I figured it would be just easier to finish up breakfast rather than just start on a new food pack and only eat part of it. Another reason was that I was sort of busy. The reason that I was busy was the interruptions kept coming along in form of talking to the ground and talking to the Agena. I was a little bit sloppy on stowage in space. We had a lot of items put away before I began the EVA preparation. The EVA preparation alone took about the same length

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of time it took on the ground. I washed off the inside of the visor with a wet wipe. This time I really concentrated on taking a dry rag and wiping it off, polishing it off clean inside so that there wouldn't be an excess amount of the wet wipe. I had done that, to some extent, the first time and I must say the 50 foot umbilical behaved very nicely; I got all the connections made on the preliminary EVA stuff, and I took those Velcro straps that are in various places along the umbilical, and I used those to sort of tie the umbilical down so that it would get out of the way. In other words where it came down from the tether hook at the upper left part of the right instrument panel to the repress valve, I had it tied down so John could see the MDIU, so it really was not in the way at all during the dual rendezvous. So the way we worked this thing, during the station keeping we go through the whole EVA prep so we got it divided up into an early phase and a late phase with hours in between them, and all during that second rendezvous we got this umbilical all over the place, but it wasn't in the way, it was all stowed and had little corners tucked in little pockets and what not, and it worked out okay.

FCSD Rep When was the EVA prep?

Collins We finished by 45:40 and ate at 45:15 supposedly right in the middle of the EVA prep.

Young And of course we didn't go EVA until the second part of the ...

Collins 49 hours wasn't it?

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- Young It was 49 hours, so he was 4 hours with all the stuff over there in the cockpit with him.
- Collins There was no problem; it was a good system; I'm glad we worked it out that way. We never would have gotten into EVA on time had we not done it this way. All right we went TDA forward, and at 46:10, caged the Agena. Then at 46:12:27, that was our last burn. That was the N_{SR} burn with the SPS of 6 feet per second. Was that one that was not required?
- Young I don't think we did it. I think we deleted those and did the N_{CC} and the N_{SR} with the spacecraft.
- Collins Okay, excuse me, then that one was deleted. All right S-26 mode able at 46:12:27. We separated from the Agena then and took some pictures. The separation all went very well.
- Young But I didn't want to use any fuel to keep that thing in sight; I was in PULSE MODE, and I just stayed in PULSE MODE, backed out on axis, and drifted to the left and down, but we got pictures of it. They should come out; I was running the 75 MM at 1 frame a second.
- Collins I turned the radar on at 20 feet, but I did not turn the radar to STANDBY prior to that, I don't believe. So we should have included our procedures - - and we didn't - - somewhere along the line, you flip the radar from OFF to STANDBY prior to undocking. I zapped it at 20 feet. It was off, and I turned it directly to ON and the recorder off at 200 feet, I guess

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we got that, too.

Young When were we supposed to get the recorder off?

Collins 200 feet.

Young Well, we were out farther than that because there is a list of commands to give. We sent 070 somewhere along the line to turn the beacon off.

Collins Had to get the ground to send 071. And that's about the only mistake we made in talking with the Agena.

Young So we could turn all those things off.

Collins The reason we sent 070 was because it was tacked onto that list of things we were supposed to do, and to the nominal Flight Plan which was a different case. We were so darned busy we didn't have time to really stop and think about whether that was the right thing to do. It was just another list of commands to send to the Agena, about list number 43. You were busy and didn't have time to confirm it, and I was busy, and I just dialed them in, and 070 happened to be one.

Young I'll tell you, every time you get in a hurry you lend yourself to making mistakes, that's all, especially when you have to think about what you're doing. That's the bad thing. The next two things which came in pretty quick order were to turn around and to aline the platform. We got two more updates.

Collins The N_{CC}, Combination Maneuver Posigrade up and to the North -- -- that was at 45:54:01.

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We burned that one and the residuals were: 80 was minus 0001, 81 was four zips and a two, 82 was minus all zeros.

Young We burned that one orthogonally because it looked as if it would take more gas getting all that stuff in the forward window than it would to burn it out. I'm sure that's right, too.

Collins The next one was Xsr; we burned that at 46:09:28.

Young And it was mostly downhill. I think we were right over Corpus or somewhere in that vicinity.

Collins It was 9.8 feet per second down and 0.9 of a foot per second forward, and we burned that by pointing down.

Young Yes, going around there slow in pulse mode.

Collins The residuals on that one: 80 was minus 0.1, 81 was zero, 82 was minus 0.1.

Young Then we came back up, and what time in the Flight Plan was that?

Collins That was 46:09:28.

Young And very shortly thereafter we started looking for the Agena.

Collins Well, we saw the Agena before that. At 45:58 we said "The Agena.", but it turned out it was the wrong Agena. It never occurred to me that it was the X Agena.

Young It never did to me either. It was big as a house, too.

Collins He said "Roger, your range is 95 miles," and instead of thinking, "That's the X Agena, you idiot!", I thought "Boy, I've got good eyes!" That was funny.

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Young That's what I thought, "My gosh, if it's this bright right now at 95 miles..."

Collins That sun really lights it up.

Young It would have put our eyes out, but it was the other Agena, so we just kept on coming. I was getting a little nervous about the backup parameters; they kept saying, "Okay, we'll give them to you over the next station." We came around over the states, over the Canaries and Tananarive, and still no backup parameters. It was Carnarvon before we got them, I think. Those numbers were of interest; they said the Agena sunrise was 47:04:03, and FOD TPI time is 23 minutes and 17 seconds after sunrise, and the Delta V is 24.9 forward and 1.1 up, and the Delta H is 7 ± 2 tenths of nautical mile, and at 16:16 you'll be at two miles with an R dot of 47.8, and 18:46 you'll be at one mile with an R dot of 44.4 degrees. What that meant was that at 23 minutes and 17 seconds after sunrise, we would be at our normal TPI angle of 32.9 degrees, and I don't remember exactly when we went, but that was pretty close to being right. So at sunrise we did just what we were supposed to do. We went over, and went to SFF, pulsed, and aligned our platform; twelve minutes later we rolled over on our back and pitched up to the proper angle, which at 12 minutes after sunrise was 20.3 degrees, and there we ran into a problem in that if I pitched up a couple of degrees more I would be looking into the sun,

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and if I pitched down a little bit, I was getting reflected earth shine into the RETICLE. So I was blind looking out the window; I couldn't see anything.

Collins The sun was out-of-plane to our right when we were erect so when we were inverted it was over on your side.

Young If I rolled a little bit one way it was okay, and if I rolled just a hair then I could get the sun out of my window, but I didn't psyche this out, really, very early, and I kept looking out of the window and looking for that son-of-a-gun. When I saw that thing up there, it was a dot like a seventh or eighth magnitude star. I could put it in the center of the reticle, and it was a dot. In fact it was two dots; I had to close one eye to keep it as one dot. It moved all over that thing, but you could really get a good angle on it. Once you tracked it, I bet I was keeping it in the center of that reticle to within -- -- ± 5 hundredths of a degree. I mean it was a precision thing as far as I was concerned because we were going to go get that thing. I was sure glad to see it, and I didn't really see it until -- I think it was somewhere between 15 and 18 minutes after sunrise. And we could figure out how far away that is, but it's a long ways out, you know, to see something reflecting sunlight like that. I reported to the ground when it was, and we ought to look back at the transcript and see when I reported I saw it. And then it was a couple

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of minutes later that I started getting it full time. I knew that once I saw it, I was going to get it from then on.

FCOD Rep You reported that you had it at 47 hours and 7 minutes.

Young 47:07. That's 4 minutes after sunrise. Oh, I know why I had it then, because I was alining the platform, and the sun was down below the nose.

FCSD Rep Yes, the sun hadn't come up yet.

Young The sun hadn't come up over the nose. Yes, and I could see it then. So I was pretty sure that I was going to get it when I rolled over. When you're level in that infernal thing, at that altitude the nose is sticking up above the horizon like flying an airplane in a mirror landing pattern or something down low, and so a lot of times the sun would be underneath the nose when I was over like that alining. But as soon as the sun came up it just vanished -- just quicker than the dickens. But if there was any way to shield the sun out of there, I think you would see it all of the time in reflected sunlight, or earth shine or what the heck it was shining in. Anyway we saw it, and Mike was punching the angle out and reading it off, and I said, "Lets go at 32.9 degrees at such and such an angle," and so at 32.8 degrees we went. We applied 25 feet per second in sort of a peculiar manner, and I didn't dare take my eyes off that son-of-a-gun. Coming up the 25 feet, Mike was going to time the burn, and I'll be damned if I didn't forget to press the

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START COMP and went ahead and burned at 30 seconds anyway, and after that I was sweating blood. I wasn't going to let that son-of-a-gun out of my sight and the up/downs, whatever that Mike said they were, were going to be good because I was really going to boresight on that son-of-a-gun and the two corrections that Mike gave me to make were four up and one down and we applied them. And I think that's the first nominal rendezvous case that we ever had, literally, outside of that work that we did at McDonnell. We have never seen a nominal rendezvous case in a simulator. We always had something harder to work with, which, I guess, was good practice.

Collins Did you tell them about what we burned in the -- --

Young 25.4. And I was just telling them that you gave me real precise corrections, and so I burned them, and that last burn, boy, that needle didn't move in pitch off of there; the target was moving off -- --

Collins Which way did we put in that out-of-plane?

Young It was moving off to the left. And we put in initially 3 feet per second to the left and then another couple of feet per second to the left, and we kept charging on in there toward it, and at the nominal time which was 16:16, you said I was at two miles. You were using the sextant to give range. What did you think of that?

Collins I remember the sextant as being accurate from about a mile on

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in, maybe a little over a mile. But I had pretty good confidence that those numbers from a mile on in that I was giving you were good numbers. Of course, we didn't have any formal way of getting R dot out of that, and I'm not sure that that's too practical.

Young Is that what you were using that -- --

Collins Yes, I was using this right here. I really think that rather than getting ranges, and clocking the time when you get those ranges, and going into a graph, and coming up with an R dot is not a good way to go. I think it's better for me just to hold that sextant, and every time I get a good reading on it, just call out the range to you. You get a better feel for the R dot that way.

Young This number that FOD gave me was right too because he said 3.3 to the left, so I didn't apply that at TPI, but later on about the third correction when it started going off to the left, I applied it right then. I guess it was the second correction, somewhere between the second and third correction, I applied 3.0 to the left, and because I wanted to be on top of that son-of-a-gun, I wasn't going to have any out-of-plane around that mother, and sure enough it stopped it. So it was right; so that's the best backup data that we ever got from FOD, it was good. And they were right about the altitude, too. Well, we drove in there going too fast as usual one time there you

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said it looked like we were slowing down, so I added five.

Collins I think that was good, it looked like you were stopped to me at one time.

Young We added five and charged on in there and did a Whifferdill, but an in-plane Whifferdill more or less.

Collins We were about a hundred feet away from it.

Young But it was tough to get in there and grab hold of it because it didn't seem to have any pattern. I finally got in there and I noticed that if I had any rates at all, I couldn't stay with it so I had to fly on PULSE and null rates, and just about this time, I got joined up on it and it was in the neighborhood of 30 or 31. I remember the ground asked me where I was and I said 7 or 800 feet and closing, and they said that that's great, and I knew then I really wasn't there yet, and so the worst part was yet to come as far as using the gas and -- --

Collins That's right, you're not through using gas until you're up 10 feet away from that thing.

Young That son-of-a-gun is going to get to you, unless you can be assured that you know R dot and can go in easy on it. And you can't be assured of that with just the old eyeball, I don't think. You've got to go in there and get on him and do your best right there toward the end. And that's going to cost you more gas. Maybe there's a better way, and maybe a real smart guy would know all this. You could see him

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growing in the reticle, all right. Well anyway, I went in there and did this Whifferdill, and whipped around, and picked up, and came in, and grabbed hold of the engine, and during that whole night pass, while Mike was doing his final EVA prep, I was holding onto that engine, and finally moved down toward the TDA. But they kept asking me what kind of rate the thing was in, you know, and I had no idea. When we first joined up on it, though, I wanted to go over to BEF and PLAT, so I got over to the BEF side. When I was perpendicular to the engine axis or the axis of the Agena, I was pitched up about 10 degrees when I started. During that whole night pass, it pitched up to 60 degrees. So, I could never get to BEF and PLAT from where I was. There was no way to stay perpendicular to the longitudinal axis. So it was in some kind of a pitch-yaw oscillation, roll over, but it was a real slow one, really slow. I don't know how you'd say how much it was either. Being in ORB RATE, there was no way that I could stay in the BEF mode, and I was a little afraid of not being able to. But why don't you tell them about your EVA PREP.

Collins Yes, well, this is one of the times when we were doing two completely different things. You were very busy flying formation, and I don't think you really had much idea what I was doing, and I had absolutely no idea what you were doing. I was just busy over there thrashing around getting all the

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equipment out, and getting the ELSS unstowed. When I unstowed the ELSS, by the way, it came forward and banged against the back housing of the center bright light, and the light shorted out and there was sort of a flash up there -- --

Young A bright flash, I remember looking at that.

Collins And the light ceased working and a couple of parts fell off the back of the light. So that's something that should be fixed.

Young From then on, he wouldn't let me turn the light on, I remember that.

Collins So we taped that switch.

Young We used the dim light.

Collins I taped the light switch, and from then on we used only the dim position. Anyhow, I think that should be fixed because that ELSS takes a bit of rocking to get it started up on its rails, but once it's started it comes very easily because of the zero G, but it, nonetheless, has its inertia, and it rams into that light housing pretty easily. So anyway, I spent that whole night time getting the final EVA prep, and here again everything worked about as we planned. I'd say it took maybe -- well let's see, John, you started station keeping right at sunset didn't you?

Young Yes.

Collins And we opened the hatch right exactly at dawn.

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Young On the primary rendezvous after some reflection on the subject. At around 2 hours and 30 minutes we were given and N_{PC} by the ground, 9.6 feet per second to the South. At 3:47, 3 hours and 47 minutes we did an N_{SR} . From about 6 minutes to about 20 minutes after N_{SR} we did a Platform Alinement from about 8 degrees to 12 degrees. After that platform alinement at 58 miles I recall that I was reading 2-1/2 units right when I was on the center line of the ball on low scale. Which meant that I needed roughly 20 feet a second to correct out-of-plane at the node. The assumption I made there was with the ground information indicating that I had zero platform alinement - the assumption that I had to make was that I had a shaky platform alinement in yaw. So at TPI at 4 hours and 35 minutes the closed loop solution came up and it said 41 feet per second forward and 16 feet per second left. My assumption was that that was a wrong closed loop solution based on the fact that the plane change should have gotten us a zero out-of-plane position correction, and the platform alignment must have been bad because of these needle indications. The ground's backup solution was 34 forward and 1 right which even served to substantiate that assumption that I made. My opinion of the whole business was about 37 feet per second forward and zero left-right, and that really, I feel,

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is the one I should have applied. The first and second Midcourse Corrections were one right and five right. After I made the last Midcourse Corrections and went to inertial needles, I could see that I had one heck of a lot of out-of-plane. The Agena was moving across the stars to the right and was going like a ding bat. I started thrusting to the right. We passed by it I guess at 700 to 900 feet out-of-plane, still going like a ding bat. I couldn't really believe that I had that much out-of-plane. It was just incredible that I had that much, and it was difficult for me to believe. One of the mistakes I think that I made was that I was trying to evaluate the inertial needles and the radar needles, and I was doing a lot of out-the-window and back-in-the-cockpit type evaluation. I left my range rate up to evaluate the dual rendezvous braking technique, and that was an error in judgement. I admit it now, but it would have been a sound test procedure if I hadn't had so much out-of-plane. Anyway it darn near cost us a primary rendezvous, and I still don't understand why the ground solution and the onboard solution which apparently was correct differ so much in out-of-plane. I think it points out a basic problem. If we do have situations where the ground is going to be that much different from the out-of-plane solution and the closed loop solutions;

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then with this knowledge we shouldn't do these rendezvous's 90 minutes after we launch the Agena. That's my opinion. We shouldn't be doing a rendezvous until we find out where that thing is because, after all, the mission depends on whether or not you make that rendezvous. Okay I'm done talking about that one now, let's go to the EVA.

Collins Okay, this is the umbilical EVA.

Young Right.

Collins The EVA prep was a pretty critical thing just as we knew that it was going to be. John was very busy flying formation in the dark a couple of feet from this Agena. He wasn't aware of what I was doing, he couldn't be, nor was I aware of what he was doing. I was over on the right hand side of the spacecraft thrashing around getting all the equipment unstowed and unneeded gear stowed out of the way and the ELSS out and checked out and donned and what not. I think in general we really did about as good planning as we possibly could. Although, it did end up being fairly rushed. I got everything done that I wanted to get done but just barely. The sun was just coming up as I completed the EVA prep and everything was GO to my satisfaction. As soon as the sun came up we dumped cabin pressure and opened the hatch and I stood up. The first thing that I had to do of course, normally I would have hooked up the 16 mm

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camera, but it was not working. It was broken. The first thing I did was push the button which popped up the handrail. The handrail came up normally, that's the forward handrail. The aft handrail which is pyro actuated was not in the fully extended position. The front pyro had fired but the aft pyro had not fired. So, the rear handrail was half extended and half - the front part of it was extended but the aft part of it was flush with the spacecraft surface. This meant that I couldn't loop the nitrogen line around the aft handrail as I had planned. I looped the nitrogen line around the forward handrail, and after I plugged in the quick disconnect I told John to take up the slack with the Velcro loop he had available for that purpose.

Young

During this time we were flying formation on the Agena and it's very difficult to fly formation when you have to thrust in all axes, and we were coordinating it as the voice tape will show, to insure that I didn't have to thrust in Mike's face while he was out there. But, there were a couple of times when we just had to thrust and Mike would have to get out of the way so I could use that down thruster. I'm sure that the station keeping was made more difficult by the fact that Mike was out there imparting some motion to the spacecraft and it certainly caused it to use more

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fuel consumption. I wasn't in platform mode I had to be in RATE COMMAND in order to fly on the Agena in the way that we discussed flying it prior to the flight.

Collins

As far as the nitrogen line hookup went, it was not very difficult, but it was not very easy either. The half of the quick disconnect on the umbilical itself has a sleeve around it, and this sleeve must be in the retracted position in order to have it cocked so that you can make the disconnect connection. The first time I took a stab at it, I hit the fitting on the side of the spacecraft a little bit off center - a little bit off axis, and that snapped this collar down to the engaged position, and in this configuration it will not lock in place. So, that meant I had to go back and recock it. This takes two hands, and so I had to let go with both hands for not more than 3 seconds to get that thing recocked, and then on my second attempt I did make the QD without any trouble, and then I turned on the nitrogen valve. In general, the body positioning was not quite as difficult I think as I had been led to believe by some of these water tests and what not, but on the other hand it wasn't a very easy thing either particularly because I was using the forward handrail rather than the aft handrail and my body had a sort of a sideward component whenever I pushed down on the QD, I not only tended to pitch my

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body down against the side of the adapter but also tended to roll off, and this made it slightly more difficult. Anyway, I did get the thing plugged up on the second try, and I used maybe 5 minutes doing this. The reason I wasted so much time was because I had to **correlate** my body position with John. He'd want to fire the thruster right there by the handrail, and I'd have to torque my body over out of the way. It's interesting to note that I did have my hand on that rail when he was firing that thruster which is only about 4 to 6 inches I'd guess away from the thruster. But, as long as my body was over out of the way I felt there was no danger and I didn't feel any heat or **impact** from the plume or anything like that. After hooking up the nitrogen QD, I went back to the cockpit and I.....

Young When I was flying formation on the vehicle at night I was in on the engine and locked in on it and I couldn't see more than 3 feet up the fuselage. We had the docking light on, and I never saw any lights. Maybe they were on but I sure never saw them.

Collins I don't think they were, I never.....

Young I don't think they were either. We had a docking light on, and that's the only thing that illuminated it. Thank goodness for the docking light. If that thing had gone out it really would have been grim.

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Collins Okay, we're in this EVA. I got back and stood up in the hatch and checked out the gun and made sure it was squirting nitrogen. That's the only gun checkout I did. In the meantime, John maneuvered the spacecraft over toward the end of the TDA just as we had planned. He got in such a position that my head was 4 to 5 feet from the docking cone. It was upward at about a 45 degree angle, just as we planned. I believe at one time there you said you had trouble seeing it, and I gave you some instructions about "forward", "forward", "stop, stop". So I actually sort of talked John into position.

Young This was one time when I lost it in the sunshine, remember? This was when you were out fooling around on the nitrogen line. It's all on that tape.

