E. E. "Buzz" Aldrin, April 4, 1967.

Aldrin: Showed us at that time that--they ran through the missions that they were anticipating, both X and XI, and found some problems. As far as I know, they relayed these results to the crew.

Vorzimmer: Uh-huh, as far as underwater training?

Aldrin: That's right; just how much they received as a result of some of the underwater simulation, I'm not too familiar with.

Vorzimmer: All right, does this...

Aldrin: But I know they relayed a lot of this through Reg Machell.

Vorzimmer: Right. This explains something, because--I've only had a short interview with Machell; I've got a longer one coming up.

Aldrin: I think that the general conclusion, as a result of those tests, was that there were some things that they uncovered that they passed on to the crew, but they didn't uncover anything of a tremendously noteworthy nature that they felt was important enough to involve the crews at that time, in their training schedule.

Vorzimmer: Principally because it was so much easier, and the fact that it was all positive, with regard to underwater, not negative. It was rather the fact that they didn't see the negatives in the zero g parabolas that would have made them feel that the underwater was something that would have canceled out them. This explains, what this explains is that Machell and his handbook is a little bit misleading, you know, that 400-page thing that he produced, what he said about "underwater simulations was used in GT-11 training," you see. This misled me tremendously, because I asked Dick Gordon...and he said no GT-11 crew or backup had underwater training. So it was a little misleading. He was trying, you know, this was a sort of a big blurb for the history of EVA, and he was showing that it was available and had been used to some extent, but not necessarily for crew training for X and XI.

Aldrin: Well, you can't wait until the last two months before a flight, and then say "well, now, we've got a new little simulation we'd like to have you participate in." Because, gee, the last

month, anyway, is all tied up with spacecraft tests and putting the final touches on mission rules and training in the simulator, and unless you have scheduled some of this EVA training into this period, well, that isn't the time to come up with anything.

Vorzimmer: You might say that the last six Gemini crews took a lot less guts than the first six, in the sense that there had to be some real active complaining to ease up on schedule, and by the time you get around to your last mission, nobody is even daring to come to you and ask you to do these things. They were a little bolder in the beginning about making unrealistic time in training lines than they were in the end.

Aldrin: That's right. Most of the people that were involved in the last--command pilots in the last four flights, three flights, anyway, had been pilots from previous flights, or backup crew members.

Vorzimmer: Because I immediately thought of when you said "you can't ask us to do this". Early in the Gemini program, they were asking all over the place, and there were some people that got doors slammed and things like that because they just refused to put up with it. It even got into mission reports where they were even asked to comment on how they thought training was and schedules. There were some comments, I'm sure, that had to be censored before they finally got into the report. I did get a lot on EVA and I think that if you were to see a copy, we could always arrange that, of Gene Cernan's thing, you'd be very pleased because he really covered it well. Well, one reason was because I was trying to get a handle on several factors that accounted for the difficulties. I've think I've got it, with the long interview with Machell coming up, it should just about close it because, you know, I've got the suit trim configuration and the netting, and then, of course, the pressurized business. Dick Gordon's trouble was having been so well trained that he was preped for EVA too long before it, and the water boiler not working to cool because there's no pressure differential, he's still pressurized. I didn't even realize, this is something I picked up in an interview, that accounts for the fact that he was half pooped before he popped the hatch.

Aldrin: Too bad we didn't get a chance to fly the AMU on IX, or to continue this investigation on XII, because there is a whole story involved in operations on the AMU, well, there are many different opinions as to how to go about doing it. This will probably not really come out, and I'm not sure that it is too pertinent since it wasn't flown.

Vorzimmer: Well, I've got some idea. I sort of wonder what you are thinking about, because I asked Gene Cernan, after we'd covered the IX mission, I wanted to go back historically, because one of the first documents I have goes back to the initial DOD-NASA agreement (headquarters level thing) stating that in return for money, the Air Force would help the Gemini program; NASA agreed. So the Air Force made several important inputs. In fact, the early history of Gemini program (I'm not sure how much of all of it will get put in) the great Air Force takeover attempt of the Gemini program. This is the one my partner is covering and it's going to go in.

Aldrin: Uh-huh, I was involved in some of the latter part of that.

Vorzimmer: Yeah, that was really interesting, which, of course, included everything, including getting purely Air Force astronauts. Admitedly, many of you are Air Force personnel, anyway, but they wanted to try it on a different basis than just being alone. But anyway, one of these inputs was in the form of what was in the MMU, complete with an Air Force plan submitted with the piece of hardware, itself, as to how it should be used, which was immediately submitted to FOD and FCSD to evaluate, you know, from their own standpoint. You know, we're not accepting Air Force, we've got to put our own restraints on the system. Gee, now, we're talking about restraints and I said that when I looked at the restraints, I couldn't find the document, (You try and find it - Air Force documents - if they don't want you to find it.) showing their initial plan, all I had was the restraints, and at first they seemed very unrealistic. If you work on the restraints, and what they imply and what they did want, for instance, they said, you know, we want a tether, which implied that the Air Force wanted untethered operation; they said we wanted the astronaut to check out the system before he pushed off in the spacecraft machine, a not unreasonable constraint; and they said, you know, the command pilot must keep him in view at all times; and that he souldn't go more than 100 feet from the spacecraft; there should be enough Delta V OAMS to affect the rescue, this kind of thing. It's a little unrealistic about what was the alternative, if these were restraints, they seem so reasonable. Anyway, Gene went through a long thing about explaining how , though they weren't really restraints and it wasn't a question of being unreasonable, it was just a question of how you programmed the testing of a...

Aldrin: Yeah, you just kind of draw the framework within which you can operate it.

Vorzimmer: All right, that did a good job of that, but then I asked him to carry on from there and he said, "well, you know, not now", looking at it from a hardware or operational point of view, just looking at it from a conceptional standpoint, there is a lot of feeling, especially after IV had gone off, that there was not real justification, for something as big, as complicated, as difficult to check out, and with all the built-in hazards that revolve around those points, and then you want to find justification in the planned operations and functions of either Gemini or Apollo for using such a piece.

Aldrin: That's true, but you have to remember, it wasn't a NASA proposed experiment. There were many people in NASA who weren't particularly in favor of this sophisticated - this degree of sophistication in the piece of gear - but it was an Air Force project, and at one time in the Air Force there was a desire to have a manual maneuvering unit for a manned operation, and also a remote maneuvering unit, which would essentially be the same thing but you would replace man's actions with a television system which would make it remotely operated from the spacecraft. So they wanted to have one piece of gear that could essentially come close to doing these two things. So in order to do the remote part of it, you had to have a very high degree of sophistication involved in it. They decided that, well, at this time we're not sure that we really need the remote part of it, let's concentrate on just the manual part.

Vorzimmer: The difficulty was that many of the Gemini people, the non-military people, using or sort of just projecting on their imagination, saw the only real justification for this as being sort of like the satellite inspection, of which was the Air Force and MOL and their own space program of which this was a part. And of course, there was this tremendous thing ever since your session with Eisenhower about just completely culling out any possible military implication out of Gemini, and they couldn't see anything of a non-military nature in the MMU that couldn't be done with a small maneuvering unit.

Aldrin: Well, you have to remember, that these things were started at a time when people didn't understand just all the ins and outs of stationkeeping. Just how you would position yourself and how close was the best place to be in flying next to another vehicle, to be able to then move from one to the other. I think we've found out that the

control of the spacecraft is very precise and very easy to control the closer you are to the target vehicle. So as a lot of people see it now, there isn't any real need to be sitting a thousand feet away from some vehicle and then move the man over there. It's far easier to move the entire spacecraft over to 15 or 20 feet, or 5 feet, something like that. When you are able to get that close, then the question is, well, how sophisticated a piece of transport gear do you need.

Vorzimmer: And there was also the point that there was no other feasible alternative to the HHMU, and when the problem of stabilization entered they had all this problem of coupling effects. Apparently, from my speaking with Mr. Johnson, upstairs--this problem about pitch and yaw aren't so bad, but roll coupling can lead to some real problems which can't easily be set straight.

Aldrin: Well, it took a rather concerted amount of training to be able to master this, and since I never went through that completely, I don't fully understand what all is really needed. I wasn't pressed with a certain degree of difficulty in being able to control yourself on the air-bearing table. Now just how much of this is...

Vorzimmer: You got one axis at a time, right?

Aldrin: Yes, yes. The result of artifacts in the simulation and how much is actually a genuine problem, these were small forces coming from the umbilical that you are dragging behind you.

Vorzimmer: And then from what I can gather, there is no astronaut in his right mind, even with hundreds of hours of training, that would volunteer to go up and use the HHMU untethered. Kinda like, it would be, you know, you don't mind if you do get into the problem of the roll, and the coupling, as long as someone can pull you back in, there'd be no problem. It would be something else if you weren't tethered.

Aldrin: Well, I wouldn't say that. I think that if you - say the type gear you had on Gemini VIII where you had an adequate supply of life support and then you had adequate propulsion supply, then with the HHMU you'd have...

Vorzimmer: You think about rescue attempts...

Aldrin: Yeah, you could stop yourself, and then you'd rely on the spacecraft to come and pick you up. I wouldn't say that anyone in his right mind wouldn't do that; you'd like to have a little bit more sophisticated piece of gear would be my feeling.

Vorzimmer: Yeah, okay, and its probably safe to say, I wouldn't say that anyway. Yeah, I think that it must have been very satisfying in the sense that the way things are telescoped, piling things onto the Gemini XII mission, as far as the plan, what people wanted you to do, the idea of holding out to answer all the EVA problems, the fact that they were answered must have been very satisfying at the end of the program, because it would have been terrible to have them hang over us.

