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NASA PROGRAM GEMINI WORKING PAPER NO. 5026

# GT-3 FLIGHT CREW SELF-DEBRIEFING

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER
HOUSTON, TEXAS

JUNE 3, 1965

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# GT-3 FLIGHT CREW SELF-DEBRIEFING

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# 1.0 INTRODUCTION

This report consists of the self-debriefing comments by the GT-3 flight crew, Astronaut Virgil I. Grissom, Command Pilot and Astronaut John W. Young, Pilot. The debriefing was accomplished onboard the spacecraft recovery vessel, the U.S.S. Intrepid, after the end of the GT-3 mission on March 23, 1965, and was started at 8:30 p.m. e.s.t.

The purpose of the self-debriefing was to record initial impressions and recommendations based on the flight crew members' immediate memory of the mission.

## 2.0 ASTRONAUT GRISSOM'S SELF DEBRIEFING

Everything went normal from wakeup, through the physical, through breakfast, and on down to insertion. First time we ran into a problem was a fuel leak, which held launch up 24 minutes.

Gordo gave me a countdown to ignition. I could hear the engines light off, and the clock started running at the same time Gordo called the bolts blowing. I didn't feel liftoff; there wasn't a distinct feeling when liftoff occurred. It was a gentle, smooth liftoff with no shock or vibration when the bolts blew. The roll program started and stopped right on time. The pitch program also started right on time. At approximately 1 minute 40 seconds elapsed, I could begin to see clouds out John's window. Prior to max q, in fact, prior to the time we went sonic, there was a little flap up on the antenna housing, on the very nose of the spacecraft, that was fluttering. This concerned me momentarily, because if it came off, it would have come almost back into my windshield.

At BECO, there was some debris floating around the outside of the spacecraft. I could see a little flash of fire up in front of us, but I could tell we were thrusting only by the accelerometer. Second stage was good and smooth, although it didn't sound as smooth as first stage. It was more of a pulsating sound than first stage. I didn't notice any POGO at anytime during first stage or second stage burn. At RGS initiate, the booster pitched over to and right on down below the horizon, I'd say about $10^{\circ}$ below the horizon, and stayed there quite some time. It gradually steered back up towards the horizon, and then back down again. As far as we knew there was nothing unusual during second stage, it was good and smooth and steering right along the horizon.

SECO was clean and sharp. I couldn't feel any tail-off, any pulsing, or any kicks from the second stage engine. I can't remember what the IVI readings were. As soon as they read out, I started thrusting and John separated the spacecraft. We could not hear the aft-firing thrusters fire, although, we could tell we were accelerating away and we could hear the separation. Again there was quite a bit of debris and stuff floating around outside the spacecraft. I actually lost track of time when I started my burn, so I burned what I thought was at least long enough, maybe a little bit too long, and ended up with a 27 ft/sec overspeed showing on my IVI's. At this time we punched off the fairing jettison and the scanner heads kicked right away. The antenna fairing jumped away and we could see the springs drifting near the spacecraft. There was a lot of debris all around the outside of the spacecraft at that time. I was a little bit concerned that some of it might get in the scanners.

We went through the insertion check list. We didn't test the sequence lights at this time. We stowed the arm restraints, but I never did stow the elbow support. It stayed up the entire flight. I didn't notice that it was up until we were reentering. I started to, but did not put it down at this time.

I alined the platform early. Alinement came right in. Even at zero pitch attitude, it was easy to tell when yaw was fairly close to zero. I couldn't tell exactly, but by pitching down it was easy to detemine zero yaw. Subsequent to platform alinement, I went to orbit rate and then to horizon scan.

The control mode check worked out fine. I could find nothing wrong with the direct control at all. Spacecraft control in direct was easy. Reentry rate command didn't perform like it had on the Gemini mission simulator. It appeared that the deadband was very wide, on the order or $\pm 5^{\circ}$ or $6^{\circ}$ in pitch and yaw. I don't recall what the deadband was in roll. They may be on the onboard tape.

After the control mode check, I switched back to horizon scan. I started my wrist watch on a hack from the Canaries. I activated the sea urchin handle on the "mark" and as near as I could tell, I did it right. After insertion, at 20 minutes elapsed, I moved the handle twice, and it seemed to me, it moved too far. At least, it moved farther than it did on the pad.

Shortly thereafter, we lost the primary dc-dc converter. I first noticed it when we got a scanner ignore light. The horizon scan mode was not holding us in proper attitude. John noticed at this time that the cabin pressure, as well as primary and secondary oxygen supply pressures, were down to zero. He immediately switched over to secondary dc-dc converter. We couldn't get the primary scanner back on at this time so we switched to secondary scanner, which seemed to work properly for a short time. Throughout the flight, I switched back and forth between the primary and secondary scanners because they would drop out after a period of time and wouldn't come back in. Upon selecting the alternate scanner, the ignore light would come on in 30 seconds to a minute, and the ignore light would stay on until we again selected the alternate scanner position. I'm not sure what was occurring here.

It was approximately at this time I noticed that the spacecraft was yawing to the left at a fairly high rate. I'd bring it back to zero yaw, and it would drift off to the left again. We tried several procedures to try and stop this, such as switching to secondary ACME, turned C/B's off, went through everything you could try, and it still continued to drift. We thought it was some sort of mechanical leak that we weren't able to stop. I never did turn off the propellant valve. As the flight progressed, this left yaw drift became less and less. During the last

orbit, if it was still there, it was so slight that I couldn't detect it.

I attempted to get ready to give a blood pressure over CSQ. Prior to getting to CSQ, I worked for about 5 minutes and couldn't get the blood pressure bulb in. The blood pressure bulb just wouldn't lock in so that I could pump it up. John got his in but I couldn't, and I don't know why. John did his blood experiment at an elapsed time of 50 minutes 18 seconds.

Turned the cabin lights down and conducted the RCS plume checks. A night side retrofire looking out the window, is going to be virtually impossible. You could see the horizon reasonably well through the pitch thrusters, but when that yaw thruster fires, it just blanks out everything out the window. John took some photographs, although we did not have any camera settings. The thrusters fired fine. The thruster plumes appear as a light-red color with little specks all through it, like sparks.