Collins At any rate, that tape was really impressive.

Young Did they release a transcript of that tape?

Collins I translated over by pushing off from the spacecraft. I floated forward and upward fairly slowly and contacted the Agena. I grabbed hold of the docking cone as near as I can recall, at about the two o'clock position. If you call the location of the notch in it, the 12 o'clock, I was to the right of that - at about the two o'clock position and I started crawling around. No, I must have been more about the four o'clock position, because I started crawling

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around at the docking cone counterclockwise, and the docking cone itself, the leading edge of the docking cone, which is very blunt, makes a very poor hand hold in those pressure gloves. I had great difficulty in holding on to the damn thing. And, as a matter of fact, when I got over by the S-10 package and tried to stop my motion, my inertia, my lower body, kept me right on moving and my hand slipped and I fell off the Agena.

Young And when you fell off the Agena, that's when that brown cover that holds those Cat Whiskers came loose.

FCSD/REP Is that when it came loose?

Young That came loose, and I was worried from then on that Mike was going to get tangled up in that thing. It was hanging on by one wire and, in fact, one time he did get inside of it where it was between him - it was between him and me and inside the Agena. It was wrapped around him, but he managed to float out of it. It was unbelievable, I don't know how he did it.

Collins At any rate when I fell off, I figured I had either one of two things to do. I could either pull in on the umbilical and get back to the spacecraft, or I could use the gun. And I chose to use the gun. I was floating free at this time. It had come loose from the chestpack. So, I reached down to my left hip and found the nitrogen line and started

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pulling in on it and found the gun, and unfolded the arms of the gun and started looking around. I picked up the spacecraft in view. I was pointed roughly toward the spacecraft. The spacecraft was forward and below me on my left. The Agena was just about over my left shoulder and below me, or down on my left side and below me. I used the gun to translate back to the cockpit area. Now, I was trying to thrust in a straight line from where I was back to the cockpit, but in leaving the Agena I had developed some tangential velocity, which was bringing me out around the side and the rear of the Gemini. So what happened was, it was almost as if I was in an airplane on down wind for a landing, and in making a left hand pattern I flew around and made a 180 degree left descending turn, and flew right into the cockpit. It was a combination of just luck, I think, being able to use the gun. At any rate, I did return to the cockpit in that manner, and John again maneuvered the spacecraft. When I got to the cockpit, I stood up in the hatch and held on to the hatch. John maneuvered the spacecraft again up next to the Agena. This time we were, I think, slightly farther away, because I felt that rather than trying to just push off I would use the gun and translate over. And I did, in fact, squirt the gun up, depart the cockpit and translate over to the docking cone using the

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gun as a control device. The gun got me there. It wasn't extremely accurate. What happened was, as I was going over, I guess in leaving the cockpit, I somehow developed an inadvertant pitch down moment, and when I corrected this out with the gun, I developed an upward translation as well as an upward pitching moment. So I did damp out the pitch. I converted that downward pitch moment into an upward pitching moment, and then I was able to stop my pitch entirely. But in the process of doing that, I developed an inadvertant up translation, which nearly caused me to miss the Agena. As a matter of fact, I came very close to passing over the top of the Agena; and I was just barely able to pitch down with the gun and snag a hold of the docking cone as I went by the second time. Again, I was on the docking cone, around on the right hand side, or around too far clockwise to find the S-10; and I wasn't exactly sure where I-which way I should go. I thought I should go around counterclockwise. I asked John....

Young He asked me, which way to go.

Collins He confirmed, so I started crawling around hand over hand on the front end of the Agena. And this time instead of using the....

Young You know that caused it to roll toward you?

Collins Yes, I was aware of that, as a matter of fact. Now the

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pitch and yaw, I was not aware of.

Young I don't think it was doing anything in pitch and yaw. Of course, I was flying on it and I really wasn't - I was maintaining my position, and it might have been yawing and pitching. But if it was, it was pretty slight.

Collins But this time instead of going hand over hand on the leading edge of the docking cone, as I had the first time when I fell off, I looked for better handholds down in the recess between the docking cone and the front of the TDA. And, in fact, I found some wires down there and it was really nice to find them, because I could get my hand completely around the wires. For the first time, I really felt that I was, you know, firmly and securely arrived at the Agena, because I could hold onto those wires. At any rate, I slowly worked my way around to the S-10 package and removed the nose fairing. It took me about three or four stabs to get both those buttons pushed. The button on the right, I think, I got the second time and the button on the left, I believe, I got the second time. And when they were both pushed in, I got my fingers down in that hole on top of the fairing and eased the fairing forward. The fairing came forward and then felt like it was locked in place. But when I gave it an upward component it did come off. And I was trying to do this very gently, because the fairing was

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connected to the main S-10 package by these two little wires, which are simply pins that would pull right out of the S-10 package. I very gingerly removed the nose fairing and without putting any pressure on the wires, I went back and grabbed a hold of the S-10 package itself and removed it. I hold, from that time on, I held the S-10 itself firmly in my left hand and the wires held, and we got the nose cone back in in that manner.

Young

And all this time I was keeping the spacecraft nose pointing at Mike and wasn't firing the aft firing thrusters. The view of the procedures he was going through to take this thing off, and the maneuvers he was making around the Agena, were utterly fantastic. It just, you had to see it to believe it. And I understand that the EVA film didn't come out and this points out a very interesting point. I think that the equipment is unsatisfactory for trying to document those kind of things, and we should get some equipment that is useful for that kind of operation. I would just be willing to bet that the value of that kind of film to our space program could be conservatively estimated to be a million dollars. And we missed it because we had inadequate equipment to do the job for us. There's no way in the world you can use that camera satisfactorily, operating in a pressurized suit. There is just no way.

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It should be looked into.

Collins Okay, then the next thing I did was come back to the cockpit, and I did this by pulling on the umbilical. I came back hand over hand on the umbilical very gently, very slowly. And when I got up right next to the open hatch area, I was pointing head down into the hatch, and I held onto the umbilical with my right hand and with my left hand I passed the S-10 in to John. He stowed it away. At that time I wanted to proceed to the next item which was the umbilical - excuse me, was the gun evaluation using the full 50 feet. So, I reached down and unsnapped the buckles, which released the second 30 feet of umbilical. You see, up to this time we just - we were working simply with the first 20 feet of the umbilical. At this time I unbuckled the second 30 feet and I was preparing to ask John to back away from the Agena. I was going to push off and do the gun evaluation when the ground called up and said we were running out of fuel and not to use any more of our attitude control fuel. So, with this information we figured that we better terminate the EVA, because I was rocking the spacecraft, and I knew that there just wasn't any way that we could complete other sequences without using fuel. In the first place, we would have had to maneuver relative to the Agena to keep the Agena in sight, to make sure we weren't

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going to contact it. And in addition, John would have had to stabilize the spacecraft, attitude-wise, for me to get any useful information about that gun and we just couldn't have done that gun evaluation in random, tumbling, drifting flight. So that pretty much forced us to terminate the EVA. John said, "come on back in", so I came on back. I started to get in the hatch and John said, "hey, how about the nitrogen line".....

Young Let me say something about the station keeping and the three body problem before you go into that. Well, first of all, I think it's evident that we knew that it would take more gas than we had allotted for this particular problem during the mission. Because you can't fly a formation on an unstabilized vehicle, and keep the guy that's outside, in sight at all times and not impinge the thrusters on him, or the vehicle, without using a lot of propellant. And it's a three body problem. You have got to keep both vehicles in sight, both the guy that's outside and the vehicle in sight at all times, and you have got to use gas to do it. So I was very happy that we got the chance to do as much as we did without running out of gas. I think we would have taken a real hard look onboard about doing any more, with the gas gage reading as it was. It was very difficult for me to see what it was in a pressurized suit.

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There's no way I could get down to take the parallax out of the instrument. And I think that if we're going to operate in a pressurized conditions, we should have some kind of an instrument that can take the parallax out of it. A mirror of some sort, or something like that.

Especially if we're going to go to a near zero on the fuel gage. Or else somebody has got to tell us what it is, because I couldn't see it. I couldn't even look down at it.

Collins

Where are we? I went back and got the nitrogen line and disconnected it without any difficulty, passed it through the handrail without any difficulty, and got back in the hatch. I stood up in the hatch with my body half in and half out. I started feeding the umbilical back in. And at this time, I was - not for the first time, but I was aware all along that the umbilical is not a very nice thing to work with. In the first place, you have no control over it. You don't know where it's going. If it does go somewhere you can't stop it from doing what it wants to do unless you devote your complete attention to it. Even then I'm not sure you could control where it goes. You have two vehicles moving, one relative to the other.

Young

I was really worried about you when you ended up with 50 foot of umbilical wrapped around the Agena.....That would have made me nervous.

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Collins That's right.

FCSD/REP The EVA film didn't come out.

Young No, it didn't.

Collins The problem is that this umbilical is uncontrollable. You have a three body problem, when all three bodies are moving relative one to the other, and the umbilical is connecting two of them. You are unable to keep track of where it is or where it may be going.

Young What you hope is that it doesn't end up connecting all three of them. That's what it amounts to.

Collins That's right. It's not a very comfortable thing. I don't have any suggestions as to what to do about it except to keep the umbilical as short as possible for the required tasks. Determine how much umbilical you need and don't make it any longer.

Young I think you had way too much for that job.

Collins Yes, we had 50 feet, and the 50 feet was arbitrarily arrived at five or six months ago when we thought the Gemini VIII Agena was tumbling and when we calculated how much we'd need if we came up normal to the plane of rotation. It looked to us as if 50 feet was a good number. In retrospect, with the stable Agena, we didn't need anything like 50 feet and 25 feet would have been a lot more sensible length.

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Young Sensible, and probably would have been excessive too. It would have been more like, I'd say, 20 feet would have been just about all we'd needed.

Collins At any rate, when I started to get back in the right hand footwell, I noticed some impediment. I just didn't seem to be getting down in there as easily as I normally do. You had previous to this, John, told me that I was, in fact, tangled up in the umbilical and I had already turned my body around a time or two and gotten about as unsnarled as I could.

Young I pulled all the umbilical in the cockpit over to my side and you had part of it wrapped around your legs. The gun was lodged in the overhead circuit breaker panel; so I got that out, and pulled it over on my side. You couldn't imagine what a mess it was. Then Mike was all wrapped up in this thing and we talked at some length about him getting out of it but he couldn't see how he was wrapped up in it.

Collins This was about the time, we told the ground we were going to take a little breather and see what everything looked like before we pressed on. What we really meant by that was, we were going to figure out where the umbilical was and what we could do about unsnarling it. We had a couple of different options. I could have gone back out and

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started all over again.

Young I had turned the OAMS control power switch off by this time, so that we wouldn't use any more fuel. Mike had the vehicle in a nice rotation rate; however I did lose sight of the Agena.

Collins I had the Agena in sight and I - we were pretty well away from it. It was behind us and a good 75 or a 100 feet away from us. No, more than that. I would say 150 feet away from us, so I wasn't really worried about contacting it. The only ace up our sleeve was this block and tackle arrangement which I think would have probably been able to force me down into the inside and get the hatch closed. But, it was sort of an uncomfortable feeling to know that I was tied up in the umbilical and that the umbilical was impeding my progress in getting back in. We finally got it all unsnarled, except for one loop around my lower body.

Young That is right. And just before I shut the thing off, I backed away from the Agena so, it would have been impossible to hit until the next time around.

Collins So, at any rate, I got back in finally, and I don't know, perhaps I was a little more tired or perhaps, it was I think it was the loop, but I noticed a slight more difficulty in getting down into the proper body position this

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time, than I did the first time. But I did get down and I did get good hatch clearance and again closed the hatch and it worked beautifully and I locked it and repressurized. The repressurization was normal. At this time we had the cockpit absolutely full of 50-foot umbilical, gun, and ELSS. So, what we did, we took the - we put the chestpack, actually we disconnected it from the umbilical, put the chestpack back in its storage place, took the 50-foot umbilical and slowly worked it from John's footwell and from everywhere into one ball and down in the right-hand footwell. Then we got the bag out, the great big laundry bag and started stuffing the umbilical into the bag. And we also stuffed everything else. As I took each connector off, you know the Y-connectors and the ELSS restraints and 16 and 24 inch hoses and we stuffed them in the bag andgun. So we made up quite a care package. We jettisoned this in two increments.

Collins One was the - one increment was the chestpack, and the second increment was the laundry bag full of umbilical and other junk. And the way we worked the third hatch opening, the ground called us by the way and told us when they had us programmed for the hatch opening, and it seemed to be about 30 minutes ahead, and it seemed to be fairly tight to us,

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but we told them we would try to work toward that schedule, and let them know if we had any trouble. Though we didn't really have any trouble. We came out just about on their schedule, on the time they had previously given us, we depressurized and opened the hatch and dumped the stuff. The way we did this was, prior to depressurizing - well, first let me say, I didn't have any stand up hoses left, and I didn't have any stand up tether left, and I didn't have anything that would allow me or make me feel comfortable standing up in the hatch, so, I made no attempt to stand up in the hatch the third time. What I did, prior to depressurizing, I wedged my body down in the right-hand footwell, in the best position for maximum overhead hatch clearance so that I had a good 9 inches to a foot I would say, of hatch clearance above my head. And maintaining this position while we pressurized the suit caused me to be sort of wedged in down there in the footwell which was exactly what I wanted. And in this body position we opened the hatch, and I dumped the stuff, threw it straight up overhead, and then I also took some Maurer pictures of the stuff departing. And then we closed the hatch again. Had no difficulty, locked it, repressurized it, and that is all there was to the EVA.

There is a general comment on the EVA. I didn't notice

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any difference in regard to objects floating either up or down.

Young

I have a comment here. I think we depressed too close from the standpoint of the overall mission. Right after we got all that stuff together, we should have rested longer and thought about what we were doing longer. There was really no need to do that so quick.

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Although I will admit that there was so much stuff in the cockpit that if we hadn't of done it, it would have been pretty miserable around there in 2 or 3 hours.

Young Well, I think as a general rule, you don't want to do things so fast that you can't think about what you are doing real good, and I think we are pushing a ragged edge on that little jobber.

Collins Prior to the EVA and after the EVA we experimented by holding objects up in front of us inside the cockpit and letting them stabilize or trying to hold them as stable as possible and then releasing them and we found objects had no tendency to go anywhere consistently. Some of them went up, and some of them went down, and some went left, and some went right, just depending upon what residuals they had when we released them.

Young Some, when they were stabilized, just sat there.

Collins Yes, some sat there for various lengths of time. Now when we depressurized the cabin and opened the right hatch, things tended very definitely to float up and out of the open hatch and I attribute this to some sort of outgassing. One time for example, John's helmet tiedown was almost like a snake, it was

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arched over from his chest, it came up and went over to the right, and then took another bend and went straight on up out the open hatch. There was definitely some forcing function there that was causing that to assume that position. But I think it is outgassing. I never noticed any tendency for me to consistently float one way or the other, but I think what it is, that it is just a constant exercise in dynamics. You rattle around in the open hatch, and you bang against the sides, and you rebound off the floor and inevitably in these motions have an upward component. If they have a downward component it is converted into an upward component by the rebound, so that sooner or later you get an upward component, and your body floats on up out of the hatch. But I think it is strictly just a problem of dynamics. The same thing when you are working with handrails or any other handholds or when you are working outside the spacecraft. As you grab something and push against it, it pushes back against you and the tendency is for you to react away from it. I think that is right. I think that is the answer to the whole damn thing. It is pretty complicated, but I think that is it. The stability problem.

Young

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Collins That is right. That is just what we think, we didn't really ever get around, unfortunately, to doing any formal evaluation of it, right side up or upside down. And that about covers the EVA. John, you got anything else you want to say?

Young Well, needless to say, after the EVA, we were pretty keyed up. And that was very interesting, it was absolutely a fascinating part of the mission and certainly to my way of thinking it was the most dangerous part from the risk standpoint. When was it after the EVA that we did that height adjust?

Collins It was darned quick after the EVA, and I remember then you complained bitterly at the time that you thought it was rushing things.

Young Yes, I did. I was nervous as a cat. We did a platform alignment of some kind. Let's see when it was in the flight plan. And when was the EVA terminated?

Collins The EVA was started at sunrise, which was 48:36 and it went for 40 some minutes. So, lets say from 44 minutes to make it come out even. That would be 49:20 the EVA terminated and that is the stand up EVA. And so, we had from then to 51:38, so we had 2 hours and 18 minutes to get regrouped from the EVA to get repressurized to get all the equipment off,

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to get it checked out and dump the cabin pressure, to open the hatch, to jettison the gear, to close the hatch, to repressurize, and to get setup for this burn.

Young Do you remember when we did the jettison?

Collins No, I don't, all I know is that somewhere around 49:20 was egress from the umbilical.

Young We can look at the tapes on that. I think that was mighty foolhardy.

Collins That was a little swift.

Young Yes, I think that was a little intemperate on our part. So I think we would have been a lot better off staying up there for another rev and resting up and thinking the thing over and then coming back down.

Collins Well, it wasn't a precise burn, but it was a mighty important one.

Young We could have lost the whole ball game then. Suppose I had been aligned the wrong way. Remember we repeatedly checked that thing out and we checked alignment out against the star patterns and against our direction of flight and against our attitude, and so I think we were right, but like I said, we were real keyed up, and I think it was foolishness to do big maneuvers right after EVA. At least before we have had a chance

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to rest up, and I think it interesting to note that neither Mike nor I went to sleep until two revs after the sleep period began. Remember that? And I wasn't particularly sleepy.

Collins That is right. Well, we got a good night's sleep the night before.

Young And another thing, I think we were just flat keyed up after that thing, and I think it was pushing it a little bit.

Collins We felt good though. I felt better right then, I think, than I did during the whole flight.

Young So did I. My morale was like 900 percent, after reaching the primary rendezvous. I felt we were really over the hump. At 51:16 we had to do a 1 foot per second south orbit shaping maneuver to miss the Agena. I can't imagine that we could have hit the Agena. At 50:30 we did the hatch opening for the depress. At 51:38 (which is a little better than an hour) we did the 100 foot per second retrograde burn. It was a minute and 57 seconds long, retrograde and we used the aft thrusters.

Collins We were supposed to be 50 psi into our Volkswagon tank, when we had burned 75 foot per second and that never happened. We burned the whole hundred foot per second

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and there was never any decrease in regulated pressure.

Young

Subsequent to that, we did all our platform alignments and all the work the next day and never ran out of gas. We spent 2 revs in platform mode.

Collins

It leads me to believe that there was something wrong with the fuel quantity indicating system. Because we sat with that propellant quantity gage on zero for a long, long, time.

Young

It was reading below zero. I was really worried about getting back down out of that orbit. It is a very important maneuver, but it is sure important to do it right. We stayed up - we discussed the thing after we had finished with the EVA, and it was very interesting. We thought we had lost our flight plan book, we noted that we lost S-12, we couldn't find it anywhere - but actually the only thing that we lost that we didn't plan on losing was the S-12, and the Hasselblad, which came loose during the EVA, and it was strapped on, and I don't know of any way to prevent one of those things from occurring. But what this indicates to me, is that we need some way to attach equipment that we are going to return, during an EVA period and should have some kind of a strap on it. It should be very

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easy to fasten and we should be able to fasten it and forget it. Because there was just no way that I could turn loose of the controllers, while Mike was out there flying around that thing, to control equipment, or retrieve equipment or sit on it, or handle it properly. I just couldn't afford to do that while Mike is out there flying around, so we lost a pretty valuable experiment, but I think it indicates there should be a strap on it or some attaching device so we can attach it to the spacecraft and forget it, don't you?

Collins

It has to be some real simple thing like Velcro or Velcro equipment. Just like those snaps or rings or something.

Young

Like those hooks that are on the bags in the cockpit. We can just put it around the circuit breaker thing and forget it because I could not afford to worry about it.