Aldrin: Without that we wouldn't be able to pursue many of the Apollo applications EVA effort, if we didn't have some basis that we could rely on that was demonstrated in actual flight. Of course, I think Gene would agree, that another exercise along the line of the AMU would have, also, given us many of these same answers that we came up with on XII.

Vorzimmer: The unanswered thing was that work in and around the Agena and EVA, itself, as a concept was satisfactorily closed on the XII mission, but as far as maneuvering is concerned away from the spacecraft, this still leaves an awful lot to be answered, because...

Aldrin: Well, it is very easy to look back, from my standpoint, and say now what did I learn in space that I didn't know ahead of time. And there really isn't a whole lot, except the simulations that we'd been through did give a very good representation of the situation you were going to be faced with.

Vorzimmer: So you really confirmed training and also speculation. Well, that's what Gene said, he said the most pleasing thing about the thing was that you would be able to come back down and say, "boy, you really made a big deal out of all of these things, and it was easy."

Aldrin: Well, it is very easy to get yourself into a difficult position. But you've learned by playing around under water what some of these situations are.

Vorzimmer: Yeah, it's a pity that it couldn't have been done sooner, because that left three missions where...

Aldrin: Well, there is nothing involved in X that indicated we didn't know what we were doing. The degree of hand-holds that were available on the Agena, the Gemini VIII Agena, were less than desirable, there is no doubt about that, but I don't think we

understood what we needed.

Vorzimmer: ...because I asked Gene, I said, well, if you knew, --- he said,I told Mike that he was going to have trouble when he gets to that Agena as far as handholds. And I said was it the fact that you had two month launch centers that didn't make it possible to put in, you know, to make this hardware input for the Agena. But they were with the VIII, weren't they, so they couldn't have made the hardware input on the VIII Agena. That's right, I forgot about that. So you slipped off the VIII Agena?

Aldrin: Right, that's right.

Vorzimmer: Oh, I see. So he wouldn't have had any choice except those...

Aldrin: See, in the AMU operation, there is an exercise to be done at the nose on XII where you hold onto the docking bar and make a few hook connections right at the nose. Well, this was something that we recognized that you couldn't just hold on in one point of contact, that being your hand on the docking bar, and then try and maneuver around with the other hand, but what you'd like to do is to someway draw yourself close to it so you have several points of contact, the side of your body, maybe, and then with the other hand--- To get into this position, well, if you start out in that position, things are fine, you probably can stay there. But to get into that in the first place is not particularly easy. You've got to do some maneuvering around and some pulling on the umbilical in order to get there. And that was not too easy. Well, its the same sort of thing that Mike had; he had to get up to the Agena in some way that he was approaching it from sort of an arbitrary direction, and then, given this situation, he had to get some sort of stability with his hands. I'm not sure whether he had two hands free to do this, or not. I guess he could have just let go of things - he had the gun in one hand and he could let go of that, and then pick it back up.

Vorzimmer: Yeah, he did let go of the gun because he had it down by his side. But you even got to the point of recommending three point attachment as even better than two. Well, I guess that the more attachments, if you're going to be at a work station of any kind for any length of time, like say more than 5 minutes, even three point attachment would be best, wouldn't it? ...

Aldrin: Well, the job you have to perform is very important, and you want to take time, which I guess this is what we learned, because you could waste away a lot of time trying to perform the job, and if you take some of that preliminary time and put it into some sort of restraint system , when you got around to doing the job, it was a piece of cake and you'd wasted a little bit of time perhaps in hooking these restraints up, but it was well worth it because it made the rest of the job rather easy.

Vorzimmer: Oh, I knew there was a question I forgot to ask Gene, and that was was the ELSS ever updated in its capacity to handle BTU work loads after Gene's mission or in any of the subsequent missions?

Aldrin: We looked into ways of drying beforehand, drying the water boiler systems and the wicking systems out so that we could load more water in.

Vorzimmer: Yeah, Gene said his gave out just as he was in the hatchway.

Aldrin: Well, that's what they conjecture, I think. No, as I recall, there wasn't any tremendous change, any significant change, in the operation of the ELSS.

Vorzimmer: I suppose then the idea is if it can handle a given work load, the idea is to use various things in the programming of the EVA to keep the BTU from exceeding the amount that the ELSS could handle effectively. In other words, keep the workload so that it doesn't overreach the ELSS, rather than raise the - go to the extra difficulties of revamping the ELSS to account for it.

Aldrin: Yes, well, they eventually boiled down to how much oxygen do you have available that you can pump through the umbilical, because you can go to various flow modes before the fact and say to yourself, "I'm going to use a lot of oxygen", and you can increase the capability for cooling. I think, and rightly so, that most people felt that "well, I'll see how the ELSS operates in the normal mode of operation, and if it operates all right, fine, I won't change it. If I see I need something else, then I'll go to some of these modes." So the normal mission was planned to make use of a normal, medium type flow. Now, we decided on XII that we'd go to a different mode of operation. But again, I found that this was not really necessary.

Vorzimmer: Yours went extremely smoothly, because you have the rest periods and the whole time line of EVA was pretty well mapped out, wasn't it? Well, I think that, as far as the EVA is concerned, I think that I've got a pretty good picture of... Oh, yeah, there's another question I was going to ask, they are just coming to me now, because they flow pretty quickly in the interviews. I guess its about the work loads. Have they ever come on (this is sort of an almost naive question), but have they ever come on to the astronauts about smoking? Or don't that many of them smoke? Cigarettes, I mean. Because this sounds like it might be a problem, you know, wind and respiratory rates.

Aldrin: You're catching me with a cold, and it's not sounding very good.

Vorzimmer: Yeah, but have they ever tried to come down on them about that? Because that's the first thing you think of is your wind, you know.

Aldrin: No, most crew people, if they are exposed to this type of an endeavor, EVA or high exertion, do quit smoking for sometime before the flight.

Vorzimmer: I see. I just was wondering, that's kind of a bad question to ask, you know what I mean - did any of the EVA pilots smoke before they did their EVA, you know - because that's the first thing you think of, because at the time, the way the press handled it, it looked like, you know, when they said they couldn't explain why these people fatigued so early, that seems like it would be one of the first questions that people would ask, like "gosh, it sounds like they are all 3-pack-a-day men," you know.

Aldrin: Yeah, well, of course, we do run, or we ran the ergometer type study which converts BTU output and compares it against the respiration rate and the heart rate, so we do have, just by looking at this for the people that are involved in it...

Vorzimmer: Right. You'd get a profile on it before they would get up there. Right. That was just one of the ones I thought I would ask, and see.

Aldrin: No one has been at all concerned about what kind of physical condition the people have been in.

Vorzimmer: Yeah, I guess it is pretty well assumed. Let's see, you didn't get the---they were going to put the AMU on XII, weren't they?

Aldrin: Uh-huh.

Vorzimmer: But that was one of the things when the time line telescope went off --- did you have an HHMU on XII?

Aldrin: No. We were going to have the AMU until, I guess, about 2 or 3 weeks after XI flew. It was still up in the air, and I forget the exact date when it was finally modified. It didn't leave us too much time to come up with some plans. But, well, as a matter of fact, the day XI lifted off, I was in the water, and I saw the lift off of XI on television, standing in the water with all this stuff on, in the suit, at Baltimore. I was there on an AMU type underwater simulation, the preparation part of it.

Vorzimmer: Well, that just leads me to another question, about this thing that everybody is going off on right now. How can we possibly relate scuba diving to practice for EVA, suited EVA?

Aldrin: Well, the emergency procedures that are involved in suited operation are intimately tied in with scuba diving. If you have leaks, why you take off your helmet and you make use of your scuba gear to get back up to the surface.

Vorzimmer: Right. Oh, I thought you were going to put a spacesuit on. I see, that's the only thing.

Aldrin: Yeah, if you're in a suit and you have a leak where you can't get out in some way, you've got so much lead on you that you can't move, you can't swim, you've got to have ...

Vorzimmer: Oh, your thinking about landing in the water now?

Aldrin: No, no. I'm talking about underwater EVA simulations. In order to do that you must prepare the people for certain emergency modes of operation that they might find themselves faced with.

Vorzimmer: Oh, so this is training for that emergency, rather than training for---oh, I see, I was just ...

Aldrin: No, it has nothing to do with recovery operation.

Vorzimmer: Yeah, and its got nothing to do with the workloads in EVA.

Aldrin: Well, let me say this, you don't always have to put on a suit to go through the whole schmeer of EVA simulation. It may be that you can accomplish part of it, of course, you're not going to be involved with flippers or anything like that, cause that gives you a locomotion that you don't want to make use of, but you could go through the EVA part of a task with scuba gear on and come up with some degree of representation of...

Vorzimmer: Well, you know, my latest thought was...

Aldrin: It is much simpler to do it this way. As a matter of fact, that's what a lot of the guys in our division have been doing, they've been running through the EVA tasks with scuba gear to work out the procedures. Of course, the crew could get their first training exposure to this with the scuba gear, and then they'd go to the suited operations.

Vorzimmer: Well, my first thought was, you know, gee, I don't mind them all going down to Florida and having a nice week in the water, but I thought, boy, what kind of a justification, you know, I mean, why did they have to make it public and try and justify it as EVA, cause I thought, you know, the only real EVA would be suited, you know. But I didn't realize that this was part of the training...