We ran the catchup mode check. It went perfect. We put in the proper numbers, and they read out properly on the IVI's. I was controlling in pulse which is a very easy way to control the spacecraft. In several respects I prefer it to horizon scan. The attitudes came out just as they should have, a minus 34.5° pitch and 329° left yaw. I then went to prelaunch on the computer and back to catchup. The IVI's zeroed and I went back to prelaunch.

I alined the platform using the FDI. The alinement mode worked very well. It's a little bit time consuming to keep the needles nulled but it's very obvious that the platform is alining with the spacecraft. It's easy to tell when it is alined, using the window. You can determine roll and pitch alinement within a couple degrees and yaw almost as accurately. You have to pitch down quite a ways to get a better yaw reference, but yaw determination, even at a zero pitch attitude, is not difficult. I activated the sea urchin egg experiment again.

We got ready for our first OAMS burn which was a 48 ft/sec $\Delta V$. We put the proper quantity into the computer, and I hit START COMP 3 or 4 minutes before time for the burn. The IVI's started to change almost immediately. By the time we started the burn, the IVI's were reading 51 instead of 48. The same thing happened on the second burn. We pushed START COMP about 2 minutes before burn; however, the IVI readout changed from 96 to 97 in the interim. I don't know why this occurred. The second OAMS burn went without incident. I couldn't hear the forward-firing thrusters, which is disconcerting because you do hear the attitude thrusters. The attitude thrusters sound very similar to those that we experienced in the simulator. Perhaps not quite as loud, but

you definitely can hear them. If the attitude thrusters are not firing, you think you've stopped translating. You can tell you're still translating by the debris drifting forward or aft in the cockpit. During this maneuver, I noticed a bolt plastered against the instrument panel. We drove the IVI's down to zero and stopped on John's time hack. We were still having our troubles with the scanners and with the yaw drift.

Shortly thereafter, John unstowed the meal and reached over and asked me if I wanted a bite. He handed me a corned beef sandwich. I took one bite, it tasted pretty good, but it started to crumble and float around the cockpit, so I shoved it in my left knee pocket. John started his food and waste evaluation, and I ran the platform alinement check. I displaced the spacecraft a negative 10° in pitch, plus 10° in yaw, and 10° in roll. I caged the platform in SEF position, and then went to SEF on the platform mode. The operation worked very well and took less than 5 minutes. The flight plan roller stuck but I broke it free. Right now, I see a little glob of dirt in it which I believe caused it to stick.

I received my horizon scanner check start time from MCC. It was difficult to hold that spacecraft 5° to the left because of the bright sun. It was approximately at this time that I started having trouble with the horizon scanner torqueing the 8-ball. The FDI attitudes weren't agreeing with the horizon. I thought, initially, that we had been driven off attitude because something had happened to the horizon scanners. After getting caged one more time and getting alined good, the 8-ball started to drift off in roll immediately after going to orbit rate. I was able to keep it alined using SEF or BEF, and controlling the spacecraft using the pulse mode or the horizon scan mode. So, it was difficult to tell exactly what my rates were or what attitudes I had during the horizon scanner check. But, I do recall that it pitched up. Maybe this will be on the onboard tape.

We got out the 16-mm camera and accomplished the out-of-plane translation control check using direct for attitude control. Without a doubt, the easiest way to control the spacecraft during translation maneuvers is rate command. However, it is not difficult at all to control spacecraft attitudes using direct. I translated aft 10 ft/sec and then back and forth at 1 ft/sec as planned. The thrusters appeared to fire very well, and we ended up with 10 ft/sec in the IVI window.

I was still having trouble with the horizon scanners and alinement as I came up to the 2:30 horizon scanner control mode check; so, I did not do this check. Instead, I tried to diagnose the horizon scanner problem. The horizon scan mode appeared to be working well; however, on occasion, it would pitch you down at a pretty good rate when the horizon scanners lost track. Subsequent to this time, I kept the platform alined pretty close the rest of the flight and never deviated

very far, with the exception of the tracking task over the Gulf of California.

I mounted the reticle and that doggone thing's in the way. It's very difficult to see the pipper when you're looking at a bright sky or bright earth. Normally, you can see it better against a sky background than you can against an earth background. I picked out a small town or cultivated area just north of the Gulf of California for the tracking task. I first tried to hold on target using pulse but we were moving too fast; so, I switched to direct. Using direct, I was able to hold on the target within a half degree or so. The biggest problem I had during this maneuver was I frequently could not see the pipper. I had more trouble finding the pipper on the reticle than I did the town, so part of the time, I was guessing where the pipper was. Another big problem was we couldn't find a good target to track. I only had a small area that was clear; the rest of the place was all clouded in and, boy, you're really moving on and you don't have much time. John did get some pictures of the spot I was trying to track.

I made the platform stability check without even really meaning to, I guess. I held yaw very close for a long duration subsequent to the alinement problem. I set the event timer over Carnarvon. I was a little worried about the night side because you can't see a thing during much of it. I was worried about getting alined for retrofire and for the second OAMS burn; so, I watched my platform alinement very closely.

I unstowed the $CO_2$ sensors, opened them, and used them. The 2-mm sensor was saturated and the 4 mm had colored just slightly. I opened up the 6 and 8 and observed no reaction.

I rotated the sea urchin experiment handle again over CSQ. CSQ reminded me or I would have missed it. We also went through the preretrofire check with no difficulty at this time.

The second OAMS burn over Hawaii went especially good. I held attitudes quite close to nominal. John had a little difficulty getting the correct $\Delta V$ (96) into the computer. The first time he tried it we didn't get anything, but the second time we got the proper number. I started the computer about 2 minutes before the time to burn, and by the time we got to the burn time the $\Delta V$'s had changed; but we went ahead and burned down on time using the aft-firing thrusters. This $T_R$-5 checklist went off like clockwork.

There's sure a big difference between using one ring of RCS, which I've done before on several occasions, than using two rings. There's a great deal more authority on two rings which you can definitely feel.

Two rings give the spacecraft a sharp kick, whereas, one ring gives you a nice, soft shove. It's easier to control on one ring if you're not doing a retrofire, because using two rings you tend to over control.