When you handed me the S-10 I had no method to control that, and I didn't want to put it in that pouch because with a fairing attached to it. It was too big to go in the right pouch, so I put it down beneath my feet and held my feet down on it. I made a conscious effort to do that. I had to do it for about 20 minutes

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and it's not easy to hold your feet down when you're pressurized. Finally I ended up putting it in my hand and holding it with those wires which could have pulled out. We could have lost it there. Before we jettisoned I put it in my hand and held it with those wires which could have pulled out. We could have lost it there. Before we jettisoned I put it in its pouch and strapped it to the side wall panel. After we finished that burn, which came out more than we expected it to, we went ahead and powered down and went to drifting flight the rest of the night. The drift rates were such that we were getting some interesting pictures. At 54:57, I took some pictures of Madagascar under the clouds. At 54:58, I think it was the African coast north of Madagascar and Mike was taking S-5 and S-6 pictures. We made two passes over Burma, Siam, and China where we got some pictures. We made a pass just south of Formosa and took a picture of Formosa and the Pescadores going North. Then on the next pass we were north of Formosa and was lucky enough to be rolled over so that we got a picture of Formosa looking at it from the South. This was a typical S-6 cloud study and occurred on two different passes. I think these will be pretty good and we were lucky to

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get those in drifting flight. We just happened to be rolled over the right way. We took many pictures of islands and atolls during those revs. Those two revs to me made the trip really worth while; to sit up there and not really have to do anything but look out and take pictures.

Collins Yes, that's the first chance we had, uncoupled from the Agena, just to look around. It was a great view. We were pretty high up, right at that point in time. I think we were probably near apogee. We were very high up. We got a tremendous pass over China. We were looking down at Quemoy and Matsu and taking pictures of those and that whole area.

FCSD-Rep Was it obvious to you when you were at your higher altitudes that you were in fact higher?

Young Yes, I think so, there is a different curvature.

Collins The darn trouble was that you could look out and just see a little slice of the horizon.

Young It was a shame that we did not turn the ACS off and blip that son-of-a-gur around and take a picture down because it would have really been something.

Collins We thought of it but we figured we had better not do it.

Young I slept pretty good too that night as I recall.

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I got some tearing in my eyes that night from whatever it was in our suits. Reflecting on this, I think maybe its because I sleep in zero g with my eyes not completely closed. I think your eyes go to a relaxed point and they don't quite close. Some people sleep with their eyes partially opened but I think it causes your eyes to tear because they wouldn't tear while you were sleeping if you had them closed, I wouldn't think. It woke me up a couple of times. They gave us a flight plan update too that night before I went to sleep. By then, I'd found a flight plan. The flight plan was down in the foot well and was plastered up against the front of the small pressure bulk head, and the white cover was facing out, and I didn't realize that it was there until I started to search around the cockpit with a flash light.

FCSB Rep

About 63 hours is when you woke up, John.

Young

At 63 hours we fired up the platform, and Mike purged the fuel cells, and then we loaded Module VI again to do D-5, the orbit determination. We aligned the platform SEF.

Collins

We did D-5 Mode Dog, D-10 Mode Easy, D-10 Mode Charlie, and D-10 Mode Dog.

Young

We did two D-10 Mode Easys.

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Young

We did two D-10 Mode Easys.

We also finished up D-10 a little bit early and sneaked in an S-1, and we got about 80% of an S-1. Then loaded Module IV. We loaded Module IV early, and we were in Platform Mode and SEF and stayed in there the whole revolution. And then we went BEF in Platform Mode, and stayed in there for a whole rev. Then you got that flight plan update on retrofire, don't you?

Collins

The things we did we got a Retro Update at 67:20 and, then we purged the fuel cells; we blew the squib on the hydrogen tank, and then we ate from 67:25 to 68:10; then Retro Prep after 68:10. They gave us a preliminary retrofire time of 70 hours 10 minutes and 30 seconds, and they changed that by 5 seconds. Our actual retrofire time was 70 hours 10 minutes and 25 seconds.

Young

Okay now, what was the retrofire IVIs?

Collins

The nominal was 304 aft and 114 down. What we actually got was 119 down and 5 right and 303 aft. Equipment storage for reentry really wasn't much of a problem because we had gotten rid of all the things that were complicated. It is hard to push stuff down in that back food box, and we stowed the D-10.

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back there on the D-9 sextant, and as a result, we had to take that Maurer camera out. What did you do with the EV Maurer?

Collins I must have put it in the right hand aft box because I couldn't find another place for it.

Young I stuffed everything in the world in the right hand food box, and I couldn't get any more in.

Collins And we sort of promised to bring that sextant back because those guys were sort of nice about getting us that sextant and getting it ready to go and everything. Young and I thought stowage was real easy.

I did too, only because we had an opportunity to jettison.

Young We didn't have anything left. That was great. Even if we had had the S-12 we would have had no problem. I put the S-10 and the fairing in the bottom of the left hand aft food box and I mean on the bottom. There was no way it could have gotten out. It was very quick and we had an eat period in there which I thought was a real good idea. We drank plenty of water. The Preretro checklist, we did it in catch as catch can type fashion. We had plenty of time. We checked off every item in there at least three times, and I think that is one time you want to make sure you have got everything right.

Collins We must have checked -- we were, in fact, BFF and the retros were going to fire off in the right direction. We must have checked that 50 times.

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Young Would you believe 40. Every time I looked out the window, we occulted stars.

Collins We did everything. We occulted stars, we checked which way the Southern Constellations were, which way the Northern Constellations were, and we picked up yaw out of the window.

Young Let's go through the Preretro checklist and see -- you didn't have any problem with drogue pin storage, did you?

Collins Drogue pin storage, no -- no problem.

Young Do you remember sort of getting upset about the drogue pins. They kept popping out? Kept jumping out?

Collins No, that was the D-rings that kept doing that.

Young Oh, your D-rings that kept doing that.

Collins Yes, I think I have all ready covered that in the Insertion checklist.

Young We put in a new voice tape all right. There was no problem there. We closed all the circuit breakers and you were holding the 16 MM. Remember?

Collins That is right.

Young I wasn't going to do that because I just felt like that was just one of those things in the way over there, and I wanted to concentrate on making a decent reentry, and I didn't really care whether we got pictures of it, or not from that standpoint. We turned on the RCS. I heard the squib fire when we pushed the RCS as a low kick. The RCS pressure was, as

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I recall, it was 2750 after we fired? On that order.

Collins Yes, a little bit below that. I think it was 2550.

Young We checked out rings A and B together and separately and direct and rate command. I got four or five checks of those things. They all appeared to be working correctly. There didn't appear to be any firing that was unwarranted or unnecessary and things were just running -- It is a real tight beautiful mode. It really jars that spacecraft. Boy, you know when you operate it. This is what everybody else has said.

Just like Gemini III, I put the OAMS control power switch back on, and flew the rest of the things, and turned around, and went BEF in platform for the rest of the rev, which was a whole rev that we went BEF in platform mode. We must have had an alinement that wouldn't quit. I can't imagine that we took three revs to retrofire and reenter. That is all we took on the whole of three. But we did and I think that is darned smart. I think you want to really take that long. I think it is foolishness to rush into things because it increases the probability.

Collins We had all kinds of time here. We actually had time to waste, but it was good that we did.

Young We didn't go with the center light bright because of this light problem we had. Mike turned the main batteries on a little sooner than T_R-22.

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Collins No, no. Not Γ_R -22, I checked -- --.

Young Retro checklist, and we turned them on sooner.

Collins Yes, they get turned on at Γ_R -4:16.

Young Calibrated circuit breaker, all circuit breakers were open and we were completely suited with the exception of gloves when we were done with the Preretro checklist. We got the updates okay. They were nominal, all information we got over the States, and went to REENTRY -- got the computer load over Carnarvon. Where was it we got the computer load, over the states?

Collins I don't know who gave it to us, I don't think it matters.

Young No, it doesn't make any difference anyway. It checked all the addresses, and they were all right, and went to REENTRY on the computer.

Collins Hawaii gave us that, I guess.

Young We must have checked. We were in reentry and rate command 10 times.

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5.0 RETROFIRE

5.1 T_R-4:16 Checklist

Young Now the T_R-256 checklist. I think it is crazy to wait that late to do that T_R-256 checklist. I think you ought to do it 10 or 15 minutes before T_R-256, but anyway I waited until T_R-7 and then started doing that, and I was getting more and more excited about the whole mission about that time. We mainly had it on our mind that we wanted to fly a damn good reentry and make sure that we did everything right. So Mike and I went through the 256 checklist at around 6 minutes. With the exception of going down to retrofire attitude, we waited until T_R-256. So we got a full platform alinement up to 4 minutes prior to retrofire. Okay, I don't agree with the T_R-256 checklist and I think you ought to fly (and always have flown the RCS,) retrofire on low scale on the needles. But I don't suppose it makes a hill of beans when you are in Rate Command anyway. Retro Attitude, push, we did that. We reported that checklist complete.

5.2 T_R-1:00 Checklist

Young When we finally got around to T_R-1:00 Checklist, we decided we would do that about T_R-2 minutes instead of one minute. So, in case we had an OAMS failure to separate, we could take care of that. We did that, and we actually were

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separating the adapter, oh, I would say T_R -a little over a minute. But not much over a minute, but all that power was cut off. SEP adapt was not as loud as I remember it from three, but still a good healthy kick and there must be some little Delta V associated with it. Mike separated all those things as we called them off. This is all on the voice tape.

5.3 T_R-30 sec

Young At T_R -about 20 seconds armed the retrorocket squibs.

5.4 T_R-5 sec

Young At T_R-5 Mike armed NO. 3 RETURO and we had counted down to T_R .

5.5 T_R-0

Young We got an automatic retrofire and Mike started his clock and the computer and then hit SALV FINIS RETURO. And the JVI's, the retrorockets counted up and there were three quick ones and I think that there was a delay between the third one and the fourth one, (I noticed) and the fourth one seemed like a real soft retrorocket. Remember that?

Collins Yes, a real soft light. I remember that. I didn't notice the delays. It seemed to me that the time was pretty good on them, but the fourth one definitely felt different than the other three. It felt like a real soft light.

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Young It felt like a soft rocket. But considering how much
Delta V we got I guess it was a pretty good one.

Collins Yes. We got, as near as I can figure from these charts,
a little bit over nominal Delta V, maybe three quarters
or 1 percent over nominal.

5.6 Postretro report to Hawaii

Young We made the postretro report to Hawaii.

5.7 Retropack jettison

Young We got rid of the retropack as soon as the light came on.
Oh, man, we started then.

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6.0 REENTRY

6.1 Reentry Parameters

Collins The onboard charts were fairly good. I made a correction in time reversed bank angle and the bank angle itself based on what the IVI's said as opposed to nominal. And I was within 3 degrees and 2 seconds of what the ground said.

Young That was outstanding.

Collins The ground said reversed bank 27 38; that was their updated information, and I said 27 36; they said bank left and right 45 degrees, and I had 48 degrees.

Young Yes, you can't beat that.

6.2 Attitude Control Modes

Young We flew a single ring, PULSE mode. I don't remember whether it was A ring or B ring, but single ring PULSE mode all the way to 400 K and about a 10 degree left bank, and then at 400 K I went to the reentry bank angle.

6.3 Guidance

Young We got guidance initiate - Guidance initiate was supposed to have been at - When was guidance initiate supposed to be?

Collins Hmmmm, let's see.

Young 400 K has a plus 40 second, minus 25 second tolerance on it. And we were 12 seconds late, so we were okay there. I remember that. We were 12 seconds late getting to 400 K. So it was within tolerance and I felt pretty good about

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that. At 400 K the roll needle went hard over and indicated it wanted a full lift, and I went to the reentry bank angle of 48 degrees left. And at guidance initiate I don't understand how --

Collins 22 22 guidance we got - yes, elapsed time from retrofire.

Young Yes, I don't understand exactly what the needles were doing at guidance initiate. They went up and down a good bit, which I guess you might expect out of a 215 158. You might expect to go up like that. The crossrange needle went - I was on low scale - the crossrange needle walked back and forth across the indicator a couple of times. And so I just held the backup bank angle, due to the fact that we were coming out of that high orbit, oh, I would say for 30 seconds or so, and then I started to follow the roll bug. And it commanded me to go to full lift, and by this time we are starting to get a little ionization off the spacecraft. And you were getting pictures of all this?

Collins Yes, that is right.

Young Of course, Mike kept asking me how many g's we got, and I kept saying none. But it did feel like we were getting some g's, but when we got to 1 g, it felt like 3 or 4. And I have to admit it, but it wasn't but 1, and as we started coming further down - Why don't you tell what you were doing?

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Collins Well, I mostly took pictures. I took pictures all the way down. That is really something out of that window. It really burns. There are chunks coming off, and just a whole glow, and I hope some of the pictures came out.

Young Yes, I do too; that would be something.

Collins 70 K, I read out address 86 and 87; actually it was a little above 70 K. As soon as I could get my hand on the MDIU - -

Young Wait a minute. I want to talk about the reentry a little. It commanded full lift for a long time and the yaw needle was centered and finally got around to zeroing out. The null position of the needles from eye position, due to parallax, in computer and attitude was one needle width below the little airplane. So, I flew to that position for down range, and the yaw position was dead center. So, I flew that position for cross range. And in a spacecraft, there was no sense in looking out of the window. In fact, that whole thing is inside a cockpit job. During that reentry, as we came down, at certain roll angles and at full lift, the sun came right in that window, and I had to hold my hand up to shield my eyes so I could see the instruments 2 or 3 times at pretty high g loads. But that is all right. That is a good way to keep the sun out of your eyes. But the sun in our eyes was the problem on that reentry. And sometimes it blinded me from seeing the instrument - -

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from seeing the attitude ball. The spacecraft really did -- When we went into these rolls, boy, you could tell it was really coupling into yaw. It almost felt like we were skidding sideways. Do you remember that?

Collins Yes.

Young And pretty soon we got down to 120 K and the needles were null. We would roll and then stop rolling, and then rolled again and stopped rolling. I don't remember the exact description of it. We got down to 120 K and it looked like we had a little less than 1 unit, or 2 mile miss in cross-range, and downrange was right on. So, I went to full 90 degrees to take that error out. And I would estimate that by the time we got to 40 K or 38 K, where we put out the drogue, we might have taken out another half mile or so. I felt real good about us having pretty close to a 2 mile miss on the spacecraft needles. I don't remember what the peak g's were but they are incidental. They might have been 6 or 7 or 8. I wasn't looking at the needle. All in all I thought it was a very interesting reentry. Mike was reading out address 86 and 87. What did it say?

Collins I've got it written down here. I called it out. I didn't write all the digits down because I was busy, and I couldn't quite get my arm up there. As I recall 86 was 02626 instead of 02656 which would have been nominal. And 87 was

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28807 instead of 28800.

6.4 Impact Targeting Confidence

This says we landed east of the carrier, but it also says we landed south of the carrier, and in fact I think we landed east and north. Isn't that right?

Young That's right. And the thing was calling for full lift toward the north as we came down through.

Collins It was asking for full lift toward the north?

Young It was asking us to correct that error.

Collins To go north. Okay then, I guess it was just a normal inaccuracy in the system.

Young Well, I think that system was accurate, but I think the carrier was in the wrong place. I do. I think they were off. Those guys said we landed within 2.6 miles. Did you know that Houston thought we landed within 2.6? You can't beat that.

Collins The carrier started up at 8 miles. They told us we landed 8 miles away and then they gradually kept working that number down, and down, and down.

Young Yes, I was real disappointed when I saw how far away we were.

6.5 Drogue Chute Deployment

Young We got the landing arm switch normally, I guess, about 65 K. I wasn't really in a hurry to do that. We talked to Houston

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about what we were doing. We told them we were at 2 g's passing through 100 K, and got the drogue armed at about 65 K, and punched it out at 38 K. When it punched out nothing happened for a little while. We were still in REENTRY RATE COMMAND. Then all of a sudden we started getting these wild oscillations. I guess this is just a period when the vehicle is kind of unstable but it was a real wild ride. I didn't experience anything like this on Spacecraft 3. Right in the middle of those wild oscillations I went to RATE COMMAND. They started getting worse so I shut the RCS off. Then they started dying down. I don't have any idea whether the oscillations were due to the stability of the area that we were passing through, or due to the fact that they were being coupled into by REENTRY RATE COMMAND, or what they were due to. But, it definitely looked like RATE COMMAND didn't help us any on the oscillations, and it might have just been that that's an unstable period, and just don't sweat it because pretty soon you will be out of it. But as we did get lower down the thing did stabilize out. Remember that?

Collins Yes. It got better.

Young I remember Mike kept saying, that's all right, John. I kept wondering how he knew it was all right because it certainly didn't work that way on Spacecraft III. I think

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it was funny. I was still targeting the spacecraft at 40 K to take out the rest of this crossrange miss. We ran out of lift about 40 K and were definitely coming straight down.

6.6 Main Chute Deployment

We got the parachute out at about 15 K. I tried to reach down and unstow my D-ring, but I didn't have any luck on that. Fortunately Mike was able to get ahold of this. At parachute deployment that would have cost me my seat open and my seat release capability, but I think we made it all right. We had to have that chute. When the barostat light and altimeter said about the same thing, I opened the main chute and that was a pretty wild ride too. The main chute, just as soon as it got open, breathed a second or so and then it disreefed in a normal fashion. And it was a beautiful chute. I didn't see any tears in it, but I wasn't really looking for tears, and then we had a rate of descent of around 29 feet per second. And then we started to spin up like a top. After it opened up we were coming straight down. We went to single point release, and we got one jolt, and we felt that one, and it wasn't very bad. It was a pretty interesting single point release. It wasn't hard at all. We braced ourselves well. We got two jolts - two definite jolts. It looked like it went part of the way and

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then fell the rest of the way. I don't know what the heck caused it, and I thought the thing had jettisoned the parachute. I thought it had fallen off the parachute and I thought, "Oh No", but it hadn't. And all this time Mike was taking pictures of all this; the parachutes, the single point release, and the operations on the drogue, and the reentry, which I thought was pretty remarkable.

Collins Well, tell them about the parachute spinning up.

Young Yes, after we went to single point release, we sat there for a second, and then this darn parachute started to spin up, and we were going around like a top. And Mike kept asking me about that and asking me what the rate of descent was. I wasn't worried about the rate of descent, but I didn't understand why that parachute was winding up like that, and why it was winding us up. We spun up and spun up and spun up, and it seemed to get real fast all of a sudden, and then it started to die down and die out and quit all of a sudden. And then it started to unwind and go the other way. It was a weird ride but I was pretty happy about it. I thought that it was going to make us hit the water like a ton of bricks, going around like that, but when we finally did hit the water, it was a real soft splashdown. We were braced for actually falling through the bottom. Mike got all the valves closed and everything. We had turned the

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RCS motor valves off at I would say, 28,000, and so there were slight flames licking out of the RCS but nothing to concern us. We didn't have any apparent leak. Did you have flames coming out of your side?

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7.0 LANDING AND RECOVERY

Young I had a flame but it was just normal burning of whatever it is that burns in there because it was just like it was on Gemini III.

7.1 Impact

The impact was real soft and we had a slight burning odor that just smelled after the thing hit the water and that is all we had. And we no sooner hit the water than the helicopter was there. We weren't in the water 20 seconds before there was a helicopter there. I tried to get some pictures of it out the window. The impact was soft.

7.2 Postlanding Checklist

I estimate that Mike Collins was through that postlanding checklist about 2 minutes after we hit the water. I never saw anything like it.

7.3 Communications

Communications on UHF was satisfactory. We didn't try the HF. The swimmer contact was satisfactory. Recovery status information was okay.

7.4 Postlanding Spacecraft Status

Postlanding spacecraft status: there were no RCS fumes. The main chute fell practically on the spacecraft because there was very little wind and, as a matter of fact, when we jettisoned the parachute, there wasn't enough wind to blow it away from the spacecraft, so it just sort of laid there. Although the

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pyros had fired, the thing didn't jettison out. So we were able to recover the chute too. The windows had this crinkly stuff on them which disappears after you get in the water. There were no leaks in the spacecraft. Electrical power was normal. Oxygen was normal. The hatch was very easy to open.

7.5 Comfort

The ocean was like a bathtub. We had two to three foot waves. The only mistake I made was in not getting Mike out of that right-hand footwell sooner. You should have got out and sat up on that hatch.

Collins I was hot - I was really hot down there.

Young With that suit on like that, I can understand why. We got

7.6 Recovery Team

out with the recovery team and for some reason they didn't have that dog in there thrown, so I got back in there and threw that switch for them and helped them close the hatch and it closed satisfactorily. We were in the life rafts.

7.7 Crew Egress

When they took Mike up to the helicopter they dragged him through the water a little.

Collins Oh, that is all right. I didn't mind that.

Young Well, they were not supposed to. They tried not to. But we were picked up by helicopter and I assume we got most of the switches shut down. It doesn't make a hill of beans anyway.

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FCS Rep Did you get dragged through the water too, John?

Young No, they picked me right out of the water. We inflated our life vests after we got in the raft because they wanted us to.

And then we put our neck dams and stuff on. And then we got into the helicopter and stood up. I didn't feel any worse than I had any other time, you know. I was pretty darn happy to be there.