Aldrin: No, I went through the tank in Baltimore first with the scuba gear, and then my suit. Then when I was familiar with what the task was, then each time I went up there I just went suited.

Vorzimmer: All right, there's no---as a scuba man, having done some, anyway, myself, when your pressurized, when your outside pressure is the same as regular earthbound pressure, there's no problems, but in scuba diving, when you are actually scuba diving, you notice a pressure differential on your lungs, like when you take in. Mind you, it depends on your demand regulator, but you can still notice the difference. This isn't the case in EVA, is it?

Aldrin: No.

Vorzimmer: You're pressurized close enough to ground pressure so you don't feel a great strain in taking in...

Aldrin: The breathing is such...well, it depends on what kind of scuba gear you have. Some of the regulators are very smooth, require very little effort, and of course, for a good one it doesn't vary when you go up or down in the water.

Vorzimmer: Right. Well, that was--mine did. Okay, well, now, the main thing that I wanted to talk to you about was, of course, this orbital mechanics and rendezvous and docking and I did have one of my first interviews yesterday.

Aldrin: Oh, you didn't want to concentrate on the EVA part, then?

Vorzimmer: Well, no, wait, hang on. If there is something about EVA that you feel you want to put in as far as an input is concerned, you know, that isn't on the record, you know, I more than welcome it, because this is exactly the opportunity to get the kind of stuff that couldn't be gotten otherwise.

Aldrin: Well, of course, I'm not sure what all you have.

Vorzimmer: Well, in writing this preliminary paper which is going to be helpful for the book, on, you know, this dispelling the myth of the great unknown and mystery factor about EVA. The press has been on this ever since IV, where they tried to make like rapture of the deep where, you know, you've got a great euphoria. And then when they couldn't work that one out after No. 9...

Aldrin: One thing you have to realize, and it may be that the guy that is up there realized it more than anyone else, all the effort that has gone into putting him there, and he has a little bit more opportunity to learn what's going on and become familiar with the situation, so that he is very reluctant to want to call it quits.

Vorzimmer: Uh-huh. That's true.

Aldrin: It is a rather pleasant situation, but it isn't the sort of thing that people lose their heads, at all, as to what's going on. In fact, during our third EVA, I didn't see any reason why we were in such a hurry to get back in again. Just standing in the hatch, I could have just stood in the hatch and floated around a little bit and could have learned a little bit more about that type of configuration.

Vorzimmer: Yeah, and the same applies in a different context, too, what you were saying about not wanting to leave the situation, you know. And that is when Gene Cernan was in the back, the idea of saying well, I'll hold on for another pass, and give it half a chance. I mean, its not for any euphoric reason, it's also for the reason that, damn it all, it cost a hell of a lot of money to get up there, and also for personal reason, damn it all, this may be my only chance for a long while; and then there is always the idea that a lot of other people, you know, get so far, especially on that AMU, it must have been tough to call it quits when you did absolutely just about everything that was required except to unleash yourself and push off, so that there is always that point; you don't want to call it quits for a lot of other reasons, besides that, you just like it. But, I want to do a good job on...

Aldrin: Let's see, did we go into the flying aspect of the AMU?

Vorzimmer: How do you mean?

Aldrin: The training for how you maneuver with it?

Vorzimmer: You mean the 135 zero-g?

Aldrin: No, the actual flying on the AMU?

Vorzimmer: You mean the air bearing table.

Aldrin: How you operate the AMU.

Vorzimmer: Oh, yeah. I went into that, you know, I read the thing that Machell put out on the...

Aldrin: Well, in one part they talked about techniques that had been set up by the contractors, by LTV and also by people at Langley, as to how you should go about flying the AMU, to go from one point to another.

Vorzimmer: I see.

Aldrin: Now, you see, there is a peculiarity with the AMU system in that we didn't have any side thrust, you could translate forward and back, and up and down, but there was no translation to the left or to the right.

Vorzimmer: I see.

Aldrin: Now, when you want to go from one point to another, we call--you break down the task you're performing into maybe three. One of them is maintaining an attitude control or an attitude reference, some particular orientation. Then if you want to move from one place to another, you have a motion toward it that you want to keep at a certain rate and if you get close, you want to stop it. So this is a range rate type control. Now the direction that you are going has a particular orientation to where the target is. Now if you're not going toward the target, why you are going to see some drift in what we call line of sight. So it is just like the rendezvous maneuver, you have to control the line of sight so that you are moving toward the target, not toward some offset point. You do this by observing the motion of the target against some background, or with respect to some reference range. It may be the total, in other words, you look out and say, okay, I know what...

Vorzimmer: But isn't the target, to all intents and purposes, a stationary one? If your relative motions to the earth are the same?

Aldrin: Yeah, but if I'm moving off this way as I look up at the target, you can appear to move this way. If I go toward him at one point, I still have this side velocity, and I'm going to see that and eventually I'm going to miss it. So what you have to do is observe that you are going to miss it and now thrust to stop this motion of the line of sight. This, of course, is perpendicular to the line of sight, so you have to have a capability of thrusting up, down, left and right, to be able to keep yourself on a collision course. Now the AMU you didn't have this left-right thrust capability, so in order to make up for that, you say, well, the recommended way to do it was to say, well, if I see him drifting off to one side like this, what I'll do is roll over like this and then I'll use my up thrusters to go along with it, and then I'll see how things go there. Then he may be drifting this way and I may keep going back to the original orientation, or I may hold whatever I've got and then look at the problem again. Then there may be

ways of, well, if I see that the target is moving off this way, I may turn sideways and thrust forward and then go back like this.

Vorzimmer: How do you turn sideways?

Aldrin: With attitude control, the same way that you'd roll.

Vorzimmer: I see.

Aldrin: You use the attitude hand controller and twist it to the side, which...

Vorzimmer: That's right. Okay, well, then, you really don't need it because if you have attitude control instead of maneuver control ...

Aldrin: Yeah, but everyone agreed what we'd really like was not to have to make an attitude change to be able to thrust in this direction, because that's the way we fly the spacecraft. Well, I looked at this situation. Somehow, I started flying the trainer out at Edwards, and I didn't care for the fact that you didn't have this left and right control. It seemed like it was very messy to have to go to some of these other ways. So to the extent that that simulator would enable me, why, I would turn to the side somewhat and come in sort of askew. Now I could use my forward thrusters which would give me left-right control, but they would also give me a little bit of closing and stopping and I had to play this off. Then when we got up to Dallas where they had a simulation where you could turn completely away from the target if you wanted, I told the people that one of the first things I wanted to do was to investigate a different way of flying one point to the other, to see, you know, whether it would be simpler or if we'd have any other problems, or just what the story was. The guy up there who had flown this simulator many times listened to me and said well, that's great. But he didn't really think it was worth anything, but he said okay, we'll let him play his game, you know, so I went in there and flew this thing and he was really amazed. He said he never would have believed it if he hadn't seen it - how much easier it was the way I had come up with flying it. That was to point yourself toward it and establish a closing rate, then immediately turn sideways. Then everything was done after that in a sideways motion, so that you were essentially flying the AMU approaching your target side. Now you have up-down, left and right. You didn't need to thrust this way, or if you did...

Vorzimmer: Right. Initially you commit yourself in this side attitude and...

Aldrin: If you didn't like the closing velocity, then you come back and you make some change. But usually you establish that and you could observe that. This was something that you didn't have to do something about immediately.

Vorzimmer: Right. Initially you commit yourself to this first 90° motion, and then you orient yourself so that you have the alternatives as you need them, as you close in on the object, so that you wouldn't reverse...

Aldrin: That's right, now, as you get just about ready to get there and you know that you've still got a closing rate, at some point in there if you say, well, I'm closing a little bit too fast, you can come around like this and take off a little bit, and you can say well, all right, I've still got --- and then go back to this. The last thing you do before you get there is to turn right around and give it one squirt before you get there, you disable the system and then catch what you are coming to.

Vorzimmer: Oh, right. Because doing it in reverse, you have to do it all at the end whenever the situation arises. Yeah, I could see that. Did you do any hand-hold maneuver unit training?

Aldrin: Rather briefly.

Vorzimmer: Yeah. But, then, of course, you stayed on the spacecraft the whole time in your EVA?

Aldrin: In the actual work, yes. Everything was done with handholds; all the motion and all the transporting was done by holding onto the spacecraft one way or another.

Vorzimmer: Uh-huh. One of the other things, one of the other factors that dispels the so-called mysteries of EVA, is this thing about suit-trim, due to the nylon mesh underneath is trimmed in a sort of this type position, roughly a sitting position with things like... then added to that the fact that the suit is pressurized which has another, which accentuates the trim configuration.

Aldrin: Well, certainly, if it weren't for the pressurization you could put your hand in any position you want and it would stay there, sort of

like an overcoat.

Vorzimmer: Oh, really? Well, what about the trim netting? The netting only has one access of...

Aldrin: Yeah, but that only really comes in to play when he's pressurized.

Vorzimmer: Oh, really? When you're not pressurized in the suit, you don't feel the netting at all?

Aldrin: No.

Vorzimmer: I see. What about weightless, unpressurized weightless? I was told that there was a tendency for the arms to drift into some sort of trim, if you want to use that term, trim configuration, which might have something to do with it. It's probably very small...

Aldrin: Yes, but the forces involved against that are...

Vorzimmer: ...the visor with this fact that...

Aldrin: But that was pressurized.

Vorzimmer: Right, but I was trying to think now, how much of that work against configuration might have been due to the structure of the suit.

Aldrin: Oh, that was...

Vorzimmer: It was all pressurization?