At $T_R$-1 minute, we punched off the adapter and, boy, there's no doubt in your mind when it goes. In fact, that was the biggest bump we'd had up to that time. It kicked free and we saw debris floating around the spacecraft. Retrofire came right on time, fired automatically. I'm positive my platform was properly alined at the time. I had cross-checked with the horizon before pitching down to retrofire attitude. I held attitude right in the 8-ball circle during retrofire. John called out the IVI readings which, as I recall, were 331 aft and 105 down. I never saw this much in the down direction on the simulator. All four retros fired; however, there was a slight pause between one of them, but I've forgotten which one now. It seemed as though it tailed off just a little early.

I jettisoned the retro adapter upon getting the retro jettison light and, once more, there was much debris around the spacecraft. We started through the postretro jettison checklist. We received our update times for bank angles which were 45° left and a reverse bank angle of 55° at approximately 11 minutes after retrofire. I had no difficulty controlling attitudes during reentry. I held the nose just slightly above the horizon, this gave me the same indication on the ball as I'd been used to seeing in the trainer. I held this attitude until about 6 minutes after retrofire. I was already getting reentry steering from the computer on the roll needle. It commanded me to fly inverted to the max left position. I was using direct with both rings. I rolled to 45° left, and I was going to hold that until 11 minutes after retrofire time, but the computer was indicating that I was short. Much before the time to reverse bank angle, the crossrange error nulled out. The computer indicated that we were about 60 miles short; so, I held max lift all the way down and modulated bank only about 4° or 5° in order to keep my crossrange needle zeroed. At 80 000 feet, my crossrange needle was probably off to the right about 1 needle width, which I judged to be about 2 miles. The downrange needle was still showing that we were 50 to 60 miles short. I think I reported all this to the Cape.

The altimeter jumps around and is erratic down to 50 k; so, I didn't trust it very much. At 50 k we got the drogue light and deployed the drogue chute at the same time. The drogue sure looked good. It came right on out and stabilized the spacecraft. We turned off the RCS switches, and the oscillations started building up; so, I had John turn them back on which stabilized us again. This same situation occurred a second time and we went through the same operation. Rate command stabilized us very nicely and the thrusters were firing fine.

I wasn't concerned about firing the thrusters with the drogue chute deployed. I had John turn off the propellant valves and let rate command use up the remaining fuel in the lines. Even a long time after all fuel was used up, I could still see a little fire coming out of the nozzles.

At 10.6 k on the altimeter, I punched off the main chute and got the 10.6 k light at the same time. My 40 k light came on at 40 k, or very close to 40 k, on the altimeter. The chute came out in a reefed condition and stayed reefed for 8 or 10 seconds. It dereefed very nicely. It breathed about one time. It was a good solid chute. I couldn't see any holes or torn panels in it anyplace. The rate of descent was 30 ft/sec. I went to the three-point landing attitude and got the biggest surprise of the whole flight. John and I plopped right out of the seat and I broke my faceplate on the reticle mounting bracket. That was quite a surprise.

In the landing attitude I couldn't see the main chute. However, I didn't try bending over to take a look at it. I could see the bridle. We got set for landing. I got a call about this time that we were 5 miles off the bow of the Intrepid, which turned out to be a 60-mile error.

Landing was pretty normal. She drops right on in. I waited a second for it to come up to the surface, and it didn't. I happened to be looking out John's window and it was completly underwater. I looked at mine and it was completely underwater, also. I punched para-jettison and we popped right up to the surface. Evidently a strong wind was towing us nose down. There was no water in the cockpit; no unusual gurgling. We noticed a lot of sputtering and yellow smoke from the RCS thrusters. It looked like there was a lot of fuel that was cooking off. I thought perhaps it was because it was so hot. We had the snorkel open, closed it for a little while, and then opened it again. We did get some smoke in the cockpit and some odor. I think this was from the hot spacecraft shingles. I couldn't see any yellow fumes at this time. We stayed on $O_2$ high rate with our faceplates closed, even though my faceplate had a hole in it, until the smoke gradually cleared.

The spacecraft was floating very nicely. I wouldn't have been at all afraid to open the hatch but, of course, I didn't. The water wasn't washing over my window, nor John's. We had word that the scuba divers were going to be with us shortly and I did see one diver drop in the water about 20 or 30 yards off the nose. He swam up and stayed around the nose of the spacecraft for quite some time. I never did see the other scuba diver until after the collar was on and he walked up along side the spacecraft. At first, I didn't realize the collar was attached and couldn't figure how he could be up there like that. John and I were

getting very warm and started taking off our suits. John had managed to get the bio-connector off the suit and had it stowed way back in one of the food boxes. He wasn't very anxious to get it because he had worked up quite a heat load. So, we just took our suits off down to around our legs and left the helmets on to transmit. I got out the lightweight headset but never did use it.

The scuba divers were all there. We kept getting hotter. We were using the suit hoses to blow on us which helped a great deal. Also, we had a little problem getting water, but John probably will give you a few thousand words on that. He put enough of them on the onboard tape. After a while I started to open the hatch, but about this time one of the scuba divers yelled in and wanted to know if I wanted it opened. So, he opened it from the outside and put up the splash curtain. The spacecraft was riding very nicely with no water at all coming in. In fact, I don't think any water would have come in, even if the splash curtain had not been up. Shortly before this time, we got a call that the Intrepid would be 1 hour 35 minutes getting there, so, we decided to come back by helicopter. I took my suit the rest of the way off, put on my harness with the Mae West, and got in a nearby rubber raft. They dropped a collar down to me and hoisted me up. They picked John up, and we heard later they closed the spacecraft hatch.

During reentry I did see quite a bit of fire. Everytime I fired a thruster I saw a big flash. The fire ball isn't very bad. You can see through it during the entire reentry. Very early in the reentry, we could see the retropack and it was burning quite rapidly as it came in. Yaw was pretty easy to determine because you've got so much debris stringing back behind you. You can almost pick out your trim angle.

Banking was relatively easy, watching the horizon. I used the ball as my primary reference but you can see the horizon the entire reentry. It isn't a great big tremendous ball of fire that you can't see through. I don't know if we were transmitting through the reentry experiment or not, we never heard any transmissions. We noticed a change in the color of the ionization sheath when we initiated the reentry experiment.