Collins Same here.

Young And so they took us on over to the boat and I think our training on all that stuff was pretty accurate. But I think landing and recovery was a piece of cake. Do you have anything to say about it?

Collins No, I think you covered it, John, with the exception of the wild oscillations on the drogue. I would estimate they were plus or minus 25 degrees.

Young They were really wild too.

Collins And the spin up on the main chute which I never heard of before. Those are the only two things - really, the drogue didn't alarm me because I remembered a lot of the debriefings, people talking about that, but that spin up on the main chute, I didn't like that at all.

Young That was really something. I wonder what caused that, do you know? It almost looks like someone packed the parachute in a knot and packed it up there without having the risers...

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8.0 SYSTEMS OPERATIONS

8.1 Platform

Young It was a nice platform. The alinement was nice both day and night. I don't understand what the question is.

FCSD REP Did you have trouble **aligning** it day or night? Any particular problems?

Young No problems. I will tell you one thing that helps aline it is that D-10 for SEF alinement. It picks up **instantaneous pitch** and yaw, and you get roll out the window and you got an **instantaneous** platform alinement. And I think that is maybe one of the greatest things we ever looked at in the space program because it sure could come in handy to minimize the amount of time you have to spend in Platform mode and could be a real fuel saver over a long mission. Day platform alinement: I only did the one after launch and an SEF alinement on the last day. I thought they were pretty straight forward. I think I only did one night platform alinement on the stars and it was easy. The rest of the time we were caged to the Agena, which, of course, is easy enough. The cage mode was satisfactory. The SEF mode was okay, the BLEF was okay. ORB RATE was off repeatedly because we never were at the nominal spacecraft altitude which was designed for a 146 circular, and it was torqued at 240.5. And you could tell it was off; it was very apparent and after a little while of **operating** it, ORB RATE torquing was

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off. FREE, I only used that once and that was during the boost phase. EDAT was okay. Window markings, I never paid any attention to them. I don't know why we have those.

Collins The Gemini III crew asked for them, John.

Young That is right, they were for Gus's eye position so they didn't do me any good. The platform controls were okay. The accelerometer bias which was corrected over Carnarvon on the first pass was negligible the remainder of the flight. I made it a practice to go to Computer and STARE COMP early and we never got any numbers coming up in the windows. So whatever the accelerometer bias was, it was real low. We corrected again for retrofire and when they did that, it looked good to me the whole time.

8.2 OAMS

On the Pad operational checks of the OAMS, I think about the second time around on pitch down that things started sounding pretty crisp. But after that first time it didn't sound too red hot. Inflight it worked like a charm, just like it was supposed to. Flying it was no sweat. System monitor and source pressure was great. Source temperature great. Regulated pressure, okay. Propellant quantity, I am not sure. Like Mike says, that propellant quantity was adequately monitored although our source pressure was down to about what? 675?

Collins Something like that when we separated.

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Young Yes, there couldn't have been a heck of a lot more in there, although, with those big propellant tanks, there is no telling how much there was in there. I kind of wish we had done another burn to deplete it. I don't know why they didn't. We should have done a burn to just sort of arbitrarily bring down apogee as much as we could. And I wondered why somebody didn't think of doing that. And I meant to ask them about it. It seemed to me that we could have run the OAMS out and given that thing a good test, but I didn't want to rock the boat. In the long run, I guess it is better for them to get a good hack on what our orbit is, really and truly, than to make any big changes in orbit right at the last moment. My experience on III at least showed that would be the case. Monitoring of OAMS propellant remaining: It's very difficult when you get down there low because of the parallax in that thing.

Collins The gage which is convex should be concave, because you do not care up on the top of the dial but you do down at the bottom.

Young Operating with the suit pressurized, I had no idea what was in there. None. I couldn't bend over to see it.

Collins I would like to know a little bit more about that OAMS system. I would like to know where the ground picks off their readings and how they are apt to be different from the on board readings, or could we both be wrong?

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Young They kept telling us we were going to run out of gas and we never did.

Collins So, if there are errors in the system, what types of errors could they be and would the ground have any better way of picking them up than we had? This is something we had better look into because XI and XII are flying with this super OAMS and there is no point in their not knowing what their fuel quantity remaining is.

Young The selectric controls and switches are nice. The attitude controller: that is a beautiful controller. Maneuver controller: that is a good controller, but I might have inadvertently put in some forward thrust on the second midcourse of the primary rendezvous. The solution looked coupled because from 25 down it read 24 aft. I don't see how you could get there unless you inadvertently did that. But that wasn't the fault of the controller, it was the fault of my position in the seat, maybe. We will have to look at the thruster firing and see exactly what happened. Inflight malfunctions, there was none. Right. Did you notice any?

Collins No.

Young I thought it was beautiful. ATTITUDE CONTROL mode, RATE COMMAND: RATE COMMAND is a tight, good, solid, operating mode. The REENTRY RATE COMMAND works just like it is supposed to. It is a good mode, DIRECT is a beautiful operating mode. PULSE

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works like it is supposed to. Horizon, we didn't use the horizon scan, not once. Platform works just like it is supposed to. Heaters, the RCS heaters came on - we left the OAMS heaters on all the time and the RCS heaters came on, when?

Collins They came on the first night. The first night I turned them on and left them on all the rest of that night. All the rest of the flight virtually.

8.3 RCS

Young RCS operational checks were perfect. System monitoring was easy. Source temperature and source pressure was readable. Controls and switches were okay. There was no inflight malfunction. RATE COMMAND, REENTRY RATE COMMAND, I didn't try. DIRECT on - yes, I did. I worked out in DIRECT, in RATE COMMAND and REENTRY RATE COMMAND and PULSE too, and they all worked. But that RCS - that really belts that spacecraft around. When you fire the RCS, that nose moves; and I mean right now. Those retro offsets would have to be like 90 degrees to alignment before that thing wouldn't be able to handle them I believe. Made a lot of torque. I think they are more responsive - they actually give the spacecraft a kick when they fire. Did you notice that?

Collins Yes.

Young Really, just belted it -

Collins -it is a long instantaneous belt-

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Young I suppose one of the reasons is because of the short line lengths and everything. When you fire that valve you have got it right now. Heater operation and frequency, they came on - those are the heaters that came on. Thruster plume observations, they looked normal to me. Were you able to get a picture of those?

Collins Yes, I got pictures of the RCS checkout. Now, I think all the film is going to show - you know I had those little tufts of asbestos (or whatever they wrap those pipes in) sticking up - and I think when the RCS thrusters fire they are displaced and that will show in the movie film. But I don't think you are going to see the flame or anything. It is just not that apparent. But we will find out.

Young Systems shutdown. We shutdown the system at - in RATE COMMAND at about - my guess is 27 of 28 GOC. We shut right down and there were no fumes, there were no fumes in the spacecraft as a result of them. There was some fire coming out of one of my thrusters (I forget which one) on the way down, but I guess that is normal. It curls out. It looks like something the - resin or something in there burning. But I didn't see anything abnormal about the operation of it all. It was real fine. I think that control system in the spacecraft is just outstanding. Boy, you can do anything you want to with it. It is a

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dream system. What about the ECS?

Collins Yes, well, on RCS, the last item we did have some fumes in the cockpit, did you mention that? When we opened the inlet valve they went away within 2 or 3 minutes.

Young Shoot yes, but that is normal.

Collins I know it. I know it. No problem. I think that is the point, if that is it, it is no problem. You shouldn't have to worry about it when you open the inlet valve because of fumes, go ahead and open it. They are not bad.

8.4 ECS

Young Suit Command Pilot, mobility pressure, temperature, humidity, CO₂ comfort controls, and O₂ demand regulators. We didn't have any CO₂. The humidity was normally hot. When I was in a suit I operated my flow control quite a bit and at night I would turn the flow control practically off. The normal sleeping configuration in that thing was neck dams and I didn't use my wrist dams. Most of the time, I was comfortably warm. I had my flow sometimes shut almost off at night. I was cold. In fact a couple of times there at night I shut it clean down. Comfort. What can you say? At zero g, shoot, it feels comfortable enough, but that thing cools you by your sweating and then it runs that air over you so it is not any too good. Mobility, - the mobility was adequate for flying a spacecraft. But, it is not the kind of thing that you could do, you could

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not change the camera film and you couldn't let go of anything long enough to operate anything by the hand controller and the maneuver controller. I would like to have tried to do the S-13 up there pressurized. The humidity, that was a problem. I am sure that there are places where it got high. Why don't you talk about your suit. I have finished.

Collins Mobility, for a Gemini suit, I had good mobility. I think that the David Clark link-net suit has come about as far as it is going to come. You have got to have a different design to get more mobility in future programs. But, what you really need that the David Clark really does not have is a lot of waist mobility and thigh mobility. For example, when I was tangled up in the umbilical I had no way of getting untangled because I couldn't bend my waist to see what was going on down below and I couldn't raise my leg because of the lack of thigh joint mobility to do anything about it. So, I was just sort of trapped with the umbilical wrapped around me. That should not be. You should be able to get waist mobility and thigh mobility in a suit. Other areas of - where you definitely need improvement are in the shoulder joint which the suit people are well aware of and in the gloves. That glove design is just not very good for repeatedly manipulating hardware. It is a constant struggle to make your fingers and your thumb do what you want them to do. It is done at the expense of muscular

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effort which tires your hands out very rapidly. I found during the EVA that my hands were the only part of me which became tired, but they did tire very rapidly, only because I was doing simple things like grabbing handholds and manipulating cameras. That shouldn't be. You should be able to do those things effortlessly, almost.

Young Let me put this on the tape about this suit and operating in a vacuum. Boy, I really think that one of these days we are going to have to get lock locks on all those things that can come open, like the zipper and the helmet ring, and the gloves. There is no sense going out in a hard vacuum with a device that can inadvertently (and I don't care how remote the possibility is) be knocked off. That includes the hose fittings too. There ought to be some kind of mechanical lock lock like a lock on an airplane wing to keep us from killing ourselves when we are out there. I think that is the most dangerous work we do and that whole suit is a single point failure item too, which I don't know how you are going to get around it, but you sure get around those kind of inadvertent single point failure items by putting lock locks on those disconnects and on the gloves and the helmet.

Young Now Mike taped his neck ring - his neck fitting?

Collins Yes, the snap - the metal clamp on the front of the neck ring, which is used to lock the helmet down onto the suit itself.

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Young And at one time or another in some training that we were doing, we inadvertently opened the zipper.

Collins Yes, I popped a zipper in training and ..

Young And those kind of things will kill you in that vacuum. There is no reason to have them there, because we can prevent it and I think we ought to do something about it.

Collins It would sure help.

Young It will kill you deader than a door nail.

Collins The suit starts off being a single failure point just by virtue of the fact that you have got one gas bag, it is just one thin layer of bladder material that is separating 4 psi from no psi and from then on, - these other failure modes just add one on top of the other. And I really don't know how you can get around some of them without going to the further encumbrance of double bladders and double visor seals and things like that and I sure don't think we need that.

Young But you know it doesn't have to be a very complicated thing to give you a mechanical lock on these fittings. Like the bailer bar on the neck ring, that lock on that is a real smart device.

Collins Yes, that is true. The pressure held constant in the suit. I was running a little bit under 4. The temperature: I was hot. Except for brief periods the second and third night, I was hot the entire flight. I was also hot throughout 6 months

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of training in that suit. That super insulation in that bunny layer does a very good job, it prevents your losing any heat through radiation so that you have to rely on the convective currents of oxygen over you, and then you have to supplement those by evaporative cooling (by sweating). This is just not a very good situation. I think this is why people come back tired, and dehydrated, and irritated, and hot, and rundown, and what not. It is because of this constant cycle of being hot, sweating, evaporating, being hot, sweating, evaporating, and passing fluids through your body. I think - again, I am not talking about the Gemini program, but for the future - what we really need is that water cooled underwear. That solves that problem nicely.

Young I think you are right. That is the only way we are going to lick it.

Collins And on future programs, I think if this thermal layer is integrated into the suit, then we ought to plan on taking that suit off most of the time, and if there are some operational reasons why you have got to wear the suit for long periods of time, then I really think that the EVA cover layer ought to be a separate garment.

Young Is that what they are doing on Apollo?

Collins Yes. Last I heard.

FCSDREP How was the visor fogging?

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Collins The visor fogging, there was none. I put the wet wipe on the inside of the visor and when I put it on, I left an area over on the extreme right without putting any on there, just for comparative purposes. I had no visor fogging on the wet wiped area and no visor fogging on the unwiped area.

Young Good test.

Collins The 50-foot umbilical worked fine. I think the trouble is -

Young It was 30 feet too long.

Collins Yes, it was too long. I think it was fatter than it really had to be. I don't think those thermo people at McDonnell are too realistic. They had that cover layer (that insulation material) so loose that the umbilical needlessly filled up a bunch of extra space. They could have been clamped down a lot tighter. Y-connectors, electrical jumpers, standup hoses, and that equipment is all right. It is pretty crude. I really think what we need is to have those things integrated whenever possible. For example, I think the 18 to 24 inch extension hoses ought to be an integrated part of the ELSS and stowed with the ELSS so you don't have those connections to make. I realize that we just can't do that inside the Gemini, but I am talking about in the future. There is no point in having extra failure points and extra connections to make. Everything that can be built into part of another unit, should be built in and stowed that way. The thermal gloves, I got a good fit

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on those. One pair out of three. There is a lot of black magic associated with building a good fitting pair of EVA gloves, and I am sure the government wasted a lot of money buying gloves from Dave Clark which don't fit right. I don't know how that can be solved, but I think somebody ought to take a hard look at how David Clark goes about measuring and how they go about translating those measurements into gloves. IIC, for example, sometimes takes hand molds, and they seem to have good success with hand molds, and maybe Dave Clark ought to look into the same thing. Innerconnect, ELSS chest restraints: The ELSS restraints worked fine. The ELSS rode neither up nor down and they worked okay. The hatch closing device worked good. The EVA visor: that gold material is totally unsatisfactory. I would say I scraped 40 percent of the gold off before I ever used the visor the first time for EVA, and we had gold dust all over the cockpit. We had it all over us. We had it up our nose, in our eyes. On my post-flight medical, doctors were digging gold out of my ears. We were the gold dust twins.

Young That is right.

Collins We had gold dust every which way. The least little flick of a finger nail on that visor would just peel the gold off.

Young I don't see why they don't look at using some other kind of filter.

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Collins That is right. I know emissivity of gold is good, but they have got to find another material which has good emissivity and still doesn't flake. Now this started before liftoff. When I got inserted and the hatch closed, I wanted to open my visor. I removed the EVA visor and opened the main visor and the EVA visor already (at that stage of the game) was starting to become scratched. I banged it up some more doing the insertion checklist. I scraped some more of it off by putting the visor cover on it and I scraped some more of it off during the EVA prep. And by the time I used it for the first time, there were great areas with huge gaping holes in it. This is just totally unsuitable.

Young What did you think of the method of attachment?

Collins The method of attachment with the Velcro straps, I think is (I feel pretty much the same way as I did before the flight) infinitely better than the other way. I think further improvement would be to have just a friction kind of a swivel device on that -

Young There could be such a thing; it is so hard - Why do they have to be so shock proof?

Collins Yes, I think what you really need is a visor just like we had - which you can Velcro onto the helmet, - but then once it is Velcroed you can change it from up to down or infinitely various positions intermediate-wise just by moving it up and

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down with one hand. And I think that could just simply be a sliding friction hinge on either side. I think that is the way to go with it. But anyway, mostly it was the gold that is objectionable.

Young The hatch closing device was easy to use, wasn't it? Worked just like it was supposed to.

Collins The hatch closing device was easy to use. We had the -

Young We didn't try the overkill.

Collins No, we didn't need to -

Young But it was sure nice to have it along.

Collins That is right. Cabin pressure: Cabin pressure after liftoff at 1 minute was up to 5.9, if I remember the number correctly. But then in orbit it bled on down to about 5.3. We were holding 5.3, weren't we, John?

Young That is right, pretty much. Three depressures and repressures, works great.

Collins Cabin temperature was hot in my opinion.

Young It was up to 94 when we were powered up and when we were powered down it got down to, oh, I seem to recall 81 or 82.

Collins Humidity: I never noticed it being too moist. It was probably on the dry side. CO₂, I never noticed any problem with CO₂. Comfort day and night: I was hot all day and I was hot all the first night and I was hot the second night for several hours and then I finally got cooled off the second night. I

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was hot the third day, and again I got cooled the third night.

Young If you remember, we were on single suit fan after the standup EVA all the time. So we never really got a chance. . .

Collins Well, essentially I was hot 3 days. Cabin pressure relief valve: It works.

Young Cabin pressure regulator: It works. Cabin vent valve: It works.

Collins The repress valve: Just fine.

Young I tried to dump the cabin pressure the first time with the cabin vent plug in. The cabin vent plug works.

Collins Cabin repress valve, cabin inlet valve: It works.

Young Recirculation valve. It works. One time we were rather uncomfortable after the standup EVA, and after we were on the ECS test. We had breathed the suit down, and it was then that I noted that I had the recirculation valve closed. No wonder we were so hot and uncomfortable. We were breathing the suit down around us.

Collins Right. Primary oxygen: The only problem with the primary oxygen is, that with the big 14 day bottle for the first 2 days of the flight, you have to constantly turn that manual heater on. You have to constantly watch it and constantly keep the manual heater going.

Young We did it the last day too, before reentry. We bumped it up a couple of times.

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- Collins That autoheater ought to be bigger.
- Young Any time that we were powered up, the pressure would fall down.
- Collins That is right. That autoheater should be bigger. That is the only thing I can recommend for that system.
- Young Flow rates were good. We never had to worry about that even doing repress. We could go to bypass on the radiator and we never lost any oxygen out of the secondary bottles. So the flow was adequate to hack all stuff.
- Collins Secondary oxygen: I don't have any comment at all on that. The pressures we read out a couple of times, I think they were 5300. They were pretty evenly balanced and they just stayed up there,
CO₂ partial pressure: I didn't pay any attention to it. What was that John?
- Young It was right on zero everytime I remember noticing it. It never did anything.
- Collins ELSS: The ELSS worked as advertised. I started out on medium flow and stayed on medium flow for about half the EVA, became aware of the fact that I was feeling warm and switched over to high flow. I wasn't aware of being either warm or cold after that, so it must have done a pretty good job cooling me on high flow. The pressure in the suit held steady while on the ELSS. It was just under 4.

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The monitoring system: After the initial checkout, I just didn't pay any more attention to those gages. I was too busy with other things.

Young That's right. I didn't think you would. It's a great thing to have on there, but if you've got enough time to look at it, you haven't done your flight plan. There ought to be a time period in there where you get a chance to look at it, but we were so darn busy we did not have a chance. I should have told you to look at it.

Collins Maybe if the light had come on I would have been aware of it.

Young You don't have to reveal or check your suit pressure. If your suit pressure fails that light will come on and it will slug you some more oxygen. If it doesn't you're dead, and there's nothing you can do about it.

Collins I still think that peanut light design is awfully poor on the top of that ELSS, but I'll have to admit that it wasn't aggravating to me that the light was constantly on. I'm not even sure that it was on. I never even noticed or paid any attention to it. The 50 Foot umbilical: I think they did as good a job as they could on stowage of it.

Young After the first day the position of my legs being straight down in the cockpit didn't bother me. On the first day I had a few leg problems but they went away. I thought they would in zero g. I still think we ought to keep stuff out

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of the footwells as much as possible. I think it's a mistake to stick stuff in there.

Collins My only squawk on the 50 foot umbilical design is the attach point on the left hip where this metal bracket fits over the parachute harness. When I came back in from the umbilical EVA and repressurized and got ready to take that umbilical off, I went down to pull the pin, and found the pin was already pulled. It had come completely undone, and the back gate on the bracket had swung open and the only thing that was keeping the bracket from coming loose, I assume, was just the pressure of the inflated suit against the inside of the parachute strap. That should be fixed before that thing flies again and perhaps the fix is as simple as making a greater diameter tip on the end of the pin to make it fit up in there more snugly and require greater force to pull it out.

Young You actually were in untethered flight.

Collins Yes, of course, I was connected by the oxygen and electrical connections, a couple of them to the chest pack and one of them to the suit.

Young That's going to make Mr. Mathews nervous. Did you hear that? When he got back in he was uncoupled from his tether. But he was coupled to it before he went out because I checked it.

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Collins Yes, I put the pin in and you checked it.

Young I checked all of his connections.

Collins Well, I was still hooked to the umbilical a couple or three ways.