Aldrin: Yes. Well, you can't separate the two. When you pressurize the suit, it goes to a neutral position that is determined by the netting inside.

Vorzimmer: Oh. But apparently, that was more than people realized, cause, I mean after all, there is...

Aldrin: Well, you just didn't want to move away from this position and work in some area for a long period of time.

Vorzimmer: Uh-huh. And there is this much difficulty in gravity, when you really think about it, of holding your arms out like this for more than 10 minutes; this must be similar to what you are doing - its almost like adding gravity in that suit.

Aldrin: That's right, its very tiring.

Vorzimmer: That was something I didn't realize, and then combining the visor fitting problem with the fact that your water boiler isn't working because you haven't depressurized yet, it does add a, you know--what bothers me, and the reason I was very keen on writing this paper even though someone else suggested it, was that nobody has gone to any effort to explain why. The public, I think, still remains, they feel that there have been mysteries to EVA. That was another thing, anyway, that helps to understand the problems, but no one ever mentions the suit configuration under pressure as being very much accounting for the problem.

Aldrin: Well, it was all recognized by us.

Vorzimmer: Yeah, but that's the trouble, that's another reason why I was saying to these people I have interviewed, saying the official history is the place to put those things which you yourself are aware of, you know, as a problem resolved, or a task achieved, or an objective accomplished, which in realtime with publicity, they latch onto ... in other words, three rendezvous accomplished in - well, three different types of rendezvous accomplished in one mission, and it was never mentioned because of the fact of the "angry alligator," and because of the AMU problems, and in other words, when the dust of publicity sort of settles down after a mission, it must be very disheartening for the man who was on that mission, and all the people who were involved in the mission to find that...

Aldrin: Oh, well, we know the significant parts are recognized by the people...

Vorzimmer: By the people that are really in , but just the same, one of the first lessons I think you learn when you come to work for the government, and I'm not saying, you know, is the fact that how when you really realize the implication, how the public is made aware of these things can be important, because when that budget gets cut, because they think, you know, that nothing has happened, then you suddenly become intimately aware of the importance. I'm not trying to justify Public Affairs people, I think they sometimes get most aggravating, because I'm sitting in a building full of them, and I think they are the biggest bunch of "duds" I've ever seen, but on the

other hand, you know, this is just another way of saying that that can be more important that a lot of people realize. You know, you can have the most beautiful scientific thing, and if the public isn't educated to appreciate what is being done, and they only see the failures that the press are only too happy to point out for their news media. It sure can make a whale of a difference. So it must be a little bit disappointing, I mean, after all, you know, you've got your kids and your wife and your neighbors, you know, and they look for you to come down and all they can see is boy, you sure couldn't get that AMU off your back, and you sure got pooped out there pretty quickly. And there's just the sense, you know, that you do want public record, some permanent record to carry, and you don't want it, just like, you know, to be continually drowned out, because they thought that the loss of the camera or micrometeorite package was worthy of three times as many pages of newsprint than the fact that you accomplished three different types of rendezvous, or that you accomplished an M=1 rendezvous, or that you showed that there were three kinds of prime and backup systems for accomplishing a rendezvous with radar, etc. I mean, somehow, the public record, as far as print and popular conception, they are really not that interested, because of the effort and the type of people it takes to translate this into terms that can be appreciated, so all this stuff about radar transponders, they are perfectly willing to say "and rendezvous was accomplished", in other words, they're more concerned with the number of minutes it took than with the equipment that you proved out could work. So that's one thing I wanted to emphasize as far as the interviews are concerned, because I thought this was a good chance for the people concerned to emphasize what they thought from a skilled, professional way, was the thing about the mission that deserved the greatest amount of coverage, and I've gotten some things that - I've gotten educated myself because outside the mission reports and the briefings and the press, and the air-ground rules, the only thing I've got is just a layman's thoughts. So I learn a lot myself when somebody says "Look, now, the most important thing about my mission was this," you know, because sometimes it has been obscured. And so, sort of getting on back now toward your own field of specialty, then its the rendezvous and the orbital mechanics, you know, this is a good point because it is so complicated, because it is very hard, even for myself, to visualize, you know, in three dimension some of these spatial things, you know, like transfer maneuvers and...

Aldrin: It's hard enough in two dimensions.

Vorzimmer: Right, to visualize this, this is one of the things that I really wanted to think on, because, after all, rendezvous is one of the prime objectives of the...

Aldrin: It all depends on how much detail you're going to be going in to, how much use you'll be making of pictorial displays, and that sort of thing. It is very difficult to sit down and write a lot of words about rendezvous.

Vorzimmer: Right. It's also going to be how well a particular person like myself can translate into understandable sentences, without just using two dimensional pictures plus words. Well, why don't we just start this way, we'll start with the history because this is always a good way to work up to it. In other words, all right, one of the early objectives of the Gemini program, we'll just go back to say '59, cause it was '61 when they came, when Chamberlin set up full design and function thing, was of course, rendezvous in the program. And, I'm trying to think, a man named Grimm, Dean Grimm, and something Kramer...

Aldrin: Paul Kramer?

Vorzimmer: Don't know, something that ended in ly, not Carley, but Timberly or something like that...

Aldrin: Lineberry?

Vorzimmer: Lineberry, okay, that's right. Lineberry, Grimm, yourself...

Aldrin: Tindall.

Vorzimmer: Tindall. How about Colonel Stafford? Was he on that at the beginning?

Aldrin: Well, there were a lot of people involved in it.

Vorzimmer: Well, I want to get their names, you see. One other thing about official history, that you can't get away from, is that everybody has to be named, you know what I mean. Credits have to be doled out, I just want to think of a few to remember all the people involved.

Aldrin: Well, there are the flight operations people. I moved around quite a bit (this was before I got into the program) just to find out who really was making a lot of these decisions. Some of this even took place before Matthews took over the Gemini program. I came down from MIT and sat in on a couple of meetings - I guess the first one was the first rendezvous and reentry meeting they had in July of '62. We talked with some of the Lockheed people, the McDonnell people, about the way that rendezvous was going to be accomplished. And of course, at that time they had put a certain amount of effort into it, and it was based around the primary on-board system of operating. That is, getting radar input and combining this with platform reference information, and processing various tracking to come up with a solution.

Vorzimmer: These are in-craft radar ...

Aldrin: On-board radar. Now, everything that was brought to bear on this was how do you make that system do the job, and there were several people interested also in how well can we do in case some of these systems don't work, and how well can a person judge to see whether the primary system is working properly. We all pretty much came to the conclusion that you want to have some fairly simple, straightforward way of operating, to put yourself in a position so that the backup and the monitoring modes would be meaningful. The problem itself is very complex, how you get from one point to another, but if you can set the stage so that you can eliminate some of these variables and wait for a certain situation to occur, then you can by similarity, say "well, I expect, given these initial conditions which I have strived and waited until they occur, now I can compare this with something that I know." In trying to get this point across, I guess, in a version of writing up my thesis, I compared this to flying an airplane. Certain things that you do in flying an airplane, the fighter type, like the gunnery pattern or landing pattern, in an air-to-air gunnery pattern or a landing pattern, once you get on a downward leg, you're essentially moving parallel to the runway, but in an opposite direction, and what is your thought process? Well, you try to get a certain altitude and speed condition; say you look out at the end of the runway or at the target, and you wait for a certain condition to occur, you wait until you travel on down here, and when you reach that point, then you start to make a turn. Now, immediately, you start comparing what you see with what you've learned you should be seeing and you make corrections accordingly. You are putting yourself on some sort of collision course, into this point that you want to reach, whether it is firing at the target, or whether it is landing on the end of the runway. And you fly a pass and you make an observation, then you make the correction

based upon this error in observation. And you're trying to fly nominal, now. You don't always force yourself back to the standard one, but you adapt yourself into one that's going to get you there. You have to make these meaningful observations, but what did we do? Well, we learned that you don't start from any arbitrary position and say I want to land and then go right from there. You set the situation up beforehand, so that you eliminate many of these variables so that you are looking for one, really, cause you can have two or three things changing...

Vorzimmer: ...you stayed nominal all the way?