## 3.0 ASTRONAUT YOUNG'S SELF DEBRIEFING

The preinsertion activities were normal. After insertion and during countdown, you could hear very faintly the OAMS isolation squib valves and the RCS isolation squib valves fire, but you had to be listening for them. The pressures came up just exactly like they do in the simulator. We had some dead time in the countdown where we had nothing to do. I think that we allowed a little too much time for the thruster firing, anticipating problems that we didn't have.

Engine ignition was normal; it wasn't as loud as I expected it would be, but you could definitely tell that the engine had lit off. At 3 seconds, I started my elapsed time part of the G.m.t. clock in the spacecraft, and, shortly thereafter, CAP COM called bolts and liftoff. The first few seconds after liftoff the ascent felt pretty slow with very low vibration, not by any means bad. You could tell both the roll program and the pitch program by booster motion, and after a few seconds you could feel the ascent roll and pitch correlate with the inertial system, just precisely. The ambient noise level got higher and higher up to a point, where, I think, the vehicle went supersonic, and then things quieted down; and then it got a little noisy again at max q, and then backed off some more. I think total booster noise level was lower than in the simulator. But after the vehicle went supersonic, ambient noise levels were reasonably low, in fact, just as low as the simulator, which I consider reasonable.

Going up through 50 seconds, the cabin pressure went up to 5.8. It climbed right on up to 6.5 to 6.6 to 6.7 and held there, and later on, after SEP, it came back down. You couldn't hear the cabin pressure relief valve relieving at this time, although, it just appeared to be lag that was causing the high pressure. That was the first, to my knowledge, that anybody had seen the actual value of cabin pressure. It indicates to me that the cabin relief valve setting is a little too low to prevent damage to the spacecraft, and that the spacecraft should be tested to a higher pressure. It seemed to me that there was a very low amplitude vibration right before staging. This vibration occurred at a time when I was unable to lift my head off the head rest to avoid it. The booster was steering properly; it had an indication of a little booster-high loft, and then we had a 2° to 3° computer pitch attitude error on the FDI needle, indicating that we should pitch down to steer out this high loft. Yaw and roll steering appeared to be nominal in all respects. I guess we had a hot booster during first stage. We received the 1:45 and 2:25 DCS updates, and I was able to reset the DCS light on both updates. The T-3 update had also been received prior to launch.

At staging, a loud sound followed by a sort of an indication best described as a flash of orange-yellow light came up around the spacecraft. It surprised me no end, but, I guess, looking back on the pictures of staging, that this should be considered to be normal for fire-in-the-hole staging. The guidance looked more like a GT-2 launch than GT-2 did, because, right at BECO, the computer attitude error went full scale and it was a lengthy period of time, I estimate 15 seconds, before the RGS started to steer out the attitude error. When the RGS started to guide, it pitched the booster right on down to the horizon out the window, right below the horizon on the ball. And, at this time, I could see the horizon out the window, and it was a beautiful sight. Engine 2 ran smoothly at a very low noise level. There was a long time period where a lot of motion wasn't apparent. Then, as that baby began to pick up speed and pick up g's, you could tell she was moving. She was really hauling the mail! It is very exhilirating to be sitting there with that much machine going under you. That is a real thrill as far as I am concerned. We reported GO for staging, and we reported both updates received. It was a little difficult to get the second update DCS light out. The report on 3:45 was GO. $V/V_R$ = 0.8 as I recall, was right on the money, time-wise. When we went to launch phase 3, I was fascinated by the view out the window and couldn't take my eyes off the view for anything else. Normally, gave the attitude error a look-see, as I recall, it was about 6° down (high scale), indicating still that we were high. It didn't correct itself to any extent during the rest of the flight. Although I didn't pay a great deal of attention to it, I admit, due to the fascinating view out of the window. At SECO, a lot of what looked like debris, sparks and large white flakes flew by us. We went to direct, maneuver and attitude, and separated the spacecraft. I was waiting to hear the thrusters firing; I just barely heard them. I don't consider aft thruster firing a good separation cue based on this flight. After Gus had pressed the maneuver handle for about 2 seconds, I separated the spacecraft, it pitched forward with a noticeable separation. I was slow, as usual, getting to rate command, but got to it, and Gus rolled level. I felt pretty rushed at this point. I didn't get $V_{GP}$ or $T_{AP}$ recorded as I should have, but MCC said that we were GO, so I didn't really see any need to worry about an apogee burn. The insertion checklist came hard; we stowed the D-rings right away. I feel that, in regard to this D-ring, that it is practically inexcusable to be able to safety the rest of the seat - and not be able to safety the D-ring. With the cover back in zero-g, the D-ring floats right out its stowage. To me that constitutes an unnecessary hazard. We should have another way to safety that D-ring. We should have a mechanical latching device to safety the MDF systems down there so that we can't inadvertently pull the D-ring in orbit.

Drogue safety-pin stowage was a piece of cake; it is very easy in zero-g, after having sweated over it for the last month in 1-g. It

seemed that everywhere I turned I was bumping my head on the spacecraft overhead after I unfastened my seat belt and shoulder harness. I never did sit back down in the seat again. My lap-belt restraint was loose practically the whole flight, and the only thing that kept me in the spacecraft was the pressure of the hatch on my head. Of course, this gives you a better view out the window. You are jammed right up against the hatch. This really eliminates any need whatsoever for all the concern over eye positioning as far as thruster burns on docking, et cetera. The spacecraft is just like any other vehicle as to eye position. Once you have flown it awhile, you learn to operate from that position as to eye level. Based on this, and because we want as much room in that cockpit as we can get, I think we can eliminate the egress kits that keep your height of eye just so.