Young Yes, those umbilicals will hold a thousand pounds. You'd have to be a baby elephant before you could bust that.

Collins I can't get too excited about all this. All I'm saying is I think this is the way the design is, and it should be changed before it goes on XI. I think it's just a question of using a bigger pin.

Young One with a more positive connection where you can screw it on there, wind it on there or something. The coolant system worked O.K. We went to bypass on the first repress, didn't we for awhile?

Collins Yes we did.

Young And then we didn't go to them on the last two.

Collins That's right.

Young I couldn't tell the difference.

Collins Nor could I. This is something we couldn't get squared away, Preflight either. It all depended on who we talked to whether we were supposed to go bypass or not.

Young I don't think it really makes a hill of beans. Evaporator operation and configuration: Yes it operated. One thing about the evaporator was that the water boiler yaw was a

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continual problem during the Orbit Determination which I left completely out of there. That cotton picking water boiler would yaw me off those stars while I was doing calculations in the cockpit and I thought this might be a problem and sure enough it was. I had to go back and get on the stars and that cost us some time there. That thing was yawing during that first orbit and I was in there trying to plot these residuals and to line this thing up and that infernal thing was yawing us off.

Collins I thought you did a great job getting those stars aligned. We did lose some time, but in general those stars were right there exactly where I needed them when I needed them.

Young That was a problem that I mentioned to those guys and they said, "Oh, that wouldn't be any trouble," but you just can't calculate in the cockpit and keep stars aligned at the same time when there's a yawing influence on the spacecraft. The radiator coolant loop operated O.K. Weren't we on A and B pumps most of the time? Primary A and secondary B?

Collins We were on that for the EVA. We were on both A pumps for most of the high power operations. We went to both B pumps the first night. Then after that they asked us to stay on A and B. I don't know why. The pumps worked fine. I couldn't tell much difference between which was which.

Young They said one of the pumps had a funny in it.

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Collins That was the secondary B pump.

Young We never noticed it at all. They said the pump reservoir low light had a funny but we never noticed it.

Collins Normal throughout. The water management panel is a loser. It's terrible and very inaccessible. The valve you use to dump the urine is extremely hard to turn. I tried and tried to turn the condensate valve with the swizzle stick, and it's just too high torque to do it, so I finally had to get completely unstrapped and turn around in the seat and reach down there and turn that valve to the tank fill position. The valve you use to dump the urine was extremely stiff and the center OFF position was not clearly defined so that when you went from OVERBOARD DUMP back to OFF, there wasn't any detent, so you never knew when you got it off. We wanted to be careful we didn't overshoot and hit the Evaporator position, so that meant that we had to constantly let go and get the flashlight out and shine it down in there and make sure that it really was in the center position. That whole business of having to preheat with the electrical switch no less than 3 minutes and no more than 5 minutes prior to urination and then having to put that electrical switch to dump and the other valve to dump is just a very cumbersome procedure. There should be some simpler way of doing it, and those controls should be up where you can get to them.

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Of course, it's too late on the Gemini program to worry about that.

Young The urine system assembly and operation: Oh, man, there ought to be a simpler way to pee than that. All I can say about the urine system is I think we ought to go to the direct overboard system, and the sooner the better. It's too cumbersome, and flight time is too valuable to waste it urinating like we have to do. The whole procedure involved in unstowing that thing, putting it on, making the disconnects, connecting it, unconnecting it, and going through the procedure of doing all this stuff, and making sure you don't get urine all over the cockpit...

Collins Even when you do everything right you spill the urine.

Young That's right. There's no way out of it, and I think we ought to go to the direct overboard system. You waste time and you spill urine. That might have been part of our eye problem, you know. We were in a hurry most of the time when we were doing it. We'd go as long as we could and then we'd have to stop and urinate.

FCSD Rep How was your water?

Young The water was good. I've got where I kind of like ROCAL better than the other kind. The water in the spacecraft tasted better to me than the water on the ship. I know that sounds terrible, but it did. The water on ship was just

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as flat as it could be but that stuff in the spacecraft has got that ROCAL in there.

Collins The water was nearly deaerated. Every once in awhile I noticed that in the food bag there would be some air bubbles but in general there wasn't very much at all. Nothing to worry about.

8.5 Communications

Collins The Interphone worked fine at all times. The voice quality was good and it operated normally. The UHF: We had trouble several times during the flight hearing on UHF No. 1 and I suppose it was just antenna pattern problems. We were directly over station or we were just about LOS to the station, but one time we did switch over from UHF No. 1 to UHF No. 2 and that didn't seem to help matters appreciably so we switched back to UHF No. 1. That leads me to believe even more that it was an antenna pattern problem. We never extended the HF antenna and never used the HF. Voice procedures: I don't have anything to say about that. The Voice tape recorder worked as advertised. Personally, I think it would be a good idea to have a light on when that thing is running continuously just as a reminder, and yet on the other hand you don't want the cockpit full of light.

Young I don't know. We didn't run out of tapes. We put our last tape in.....

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Collins We carried nine tapes and it worked out just right, although I think we could have used a few more, I think.

Young If we'd have had a nominal mission then we'd have gotten a chance to get into those experiments more, and I know we would have run out.

Collins And if we could get more time on each tape it would save procedural time. It seems to me if you could quadruple the one hour number it would sure be nice.

Young Our EVA's were not long enough to remove the tape recorders from that receptacle that its in and slap it upon the wall. I really didn't see any advantage to doing that anyway. I don't think a guy should have to change the tape during an EVA. I think that's one of the things you shouldn't have to do. I don't think you should have to change the film in the camera during an EVA, but maybe that's asking too much at this stage. I think if a guy is going to be outside the spacecraft and you're going to have one of these three body problems you'd better devote your time to stick and throttle. I don't think you can afford to stop to do that because you might kill him while you're doing it.

Collins That's right and that would be a mistake.

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O.K. on the DCS system, everytime the ground told us that we should get an update we did in fact get a DCS light.

DCS as near as I can figure worked perfectly.

Communication controls and switches - we did not use VOX.

We used continuous Intercom push-to-talk about 95 percent of the time. We occasionally went over to push-to-talk.

Young Remember how our keying. . . .

Collins Yes.

Young That was okay, wasn't it?

Collins Yes, keying was all right.

Young Antenna selection, remember when we had some trouble with communication.

Young I already talked about that.

Collins Oh you did. I think that's a good way to solve it. Switch antennas every time.

Young Right. I think that will solve most of the problems because the antenna pattern nulls.

Collins Well, all I said previously was that I thought that the trouble was in the antenna patterns rather than the UHF. I didn't go into detail but what we did was switch from adapter to the reentry.

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clear. Like that time we were over the Canaries and they faded out we were right over the Canaries and went to REENTRY, and they came in loud and clear.

Young Sleep configuration: We were on UHF No. 1 and the select switch was in Intercom rather than JHF. The volume was a medium setting and that's all I know to say about that.

Collins Beacon control: We did what the ground told us on that. We were on Command most of the time. Sometimes we were on Continuous. EM Controls, transmitter and antennas: As far as I know they were fine.

Young They were fine.

8.6 Electrical

Collins Every time I monitored the system it was 100 percent normal. The main batteries were always good although there was a lot of difference between individual batteries. For example, when I checked them I wrote them down one time prior to retrofire.

Young We never lost anything because of them, especially -- --

Collins No -- --

Young -- -- during the reentry so I don't think they are even worth worrying about.

Collins Right. Well, they went from 22.5 volts on number 4 up to 24.5 volts on number 2.

Young But you weren't given this 5 seconds minimum were you?

Collins Yes, I did that time, the maximum. I gave them each one 5

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seconds and wrote down what they said. So old battery number 2 is a real hot one. The other ones were down in the 22's; it was up to 24.3. Fuel cell operation was flawless. The individual stack currents were all pretty close to being evenly balanced. The purges went normally. The only thing is I goofed twice on the oxygen purge, and I left a purge switch on a lot longer than two minutes. Now with the 13 seconds on the hydrogen it's no problem; that's such a short time period, all your attention is riveted on timing the 13 seconds, and you don't forget to turn it off. But on the 2 minute purge periods you can't sit there like a fool for 2 minutes. You go off and do some other task, and then you forget, or at least I forgot to come back and turn off the purge. I really am not fond of those little rollers. I think one of these days they are going to get somebody into trouble. He is going to leave the purge switch on when he goes to sleep and drain all the oxygen out of the tank.

Young How about the crossover valve? That didn't give you any problems.

Collins No, it didn't. I never forgot to turn it on but when I forgot to turn the oxygen purge off, of course the crossover valve still stayed open. That doesn't hurt anything. What I think we really need in this spacecraft is a regular old timer, like on an old fashioned stove,

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where you can crank the thing around there to 2 minutes and when the 2 minutes elapses, it rings a bell. You can use it not only for oxygen purges, but you could use it for lots of other little things on the spacecraft.

Young That's right. There's lot of -- --

Collins Like you could put it in that you've got an OAMS burn that's a minute and 14 seconds. You should be able to crank that thing around to 1 minute 14 and when the bell goes off -- --

Young Quit.

Collins -- -- stop thrusting.

Young That's a good point.

Collins I think it would be useful in a number of ways.

Young If it was accurate it would.

Collins Count you down to any kind of an event and then it attracts your attention when you're doing something else. I would much rather have that than that accutron clock. Wouldn't you? Or that eight-day clock. I think we'd be well advised to have some crude, simple little timer that would maybe time events up to one hour and it would have an accuracy of plus or minus a second or two. Well there isn't anything else to say about electrical except that it was nominal.

8.7 Onboard Computer

Young Onboard computer; it was nominal.

Collins That's right. There was no funnies in the computer anywhere.

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It worked nominal.

Young I'll tell you one thing though. I think orbit determination and navigation predict are two of the worst cotton picking modes that has ever been developed for manned space flight. That is because I don't think they were really developed for manned space flight. They were developed to solve the equations of motion and they do that very adequately, but they don't have the capabilities to solve an applied problem which they ought to have if they are going to be used in Gemini programs. I hope that next time we go, we don't let them do us this way. Rendezvous mode, I -- well, there was a funny in that, but I guess we'll have to wait until post-flight analysis to see what that was.

Young Retrofire was a nominal operation. Reentry computer was right on the money. Updates -- over some. Did the MDU give you any problems?

Collins No problems.

Young Computer mode?

Collins No.

Young Pre-launch?

Collins No. Went through all of those things. It was beautiful.

Young Navigation mode in Module VI is a terrible mode to thrust in. We made two burns in that. We made NCl and a plane change. We made an SPS burn in it too, I think. Trouble is, it counts

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down. It navigates while it counts you down so it skips digits, so it skips numbers. In other words, you'll be at three feet. You'll be thrusting along and all of a sudden you're two feet aft. And you've gone from three feet to two feet aft, whereas in a nominal one you would be three, two, one, zero and you'd quit. And that's a terrible mode to navigate in, as far as Rendezvous mode. Module III, I think, is great. There again I think we ought to look at the increase in the length -- we ought to look, probably, at the decrease in the length of time that this thing takes to solve these things -- decrease in the sampling rates, but increase in the time between data point take. Every two minutes, probably, take data every two minutes, and let the computer take it every one minute, because I don't really see any sense at all -- --

Collins I think we have that capability. There's an address in the computer you can dig into and vary that sampling rate.

Young Yes, in Module III there is. And I don't see any reason at all for a guy to sit in there and do like Mike does and take data point after data point after data point and apply it on that chart because it's meaningless, unless you're going to use it for something.

Collins Well, I think our whole scheme of taking those data points every minute and 40 seconds -- and the only reason we did

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was to get address 69 for range instead of -- because address 69, it's range corresponds exactly to the angle you measure in the address 96.

Young This is the one the computer uses to figure it's closed loop solution and what you're doing with -- --

Collins But as far as that polar plot goes, I think, if you feel like getting a point on the polar plot any old time, just go ahead and mark it and get address 36 for instantaneous range and 96. I think it's close enough for that polar plot. I think it's unnecessary to stick that 1 minute and 40 second data point scheme just to get data for the polar plot.

Young Predict navigation, as I say, predict navigation -- it doesn't have an iterate loop in it, it needs to keep Mike from adding and subtracting and plotting curves. And I just can't understand how anyone thinks that's predict navigation where the crew has to do all the work. That's the way I feel about it. The computer was through with it's prediction in, maybe, a minute and 30 seconds, but Mike worked from Carnarvon until Hawaii to add and subtract and to look up curves and plot curves and iterate data points that the computer ought to be doing. An nobody can tell me that's a smart design because it's not. Reentry mode worked like it's supposed to. I think orbit determination mode could be improved if, instead of entering the right ascension and declenation of the stars,

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that that stuff was stowed preflight. That would save you some time that you don't have in an orbit determination. If they're talking about improving it, I'm not sure that orbit determination will ever be workable because I don't think the horizon is that fine.

Collins Not when the moon is down.

Young Is there a place in here where we're talking about all this stuff. The statement was made by Mr. Kraft in FOD that prediction mode didn't have the mathematics to solve these problems anyway and somebody ought to look into this because if it doesn't, we're kind of wasting the Government's time to carry it on the spacecraft in the first place, and certainly wasted a heck of a lot of time on training hours. We spent about a hundred hours of our simulator training time involved in solving orbit determination and predict navigation problems. We could have spent it on other modes to better training advantage. ATM worked out just as it's supposed to.

Collins ATM worked as advertised. No problems. We loaded all modules -- or we used all modules except Module V and everything worked normally.

Young We loaded VI and then we loaded III and then we loaded VI and then we loaded III and then we loaded VI again for the last orbit determine, remember? And then we loaded IV. So it got a good work out, six loads.

Collins All in AUTO MODE, and all worked normally.

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Young Radar warmup time. Yes, it takes warmup time. Although one time Mike turned it on without having any warmup after he backed out of the Agena and it came right on after we were out about.....

Collins 10 seconds.

Young Yes. It came right on. It didn't have any warmup time. We gave it five or ten minutes warmup time when we first started. We turned it on about 2:50 in the flight plan, seems to me like, and we got a solid lock on at 3:06 and 234.43 nautical miles and maybe it broke lock once or twice there, only intermittently and for a short period of time. I didn't look at the needles until after N_{SR} , but after N_{SR} the needles were just as solid as a rock. The radar needles indicated no variation in the alinement of the radar. It appeared to me to be exceptional. The pitch needle, when I finally saw the Agena at 58 miles, the pitch misalinement between the optical sight and the bore sight was zero. The yaw misalinement, when the radar needles were centered in yaw, the target was half a degree to the right in the optical sight. I think that's an exceptional radar system and an exceptionally good bore sight. Loss of lock, we didn't have any. We didn't have any false locks and I discussed the bore sight.

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8.9 Crew Station

Young Crew station control and displays: The sequential telelights worked. The event timer was a second and a half behind the digital clock when we got our first time hack over Carnarvon.

Collins The digital clock could use a guard on it to keep it from getting inadvertently stopped.

Young We stopped the digital clock a couple of times and had to get time checks and it's pretty difficult to get those guys to give us a time check on the even minute too, far enough ahead so that we can get a time check. They didn't know we wanted to restart our clock. That Accutron GMT clock, I don't know what you use it for.

Collins I don't either.

Young It's a nice clock, but what do you use it for?

Collins We ought to have an old stove timer in place of that Accutron. I think that's the place for the timer.

Young The IVI's worked normally in all respects except that one time where we got a twelve when we input a six into address 26. I never have understood it. It did it twice in a row. We couldn't stop to do it anymore times just before N_{SR} and I bet you a hundred bucks, nobody will ever find out what's wrong with it. Sure made me nervous. Made me nervous about the closed loop solution too. That's why I only applied only half of the closed loop solution on the first pitch

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Young down and I should have applied all of it obviously. I mean I applied half way between Mike's solution and the closed loop solution on the first down thrust. I could have saved us some gas if I would have applied the full one. Flight Director indicator is okay. Range and range rate indicator: It was working peculiar, there coming in there. It had some funnies in it. One time the range rate jumped to zero and then it jumped back on as we were coming in on the target and I don't know what caused that. Mike was always reading out of range rate that sounded pretty reasonable. I asked him what he was reading one time when we were coming in on rendezvous.

Collins Oh yes, during that last time...

Young Mine was reading an opening number, a big opening number and I knew that wasn't right.

Collins I read R dot and R out of the computer continually during the breaking and they seemed to be all right.

Young Yes. Fuel and oxidizer pressure gages worked just like advertised. There was no funnies in either one of them. The pressure was really great. The altimeter worked exactly like it was supposed to on our way down. It didn't work on the way up very good. The rate of descent indicator worked like it was supposed to, 29 feet per second. The accelerometer worked like it was supposed to; we used it

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Young for measuring acceleration both for PFS burns and the IVAR. We also used it for measuring acceleration of the retro rockets, and the reentry. But that's what we used it for, g readings. Also I think I put down on the voice tape what it indicated. I think we had 6.8 g's at SECO and 1-1/4 g's negative for our last PFS burn. Switches and circuit breaker panels: we had an inadvertent opening of the cryo quantity and regulator pressure circuit breaker, didn't we?

Collins Yes. I knocked several circuit breakers open over on the right hand circuit breaker panel.

Young Then we inadvertently shut off digital clock twice.

Collins Yes. It was during the EVA prep was when I knocked the circuit breaker open, but actually I guess during some of the EVA itself.

Young The time we really rattled the switches in there was when we were getting back in. We knocked switches all over the place when we were getting all that stuff in the cockpit with us.

Collins The only thing you can recommend is just put it in the checklist to check circuit breakers and switch positions every once in a while. Particularly after you go through a big exercise.

Young I don't think you could get in serious trouble; you might if you knock some of those overheads off.

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Collins Mirrors and swizzle stick worked fine. Lighting: That water measurement panel could use a light on it.

Young The right panel, the pedestal panel: I guess it's okay. Utility light: didn't use it. Did you use your utility light? We used a flashlight didn't we?

Collins I used the utility light to shine on the Encoder.

Young That's right. That's a good one.

Collins The only trouble was when I had the 16 mm camera hooked up, then I couldn't do that.

Young You had to use the flashlight.

Collins So I used the flashlight to check the Encoder. Now the Encoder could use a little light of its own down there.

Young Man, you sure gave it a good work out. the outside lighting: What do you mean outside lights?

FCSD REP The docking light.

Young Okay, if we hadn't had the Docking Light we wouldn't have gotten no...

Collins Would you like to evaluate the sun as an outside light sir?

Young We had the docking light and it was the only thing that got us through the night pass so we could do the EVA. We'd have never made it without it.

Collins Fingertip lights are a good idea, I think.

Young Think so. I used the gloves sometimes when they were off at night when we were asleep to read the digital clock and

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Young to read other gages in there like cabin pressure gages and

Collins I used the fingertip lights to light up the Encoder when I had this 16 mm camera operating.

Young How about on S-13. Did you use it outside?

Collins No, I didn't need to use the lights outside. Wait a minute. On S-13, I did use the lights for the first few exposures and then I found out it wasn't really necessary and I thought I might cobble the guy's film up, so I turned them off. I did the rest of S-13 in the dark.

Young Flight plan, rendezvous experiments and systems books preparation: they were prepared. Available management and usefulness: Well, we changed the whole flight plan two days before the flight, the center part of it in regards to Agena operations. So, a lot of mine was rewritten. The reason I was using the flight plan to help us with this Agena configuration control problem that we had, was to try to make sure we had it in the right configuration and to try to make sure that we were doing with it what we wanted to do, but we finally got so far off nominal that it just didn't work anymore.

Collins Well, in general, how did you think our scheme with these four books and all worked out?

Young I think that was great, don't you?

Collins Yes, the only mild criticism of it is that with only one

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Collins plan I'm sort of in the dark. I don't quite know where we are or what we're doing next and all that. That's why I put this summary flight plan on the back of my rendezvous book.

Young Yes, well you were a lot better off in that regard than I was, because my flight plan the last two days was worthless.

Collins If I had it to do over again, I'd do everything the same except I'd add a bunch of blank pages, just plain old blank pages, to copy down ground updates.

Young Yes, I can't understand why we didn't have any pages for these flight plan updates. I should have known the mission wouldn't be nominal after the first day, anyway.

Collins The second thing I'd do is I'd carry some sort of an abbreviated flight plan on the back end of the rendezvous book. A little more detailed than the one I did carry.

Young That should have been obvious to us. I asked John Rivers where is our flight plan update log and he said, " Oh, you use experiment logs for that". But I don't think we want to do that. I think you want special log pages.

Collins All you need is blank pages.

Young That's right.

Collins I think all these fancy logging sheets are probably more a waste of time than anything else. All you need is a piece of paper to write it down on.