Aldrin: Yeah, you have two or three things changing, and if you do, then you find that while one of them may be right, the other isn't. Well, then you haven't set the conditions up properly, so in trying to apply this to a rendezvous condition, many people have come to the conclusion that its a very simple setup. If you have a target in orbit and you say, "Now what I want to do is focus everything in relation to this target that's in the orbit, so I will set up a coordinate system that goes down to the center of the earth here," and rotates with him. He's going in orbit this way, so the earth may be down here. Now this coordinate system rotates in this direction here, with his orbital motion. The surface of the Earth and that sort of thing, is in a plane of his orbit, and the surface of the Earth is moving this way rapidly, at the same speed that he would be moving that way in orbit. Now you can look at what happens to people or to other vehicles that may be in his vicinity in some sort of an orbital condition. What I've really got here is the Earth, with one target in orbit here. Now if I look at another vehicle in orbit, in a circular orbit also, but just a little bit lower down than he is, I'd find that while, if he were in a position at some point below this orbit, he would stay that same distance below this orbit and he'd be in this direction. He would catch up. The reason he would catch up is because he has a shorter distance to go in orbit, but also, because of orbital mechanics, his motion is faster; the closer you are to the center of the Earth, the faster you would travel. So not only is he going a shorter distance, but he's going faster also. So there's a rate of catchup that goes on here. Well, now you can see analogy, if you want to go from some point up to this one here, if you set yourself in this condition here, you'd have really only one variable that is changing, and that is this angle that you observe. You get an angle like this, at one time, or an angle here or range, something like that; you pinpoint one thing that's really changing, that's your position along here. Now, you can look at various trajectories that will bring you on in to an intercept, and they range from the ones that come in like this that would be similar to a transfer that takes 180°, depart this orbit here and come over and intercept over here. That

is called a "Hohmann" transfer, and we learned a long time that that's cheapest way to do it. But it's also a rather sensitive trajectory for many reasons. That is, if you are applying a certain change in velocity here, and you're getting the maximum amount of radius change here for that change in velocity, which also says that errors that are apparent here, due to my not being in the right orbit or applying the wrong velocity, are going to be magnified to the maximum degree 180° later. So you say, well, maybe if I don't try and do the optimum or do something that brings me in a little bit more brute force, I could drive from about here and I could try and do it with a larger amount of velocity here and a larger amount of velocity change when I get there, come on up with something like this then, you find, well, gee, I'm not as sensitive to errors and things are a lot more straightforward as far as what I see, but I need to expend a lot of fuel here and a lot of fuel here. So it becomes a trade off. How do you want to do it? Well, we've said that someone in a lower circular orbit would move along like this. What happens if the person isn't in a circular orbit here, if he's in an elliptical orbit? We'd find that he was something like this; you would have apogee and perigee, and apogee as he approaches, but this motion is really a combination of two motions. Let's say for example that--I'm just giving you a little background here, it may be helpful--that here I've got this guy in a circular orbit. If I had someone else in a circular orbit at the same altitude, but placed a little bit behind him, he'd be right here and he'd stay right there. Now, if I put a person in an orbit that has the same mean radius, or semi-major axis that have the same period as the guy in the circular orbit, what would his motion look like? Well, it turns out that his motion would be something like this. He trades out this ellipse, which turns out to be very nearly a 2 by 1 ellipse. So what do we really have in this case here? We have an ellipse going on, but also the center of that ellips is moving like this, so we have the end result of this kind of motion, the combination of these two. Now, of course, if somebody is following him in a circular orbit, he's going to be this way. So, you say, the first thing I'd like to do is to get this condition of approaching in a smooth fashion. But then you have to do something out in here to get into that condition, and we're going with the assumption we are only dealing with circular orbits, you see. Now, let's say that I do that and now I come in here and I want to make this trajectory. You have to decide, between these two orbits now, what sort of transfer do I want to have? In other words, what central angle do I want to go through? Is it going to be 180, more than that or less than that? And what direction do I want to approach him from underneath? Or do I want to approach him from being right

out in front of him? That means that during the last portion of this, I'm going to be looking up this way against the sky; if I approach him from above, then I'll be looking down here. I could very easily get into a situation where I'm really moving like that and if it worked out all right then the target could be right here. So I could have that kind of an approach trajectory. Well, in looking over all these things, we finally came up with certain more favorable ways of doing it, and it turned out that it was something like 130° of travel, and if we had the starting point such that to depart a circular orbit, and looking right in this direction, if it was also such that I thrusted in that direction to leave this orbit, and then start out moving like this-- And if it was on the right trajectory, 130° later I'd be coming in like this. I'd be approaching, looking about in a direction like this. When you compared the cost of that one with this optimum Hohmann transfer, it was maybe 1.8 or maybe 2 times, twice the velocity, but it more than made up for itself, because we were making ourselves not susceptible to errors. Now, since this is the non-optimum portion of the trajectory, in other words, I'm covering this radius change, sort of a non-optimum way, I may be getting from insertion into orbit up to this point, in a very optimum way. So it leads me to want to minimize this amount of altitude change, because that's going to be done inefficiently. Also, the smaller this is, the closer I am, and the better the radar system works. However, if I get this thing too close, that little error in getting into this orbit will be much more magnified and will give rise to large changes and things happening that I don't expect. So you have to look at this and make many, many runs with these errors and you come up with ways of saying well, which is really the optimum altitude difference to have in here.

Vorzimmer: You have a small, before you get to that position, when you are going up to that position, you have a small buffer there anyway, don't you? I mean, before you get to that point you know, where you started it? You know the one over there...

End of tape.

Aldrin: Why people make selections is their own--it's rather difficult--you volunteer for the program.

Vorzimmer: Right. But, you were obviously started on your PhD research before you came here.

Aldrin: Yeah, let me briefly run through it and you can pick out what you want.

Vorzimmer: Okay.

Aldrin: Coming back from Germany in '59 to go to MIT, it just occurred to me that flying airplanes wasn't enough anymore, you had to get a little bit more education, so I got enrolled in MIT in a two year program for a masters degree. While I was there, Ed White had been selected for the Gemini second crew. I communicated with him a little bit and talked to him some, and it was about that time that-- I was beginning to get interested in rendezvous, because I thought about whether I should maybe leave MIT after two years, and go to test pilot school, to further qualify myself for possible astronaut work, or whether I'd be better off staying at MIT and work for a doctors degree. You know, it was something that I could probably do at that time, but to do it at any other future time would be, after putting in 2 years for masters degree, it would probably be very difficult. So I finally made the decision that I'd be better off to stay and work for the doctors degree fairly close at hand, at least I could make an effort for it, then maybe go on to Edwards after that. Anyway, I started thinking about what subject I could work a thesis around, and it had to be something that was useful in an operational way, somewhere in the next 10 to 15 years. That's what I was looking for, something to work on that could be used in some fashion. It had to make use of the particular talents that I had, background experience as a fighter pilot and military academy, combined with the navigation and orbital mechanics, or whatever MIT had to offer me. I couldn't just plod down analyzing and adapter control systems, or something like that, or coordinate systems for inertial navigation,because there are a lot of people that are there that can do that, but I had a talent as a pilot that I wanted to couple into whatever I did. So three things came to mind; one was working on a landing type vehicle without an atmosphere around the moon. Of course, we were involved in the Apollo program at that time and I knew all sorts of people were beginning to work on that, besides

it didn't seem to have too much significance to the Air Force and I wanted what I was doing to be useful to them. I looked at reentry guidance and I figured, gee, there are all sorts of airplane makers that their aerodynamicists are out of jobs, because they aren't making as many airplanes anymore, they are sure working on this problem, and how can I really contribute to that? It seemed to me that the field of rendezvous is something that no one had an operator's concept yet in that field. No one had taken the pilot part of it and really coupled it into the orbital mechanics to come up with a guidance. People that had done this from a pilot's standpoint were very naive in their approach. And, of course, people who had gone the other way with automatic system had no thought at all of the pilot other than someone to push buttons, the systems would be automatic as far as they were concerned. So that is what I started to working on, and to narrow it down, you've got to pick some sort of example. You can't just say, now, let's take an arbitrary vehicle because you never find arbitrary vehicles. You may find two or three different types in the total of history that you'll ever think about. So the best thing to do is to look at a specific one. Well, there is the choice of Apollo or Gemini. Gemini appeared to be a lot more geared toward the manual pilot approach. Apollo was much less defined at that time, we didn't even know whether we were going to lunar-orbit rendezvous, really. It might have been Earth-orbit rendezvous. So I sort of used Gemini as a model,looking at this problem of manned controls for rendezvous, of course. It depends on what man can do - he doesn't have a radar sight inside him, so you say well, let me look at the line of sight guidance--how much thrusting do you do with perpendicular line of sight, assuming you have no information as to what's going on with any radar system, or maybe its just basic information and you'd have to process it in some fashion. So that got me interested in that and I started going along that line and I found it was advantageous to maybe sit in on a meeting down here and see what they were doing. I was out at SSD talking to some people out there in Los Angeles, from there I came back through Houston to that meeting that I attended in July of '62. Then I communicated back and forth with some of the people here, Chamberlin and the man that worked for him, Jim Rose. And I sent them a couple of things that had occurred to me that might be pertinent. I don't know where they ended up, I guess in a file somewhere. And then of course, I got assigned from MIT--

Vorzimmer: What was the title of your thesis?

Aldrin: Line of Sight Guidance Techniques for Manned Orbital Rendezvous. I was assigned out to the Gemini target vehicle office at SSD in Los Angeles for my assignment out of MIT. I was working with the Agena and the studies that Lockheed was doing concerned with the rendezvous sequence of maneuvers. From there, of course, I started attending these meetings. Then we appointed an ad hoc committee at SSD to study the USAF participation in the Gemini program. This was March of '63. I got myself involved in that group and came here for about 2 months with that program. The competition for the selection was taking place during that summer for the third group. In the meantime, it looked like there might be an opening in the Air Force experiment office here in Houston. So I was assigned here, whether or not I was selected. The selection, of course, was made in October of '63, and we started working in '64. About 6 months of schooling, academic training, and during this time I would attend as many of these meetings as I could, mission planning meetings, and it was during that time that we came up with plans for Gemini VI, at least looking at it in a preliminary fashion.

Vorzimmer: Yeah, I suppose that segment of your training which dealt with orbital mechanics, etc., you could in turn use to go to those meetings. I'd be interested in hearing a little bit about when you were assigned to SSD, and then when you transferred over. Were you on the ad hoc committee for the Air Force participation in Gemini, I think it was in January of '63 that, or December, '62 or January '63 that the NASA/DOD agreement was signed, and what exactly did . . .