I unstowed the blood pressure bulb after insertion. I changed the waste valve to normal and stowed both Gus's pins and my pins which was quite easy at zero-g. We didn't get any reentry quantities, that I recall, from MCC, but we did over the Canaries and Carnarvon. I stowed the inboard arm restraint but didn't stow the outboard one. I saw no need to; in fact, later used that for stacking equipment. The water valve was left pressure-off and we drank pressure-off during the whole flight. The high frequency antenna was shut off. We went to ADAPTER on the antenna selector just after we left Bermuda, apparently, so I never did know whether our UHF antennas had extended or not. We just left it on adapter until we got over the Canaries. I didn't do the battery test until sometime past Kano, but seemed to me that there were more important things going on then; so, we just put it off until later. The blood pressure bulb was an item we had never seen before, and it had two ends. One end we plugged into our suit, and Gus couldn't even get the bulb into his suit; and the other end apparently may have been used for pulling water out of the adapter. After we got down on the water, we used the same end to pressurize the drinking tank that we used for the blood pressure before, and it worked okay. While Gus was doing the control mode check, we arrived over the Canaries with me on the UHF2, and the radiator on Flow; and I stood by to give my blood pressure. Gus was standing by to twist the sea urchin egg experiment. We got the update information and as we didn't have the flight book out yet, I logged them all on flight cards. I am not sure of the correctness of this information. I am not satisfied that we have the proper method of receiving and logging this kind of information. We were getting information from the ground which wasn't in exact format with the forms that we had onboard. Ground stations were giving us the same reentry backup quantity information, but it was spread out and in different order. I consider this extremely bad due to the critical nature of this type of information. If you ever got in a tense situation, you want that kind of information given in the same order every time, so that the flight crew recording it can get it down and get it right the first time. A recording setup at a guy's fingertips, literally, so that when

information comes up to him he doesn't have to pull out a flight card or a piece of paper. He just writes it down immediately. Gus had a very effective way of doing this. He took one of his Pentel pencils and wrote on his flight suit. Well, that is fine, but in a two-week mission you are going to run out of flight suit. I recommend a suitably configured kneeboard. The old plotboard just won't do it. I wouldn't recommend writing on the flight plan, because you can't read it.

Over the Canaries, the radiator outlet temperature was too high so we had to go back to bypass. We had almost completed the pass, and they wanted a radio check on UHF 2. We had not established the voice procedure for doing this and, of course, we had been on UHF 2 the whole pass and also on adapter antenna, unless Gus had changed it back unknown to me.

We took the pictures of the RCS thrusters with the 16-mm camera. Over CSQ, we got our radiator temperatures and they appeared adequate (42° F), so we left them on flow. Over Carnarvon, we got our information on 2-1 reentry parameters, and had the full load read to us and had it verified before we left Carnarvon. Our 2-1 $T_R$ checked within 2 seconds. I started the blood experiment over Carnarvon at an estimated 50 minutes 30 or 40 seconds, and it was difficult to tell how much because, when I tried to actuate the experiment, the bracketing on the experiment was different and the clearance dimensions were different from the mockup in the simulator. I thought, for a second, I wasn't going to be able to actuate it. This is the kind of thing that we want to make sure never happens again, because if an experiment is worth carrying, it is worth operating properly. If not, we should remove it from the spacecraft. 50:18 is what showed on the flight plan, but I think it was more like 50:30 or 50:40. The same lag was experienced on de-energizing it, because the dimensions weren't what they had been all along in the simulator. The forces to operate it were not excessive.

We unstowed the 16-mm camera, and we installed the urine nozzle, over Kano. I took off my urine bag, which I didn't use, and used the urine system. I spilled a little urine - not as much as I expected to spill on my first attempt - and cleaned it up with a towel. As far as I am concerned, towels are a must for long duration flights. It is impossible to do anything in that spacecraft without spilling water, unless you have a lot of time and are extremely careful and lucky besides! We need plenty of clean-up towels because water over a long period of time is going to get us in a lot of trouble. The same is true of other things floating around the cockpit, and we noticed quite a few - screws and unidentified plastic objects and a lot of dirt. We have to have a better method of cleaning the spacecraft. I recommend that during manufacture of the spacecraft, and after they get to final systems test, the seats be fitted flush with the walls all the way around so that

shaving and parts that fall down in that seat area will not end up in the bilges. Everything that goes in there falls down that way, and it is going to be a continual problem. One of these days, it may prove to be a hazard if some piece of loose metal floats around in there and causes a short.

Just past the Canaries, we lost the primary dc-dc converter and the first indication that I had was when I looked over at my $O_2$ pressure and it was reading 250 psia. Well, it was rather stupid of me, but because I had expected this might happen from previous discussions, I reached over and slapped on the manual heaters. Then I looked and saw that we had no cabin pressure or any other good quantity gage, so I changed to seondary dc-dc converter and everything came back on the line. But the $O_2$ pressure, of course, was off scale high. In fact, it was off scale before liftoff, so I imagine the PRI $O_2$ vent valve was relieving. I got the $O_2$ pressure to come back on scale by going to $O_2$ high rate for a short period of time, and going back to auto heaters. It then climbed right back off scale. It wasn't until we did the $O_2$ high rate check midway (2:45 elapsed) through the flight plan that it came down off the peg for any appreciable length of time. It only stayed off the peg after we shut the heaters off. It stayed about 825; it never went down to the dome on regular oxygen breathing. I was surprised during the $O_2$ high rate check that we only used about 5 percent of the oxygen, when the card I had indicated that we would use 7 or 8 percent. We had too much oxygen, but I was very pleased with the way the cryogenic oxygen system performed. The cabin was almost leak-tight. The suit temperature was fairly comfortable, although the flow was marginal. Suit inlet temperature was 54° and got as high as 58°. Now cabin temperature varied from about 90° to 92°, 93°. It was a little too hot, although it depended on whether you were in the sunlight or out of the sunlight as to just how warm you would be in the cabin. On the night side, as I recall, it was very comfortable. When I opened up the suit over Carnarvon for the waste evaluation, the temperature to me was pretty comfortable.

I had a feeling of being too rushed throughout the first part of the flight plan. I really believe that on a long mission the flight plan should be set up so that the crew will not be so rushed and also not be busy over the primary stations. Everybody wants the crew to report to the primary stations. This would be fine if they just gave reports over the station. Over CSQ, on the first pass, we got a radiator outlet temperature and it was down to 42, so we left it in flow. I think we gave an oral temperature but I don't remember. We reset our G.m.t. watches. We needed all our G.m.t. hacks on the even minute. I thought this was clear to everybody, but it wasn't, so this hack that we got didn't do us any good. This is typical of the kind of procedures

that we must set up in order to have this range-spacecraft interface operational type working relationship. This is something that is going to have to come with time and more effort on the flight crew's part. After I verified the 2-1 loads over Carnarvon, I felt pretty confident of the DCS updates; so we didn't have anybody read out the 3-1, 4-1 update quantities. I did verify target latitude and longitude of 4-1 particularly, and I verified and read out the onboard parameters of 3 through 11; and also the $T_R$ times were repeatedly checked.