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Young

I'd like for them to get uniform on the ground on how they pass the flight plan updates up to you. Everybody does it differently. Sometimes they give you the time you're supposed to do it at the front of it and sometimes at the end of it and sometimes in the middle of it. Sometimes they go at it like, "Well, today you're going to do this and so and maybe get a little more." We need to get a format type thing and have it read off to you in that format. I think it would be a lot less subject to the errors that we have made when we have to ask them when the Comm faded out and they said, "Well, where did you leave off at". You never knew what they were trying to tell you next. These things should have been available earlier. We made the mistake of changing that flight plan too late in the game. I should have thought of that two or three weeks before. When it started to be obvious that we might end up at that high altitude, we should have thought of that. In fact, I should not have thought of it somebody else should have. The onboard data management was okay, but I think next time we ought to carry more clips to pin the pages open. I didn't carry enough clips. I didn't have but that one that I bumped from you and I kept losing my place.

Collins

Yes, just big old paper clips. I found those useful too. I also believe in color coding those charts.

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Young There was no way in the world we could have done that flight plan without those cards, those EVA checklists, and the flight plan; we couldn't have controlled the Agena configuration. Well, I guess we could have written it down somewhere and done it but it would have sure been more subject to error than it was. I don't see how you can do without a document like that. I don't know where they are going to put this stuff they have to carry to go to the moon with though because there is sure going to be a lot more..

Collins Maps and overlays: we did use that orbital path display. We used it for about one fraction of one rev and it's a nice tool. It's a good little thing. Our only problem was that we were too busy just to play with it.

Collins Star charts: I never used.

Young The reason was, we were too busy..literally.

Collins Stowage, I thought our stowage map was very, very good. We went through enough stowage reviews and mockups and training exercises and goodness knows we had enough changes and by the time we finally launched we had that stowage down to a fine art. I thought that was one of the areas we were best trained on. When something came out of a box, boy, I knew exactly where it was supposed to go and what it was supposed to do.

Young We really didn't need a stowage list.

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Collins No.

Young There was nothing that we didn't know where it was.

Collins That's right. A place for everything and so forth.

Young Right, we pretty well had it sorted out. Belts, that infernal safety belt of yours is a good....

Collins Yes, the right seat safety belt, the right hand side of it, that strap got doubled back over on itself and that wedged.. the adjusting mechanism there and I couldn't tighten it down. So, my lap belt was completely loose during reentry. The harness: shoulder harness worked good. Life vests worked good.

Young I never removed my life vest for the vacuum operations or during flight. You removed yours. It didn't bother me to leave them on, but it was a help to you to get them off for EVA. We inflated our life vest after we got in the water and it worked. Both of them. Waste disposal: yes.

Collins Yes, we had one each waste disposal and it works all right.

Young I still don't think we ought to patent the bag just yet. Color coding was very colorful color coding.

Collins The only thing about color coding is if I had it to do over again I would color code the ends of that 50 foot umbilical. I'd take and make the ends of the gun line and nitrogen line, blue and I'd take the...

Young Oxygen line and make it green.

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Collins I'd do things like that. It would be simpler when they are all lying out in your lap and everything's white and all snarled and tangled with one another, if they were color coded.

Young Yes.

Collins And I thought of this several times during the training, but I figured, oh well, it's...

Young Put green tape around them or something like that.

Collins That's right, that would have been easy. If I had it to do over again, I'd sure do it.

Young Yes, we could have done that.

Collins It worked all right the way it was, but it would have saved time and been less confusing if they were color coded.

8.10 Spacecraft Exterior

Collins Hatch operation: the hatch worked beautifully. There is no point in belaboring the point. The forces, I guess, were 15 pounds against that actuator. To get the hatch down to a closed position and to get it into the last sawtooth I'd estimate 40 pounds.

Young I wouldn't even think it was that much. I thought it was pretty darn easy. I may have been, but I sure didn't notice it.

Collins Well, I had trouble with one arm by myself getting into the last sawtooth.

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Young You just don't have any mechanical advantage.

Collins I know it, it just required you to come over and give it one little tweak, and it went into the last sawtooth.

Young I could hold it down, I'd estimate, $3/8$ ths of an inch past the last sawtooth by just sort of leaning back on the hatch closing device. I was not pulling much arm on it.

Collins That's right, well I was pulling down for all I was worth. If they want numbers, I'd guess 15 pounds to move against the actuator, and then once the hatch was down to get it in the last sawtooth, I'd estimate 30 to 40 pounds.

Young Handrails and Velcro pads: We've already discussed the handrails.

Collins Our handrails-- in general, we just need more handrails or more handholds of some type on the outside of any vehicle we want to work with.

Young I think that's a good point. Handrails and foot--I don't know how you'd get your feet in it, I don't know how you would.

Collins I guess what you would have to do is tailor the restraint device to the particular job that you want to do.

Young That's right.

Collins In general you need lots of good handholds. The ones that I enjoyed most were the ones that were small diameter things that I could get right up into the palm of my glove. Ones

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Collins that I didn't have to grasp with my fingers, but I could get right in the palm of my hand, and there were things like ropes, wires, and things of that nature, I found over on the Agena.

Young You know what you really need to operate on another vehicle? You need to be tethered to it somehow or other. You need this thing like this fellow out at Lockheed has. It's a wire that comes out from you, and it's loose, and you can throw a little thing that takes a mechanical advantage, and it becomes rigid. You could put a snap in the end of it and slap it on something and rigidize this thing, and you'd be stabilized and ready to work on something. You wouldn't have to worry about floating away from it or going end over end or what. Window covers - you jettisoned yours right after SECO, and I got mine after we left the Agena before the dual. I had a clear window pretty much after that, but it sure was smoggy before I got rid of it. Sometimes at night, I could see very few stars.

Collins Well, my window was smudged. I jettisoned my window cover at Insertion Checklist, and gradually during the flight, I seemed to build up a kind of a little granular film on the outside of the outside pane. I think this came from the Agena. From the PPS burn.

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Young I do too.

Collins That's when I first noticed it was after the first PPS burn. It didn't seem to get much worse after that.

Young When that baby lights off, that stuff comes up front, and when it tails off, it comes up front. It's just going out in a vacuum and coming every which way.

Collins I only had one smudge mark on the outside of my outside pane. It looked like a mechanics fingers or something had smudged across it. But most of my problem was on the inner surface of the outer pane and there I had around the edge little whiteish circular blobs. It looked like somebody was growing a mold culture or something. Did you notice those? All around the edge....

Young Yes, I noticed that.

Collins And out in the center of the inner part of the outside pane was generally just a streaked film. It seemed to increase as the mission went on.

Young Yes, it sure did.

Collins And I'm not sure how bad all this was. I'll have to look at the pictures and see just how bad it was. But, I could see fairly well out through the window.

Velcro pads, we did not carry.

Young The glare shield - We forgot to jettison it during the stand up EVA. We didn't get a chance to put it on, and we

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Young jettisoned it during the Cabin Depress. But, I really think that for looking out the window, to shield your eyes from that sun for tracking tasks, a glare shield or something that will not degrade your ability to see, that will get rid of some of that sunlight, is a good idea. Something like these sun glasses that adapt to how much light is coming in. If they can do that in a hurry, that's the kind of thing we ought to have, and we ought to wear them all the time. Because, boy, when you're looking out of that window and trying to track something, it's really rough when that sun is in that window. That dual rendezvous tracking task was the toughest thing I ever did. Trying to keep my eyeballs on that thing. I was seeing two targets there about half the time.

Collins That's because our eyes were hurt.

Young The docking bar - that's a nice docking bar. What do they want us to say about it? Sure left in a hurry didn't it?

Collins Yes, it worked normally, it worked...

Young Did you get a picture of it leaving?

Collins No.

Young You said you were going to take a picture.

Collins I know it, but I didn't. I was busy there. It goes at a retro pack jettison, and it did. The Pyro fired, and it really left.

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Young Yes, you can see that.

Collins It came out when I hit the Index Bar Extend, and it came out fairly slowly.

Young EV camera mount.

Collins We didn't use the EV camera.

Young It's in the left hand aft food box.

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9.0 VISUAL SIGHTINGS

9.1 Countdown

Young Countdown. Did you see anything during the countdown?

Collins I saw wasps.

Young That is right. There were wasps around the R and R can.

Collins They thought they had found a happy home.

Young They sure were wrong about that.

9.2 Powered Flight

Powered flight - liftoff. I saw it but don't ask me how. BECO, we saw it. BECO and staging are both the same thing, near as I can tell, and Engine 2 ignition. There was a little debris associated with that, but it was a flash of yellow fire mainly and went up and out of the way. Horizon view, unbelievable. What can you say about it? It is a good thing that horizon doesn't come into view in that left-hand window. We would be in trouble because the guy never would monitor his fuel pressures like he is supposed to. Fairing jettison - Eventually it got jettisoned, and boy that stuff really comes off the spacecraft when that thing goes.

FCSD Did you see anything flying off the spacecraft?

Young Like that line that came around and clonked up when we did that DIRECT turn around? Yes, I thought that was pretty interesting. It was obvious what it was. It was that plastic jobber that goes around the MDF ring, you know it is that

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station back there where it makes these two cuts around the spacecraft. It was a big long plastic seal.

9.3 Orbital Flight

Man-made objects in flight. Right after we went into orbit we looked up at the sunset and there were two of them right ahead of us. The first time.

Collins That is right.

Young And it looked like we were in plane with them.

Collins That is right - they looked like they were ahead of us and higher than we were and in plane with us, and they looked like they were going the same way.

Young The same way.

Collins They were about 4 or 5 degrees apart, would you say?

Young You separate an adapter at 215 by 158, it is going to be up there awhile maybe. Maybe that is what we saw.

Collins They were really bright. They were brighter than Sirius by two or three times, I would say.

Young Yes. You saw a satellite.

Collins I saw a satellite in polar orbit traveling north and south cutting through the star field. At various times I saw just objects which I think were maybe little flecks from the spacecraft, you know, out a couple of hundred yards or something. They were small and you couldn't distinguish between those and the larger objects at a greater distance.

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Young The Agena acquisition lights flash rate and intensity We saw those right after the sun went down. We saw the thing shine at 58 miles and from there on in until the sun went down. We saw the ACQ lights. It looked like a very faint star out there blinking. We saw the ACQ lights all the way in and I really wasn't watching them as close as I should have been. The running light, you could see those very easily. The exterior condition of both Agenas was pretty good. I admit the VIII Agena looked like it was a little worse for wear. It looked sort of old to me.

Collins It didn't look as shiny somehow.

Young Didn't look as shiny. Yes. The Agena ACS- very nice.

Collins Yes, we could see the ACS fire.

Young With certain lighting conditions, we could see a sort of blue plume-type thing. Do you remember seeing it?

Collins No, I saw the 16 pounders-

Young -Yes, we saw the 16 pounders and the 100 pounders fire and, of course, the PPS fire, but under certain conditions of sunset you could see a blue plume from the ACS. I saw this three or four times. But, you wouldn't see it in the middle of the day. It was just at sunrise and sunset with a certain way the sun was shining. Sunlight reflection - boy, there was a lot of that. When that sun came in that window, after I lost the little RTV 90 sun shield on that optical site, and

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reflected off that thing and into your face, it gave me a sun bath. I mean it would burn you. Agena observations after undocking: - There's the Agena up there at 95 miles, "good gosh, it is big".

Collins Yes, we mistook the Gemini I Agena at 3 miles for the Gemini VIII Agena at 95 miles.

Young I don't know how you could make that mistake. But we did it. I saw the Agena VIII when I was still SEF and alining the platform. My guess is that the angle on it was 18 or 19 degrees above level, and the sun had not come up yet. It was just above the nose of the spacecraft, and I could see it. Just as soon as the sun got up above the nose of the spacecraft it just disappeared like that. So, then I flipped over, and I could see it intermittently when I could get the earthshine out of my eyes enough. I could see it intermittently for about 4 or 5 minutes, and then I saw it full time.

Collins That earthshine was pretty bright.

Young I started seeing it full time right at 17 minutes and that of course is getting along to a pretty high angle, 24 degrees. Boy, between the time that I lost it the first time and re-acquired it, I was breathing blood. I didn't think we were going to get there, and when I first saw it, I wasn't sure that it was either. I thought, boy, that must be a speck on the windshield, or a dot on the windshield. But that was it, thank

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goodness. Running lights - I didn't see any running lights on the VIII Agena and running lights on the X Agena. I saw the EV astronaut. What can I say about that?

FGSD REP Anything unusual there?

Young It was a very unusual sight. I just wish I had gotten some pictures of it. I don't know what else you can say. Mike was out there boy. Geographical - Some of the views we had of China, Formosa, and some of the times when we were in that drifting flight over the Pacific the views were incredible. Celestial views - We saw the Magellanic clouds, the southern constellations, and the northern constellations although as the flight wore on and the optical properties of those windows went down we weren't seeing as much as we did when we started. Stars during the rendezvous phase: yes, there was some. If there had not been stars, I still would not be there.

FGSDREP Could you see stars during the daylight hours?

Young I don't have any idea what those times were.

Collins We saw stars right as the sun was first coming up. We could see bright stars. Matter of fact, that would be a good time to take star-to-horizon measurements.

Young I think it would be the only time to really get some good ones, but you would have to grab a lot in a hurry.

Collins I am not sure that would work either. I am not sure it is possible to do that because on Gemini VII they tried to take

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star-to-moon limb angles, and they found that the moon limb washed the star out. You couldn't see the star because the moon was too bright. The same thing might be true here. You might crank that star down and just have it disappear when it got near the horizon because the horizon is just too bright compared to the star.

Young Cloud coverage - There were a lot of clouds in some places and more in other places. It was typical July weather. There sure were a lot of clouds in the Atlantic or in the Pacific in places, especially over that equatorial cloud belt. Horizon- Why don't you talk about the way the horizon looked in the daytime? Remember when we were talking about how scalloped it looked at night? It looked scalloped in the daytime in places too. Remember me saying that I thought the star horizon measurements would be tough in the daytime too because of scallops.

Collins That is right. If the area that you are looking at is overcast, then the line is fairly clearly delineated, but is not exactly even; it is scalloped out if you have thunderstorms. The horizon line is uneven, and if you are looking at an area where there are no clouds, then the natural horizon is poorly defined. So, the more clouds the better the definition, but the less precise the altitude of the horizon is apt to be because of the clouds.

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- Young Thruster firings - I could see sometime when we fired the aft firing thrusters. I could see aft firing thrusters light at night when we fired them. I saw them on Gemini III and I saw them on this one too.
- Collins Yes, I remember that too.
- Young Translation - Thrusters-- yes, the braking thrusters. You could see the RCS thrusters real plain. But I don't think any of that is unusual. Could you see a plume coming out of those things when I fired them when you were outside?
- Collins When you fired that one when I was outside right by my hand, I could just barely, barely notice that something was coming out of there.
- Young Is that right? You could see it, though.
- Collins Yes, just barely. I couldn't feel anything. I couldn't say I heard it; I was just aware of the fact that it fired. I guess it was a slight vibration, more than a hearing. I guess it was just a vibration, yes. I was probably feeling it through my arm, is what I was doing.
- Young You were holding on to something.
- Collins I was holding on the spacecraft right next to me.
- Young Retrofire and reentry - We didn't see the adapter, did we?
- 9.4 Retrofire and Reentry
- Collins No.
- Young There was a lot of debris where we jettisoned the scanners and

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and the docking bar. They both took off. Retrofire was nominal in all respects. We could see the retrorockets firing. Retro pack jettison was nominal. Spacecraft oscillations - We saw plenty of those. Ionization - Mike saw that.

Collins Yes, took some pictures.

Young The horizon - Saw that. It was great. Hey, that coming down was something. Drogue deploy - We saw it. R and R SEP - We saw it. Main chute deploy - We saw that too. Single point release - We saw it.

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10.0 EXPERIMENTS

10.1 Star Occultation Measurements (D-5)

Collins Star occultation measurements, experiment D-5. Equipment set up and use: it's okay except those aux receptacles are still hard to hook up to with cords. I didn't have to use John's pliers but I had a difficult time getting them hooked up. Star acquisition was easy on the stars that we used.

Young Yes, it was a piece of cake. Just like in the simulator. Even easier, I think.

Collins And it was easy through the photometer. We did that experiment twice and the first time we did it was on the second day when we were hooked to the Agena. The airglow completely blotted out the star. What would happen is the star would go down into the airglow, and as it got to about the center of the airglow layer, I was no longer able to see the star. So I took the photometer away from my eye and looked out with my naked eye for the star just in time to see it emerging from the bottom of the airglow. I'd then put the photometer back up to my eye and continue tracking until it was obscured by the real horizon. On the third day, that was no longer true. I could track the star completely through the airglow and it was not until it went behind the real horizon that I lost sight of it. So I don't know whether this has something to do with the difference in moon or what. I can't explain it but that's what

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happened.

10.2 Ion Sensors for Navigation (D-10)

Collins Ion sensors for navigation, D-10: John, why don't you talk about that? That's your favorite.

Young Okay. Well, you talked about the extension of the sensors. They extended just like they were supposed to. You went to high scale on the FDI's. (When we first put them out, I was trying to aline the platform since we had been in drifting flight the whole night in mode A.) We started doing D-10 and I rolled over and was alining SEF at night on some night star in the orbital path. When we came into daytime I lost the star. Instead of pitching over and picking up yaw off the ground, this thing looked like it was working right, and since we had plenty of time, I used it to determine yaw. I had compared it with some yaw stars at night and the thing was on in yaw. There was no doubt about it. So I used it to pick up yaw with Mike's ball by flying Mike's needle to center in yaw and pitch. I went to cage and SEF on the platform right away. And the thing moved off to the right in yaw as if we had some kind of roll error in there and the SEF mode went out and then we came back in and it centered. So, it looked to me like when we were perfectly alined the pitch needles and the yaw needles were both centered. After we'd been in ORBIT RATE for awhile on the platform you could see that the platform was off, but

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these yaw and pitch needles on D-10, in my opinion, were right on the whole time. And I bet that's what the data is going to show. If they were off, they weren't off very far. It's all on the tape how we did the experiments. I think it showed an instantaneous capability to pick up pitch and yaw and after waiting out those sensors so that they'd be out of the line of thruster firing. Every time we fired the thrusters those sensors jumped all over the cockpit. They sure gave us good indications of yaw and pitch. I thought that was something.

Collins That's right. And the recovery time from the thruster firing was extremely rapid so I think the scheme is useable even though these sensors are in the path of the thrusters.

Young I do too, but we didn't fire the lateral or the vertical thrusters so we don't know if that would have clobbered them or not so we couldn't use them. But I think you could mount them so they'd be well out of the way. You could mount them up on the nose like the horizon scanners or someplace in that area and jettison them before reentry.

Collins They didn't work BEF. They just worked SEF.

Young In fact, you could even mount them with reversible heads so that they could be used BEF or SEF to pick up something.

Collins Or a double headed thing or a selector switch or something like that.

Young BEF, SEF, sure.

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Collins Generally, it was a darn good experiment, and I thought it was worthwhile.

Young I thought it was outstanding because I could see immediate application of it.

Collins We took some high speed black and white pictures of the right-hand eight ball during these maneuvers and if they come out they should give a better idea than our voices here on how the needles behaved.

Young During the star occultation measurements (D-5) they sent us up this method of controlling the Agena to pick up these stars, and it almost ran us out of gas, using the yaw rate on, yaw rate off. We almost ran ourselves out of gas, out of attitude gas. So, I don't think that's a good method of doing it. In fact, I recommend gyro compassing for all modes of Agena operation. There's no sense doing anything else. Just takes too much gas to do the other one.

10.3 Tri Axis Flux Gate Magnetometer (MSC-3)

Young The tri axis flux gate magnetometer: we turned the switch on and forgot it, right?

Collins Yes.

10.4 Ultraviolet Reflection of the Lunar Surface (MSC-5)

Young The ultraviolet reflection of the lunar surface: we couldn't do because of the lack of the moon.

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10.5 Gemini Beta Spectrometer (MSC-6)

Young The Gemini beta spectrometer MSC-6:

Collins We turned it on on the insertion checklist. That's all.

10.6 Gemini Bremsstrahlung Spectrometer (MSC-7)

Young The Bremsstrahlung spectrometer worked magnificently.

10.7 Color Patch Photography (MSC-8)

The color patch photography MSC-8: that's your favorite experiment.