Aldrin: Well, a lot had taken place before that. All this stuff about "blue" Gemini, and the Air Force being big in the Gemini program had flared up and then had been put down before this time. So this was just a renewed look at what their participation could be; we looked at purchasing several Gemini vehicles and interspersing them in the Gemini program, we looked at that, we looked at just the experiments, we looked at maybe two at the end, and then we looked at a program of maybe 4, 5 or 6 Gemini spacecraft used at the end of the Gemini program, launched on Titan 2's, or launched on Titan 3's. Then we made various recommendations. In general, if you're going to get into it, we said, well, you may as well get into it all the way and go with the Titan 3.

Vorzimmer: Yeah, there were a lot of reservations about using that.

Aldrin: That was about the same time the discussions about whether to go with Gemini or with Dinosaur. This delayed things, and they finally decided it was Gemini, but then they wanted to study what this lab ought to be. They didn't want to just have a trans-stage back to erring with the Gemini, and do things that we had been doing.

Vorzimmer: Well, the Air Force apparently , I mean, the Air Force MOL is not a dead issue, is it?

Aldrin: No, no.

Vorzimmer: Even though Apollo applications seems definitely to be a sort of competition, but I guess they are not supposed to be...

Aldrin: Well, it's certainly for entirely different purposes.

Vorzimmer: Yeah, I think that may be eventually the...

Aldrin: It's got specific hardware of an offensive-defensive reconnaissance nature to look at, it's got a capability to build up...

Vorzimmer: Yeah, this may be the key to providing, to sort of eliminate this attitude of competition, because when I first got here, or a couple of months after I got here, some friends that are in Apollo, they were just getting assigned to Apollo application, and they were sort of chuckling about all the things that they had planned for AAP, and saying, boy, wait until the Air Force hears about this, you know. They were very well aware that they were sort of eating into at least the concepts of what the Air Force was doing, and you know, when it comes to money, they could sort of assimilate the Air Force things with NASA's, which will be by then NASA's long history of the proven programs and the Air Force, you know, having had this history with Dinosaur and a few other things, they sort of envisioned, you know, we'll just sort of eat away at the Air Force's thing. I mean, I don't know, I don't think there's any...

Aldrin: That's really not a constructive way to look at the problem. The answer to the thing is how do you satisfy all the needs, and it is complicated by the stated peaceful uses of the NASA program, and it's stressed, I guess. And the need to adhere to this as far as

acceptance of other nations, the use of their facilities, tracking stations, and that sort of thing.

Vorzimmer: Yeah, that does make it difficult. That's the point I hadn't thought of, that other nations might not lend their tracking efforts to an Air Force project. That does make a big difference, but then in the funds, too. If you separate NASA from the Military, then the military, while it may not have to compete with NASA, it has to compete with, as long as there is offensive action like in Viet Nam going on, then they have to compete in the budget with that. So they would really be caught in a squeeze. I suppose the best thing that could happen about now would be some sort of crucial action in Viet Nam which would then certainly let off the pressure on the Air Force space program, because then they...

Aldrin: Yeah, I sure wish they'd move along a little faster. Of course, they've got money problems just like everyone else does, perhaps worse than here.

Vorzimmer: Okay, that sort of---I want to---I notice that you did carry the hand-hold maneuvering unit on XII.

Aldrin: No. No, we didn't.

Vorzimmer: H-m-m. What happened to that? That just got bumped off, huh?

Aldrin: It was never on. The AMU was on and when it was dropped we put on a work station on the Agena and a work station back in the adapter.

Vorzimmer: And there was no --- that's funny, cause the Mission Report said the HHMU was carried for evaluation.

Aldrin: Nope. It was carried on XI. It was back in the adapter to be picked up there, but of course, it was never used.

Vorzimmer: Well. Oh, yeah, you want to --- I suppose --- I save a lot of these things for Scott Simpkinson, cause he's my favorite man for...

Aldrin: You'll get a lot of good stuff from him.

Vorzimmer: Oh, I sure do. That was on the PPS anomaly, you know.

Aldrin: Yeah, what actually transpired to put a no-go on that, he'll be able to give you the specific...

Vorzimmer: Right...made a reconfiguration. I forget whether the fuel went in first or the oxidizer, anyway, he explained it all. I just have to get it off the transcription. But apparently, the attempted firing after you'd already come down, did work and helped establish what the first anomaly was. But at least, I think they believed it was carrying on something like that.

Aldrin: Of course, that fact there tended to change our flight plans significantly because, in the first place, we had to hold for two days which slipped the eclipse from the third day to the first day, excluding lift-off day. It changed it back two days. And of course, our feeling was when we slipped that that was the end of the eclipse, that we just weren't going to change the flight plan. Because we had the PPS burn scheduled for that time, and we were going along that route, but then of course, when there was no PPS burn, the decision was made to go ahead and make maneuvers and do whatever we had to take pictures of the eclipse. We had discussed this many time and we had eclipse photography equipment available, but it was EVA type gear, and we weren't going to be doing EVA for this eclipse, so we didn't use the photography for that, but we used different film that we had onboard.

Vorzimmer: Yeah, that was a tragic story, too, it was so, I mean, not getting the pictures after all that. I notice that one thing that Dick Gordon and Pete Conrad were saying about the XI mission. You know, they were talking about how good their time line was and the actual simulations, the rehearsal simulations, for things like, well, what Pete had learned from V on stowage because of long trips, and Dick had been practicing for EVA prep, and they were ahead of themselves on EVA, and I notice that you had to request a 1-revolution delay because, in fact, your experiment was in the second standup EVA.

Aldrin: The second standup?

Vorzimmer: Yeah, the preparation for it was so hurried that you called down a request for a 1-rev delay.

Aldrin: Yeah. Well, the only thing we were doing in that EVA was taking pictures of a star during the sunrise, and it doesn't stand out as a significant point in my mind that it was a procedures or a stowage problem that we had. It was something that may have been put in there or it may have been a control system problem, or a control system analysis that we were going through at that time that was more important to do than to prepare for EVA. Because as I recall that preparation for EVA just went like that.

Vorzimmer: I see.

Aldrin: So it wasn't that we were starting, we were making preparation for EVA and said, well, gee, we got to have another orbit before we do. The decision was made fairly early that we were going to delay it, and just why it was is not real clear in my mind.

Vorzimmer: Gee, I had to go back to the time line, it could have been that some other problem did it.

(Tape continues to move but the sound is off.)

Aldrin: Got into a position to dock the second time and I think we came in a little bit slow, so that all the latches weren't engaged, only one was engaged, so we had to back off.

Vorzimmer: Oh, I guess that wasn't it. There was one...

Aldrin: And it hung up a little bit and in the process of getting off, why then it looked like we had a control problem, cause we started moving and thought the Agena was moving, then we looked at the 8-ball, and found that we were the ones, so we weren't putting in in-put, so we would expect, you know, some motion, if it had been the Agena. But we were obviously moving around and it looked like we had a control problem, so it seemed to move when it didn't. The Agena was here and we started moving off like this. Well, Jim couldn't see it, but I could still see the Agena out of my window, so I took the controls and said I think I've got it, let me take it and move back over. So I got it back in control again, and we docked twice that way, then it stayed docked.

Vorzimmer: Who normally does the docking, the pilot or co-pilot?

Aldrin: Well, the idea was to have each of us dock twice.

Vorzimmer: I see. Well, I don't know, I guess it wasn't...

Aldrin: I don't remember anyone having problems like that docking. Now EVA, of course, Gene pushed off from the hatch to try and catch the docking bar and missed it, went out to the end of the tether and had to come back and try it again. And Dick did the same thing, he had the Agena, they were docked with the Agena at the time.

Vorzimmer: Yeah. No, this was a case where docking and apparently had to come straight on, and hit the ring of the docking adapter, and set the Agena in motion. Well, maybe I read it wrong.

Aldrin: Well, the Agena got set in motion on our flight.

Vorzimmer: Was that on one of your dockings, then?

Aldrin: Yeah.

Vorzimmer: You were using— the story was - I just happened to see the transcript, and you know, there is so much material, I don't always remember—and then Dick said that whoever it was has got a nickname, because he was using a different mode for docking than normal docking mode, and he said "we call him 'ole butterfingers", or something like that, because of the...

Aldrin: I haven't heard that one.

Vorzimmer: Oh, well, never mind. I'll have to go play through Dick Gordon's tape. Okay, well, yeah, this is the idea on yours is the rigidizing mechanism didn't lock on---Yeah, well, I guess maybe it is, yeah, I'm sure now that I read this that it is referring to yours, so...Jim, is it Jim Lovell?, was talking about it, because they separated from the docking cone and imparted rates of about three per second, to the spacecraft in all three axis.

Aldrin: Yeah, that is because it didn't come unhooked. We had to pull away from it, thrust away from it.

Vorzimmer: Oh, I see, this is where the analysis shows the TCA-4 was low in thrust before docking. So you had, for a change then, you had thruster problems, too, on XII?

Aldrin: We had quite a rash of thruster problems, hampered us later on quite a bit. Moving the Agena around to a different orientation; that was compounded because you see, in X was the other time that they had done this, the first time, and they had burned the Agena a couple of times, so it was down some in weight, and of course, when they did experiments on XI, they also used almost all of the propellant when they did the experiments because of the high altitude orbit. We hadn't used anything, and it was a very heavy, massive vehicle, and we had our own control problems, and it would over shoot at a particular yaw maneuver, when it would gyro-compass from one heading to another. We would tend to overshoot.

Vorzimmer: I see. Then, I notice here, you lost radar lock and no radar data was accepted by the onboard computers for 21 minutes, and then it began to accept radar data again, although you reported it was continued to be erratic afterwards.

Aldrin: Yeah. You want to expand on that a little bit?