The radiator outlet temperature was good over Carnarvon.

I took 16-mm pictures for the RCS plume observations as Gus fired the B-ring. I do not know how those will come out.

The catchup mode check worked perfectly. The 25, 26, 27, 56, and 57 addresses read out perfectly. I could just barely hear the aft-firing thrusters and a little bit of the forward-firing thrusters, but the noise cue was very difficult to tell. The attitude thrusters, I think, were louder than the maneuver thrusters, and you could feel the spacecraft move every time the attitude thrusters were fired and they sort of provided a statical background interval on this low noise-level solid maneuver thrust. The aft-firing thrusters are very low in noise level. At approximately 1:15, we got to the first tape change. The tape changes at zero-g were easy compared to what they were at 1-g with the suit gloves on. It is important after the tape change to check to assure that the recorder is closed properly. Our translation maneuver wasn't nominal for the first one; it was 48 ft/sec instead of 66. The burn time was 1 minute 14 seconds, and we timed it to the second. We started the first burn at 1:33 elapsed. Gus burned using thrusters 11 and 12. Of course, you could see 11 and 12 thrusters burning. Gus stopped the burn at 1:14. At that time he was reading 2 in the forward window of the IVI. We put on the maneuver load of 48 in address 25, but on the IVI we read 50. So Gus only burned 48 when we got around to burning it. It looked like a very nominal type burn. At the completion of the burn, we tried to pitch over and see the ground, but the sky was overcast; so there was not a great deal to be seen. We got the DCS 3-1 retro, 3-1 command load up, and put the T/M to delayed time and dumped through the standby T/M. I think it was pretty nominal. Some of the minor problems we had with T/M switching later in the pass I attribute to the fact that we did not have the delayed time transmitter and we weren't too clear on just what procedures we were going to use on dumping T/M over each station. The last week before the flight it was changed, and the procedures were changed in flight. Notwithstanding, I am pretty well pleased with the total flight, definitely the way to fly a machine. It is definitely the way to go!

The whole southern United States was cloud-covered. The first night-pass-around, the first thing I saw was the Southern Cross and the Alpha and Beta Centauri very clear. It appears to me, with our knowledge of the stars, we can line up yaw on any given set of orbits anytime, anywhere. Gus did this coming through Orion's Belt on the last orbit flying forward. Yaw was very easy to pick up, I thought. That vehicle is really moving on, and so there is no question about picking up yaw. Once you do look out the window, it is very difficult to get your eyes back in the cockpit. Most of the time it is either so dark you can't see anything that is going on in the cockpit, or it is so bright outside that when you do look back you are temporarily blinded. But the view out the window, no question about it, is worth the price of the trip. It is worth any price.

The food and waste evaluation was started right past the Canaries, and I was still doing it over Carnarvon. Packaging - I still think that the check valve in the packages should be positioned up close to the end of it so you won't have to cut the sleeve and open the valve with the scissors. On one of the packages, the germicide pill floated off just as I took the package out. I didn't cut it loose, it just came off. I reconstituted some applesauce, some grape juice, and opened a package of chicken bites, and left the brownies closed - as we agreed to leave them closed because of the oil in them. The chicken bites were just as I always remembered chicken bites - just barely edible, and difficult to get out of the package. If you made a wrong move, you are going to have a lot of crumbly chicken bites floating around the cockpit. The applesauce and grape juice reconstituted right away, and I was able to eat it right away. It is difficult to get the feeder part out of the package with a glove on, but nevertheless, you can do it. The repackaging of the food bags worries me, and I noted that in zero-g the grapefruit juice just sort of creeps around that package even though it is folded up and sealed. Over a period of time, the grape juice or other liquids will creep out of the package. We need some kind of tape over the end of that package so that once you seal it, the food won't get out. I recommend that on every flight the crew eat as much of every meal as they can because there is no place to put it. The aft waste containers are worthless. If we have to spend a long period of time up there, we will need a large garbage container of some kind. All the packages floating around is unsatisfactory, and they must be stowed somewhere.

I used the urine nozzle for the second time, after I used it first over Carnarvon, and had much better results the second time, although I think it will take a lot of training to operate that urine nozzle. The valves must be positioned properly to operate it. I didn't try to direct dump and urinate into a flushing urine nozzle because that might have been rather unpleasant. It certainly would be a quick way to get urine over the side without any spillage in the cockpit, and I think

we should investigate it. I will leave that for Ed White and Jim McDivitt to evaluate. Pulling that bellows out and urinating into it and not spilling water is a shaky procedure. That urine is one of the best conductors we have. There should be some better way to relieve ourselves. We shouldn't have to worry about urinating too fast, or too slow, or a bellows pulling procedure, or spilling urine.

The defecation system - the bag works - I don't know what to say about it. We don't have any method of controlling the toilet paper and defecating at zero-g is a mess, just as I thought it would be. There is no way to get the feces to the bottom of the bag; so, it is stuffed right up to the top. It took all the strength I had to break the bacteriacide, and I didn't get it worked in properly, because I didn't have time. I think this is something we can learn to live with; but over a long period of time the moist bowel movement is going to be a darn mess. That is what it was on my flight. The ECS did remove the odor, fortunately. I had to use one of the cleaning rags to finish cleaning myself, and I recommend that we put some extra rags in there for things like that. I finally ended up - actually had some feces on my gloves before I was finished, although I took one glove off to do this. The other times, the food and the waste and urine system were evaluated with gloves on. I made an inflight modification to my pressure suit - I cut the center strap between the two zippers because it prevents you from removing your penis in zero-g to use the uricepticle. I recommend that this cross strap be taken out of all pressure suits, and the zipper be placed a little higher.

The food and waste evaluation took from over the Canaries to past Carnarvon, and I took pictures of the 2-20 translation. I had to seal my suit up right in the middle of the check with the 16-mm camera. I have no idea how the 16-mm photograph will come out, because I don't think the film settings were right for night photography. We didn't get any practice with the 16-mm. It's quite unlikely, in my opinion, that the pictures will be any good.