Collins Okay, color patch photography. I guess the equipment is all right. John put the equipment together. I extended the rod once I was out EVA standing up in the hatch. I took two or three pictures. I don't recall which. I believe it was two exposures at F/8, 1/250th and 36 inches which is what I was supposed to do first. I then was going to switch over to F/16 and that, of course, is when we had the eye irritation problem and got cancelled. This is also the time when I jet-tisoned both the plate and the rod. I frankly have never felt it was really necessary to bring that plate back and due to the circumstances which prevailed at the time, it made little sense to me to try to retrieve that plate. So I just flung it overboard so I had one less thing to worry about during the ingress. That's all I can say about MSC-8.

10.8 Zodiacal Light

Zodiacal light, S-1: we boot-legged that one. I'd say we got

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about 80 percent of it.

Young Well, I hope so. I didn't really stabilize as much as I should have on some of the stars but I think we did a good enough job. I couldn't seem to get it any better. The main motion I had was in pitch. Yaw and roll were okay but I couldn't seem to get pitch to stop. I couldn't catch the pulse just right to stop it.

Collins Well, looking out the right window, everything looked good except that we didn't get started right at sundown because we were supposed to be doing D-10. As a matter of fact, we were doing D-10 until shortly after sunset when we got started on S-1, so that the zodiacal light pictures, I'm sure, will not come out. All we'll get is a picture of the western airglow but the sun was too far down below the horizon to have any zodiacal light. Other than that, we should have gotten good pictures. We followed the western sky around to the Milky Way. We pitched up through the Milky Way, up through the zenith, down to the northeast horizon. Got pictures of the northeast and east horizon up to and including sunrise. So we should have gotten about 80 percent of what he wanted. I hope so.

10.9 Synoptic Terrain Photography (S-5) and Synoptic Weather
Photography (S-6)

Young Synoptic terrain photography and synoptic weather photography: unusual or significant subject matter. We took some pictures

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over Corpus and some over Arabia. (Dad gummit, we ran out of film.) We took some over South America and I don't remember what we were taking them of, but every time we had a chance we took some. We took some pictures over Formosa and China. We didn't get a chance to take any over the Philippines, or the areas that they wanted us to photograph. I think those S-6 pictures showing weather development - the first picture south of Formosa and the next picture from the north of Formosa - is what the S-6 people were looking for. They were looking for two passes over the same land mass and that showed the weather development over that particular island within 90 minutes and this is the kind of stuff they're looking for. We got a lot of pictures of clouds from 400 miles which ought to show a lot of cloud development and, of course, we could do none of that looking down. Remember any significant pictures you took? Remember those pictures we took over Corpus?

Collins Yes, the best ones that I thought were the ones we took over the China coast.

Young Yes, that was a lot of fun.

Collins And I'm not sure exactly where we crossed the coastline but we should have some darn good pictures. I think it was the Yangtze River.....

Young Quemoy, and Matsu and the Pescadores and the whole of the Chinese coast there. It was very pretty.

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10.10 Micrometeorite Crater Collection (S-10)

Young Micrometeorite Crater Collection (S-10). You got it.

Collins Yes, we got the old S-10. The new S-10 I threw away because we ran out of fuel and I couldn't go back to the Agena and I didn't figure there was any point saving it so I flung it.

10.11 Particle Collection Device (S-12)

Young Particle Collection Device (S-12): We lost it. That indicates to me that we need some way to restrain items that we're bringing back EVA. You can't do but one thing at a time. I couldn't do anything but fly that machine and I don't remember it sneaking out. There was no place I could stow it or jam it, or lock it to keep it from going someplace so I lost it. We need a snap of some sort on these things so we can just snap them on with a quick snap motion, say, on to the overhead circuit breaker guards and leave them. Don't you think?

Collins Yes.

Young I hated to lose it, but I think it's inevitable unless we take the proper steps to assure we don't lose it. And the same is true of everything else when you go EVA. We've got to strap everything down. If you don't want to lose it, you've got to strap it down or stow it.

FCSD REP Did you have any trouble getting it out of the mounting bracket?

Collins The S-12? No, it came out easy. The nose cover jettisoned

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as advertised...

Young You had a lot of trouble getting down in the seat to hand it to me.

Collins Yes, I did.

10.12 UV Astronomical Camera (S-13)

UV Astronomical Camera (S-13). I hope we got good data on that. Of course, we had ORB rate, swinging us through that star field. We couldn't help this because we were tied to the Agena but we got about 25 exposures or so and I hope some of them are valuable. The last ones we got were of his favorite field - Gamma Velorum - shortly before sunrise.

Young It's easy to identify.

Collins Right. The great majority of them were taken of Centaurus.

10.13 Gemini Ion Wake Measurements (S-26)

Young Gemini Ion Wake Measurements (S-26): Well, we only got one bit of data on that and that's when we departed. We turned the Agena TDA south there for a rev, when we woke up the second day to pick up the ambient data, and we took pictures of it backing off. And when we backed out I think all that data will show up, right?

Collins Yes.

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11.0 PREMISSION PLANNING

11.1 Mission Plan Trajectories

Young Mission Plan Trajectories: Well, I would have made that change sooner to get us back down so we would have had a flight plan that was a little bit more like the actual trajectories. Don't you think? I didn't have any way to control the Agena configuration. Knowing what I know now about it, I wouldn't change a thing.

Collins I wouldn't change a thing. I think we were just victims of Orbital mechanics and it all depended on when we got off, our launch time and date, and all the timing and everything else was a function of apogee and perigee and the whole mission plan had to build on that skeleton and that was variable and there wasn't any way we could prevent its varying.

11.2 Flight Plan

Young I think we had a beautiful flight plan. I think we spent a lot of time on the flight in the mission planning, in flight planning meetings, to ensure that that thing went pretty much the way we wanted it to. We had some things in there which I would have rather not have done, but that's the way the ball bounces...-

Collins I thought we had a darn good flight plan. I thought we had the best flight plan that's come along so far in the Gemini..

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Young I thought we had a darn good balance. I think we had a flight plan which was a compromise between the things that everybody wanted to do and the things that we could do and I think it came out darn well, myself.

11.3 Spacecraft Changes

Young Spacecraft Changes: I'd put some more snaps and straps and clips and things like that to hold on to everything with, but I don't think I would make any major changes. I don't see anything wrong with the spacecraft.

Collins What are you talking about here, changes that were made to our spacecraft before the flight?

FCSD REP Changes that you would make now after the flight.

Collins Oh, well, I would put a timer in there. I really would. I'd get a regular-old-countdown-one-hour-fairly-accurate-stove-timer with a bell on it and put that in where the Accutron is.

11.4 Mission Rules

Young Mission Rules: I wouldn't change any mission rule, they were darned good. As long as the people on the ground were flexible enough to break them every once in a while, we're okay.

11.5 Experiments

Collins Experiments: Doing MSC-8 prevented us from getting some nice pictures...

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11.6 Training Activities

Young The kind of things I'd like to see done differently for training activities, is to be more realistic. But I don't know how you can get it more realistic without spending a lot of money. If you're going to be practicing tracking targets where sunlight coming in the windows is a problem, you ought to shine sunlight in the window. Let the guys see what kind of a problem it is. I'd rather play the scrimmage worse than the ball game. I'd like to train accordingly. We spent a lot of time in our pressure suits doing just that and I think it paid off because our timelines involved a lot of work in the pressure suit in a hurry and we didn't have any trouble with EVA preps and stuff like that. And that's because we were more miserable doing it in the simulator than we ever were in flight.

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12.0 Mission Control

12.1 GO/NO GO's

Young GO/NO GO's: I don't know why they insist on doing that. I don't see why they don't assume you are GO unless you are NO/GO and then tell you, you are NO/GO. I mean it's just a formality. Why do we even bother with it when there is no doubt in your mind that you are going to go or you are not going to go. Nobody has to tell me I am GO for the next day. If that spacecraft is working all right, they won't get me down anyway.

12.2 PLA and CLA Updates

Young PLA and CLA Updates: Those were nice and we didn't have enough room in our flight plan book to copy them all. We had a page of them, but it wasn't enough. I wish they would read those a little more slowly. I was always in a hurry writing them down.

12.3 Consumables

Young The consumables worked just like that they were supposed to.

Collins We had plenty of oxygen, plenty of hydrogen and plenty of electrical power.

Young We had plenty of OAMS, it turns out. I don't know how much more OAMS we needed, but had we known that, we possibly could have separated from the Agena earlier, but I'd hate to have done it....

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12.4 Flight Plan Changes

Young Flight Plan Changes. The flight plan update: I knew that once we got past the first day, no matter what kind of mission we had it wouldn't have been nominal. I don't know why I didn't carry a lot of paper in my Flight Plan to write on. I had a lot of trouble finding out where the updates were coming from next. I think we ought to put those things in some format and have them read off the same way everytime. None of these missions are going to be nominal. You might as well get down to that right at the outset. This is in regard to the trajectories. If it is going to change your whole timeline—we should take a look at that.

12.5 Experiments Real-time Updates

Young Experiments Real-time Updates: I thought they were real good when we did them. Did you see anything wrong with this? Did any of that stuff in there get you?

Collins No.

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13.0 TRAINING

13.1 Gemini Mission Simulator

Young I thought it was a good thing for procedures training. Every little nitch for the Gemini -- but talking about the Gemini/Agena operations, they can't do that. We can't hack that one, if you had a hard over -- we'd give you that one. There is no way to practice status panel failures and I know that sure is necessary. Launch and orbit-- that is good. Orbit determination, predict navigation -- we never went through any of that without bombing out. Never once in the Mission Simulator did we run through one of those things without bombing out a computer. We never really had a real good time line on how long it was going to take us to do that. We were never able to run it, and we never were able to run a Sim-Net-Sim where we ran through to an M=4 without a computer being bombed out either here or in Houston. Off the line, five or six times, very frustrating. I don't think, in view of what I know now, that it was necessary to do it, but I would like to have it done. Did you think it was necessary?

Collins No, but it would have been nice.

Young We should have a set policy if....

Collins I'm still not sure if that math flow is correct.

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Young I'm not either.

Collins I don't think we have ever seen a demonstration that math flow is working properly.

Young Yes, I don't know, but they won't probably know until they analyze the data. Predict navigation. It seemed to work properly. Rendezvous -- Well the nominal rendezvous is all we ever did in the GMS, and I think that was a mistake. We should have looked at some of these off nominal cases, but we just didn't have time. That's right, we looked at the failure modes and we should have looked at off nominal rendezvous trajectory. Gosh knows we did enough of it. EVA -- We did two EVA preparations down here at the Gemini Mission Simulator, and I thought they were real good and pretty representative of what you did in flight. I think the trouble is to station keep on that rascal while you were getting your suit on.

Collins The trouble with the EVA prep, and we knew this before the flight, is that we are working with inferior equipment, and we are working under one g. The training equipment is never like the flight equipment, particularly the chest-pack. I think what we really should have bought from the beginning was training chest-pack in which we have all the lights, controls and displays and

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Collins

what not of the real chest-pack to include all the switches and including the evaporator and everything else. I realize the evaporator couldn't work at sea level, so you would have to put dry ice inside it just like they do. Instead of having a dry ice pack, just a shell with no controls or displays or signals or alarms or anything, you ought to have a fancy training pack which would do everything the real one does, except that it would use dry ice instead of a water boiler. This would have added a lot of realism to the training. For example, this would have shown up the fact that this 70-millimeter Hasselblad bracket which fit down into that keyhole slot was not a good idea. This didn't become apparent until 2 days before the flight when finally we were able to mate the flight bracket with the flight chest-pack. Then it was too late. What I should have done is tape that thing down.

Young

Retrofire -- I think the procedure was good and the reentry procedures was good. I never flew that case before. We haven't been flying trajectories where we come out at 250-158. Maybe they ought to look at that. It is a different feeling of course first couple of times. Let me say this about Rendezvous. I don't

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think the displays for braking and target alinement and target tracking is what it should be. I think that if you are going to have a display for that it should be a blinking star. I don't know how you can blink one of those stars, but they have little stars in there that look like stars. They should be able to make one of them blink, to give you the proper out-the-window display of the target. When you are operating in the daytime and looking at a point source, they should be able to put one up there for you to look at, because that is all you are going to see. It is a tracking task and they might as well get realistic about it. There was no way in the world that Mike and I had any confidence on the braking phase. We were on it and we couldn't tell how far we were to that target. We just sort of had to let it run in there until it was real obvious. It would get bigger and bigger and then take off some. That is a rather expensive way to brake. It means you are going to wait for the other guy to come back for you. That costs you some gas. All the same it's true, there is just no way that you can optically get a good picture of the braking phase without having a 3-D type. I think that looking at it through a visual display was

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okay. I was worried about not being able to see around the edges, you know, not being able to see as wide but I don't think that is necessary. I thought that would be a real handy backup technique because the only cues the pilot has is the ones he sees with his eyes. I thought it would be helpful if we are able to see a lot more. If you could move your head up close to the window simulator and see stars out to the side or see down at the ground or see the horizon over head, so we could practice these failure modes like using the sextant. We really didn't need to do that on our flight but that is a good idea to train the senses of the crew that are going to be used on the flight, if you can. I don't know how you would go about doing that, but I sure believe in it. The crew station was very realistic. Some people don't like simulators, but I think they areI can say this about the GMS. We got a lot of time in this simulator, but there is a lot of time in there where we are just lying on our back and waiting for them to load the computer or reset a computer or re-do something. Not all of it was worthwhile, but I think for the most part it is pretty good. I guess about 60 percent of it is good, but the other 40 was just

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like I say, just time. We spent a lot of time in there checking things out that wouldn't work. For example, let me just talk about the Gemini X Mission which is a pretty good one. It was a week after we got down here before the 10-2 program was checked out from Houston. Now this is because of the slip in Gemini IX. We really lost a week in the simulator, which we really didn't need anyway, but I think we should have had it in case we needed to make any change in our flight plan. We never did look at a nominal dual rendezvous case, not once. We didn't have the trajectories. The orbits people had a rendezvous for the 10-2 program that had a mile and a half or a quarter of ellipticity in it. So our cards that we were using for a time line to arrival time for a braking phase never would work. We would have to see that thing change from a blinking light to a target. It is a darn good cue as to when you are a mile away from it, but it is not a real world cue by any manner of means before you could start braking. What you would like to do is if you are in any kind of a nominal situation, you would like to go by these times. I don't think in a real world except the data that Mike got back from using the sextant that we could very

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well tell how far we were. I think you want to play it conservative, and we played it conservative. We went in there hot and I don't see how you could do it any other way. That data should have been nominal and all checked out, a month, 2 months before we ever got to the Cape. I don't see any reason why it couldn't have been. We had a lot of off nominal points and we never looked at any of them. We had a lot of off nominal settings and we never looked at any. Originally they proposed that we do the engineering evaluation of Nav Orbit Predict in Houston in the GMS. They talked seriously of that and we could never in this world have done that. Do you remember that? I am talking about all these reset points and doing our engineering evaluation. Now our real problem we had, with Orbit Determine and Predict Navigation, and I don't think we ought to forget it, is that they were doing the engineering evaluation, astronaut training, and accuracy evaluation up at McDonnell at the same time that we were doing that. That is too late. They didn't get Orbit Determination and Predict Navigation checked out until a week and a half after we were down at the Cape, which was kind of late. Yes, we got changes right up until a couple of days before flight.

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We changed our trajectory orbit once to see if that would help us any and that didn't change anything. We didn't really have a good handle on what kind of operations that we wanted to do with a docked Agena until the last two or three days. We had a logic choice that was wrong in the math flow -- that address 55 9999. We didn't find that out until about three days before flight. We had eneptial needles that never worked properly until we had done enough of them to know that they were different and that was about a week before flight before we found out that they didn't work in the simulator. That is one reason why it is little confidence that they work in the spacecraft. Everybody told me that the math flow was different. But to find out that those basic type things that we have been using to train with that late in the flight is poor. We did the same thing on Gemini III. We flew the first valid reentry less than a week before the flight. The first one that was trajectory valid. Of course, I'm not saying that all that other training that we did wasn't good in flying reentries and everything, but I think that is just pushing it a little. You are going to get in trouble doing that some day. If we ever go up there

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and run into a real late math flow program and don't have those things ironed out ahead of time, we're liable to get in trouble. If we ever run into a situation where we could have trained for it on the ground with the simulator, and not have done it would be a bad thing, I think. I guess that is all I have. I am all for valid simulations. I'm sure that GMS reentry is not like the one that we had in flight. The dynamics of it is not the same, the needle performance is not the same. I don't know what the difference is, but that needle didn't move once we got the needle centered. It didn't move off the peg the way it does in the simulator. It didn't move at all and it didn't move cross range the way it does in the simulator either. Sometimes it gets up and walks across that simulator and there is no reason for that that I can see, but it does. Anyway the things that the guy has to do, at least control wise, were things like braking and some formation flying and stuff I think that they ought to be a little more realistic. We ought to get a little better handle on how much gas it is going to take to do them. We actually need to know this for mission planning purposes. You have a lot of training time in Houston, but most of it was

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Young involved in checking out the dual rendezvous for the guys and that wasn't the right program. It was checking out the procedures and then we went to a different procedure entirely. We never got Orbit Predict to check out in Houston. They told us that it was going to be working a month before they said that it would be. One thing that I know in both simulators, is as a fact is that everytime the crew says there is something wrong, even it may go in log somewhere, and somebody may work on it, but nobody ever tells you what they found wrong with it or if it was fixed or not. That should be a more formal procedure, I think, or we never would get some of these problems fixed.

Collins I think what they ought to have is a form for the simulator like you have for an airplane and when you get through with the simulator, you write up the following discrepancies 1, 2, 3, and 4. They come along and with that, or when they occur, you tell them what happened.

Young Yes, but I think not only should you tell him, but he can write them down and....I think too when it occurs. It is not as formal as it ought to be.

Collins That is what I think too. You should sign it off like you sign off an airplane. Number one okay or something.

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Young They ought to get up something that when a guy gets out of the simulator he should sign a form that these are the discrepancies.

Collins Yes, they ought to keep a status book so when you come up to fly the simulator, there should be a book with -- I don't care if you have red diagonals and all that, but there should have a status. In other words they should had you a book and that book should say all right the following open items still remain -- the g meters are inoperative, the etc.

Young Do you remember how long before we could load any modules in Houston? It was three months before we could and they kept saying it is magic. I don't buy that. The simulator is the most valuable piece of gear that we've got and for something to go wrong with it in the DDP or something to quit or one of the DDP's to quit and then everybody say we will just reload it and go on from here. Man that doesn't show me a thing. There ought to be something wrong with it and they ought to fix it, because we wasted entirely too much time getting right in the middle of the rendezvous and then have the thing freeze up and having to start it over again. While that is good training for a while, we could be better trained if we'd completed some of these things, I think.

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13.2 Launch Abort Training

Young I'm not convinced that some of the rules for abort training would do any real good, so I don't think there is any point in going into it here. I think the probability of getting out of the Gemini Launch Vehicle is pretty low if that quits on you right close to the ground. I've always thought that. It is just like a cold cat shot, you don't have much of a chance with that kind of a system.

13.3 MAC Engineering Simulators, Rendezvous and Reentry

Young I think the MAC Engineering Simulator is a good tool but I don't think the visual display is adequate for braking. We did no reentry simulations up at MAC. I think it is useful for training procedures and for looking at different trajectories rapidly because they can reload it and present you with different type of trajectories, and I think that it is pretty important to do a lot of training on there so you can get an iterative field for how these problems are going. I kind of wish that we had something like that in Houston. We ought to have our own where someone could sit outside and watch you while you are learning the procedure, or something, and look over shoulder and help you with it like they did at McDonnell. We shouldn't have to go to McDonnell for that. They should have a better out-the-window display; I thought that was kind of wasted practice with ORB determination, using those funny looking starfields. For a quick

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and dirty look at trajectories, it was pretty good and for a method of learning procedures, because a guy can look over your shoulder whereas in a GMS nobody can tell you; if you are doing something in there, they have no idea what you are doing. And since it is something like rendezvous or orbit determination or orbit predict, it is a two-handed job, and even if a guy in one seat knows what the other guy is doing, he can only help him half the time. In a real world situation, what I was going to was look over my shoulder and try to check all these corrections to an orbit determ and orbit predict. But, I was too busy flying the spacecraft. I didn't do any of that. So, he might have made some simple math mistakes that anyone can make and I couldn't have caught them because I was too busy. That water boiler yaw problem kept me stick and throttle the entire time, and probably I might have made some math mistakes because I couldn't stop to check my work the way we could in the simulator.