Vorzimmer: Yeah, please. This remained all the way until rendezvous, according to this report.

Aldrin: Let me get a little bit of background here. In looking over ways in which to compute this first maneuver here, this was after Gemini VI flew, I had the idea that maybe there was another way to do it than this method of looking at angle change in here. If we could somehow find out what our orbit is like during this long time period in here, we could then construct what we ought to do at this point here. And if you measure, and you say, by gosh, I'm exactly circular, if that's your conclusion, then you say when the target reaches such and such an angle you're going to burn this nominal amount. But if you conclude that you have some variation in here, then knowing three things: One is the magnitude of this variation; two is if there is a bias to it; and three is what is its phasing? This is three things you want to know. You can come up and say, what you ought to do here because of this ellipticity, or non- coellipticity. So I worked out a scheme whereby we could measure something, and during this time period it turned out to be the most meaningful measurement that you could make is range rate out of the computer.

Because, as you can see (this angle here is actually a little misleading. It's actually about 8 or 9°. It isn't until you get here that it starts increasing to 16°) but there is a long time period in here where the thing was pretty low, and range rate is very nearly X velocity, well, in a circular orbit it ought to be constant, and you look in there and you determine, by gosh, it is constant. But if, coming in here, instead of being constant, range rate drops off, and it increases down here, this is low, that means you're in an apogee, you're going slower and you're going faster down here to perigee. So by making three measurements, or getting three numbers that represents three measurements in here, play in some charts, you can come up with what this is. Now the accuracy is quite good predicting your velocity change here down to a foot per second, and tests seem to indicate this. So it is not an all inclusive type method. It was one that would work as long as you had the computer and the radar. In order to get any accurate information of the radar, you had to read it out of the computer. We didn't have any direct display. So this was only really good for platform failure or for normal monitoring type mode, and it looked like maybe the thing to do , this is the way other people felt, was to continue on in what we were doing. Anyway, we developed this means of doing this, so we applied it,in a way, to performing this maneuver here. This maneuver says what I want to do is to find out what electricity I have here and drive it to zero at this point, so by making these same rate- to -rate measurements, at three different points, we can determine these three parameters--the phase, the amplitude, and the bias, and come out with a chart that tells us what to do at this point here.

Vorzimmer: But its different before that point, isn't it?

Aldrin: Well, you have to know ahead of time what time you want to do this, somebody has to tell you exactly when you want to do that. So we worked up some charts for Gemini X , and did this, and the solution that they got was within about a foot per second, or so of what the ground told them, so they burned the on-board one. We banded this and increased in sophistication a little bit. The one that X used didn't take into account what this angle was.

Vorzimmer: I see.

Aldrin: So it wasn't as precise. The one we had took that into account in the nominal case and it was fairly involved procedure, boy, we were--but I can show you what the thing looked like. We're going to be doing something like that on the Apollo thing. Radar CVH. You

make a measurement at 0-minutes, 1 minute, 2 minutes, 3, 4, and you subtract these and then you add the differences here and you come up with a Delta R, and from a Delta R you get a JX-1, and Delta X-1, and you use the JX here with a K-Delta X-2 and something else in here, you know. Then you have a Delta X-1 that you standby to use later. What you are really doing is averaging, that's the first measurement. Make a second one in here which consists of three different subtractions to try and get a more accurate average range rate, then you play around with this chart on this one and come up with a couple of more numbers. Then when you get down to 26 minutes, you get your last reading, and at that time you've got to do a couple of subtractions. You have to go in here and take a new number and modify one of these numbers up here and modify another number here, then go into this chart here, and come up with burn directions, and all of this has to be done in 4 minutes. The last reading is at 26 and the burn generally takes place at 30 minutes, about here.

Vorzimmer: Oh, I see.

Aldrin: And you don't have time to make a mistake, I guarantee you, because if you do--then you have to take those numbers and write them down here and put them into the computer.

Vorzimmer: And the ground tells you...

Aldrin: No. The ground doesn't tell us anything. We decide ahead of time what our limits are that we'll accept around the ground solution.

Vorzimmer: I see.

Aldrin: We came out within about 2 or 3 feet per second of what the ground said we should have been.

Vorzimmer: And you used your own...

Aldrin: We used our on-board solution. And, of course, we had a lockout way out here at 230 miles, I think, and it was just as smooth as could be all the way up through here. We made this burn, and the last number that was in the computer when we started looking again for it here was this last number here when we slipped out of the mode. So we, at the time this burn was made, from that point on we had no more radar according to what was indicated to us. The computer wasn't accepting any information and the radar lock-on light had gone out, and the gauge, of course, since we were greater than 50 miles, that was the limit of the gauge, the gauge was pegged at that point. So it seemed very coincidental to me that at the precise time of making burns, we should have a failure in the transponder in the Agena. I mean, how

coincidental can you be. The conclusion that people reached is that it was completely independent from this thing here, and it was just a coincidence that it happened at that particular time. I think it is remarkable that it did, because it failed just after we had our last and necessary measurement, and of course, the range was decreasing. We made this burn and, it seems to me that some major activity like switching the computer or making a Delta V change, that that's the time when something could fail in the on-board system, but they seemed to think that the problem was with the transponder in the Agena. Anyway, from here on, it was the intention to look at these range-rate numbers, not to try and compute this thing in any calculated way, but to just look and see how this thing went. If it went smooth like this we'd have a lower value of range-rate, as though you were a little higher up than you thought you were and you'd fly on less Delta V. So by just eye-balling that, with a little experience you could come up with a very accurate estimate of what you really ought to do there, even though you're not calculating--you get an intuitive feel.

Vorzimmer: But when it started coming again, you know, when you had this...

Aldrin: When it started coming on again, it was too late to start accumulating enough data to tell us anything.

Vorzimmer: But it was giving you --- wasn't it giving you some indication?

Aldrin: It was giving us roughly reasonable readings, but it was not giving us enough to let the computer attempt to compute this burn, here. You see, in order to compute this burn, you have to have this one point here, radar sample, and you have to have seven others back here. Then it averages these together and...

Vorzimmer: ...that burn there? Not this one, but that - the change of mode there.

Aldrin: About 65 miles.

Vorzimmer: You had visual acquisition of that?

Aldrin: Yeah.

Vorzimmer: I see. Is this what you used, then, to guide yourself on that? Is that what you're saying there--what you just got through saying,when you couldn't compute it, and when you couldn't, you just said...

Aldrin: Well, we didn't pick up good visual until somewhere in here. Radar was telling us intermittently about where ---

Vorzimmer: Well, how were you going to compute that burn, that transfer?

Aldrin: By visually pointing right at it for three different angle, or actually two different angle readings here.

Vorzimmer: Sextant measurements?

Aldrin: No. You point the reticle at it and you point the spacecraft at it; now you read out of the computer what your gimbal angle is, platform angle, which is the angle of elevation of the line of sight...

Vorzimmer: You did the same thing as the sextant, only using the spacecraft as your sextant, I guess, and the gimbal angle as your...

Aldrin: Yeah. To make a sextant measurement, which is a horizon to vehicle is a very touchy sort of thing in orbit, because the horizon is so ill defined, and it changes so much depending on the location of the sun. Sometimes you have a very well defined horizon, and then other times the air glow gets in, and night time measurements are grossly different than daytime. You think you see a horizon out there, and you look, and you actually see stars go down and they go right down through it. Its really an air glow layer that you're looking at. So the radar did start coming back in here, and it was not enough to lead me to believe that we could switch back in to the rendezvous mode of the computer. It had several different programs in it, and when you are actually computing this maneuver and getting ready to start this sequence which will, whenever you push the button, it will compute this maneuver and then it will go through a time sequence and compute another maneuver here and another one here. You have to be in the rendezvous mode to do this. If you're not, then you're in what we call the catchup mode, which is one where you can make this burn here, and you can make some other maneuver and it'll keep track of what's going on, you can read radar out of the computer and other things like that, but it doesn't have the rendezvous sequence. So as soon as the radar failed we switched back to the catch-up mode here to be able to read, because this was the procedure in case the radar does fail. The rendezvous mode wouldn't normally do you any good. So we stayed in the catch-up mode throughout the entire maneuver, and we computed this maneuver here based on these two angle readouts,

and we looked at what the ground solution was, what it looked like with what we probably had here, and we made a maneuver. It turned out that --- you can probably gather this from the tapes --- for that maneuver the ground had computed 3-up and 23-forward about, and I had 22-forward and about 2 up, I think, but it didn't look to me like we needed 2 up from other information.

Vorzimmer: It says here that after the radar went out you did a platform alignment, and then used the sextant at the end of the alignment period, using a local horizontal, the spacecraft.

Aldrin: That's right. We were aligning the platform so that when I had the sextant aligned with the spacecraft, I could set into the sextant an angle of 11 or 12°, at which we wanted to terminate the platform alignment. When he reached there, then I could say that we were close enough now to want to stop the alignment. It isn't a precise measurement, it just tells you when you ought to get back and start tracking it. The sextant wasn't really used in the calculation of any maneuvers.

Vorzimmer: Uh-huh. Yeah, for the day and night tracking of the target under these conditions of sun angle. Was that a vindication of that particular maneuver, the way you wanted to do it.

Aldrin: Yeah, it was the way we had the daylight and darkness set up, in other words, we had a condition of a setting sun here in this region - sunset occurred somewhere 4 or 5 minutes after we'd made the transfer.

Vorzimmer: Then there is this very cryptic statement here - a misunderstanding between the command pilot and the pilot resulted in omitting up-component of the maneuver. Was this because one guy . . . and the other guy. . .