We checked address 02 over Carnarvon and it verified. 3-1 $T_R$ time also verified. When we got over Hawaii, we got an update and I checked address 02 again. At about 2:50, I did the $O_2$ high rate check. That was the first time we got the oxygen pressure to come down off the peg since we tried $O_2$ high rate back at the first suit check. We did do a suit integrity check. I went to $O_2$ high rate to make sure I had everything sewed up tight. I didn't see any sense in subjecting myself to the heat load that you accumulate after 30 seconds with the suit closed. We had already proved in the altitude chamber, that is a valid method of checking suit integrity.

We had some problems with switching equipment back and forth. Over Hawaii, we started the gage correlation report, and we got some updated times. It was prior to this time that Gus was noticing he had a problem with the horizon scan and with spacecraft roll in Orbit Rate. It appeared to be a problem, but SEF was okay as we passed over the United States. It appeared to be perfectly obvious to determine yaw at those pass-over speeds. It is really something to see that kind of a ground track moving by that fast. Gus did the tracking task after I unhitched the sight. Most of the southern part of the United States was covered with clouds, and it was very difficult to see anything. We did track a small town inland on the southern coast of Mexico, and whether it was a town I took a picture of - on the northeastern shore of Baja, California - whether that was the town that Gus was tracking remains to be seen.

We did the secondary coolant pump checks over Guaymas after they had queried us twice. They wanted to know what the status of checks was, which I thought was unnecessary at the time. Nowhere in the flight plan did it call for requesting the status of a pump check; they were quite insistent about it. All this time, T/M was going to command and back. I was behind trying to keep up with it while trying to take pictures of the various points over the southern United States, too. We did pitch down over a place that we thought was El Paso, but it turned out that you couldn't see it, so we went on the other test. MCC queried us as to the position of our T/M. We did not do the suit fan no. 2 and no. 1 check. We also did not do the RCS heaters check. We did operate on suit fan no. 2, after the main chute. Gus set his event timer and did his platform stabilization check in big-end-forward, and eliminated the horizon scanner control characteristic check. At 3:25, I accomplished the control mode characteristic check of pulse mode, and the rate command system. They both operated just exactly as they do in the simulator. The rate command is a beautiful thing in that spacecraft, a lot of fun to fly.

We got the sea urchin experiment over Carnarvon and over CSQ. We went through the preretro checklist about four times and received a G.m.t. time hack which was again not on the minute. I got the 4-1 command load. I checked 4-1 $T_R$ and recorded the preretro command load that was in the computer. We did not initialize it at this time. But I checked at both Carnarvon and over Hawaii, and there was a different load in each time. I am sure the final load we initialized was proper retro command load. We punched in the 96 ft/sec burn at a minute 48 seconds of burn time; we were in blunt-end-forward all of this time. It was on this pass, that you could pick out the northern sky constellations very well on the night side - Orion's Belt, Auriga, and the Pleiades. This haze layer that is above the earth is approximately two lengths of the Pleiades wide. We really didn't have enough time to

observe. We stowed all equipment; it takes a while to do this at zero-g - you just can't pile it in there. There was no place, for example, for me to stow the launch day urine bag, so I carried it between my knees the entire flight. Gus said he couldn't stow it on his side. As soon as I removed it, it was full of air and hard to handle, to fold up, and fool around with in zero-g. This is certainly going to be a problem on later flights.

We went to reentry on the computer, and at 12 minutes, over Hawaii, Gus started his retroburn and burned out 96 ft/sec in what I think is 1 minute 47 seconds. It might have been a half-second longer. Here again, 97 ft/sec appeared on the IVI's even though 96 feet was inserted in address 25.

Went over the $T_R$-5 checklist about five times. Gus checked the RCS A-ring thrusters and the B-ring thrusters, and I got the adapter batteries off the line. I had been worried that we might lose the computer at this point, although the mains checked out in very good shape. We got to the $T_R$-1 checklist with Gus holding retroattitude. I pushed the OAMS - the OAMS separated beautifully - a noisy click, a rather loud noise when the OAMS separated; the electronics separated with a softer click - those little guillotines firing, and then when I separated the adapter, I actually felt a little retrograde motion and the noise was extremely loud. It really picked up and kicked its way off the spacecraft. At $T_R$-30, I armed auto-retro; Gus turned on the retrorocket squibs, and, all this time we were checking that our $T_R$ time was going down right. I thought I would start my elapsed time clock at retrofire. I pushed the manual retrofire at $T_R$+2. Well, at auto-retrofire I could not start my clock because it really boots you, but I did manage to get a big finger in on the manual retrofire. It seemed to me that it was a slightly hot retrofire. There was around 33/aft and 105 down. I read the numbers to the ground, and it was right down the line. It was a beautiful thing in rate command, right in the center of the little circle - just beautiful, and the last retrorocket wanted to yaw off, just exactly as it did in the simulator. I think Gus was laying for it. I don't know where they got the nominal retrofire, but it was almost exactly like the nominal one in the simulator. There was a considerable discussion, of course, going on at this time of what out bank angles were and what out G.m.t. was, reversing the bank angles, and I wrote all that down inside the spacecraft on the walls, having no other convenient place to write. We must have an accessible place where you can write things and have them right in front of you. After retrofire, all our maneuvers should be based on elapsed time from retrofire, since we have good elapsed time both from retrofire or 5 minutes before retrofire. But it should be one or the other, not both G.m.t. and elapsed time.

We were getting both of them quick and fast and we were having to do our own subtracting. We must have an established standardized procedure and use it every time.

I think the retrofire was hot, because we did land short and were pulling max lift almost all the way. I also think that the lift of that vehicle is not what it is cracked up to be, because the trim point on the spacecraft was way up in the middle of the machine and not at all like GT-2. We went over the retro jettison, post-retrojet checklist for the bank-angle reversal time and bank angles. I think we got them pretty well down, although we didn't get the time to reverse the bank angle in time to do anything about it. I activated the reentry communication experiment on Greenwich mean time (19:05:14), and I would have liked to have activated it on elapsed time from retrofire. The picture of reentry was exactly like the movies of GT-2. I couldn't detect that the reentry communication experiment made any difference in the color of the photos, although it might have made some; you have the same color of gases, the same spiral flow out the window of GT-2. It just appears to be the way the reentry will look color-wise.