13.4 Translation and Docking Trainer

Young I thought that was pretty good. Once I really jumped on those guys, and they put the trainer down and got all the drift out of it, and then it was just about like the real thing. You can fly it just like that, get close to it without bumping it or hitting it or touching it, and I think that is probably pretty good training.

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Collins Yes, I think that is darn good training.

Young When I got up there flying the spacecraft, with respect to the other target, there was never any doubt in my mind which way was up, down, left, right, forwards or backwards. That motion was all reflex action just like when you fly formation on another airplane. You don't think about what you are doing, you just do it. This was the same way, except for firing that up thruster. I think that time really paid off. We probably didn't need that much, but I think it was good time.

13.5 Planetarium

Young I thought the first trip was very worthwhile, and I don't think we needed another trip. When we used the GMS for a planetarium, I think it worked real well.

Collins Yes, I think the planetarium was sort of a little fringe benefit. If you think you can squeeze in a couple of trips to the planetarium. I think it is nice to do that. One could really learn an awful lot about the stars in the planetarium. Hour for hour, the planetarium is a lot more valuable than GMS.

Young But one of the problems we had, for example, it's a simple problem, was the star ball alignment. Until the last couple of days, nobody could give us pointing commands where these stars are. I think it is pretty poor. In fact, we got McDonnell and FOSD and the GMS people down here together, and it was apparent that all the stars were in a different place. None of the three

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could agree with each other, where the stars were. I knew they must be somewhere, but I didn't know exactly who was right. I think the GMS was probably as accurate as anyone. We should have star point commands two months before the flight. They knew within 10 minutes when we were going to launch, and they don't change that much.

13.6 Systems Briefings

Young I think we got enough but the one thing that I didn't particularly appreciate on the systems briefings were the Agena systems briefings from Lockheed. When we ask them all these operational questions, nobody had any answers on them, and nobody thought about them. When they did give us answers, half of them were wrong. They said it would take us about 2000 lbs for Gyro Compass, and that type of information. Why the people who make the vehicle think that I don't know. I think we were benefited by the time we spent with Mel Brooks and that bunch to get that format straightened out. Especially, if I had known that we were going to use that thing so much.

Collins Yes, I thought we could have used more Agena training.

Young If you are going to live on the Agena for a day, you should know it a little better than we did.

Collins We lucked on that. You knew what you were doing, but I didn't. I was over there throwing switches. That was my contribution to the Agena program.

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Young Yes, but you've got to remember I've been studying the thing for 2 years.

Collins I felt inadequately trained on the Agena, and I guess I don't have anyone to blame but myself.

Young You had a lot of training to do. You had to learn fresh, rendezvous and orb nav and orb predict and all that stuff and keep up with it; I didn't.

13.7 Flight Experiments Training

Young I think it was very good. I was kind of disappointed that we got S-1 changed on us at the last minute, but we got it ironed out. It was a communications problem, that we got straightened out. Remember when we changed the pattern? We were a little concerned whether it was going to be pointed in the right direction after I tried it one time in the GMS. I shouldn't have to waste time in the GMS going through something like that. I think that's another point. I wasted a lot of time going through stuff and setting it up right to use. I think that it should be all written down in a format that somebody else has looked through and given to a guy and it says "Yes, sure this can be done".

Collins We wasted an awful lot of time explaining to experimenters how the spacecraft worked and why we couldn't do their experiments the way they wanted us to do it because the spacecraft systems were designed, and limitations would not, in any way, allow us to do

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anything remotely close to what they wanted. They should do their homework, those guys.

Young Either that, or somebody should tell them what the capabilities and limitations of the spacecraft are. Particularly when you get a tracking experiment like pointing control.

Collins I don't think that we should be spending our training time briefing the S-26 experimenter on how the OAMS system of the Gemini worked, for example.

Young We spent a lot of time on that; and we spent a lot of time on experiments briefings filling those guys in and in fact, sort of being morale boosters for them. Trying to tell them that they would get good data, trying to boost their morale. We spent a lot of time with them. We spent a lot of time trying to coordinate all that stuff into the flight plan, too, and of course every experimenter had exactly three times the load that we could put into the experiments. When I first figured out how many experiments we had on the flight --. We had somewhere, I guess, between 24 and 30 hours of experiments, which meant we could have spent a little over three eight-hour-days and done nothing but experiments which, of course, wasn't feasible. We tried to give them a fair shake. We changed the flight plan so we could do their experiments. I don't know that there should be that many experiments on

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a flight. There's a couple of them that we had that were really "cracker jack". Why should they give you so many experiments? You can't do a good job on all of them. There is no way. We were only doing 1/3 of what those guys wanted.

Collins Yes, I know it. They do ask for too many things.

Young Seems to me like you could do the same thing if you had 1/3 the experiments.

Collins Now, of our experiments, we had what, 15 experiments?

Young Yes. Bear in mind now, those 100 percent numbers are just 1/3 of what they wanted to start with. They wanted three times the D-10 stuff we did, and they wanted six passes of D-5, originally. They wanted two night passes of S-13. I don't blame them. If I were an experimenter, I would ask for the same thing. I don't know that the flight crew should spend a lot of time chopping those guy's experiments down either because I'm not sure that makes for good relations between the astronauts and the experimenters.

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Some of the experiments were really well thought out, I thought.

Collins D-5 and D-10 and 3, 5, 6 and - -.

Young 3, 6 and 7, I don't know how well they are thought out, but they were pretty complicated anyway. I don't know what data they will get back from them. D-12, I didn't think was - -.

Collins Pardon me. On D-5 they gave it 28 per second completion. I'll bet you that thing is 80 per second as far as the objectives go. D-10, they gave a 43. I'd give that one about an 80, too. Zodiacal light, I'd give that one about an 80 instead of a 20.

Young S-5 and S-6, we've got it made. I thought the briefings were real good. Some of the experimenters would come around and talk to you when they had a problem, which I think is a pretty good idea. The fact that the S-13 experimenter came down here a couple of days before the flight and explained to us what he wanted---. Actually it was just too late in the flight to do that--- but he explained precisely what he wanted.

Collins Dr. Henize, he was a good guy to work with. And Dr. Hemenway on the S-10 experiment was a good guy to work with, on S-10 and S-12.

Young When you know what the guy wants, precisely. It's not always evident unless you talk to them after you have had a chance to really look into the experiment some. But we had a procedure where, just arbitrarily for example, it said, I'll take one photo

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at 10 second intervals". Well, come to find out what he really wanted was the best tracking he could get for as long as he could get it. So if we had one going that wouldn't move, we'd just let it run.

Collins You know, I'll bet Dr. Henize got good data even with that yaw across there. All that did is spread it out on his film.

Young It will be interesting to see. But 20 seconds at 4 degrees per minute is a lot of spread.

Collins He must have known that or he wouldn't have said 20 seconds.

Young Somebody must have.

Collins Yes, looking back on it, I'm surprised he didn't say 5 or 10 seconds.

13.8 Spacecraft Systems Tests

Young That's Mike's favorite area. I never got to participate in Plan X-Ray, because I couldn't keep Mike from breaking the encoder. Sure glad they fixed it. That was worth Plan X-Ray right there, to have it, or break it.

Collins I think spacecraft systems tests are usually good because they let you get into the actual spacecraft and become familiar with it, and any peculiarities it has. I'll tell you, as much as you learn about the systems from it, I think it is of limited value. I think you get more benefit from studying the handbook and reading the test report.

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Young I'm afraid so, and I think it's that way because those things are designed for the test engineers, and they should be a little more designed for the guys in the cockpit. If a crew is going to participate in the spacecraft system test they should be run in such a manner that they get some training out of it. You can do that real easily by - - - when you're doing a reentry mode test, you indicate what the attitude display is supposed to look like, and why it looks that way. You can do that rendezvous mode test by indicating what the numbers are supposed to be and why they are supposed to be that way. It's not always obvious what they are supposed to be. Originally, when a spacecraft comes out and you run through those tests, you find out a lot about it because it doesn't always work like the book says it's supposed to. A lot of the tests they run are primarily designed as engineering tests.

I agree the crew didn't get near what I thought we would get out spacecraft systems tests. They just go too slow. I don't know why they go that slow, either.

Collins Well, I don't think that the test crews were particularly sharp on our systems spacecraft tests.

Young Especially up at St. Louis.

Collins That's what I mean. I don't know if they have had a change of

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personnel recently, or what, but it seems like they'd go through those SEDRS, item by item, and they'd never plan ahead. For example, I can recall on one of them

Young We spent four hours in the spacecraft waiting on a battery cord.

Collins We wanted, for example, to look at the S-12 package and they had a work stand in the way and nobody ever thought to look .. ahead, and have the work stand removed so that when you came to that step that required looking at S-12, it would be gone. You would just blunder right on up to that step and they'd say, "Oh yes, I see we have to move the work stand". That might be a 20 minute job, getting everybody out there moving the work stand. That could have been done hours before. It's just during the SEDRS, they just seemed to go through it step by step, and they didn't look ahead or plan ahead. So what I think about the systems tests is, the cockpit time is good to get, and it's good to be familiar with the computer, and the little funnies in it. But if I had a conflict in my training schedule, I'd do something else other than go sit in that spacecraft in St. Louis, and I'd make up for it by reading the test report.

Young We didn't get as much out of it as I thought we would.

Collins Not only that, but also I get the feeling - and this could be dead wrong-somewhere back in the past, we haven't really trusted the people to put the spacecraft together right, and that our presence there is sort of verification that the thing is being

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honestly run. And I don't believe that's the case at all. I think that it is being honestly run. There's enough checks and balances, NASA inspectors, test reports, and IDR's. The paper work is so rigged that I don't believe that anybody is trying to "pull the wool" over the eyes of the crew.

Young I don't think that anyone thinks that.

13.9 Egress Training (Pad and Water)

Collins It was nice.

Young Did you feel that was beneficial? Helicopter pickup.

Collins Yes - -

Young Why did you get in the swing backwards if you felt it was so beneficial?

Collins Well, the reason I did that was because - -

13.10 Launch Simulations

13.11 Reentry Simulations

Young I think those launch and reentry simulations, all in one, were pretty good. Did you? The procedure?

Collins Yes

Young The SIM-NET-SIMS and the GMS?

Collins Yes, that's good training.

13.12 Simulated Network Simulations

Young That was good training, but that computer bombed out. We never completed a single one of them without having so many bomb outs you can't believe it. We never did a rendezvous SIM-NET-SIM,

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and I wanted to do that. I'll tell you something else that I wanted to do that I never got to do. We could never get the docked Agena configuration to work so that we could iron out this burn procedure that we finally agreed to do with FOD. I guess that is all right. It certainly worked out okay because I know we spent a lot of time on our Agena, and it did work out okay, but I would sure liked to have had that behind us.

13.13 Zero "G" Flights

Collins Zero "G" Flights, I think they are worthwhile. Yes, I think we had about the right amount of Zero "G" training. Mike, how many flights do you recall, two down here at the Cape and two apiece at Wright Patterson?

FCSD Rep Four total.

Young You've got to remember you and I had a lot of time doing that before.

Collins Yes, I felt like, really, that we got more than we needed in this. Probably, the backup crew had about the right amount, I guess. And also our equipment was pretty darn simple. On something like the MMU there's a different ball game. I think that they would probably need more than that.

13.14 Air Bearing Table

Collins I got roughly 12 hours on the Air Bearing Table. I think the Air Bearing Table is a good thing. It is extremely limited. It only goes 3 degrees of freedom at a time. That's not good. If

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you had some device that would let you pitch and yaw simultaneously, it would be a 100 percent better than the air bearings. But in spite of the air bearings limitations, I think it is good training, because if you stick with it, the motion of that gun to counteract an unwanted body motion just becomes second nature. In other words, if you start yawing off to the right, you just automatically, without thinking about it, pull the gun out to the right and stop your yaw. And the same goes for pitch. I found in the flight that this was beneficial a couple of times. Like translating over to the Agena, I started pitching down inadvertently, and I was able to stop that okay. And prior to that, coming back to the spacecraft, I was making both yaw and pitch corrections simultaneously, based on putting together what I had done in one axis at a time on the air bearings.

Young Do you think that was adequate training?

Collins Yes, I think 12 hours is just about right for the gun. On MMU I don't know. I wouldn't feel too qualified to comment about how much you should have for MMU.

13.15 MSC Attitude Chamber

Collins I did some work in the 20 foot chamber, and we did some work in the boiler plate, and we did some work in the B Chamber and

Young And we did some work in the altitude chamber up at MAC, so we had a lot of time on the ELSS.

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- Collins I don't really think all that is necessary. I think it should be a training requirement to have one chamber run with the flight ELSS. Beyond that I'm not really sold on requiring chamber runs.
- Young You were familiar with the operation of the ECS so when you were in the MSC altitude chamber, the 20 foot chamber, you checked on how that operated. You got an emergency hookup in a vacuum, which you wouldn't have been able to do if you hadn't done that.
- Collins That's right, we did that. What we gained by that I'm not sure, perhaps confidence that we could do it. I really think we could make an emergency hookup. All you need is four pounds differential pressure. It can be between 4 and 0, or it can be the difference between 15 and 19.
- Young It adds a little more spice.
- Collins Yes, it does, and I have heard this for years about altitude chambers. It gives you confidence or something. Well if I didn't have confidence that I could do this stuff, I wouldn't go fly. I'm not sure you have to do that. I think the best thing to be gained by the altitude chamber is the familiarity with the actual flight ELSS. Of all the chambers, the B chamber is the best chamber, because it does have the silver simulator.
- Young How about the sunshine? Was that bright out there and that hot? Do you remember?

Collins No, John, I don't know, because in the B chamber, I was rigidly fixed in one orientation with respect to the sun, and in the real world, I was moving around.

Young Do you think the B chamber was warm?

Collins Yes, I think it was just like the spacecraft. I think if you wanted the spacecraft to cool off at night, you would roll it up before you go to sleep. I think if you randomly orient it in respect to the sun, you don't heat up as badly as if you had the sun beating down continually on one part of the suit. I realize the B chamber has scheduling problems, but if it were possible to run each crew one time in the B chamber with the flight ELSS I think it would be a good idea.

13.16 Crew Station Mockup

Young We could use the crew station mockup for our EVA initial revision of those two cards, and chalk them way down.

Collins And that was money in the bank. I'm glad we did that early.

Young That's right it paid off.

Collins I thought our procedures for EVA were darn good. I thought we had them reduced to a minimum. We got everything checked that we needed to get checked, but we did it in a minimum amount of time.

Young That was the only way we could do that.

Collins I think that really paid off. I feel good about that. Gemini IX spent 45 percent of their time on EVA training and

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I would say that we spent 15 percent.

Young Yes, 15 percent and some time planning it.

Collins We spent all of our time talking about how you sneak up on passing Agenas.

Young It's better than rolling, pitching and yawing.

Collins But, I felt real good about the EVA training, I thought we trained for it pretty well.

Young Yes, I think it came out real well. In a real world, if you get serious about it, on a Standup EVA you can take the helmet and gloves off and do a suit integrity check and put them on and lock everything up and do a suit integrity check and go EVA in a minute. (Snap) like that. Maybe not a minute, but 5 min. or 10 min. And do a good check too, and this includes that check where you go to 3 psi and watch everything pressurize.

13.17 Gemini Adapter Mockup

Young We didn't make much use of the mockup. They did have a crude mockup of the nitrogen line connect, and we looked at it, but we didn't really use that enough to comment on it.

13.18 Agena Mockup

Young We went out on the road twice to look at ranging on the Agena and I don't think that was worth while. I think it was proved that we couldn't use the devices that we wanted to use for ranges for this purpose.

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Collins I think it was worth it one time. I think you ought to go out one time at night with a full scale Agena Mockup and just look at it at various ranges.

Young That would be good for radar failure.

13.19 Sextant Training Equipment

Young Well, we never got that infernal baby sextant that we thought we were going to use during the orb determine. It didn't come in until two weeks before the flight.

Collins It was during the Sim-Net-Sims, which was a couple or three weeks before the flight.

Young That's right, when we found out we couldn't use it, we had to switch to the D-9 Sextant, and that's too late to learn that kind of stuff. We should have been using that Sextant back when we were in Houston.

Collins I think that was my mistake, originally, and I just felt that we didn't have any place onboard to stow it. What we should have done was cut the D-9 right in the beginning and stuck with the D-9. Now, I felt that I was adequately trained on that D-9.

Young Even though you knew you couldn't use the little sextant either.

Collins Yes, that's right and the little sextant that they sent to St. Louis for the Hybrid Training was not representative of the flight sextant, and we squawked it. Everything that we

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squawked, they said, "Oh well, we'll fix that, that's not on the flight article".

Young And then we found out we couldn't use the flight article; about two weeks before the flight. It didn't make any difference because we got the D-9 on there. It caused some problems, for some people to have to scramble around there.

Collins I felt like I got enough training on the D-9, but the main reason is that I got trained on it for Gemini VII; I spent two days out at Ames training on it.

Young Even at that, some of the stars didn't split.

Collins Yes, that's what I'm leading up to.

That one I just can't explain. There must be something the matter with my eyeball. Maybe it is the function of the angle through the window that you are looking at, or the function of your night adaptation, or stigmatism. I just can't explain sometimes being able to split stars nicely and sometimes not being able to. But it happened. It happened in training and it happened on the flight.

13.20 Camera Training Equipment

Young I hoped the real stuff worked better than the trainer.
That Maurer was bad news.

Collins Yes, we broke the Maurer several times; we, of course, did break the 16 millimeter Maurer in flight. I think they did a pretty fair job of making that equipment available for us

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considering how many items they had and who was using them and what not. The camera gear is something that we should get ourselves three spacecrafts ahead, instead of giving Gemini X the gear when Gemini IX got through with it, you should give Gemini X the gear when Gemini VI got through with it, and Gemini XI the gear when Gemini VII got through with it, and so forth. That way you can do the camera training early in the cycle, and forget about it for a while.

Young I agree with you, in fact, it might not hurt to train guys in how to use the particular piece of gear that they are going to use on the flight in groups of 19. Take them in and show them how the Maurer works, all at once.

Collins I don't know that that is too practical; anyway I think we got fairly good training on it.

Young I think we got training on operating it; I think the camera for EVA operations has short comings and that you can't fly that "cotton-picking" machine and change film.

Collins You can't tell you're out of film without looking down at this little thing, and if you are out of film you couldn't do anything about it while the guy is EVA out there running around.

Young That's right. Those bits of equipment ought to be "idiot proofed", and they are not. In other words, you can put lenses in backwards, there are all kinds of mistakes you can

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make putting that gear in. I couldn't put the S-13 camera together. I don't know what I was doing wrong, but I physically could not get that lens on.

Young I thought you were going to miss that experiment.

Collins That's right, I finally had to give up and give it to John, and he put the S-13 camera together. It consists of sticking a lens into a camera body and twisting it. Now there should be one way that lens will fit, and there should be only one way it will twist, and there shouldn't be any magic to getting any little grooves lines up with any little sliding tongues or anything else, and yet, I couldn't get that camera together, and I practiced with it plenty.

Young We both had the timer off on it.

Collins We broke the timer on it in training, and we broke the timer in flight. What broke that was the Agena, when the PPS lit off.

Young That would break anything. We didn't allow slack enough against the wall. That's right, we configured it while we were waiting.

Collins You know what happened to it when we broke it by 1 g in training, and it only took 1 g in flight to break it. I really think that all those lenses, mirrors, brackets, and slides; I think the people who design those just simply aren't thinking. They ought to make a preliminary design, and then

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they ought to think about it for awhile and maybe pass it around and get some suggestions, and make it "idiot-proof", where you can only do it one way. I'll give you an example of good gear, and that's S-1. That guy on S-1 has put himself a camera together that's going to get him good data and everytime S-1 flies, he's going to get good data. Stuff like S-13, the guy is going to be lucky, because we are fighting the equipment.

Young I really feel that we ought to spend some money on this if the people are really concerned about not getting pictures. I feel pretty bad about not getting those EVA pictures; And if we had some, I think it could do a lot of good for the program. I felt bad when Tom didn't get any. They ought to spend some money and get us a camera that works automatically and tells you all these things and is "fool-proof". When you turn it on, it runs at a rate that you set it on, and you've got a button or a switch that you throw, and you never have to change the film. Or if you do have to change the film, it tells you it is out of film. Someplace where you can see it. I think those moments in spaceflight are going to be pretty rare, where you really get something that you really would like to have documented. Because in the main, I think it is going to be pretty routine business. You hate to miss it. I thought we had everything going for us. We had four

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"cotton-pickin" cameras, and we were going to have them all run.

Collins Well, that is just one of those things.

Young If that is the least thing we have to worry about, I think we are in pretty good shape.

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