The rates were just exactly like the rates we had in the simulator. They are more noticeable looking out the window, and, of course, you can see the spacecraft kicking around a bit, but to me it is quite an enjoyable ride. You feel that there is a stability there. The rates build up a little as the g's come on - and then the frequency goes up and the amplitudes come down. Then the rates build back up a little but they never - Gus flew the reentry in two-rings direct, and had no difficulty in controlling the spacecraft. Now, to me, that's the only way to reenter. Anytime that the rates did build up, Gus would slap them a couple of times and damp them out. I am not sure you really want to damp those rates anyway. He had control over his roll angle, and the needle came off the curve just like it's supposed to and centered up, and we were pulling max lift all the way through the reentry profile. I don't think we ever got above 4.5 or 5g's at maximum, and I felt like we could do it standing up. I was sure we had landed short. I think we just undershot the landing point.

I released the push-to-talk switch about 4 minutes after reentry communications experiment was energized. There is one possible problem there in that you can't always tell when you have the push-to-talk button keyed. I noticed this a couple of times while transmitting. The other problem that gave us trouble was trying to transmit to a station when on RECORD. Toward the end of the flight, I finally arrived to the point where I could transmit to a station and think to go off RECORD before transmitting.

We went over the post-retro checklist - an unnecessary checklist in my opinion. I was so busy trying to copy the bank angle and reversal

times that I just sorta skipped it. The reentry was very interesting. I could see out the window the entire way down. So could Gus, and we could see the horizon practically all the way through reentry. It was a long way until we started pitching down. At 50 000 feet I was watching both my pressure altitude and my absolute pressure gages, the cabin pressure indicator, and Gus's altimeter. We had about six indications to give you a very good hack of your altitude. There is no doubt in your mind when you start going through about 50 000 feet. The color of the sky changes radically, and the g's have backed off to a reasonable amount above 1.0. Gus armed the landing bus, threw out the drogue. On the way down, we were being stabilized pretty well by the RCS, and just as soon as he threw out the drogue, I shut off the manual shutoff valves, and the oscillations got pretty wild; so, Gus had me to turn them back on again. So we put them on for a while, and RCS on rate command damped the spacecraft. Of course, I wanted to get the inlet snorkel out, so I shut the valves off again about 30 000 feet. No spacecraft rates picked up after that. The inlet snorkel and the cabin vent were opened at 28 000 feet. We didn't go to $O_2$ high rate until some time after we were in the water. I don't feel that this produced any significant heat load that the $O_2$ high rate would have taken care of, because I don't think $O_2$ high rate gives you anything in the way of reducing the heat other than 75° F oxygen.

At 10.6, Gus deployed the main chute, and from there on down it was a nice ride. The chute went right out and disreefed in about 10 seconds, and we waited another 10 seconds and then Gus went to landing attitude. That was probably the roughest blow for both of us; it was really a jolt. It pitched both of us right up into the windshield. My shoulder harness was locked, but I don't think it was very tight because I hit my visor almost as hard as Gus did. It was an unexpected surprise. I knew it would be like a free fall, but I didn't think it would be that way. After that, I spent the rest of the time on the way down going over the post-main checklist, turned the heaters off, et cetera. I admit I may have missed some of the switches because I was trying to get the important ones.

After we hit the water we were in contact with the ship on UHF. We were getting conflicting reports as to how far away from them we were. At first, they told us we were 5 miles away from them, then told us we were 55 miles away. We also received conflicting times on when they would get there to pick us up. What we need is somebody to give us a time that's going to be valid. We should get out of those suits as soon as we hit the water. Those suits are not habitable with the spacecraft in the water. Both Gus and I sweated considerably after the spacecraft was in the water. The sea state, in my opinion, was not as bad as it was in the Gulf, when we were practicing in Static Article 5.

As soon as we hit the water, we were pulled (it felt like the spacecraft was trying to dig in) by the parachute. Gus was looking at the water, out through my window. Then he saw he had it through his window, too, and jettisoned the parachute. The shock of hitting the water, in my way of thinking, was easy compared to the one that goes with the single point release. The spacecraft didn't leak a drop. After the UDT men put the collar on, Gus opened the hatch. Then we took our suits off. I know we lost our weight in sweating inside that spacecraft until somebody came along. The oxidizer started bubbling out of the RCS thrusters so we went to $O_2$ high rate and closed our visors. We stayed there for a little while until the oxidizer stopped bubbling. Then we decided to take off our helmets, and there was the smell of burnt metal. I don't think there was any fuel or oxidizer smell in the spacecraft.

It was a tremendous mission from start to finish. I am well pleased with the way that the mission went. The reentry problem in regard to the undershoot, I think, is one we ought to be able to solve. I know Gus was holding max lift all the way in. I have the numbers of the 4-1 load on the flight cards. I think one of the things we want to do is to verify that the numbers I have will, in fact, give us a valid entry, all things considered. I think that our retrofire was slightly hot.

The main problem in flight for long missions is, in my opinion, the development of equipment for stowage, and training in procedures. The Gemini mission simulator must be configured the same way as the spacecraft. It is not going to be easy to do this, but it must be done. I think the voice procedures that are used around the range must be standardized. Flight plan changes at the last moment may be inevitable in a program like this, but they can increase the probability of a mission failure all out of proportion to their value to the total flight plan. I am glad that we were lucky enough and flexible enough to handle this situation where there were some major flight plan changes made at the last moment. This kind of flexibility is necessary, but it takes plenty of practice to do it. We have to establish onboard procedures for getting data and verifying it. We have to develop an effective way to get this post-retrofire bank angle and reverse-bank-angle times up to the flight crew, or let them do it from onboard data.

I certainly enjoyed the flight. It is the way to go! It is a lot of fun and a beautiful experience, a beautiful experience. I forgot to mention that during reentry, Gus and I saw the retropack burn up reentering after us. At some time after adapter SEP, I saw through Gus's window the pump package, or some piece of equipment, flying out from the side of the spacecraft.

It was a pretty uneventful mission, all things considered, but it was pretty interesting. I am just sorry we didn't have long enough to thoroughly look things over during the flight.