Aldrin: That's right. He said what's the burn? and I said 23 forward and 3 up, he thought he had heard it cause he knew what the ground solution was, and he made the burn. And I said, "Did you put in the 3 up?" He said, "No, I didn't put it in," so at this time I thought it was more important than putting in the 3 up to go ahead and start making our measurements for the first backup correction, than to put it in. You know, it might not have been the right thing to do, so we looked at the first midcourse correction

and we didn't need any correction, which said if we had put it in, we probably would have needed one in the opposite direction.

Vorzimmer: Well, that's worth mentioning, the cancellation of error, intentional, in fact.

Aldrin: Well, to avoid over-correcting, I think, was the reason that I recommended to him that he not bother.

Vorzimmer: Yeah, but since it was a possibility at the time that you were getting ready to rectify the situation, since it remained an open possibility you might have to redo it, you just figured to wait, and then when they showed you there was no - nothing further to do...

Aldrin: Actually it should have gone in right at this point. It takes a while to get the burn in, and by the time you are finished, you are over here, and at this point you find out you didn't put in any up correction, its probably not really an up correction any more.

Vorzimmer: Right.

Aldrin: So you want to go ahead and make your measurement in here and find out what this correction ought to be at this point, and we calculated 4 different midcourse corrections.

Vorzimmer: Yeah, so that by the time you get around to rectifying the situation, you want to hold it anyway, because you want to take another measurement. Of course, yeah, okay. Now, the night docking attempt, you know that rigidizing thing.

Aldrin: Did you get the corrections in there? I'm sure that they are available.

Vorzimmer: How do you mean?

Aldrin: The other corrections that we made?

Vorzimmer: Yeah. Then, of course, after docking when you were trying to get away from it, separating it, that's when some of your thrusters degradations caught up with you again, and because of that, you actually changed the Agena attitude in that pulling away.

Aldrin: Yeah, it was disturbed from its...

Vorzimmer: In other words, is it fair to say that because the thrusters were sloppy, because of the sloppy separation, sloppy undocking?

Aldrin: Well, I wouldn't use the word sloppy.

Vorzimmer: Okay. How would you ...

Aldrin: There was a thruster problem and the incomplete latching, when the unlatching was made, the asymmetrical unlatching was made, that, plus the thruster problems, put in a disturbance to the Agena which disturbed its attitude.

Vorzimmer: And this delayed the docking, the second docking. Now this is interesting here - its says "maneuvering by gyro-compassing the GATV proved to be a more tedious task than expected. The large amount of fuel aboard the Agena caused the Agena to overshoot the desired heading".

Aldrin: Yeah, it was really frustrating and we cursed out the Agena cause it was not doing what it was supposed to do.

Vorzimmer: It was because of the extra weight, was it?

Aldrin: Yeah.

Vorzimmer: That was just again, I think, was ...

Aldrin: Well, we are doing it in a fuel conserving mode, the operation of the Agena, and in doing that it would overshoot, and then we'd go into the higher fuel consumption and try and get it back, and that would take a while to come back, and this disrupted completely the list of procedures that we had.

Vorzimmer: And the flight plan didn't allow sufficient time for these maneuvers.

Aldrin: That's right. Everyone else in their maneuvers, everything had gone pretty well according to flight plan, and this Agena was a little cumbersome to talk to. You have to send these various and sundry commands, and you have to, in a sense, restore all these control modes back into the Agena each time you---

Vorzimmer: But you were getting a feed-back here, what do they call it, MATS?

Aldrin: All it tells you is that the last MAT that you sent was correct. It doesn't give you any total status of commands that are in the Agena. The ground people are the only people that really has that.

Vorzimmer: So you had to use your own system, didn't you, spacecraft controls?

Aldrin: We finally resorted to that, and of course, that wasn't very successful, either, because with that big mass of the Agena out there, and when only one thruster would fire when you're supposed to have two, why, it would induce a roll, because the inertia was great in the pitch and yaw direction, and that's what we were really trying to control, so had an asymmetrical roll so you'd start to roll, and now you are trying to take out the roll, and this is an unsymmetrical thruster, so you get a yaw in there.

Vorzimmer: Yeah, right. This is the trouble with experiments, too, when you are trying to point it, the spacecraft was required to provide inertial attitude control, so it was really quite expensive to make the maneuvers using the spacecraft system while still docked with the Agena.

Aldrin: Yeah, oh, yeah.

Vorzimmer: You have to use so much more Delta V to move the extra mass. I notice that, I'm getting to the point here about the thrusters. It looks like in your own report, your mission report, you're very, very--- you really made no bones about the fact that you were a little bit angry at this thruster problem throughout the entire mission. I think it was your report, it said the commmand pilot, but . . .

Aldrin: Yeah, that's right. Well, we thought that when we had this problem, we should have had some time to stop and completely analyze it and come up with a better solution, and then look at future maneuvers to be done in light of this situation, instead of - the way we handled it was, well, we've got a problem and we, for sure, didn't have enough time to really stop and figure out exactly what this problem was. We were somewhat in the dark as to what our capabilities were. We thought at first that it would be very difficult to get in position for this tether exercise. We thought it would be very difficult to get on a star, to hold a position on a star. We found that one fairly easy to do, the Agena

would hold it. All we had to do was get there initially, as long as we took plenty of time in getting there. But then in trying to position ourselves right above the Agena, we found that this was extremely difficult to do. So we never did feel that we got a good set of initial conditions; we got it by guess or by golly, and we turned out to be pretty lucky, cause we started from very near ...

Vorzimmer: Yeah, cause you got that gradient thing...

Aldrin: Well, we didn't quite make it the first time and it looked like we were going to go on over and start into an actual spinout, but as we reached the horizon, it looked like this was the time to stop what we were doing, we had gone too far, so we maneuvered so we came back up again, and as we crossed, closed this passage in here, our attitude wasn't too good again, so we'd have to tend to say well, in our position now, I think we ought to fire right just a little bit, see, translate right which might stop us from this motion. The idea was to reinstitute a zero rate position when we were above it again, and this worked out pretty good.

Vorzimmer: Yeah, I remember your press briefing illustration with the thing, but with thrusters out, that must have been a helluva job, I mean, with the difficulties, you know, added to it. It sounds like it was difficult enough without having degraded thruster action, and missing thrusters. Apparently, you really learned in flight in real time how to compensate for ...

Aldrin: Yeah, we sure couldn't predict what it was going to be like. When we separated from the Agena finally after a tether exercise, we had the darndest time trying to align the platform and trying to see the Agena.

Vorzimmer: That's what I say, that was when you learned the hard way, how to maneuver around an inactive 2 and 4 thruster, and what are the combinations you could use to fly and get the same change in attitude, or maneuver. That's why, you know, you complained apparently so strongly at the end of the mission report, saying the thruster problem complicated the entire mission, required more time, considerably more time, to obtain the proper attitude for pointing angles, and smooth tracking was impossible,

low rates for long-exposure photography was difficult, etc., you know, a complete list of ways in which you fouled up the mission, although it was still possible to align the platform. That must have been aggravating as hell because you have something like 6 missions in which thrusters are failing or degrading, one way or the other. That's what I was saying to I think it was Dick Gordon, you know, if you assume that the pool of knowledge is a communal pool, then it must be tough everytime somebody is getting ready to go up, you know, and they train so well, and some old-timer comes up and says, "Man, you think its going to be smooth, huh? Just wait until those thrusters start giving out on you." And you begin, it must have been by 12 you were beginning to learn to live with sporadic thrusters.

Aldrin: Oh, yeah, we made several training runs with thrusters out.

Vorzimmer: Yeah. No one seems to ever resolve that to my way of thinking. In other words, it sounds like you are working around the normal condition of having thrusters giving out on you. I mean, I understand you've got to plan for these things, but it also sounds like the astronauts were living with faulty thrusters, but I can just assume that in the meantime people were coming down pretty hard on Rocketdyne, and some of these people to do things...

Aldrin: Yeah, but this ...

Vorzimmer: I mean, they never got to the point where the astronaut said "I'm not going up until you fix those thrusters." One more mission with the thruster failure, although it didn't amount to ever anything catastrophical or cancellation of the mission, well, take 8. I should have thought that after 8 they must have come down ...

Aldrin: Yeah, well, that was one of the first big problems we had, I guess. Some of the others was associated with running low on fuel, and the things start going out, V had a few thrusters---

Vorzimmer: When you said that you wanted more time, was this also to run a way of checking on...

Aldrin: Yeah, to find out exactly how each thruster was working. We did this near the end of the flight.

Vorzimmer: You mean, try short bursts and---

Aldrin: That's right, and see what you get out of each one in a methodical way.

Vorzimmer: In other words, see if you could create a degradation by creating a some sort of situation...

Aldrin: Well, put in what you would expect to happen and see whether it really happens or not.

Vorzimmer: Uh-huh. So that's the difficulty, I mean, if the thing isn't going to come back, that section of the craft isn't going to come back, so it seems that the only alternative is in real-time to have somebody run some checks.

Aldrin: That's why we did that.

Vorzimmer: So it was only until 12 that we got around to doing that.

Aldrin: Well, they knew for sure that other thrusters were out on previous flights, they didn't understand for sure why they were out.

Vorzimmer: Yeah, but I mean, they couldn't test, they didn't get around to testing and to try to find out the why ...

Aldrin: Well, I'm not sure they really pinned it down on XII, whether it was a thruster or whether its a freezing in the line, or what it was.

Vorzimmer: Will they use the same thrusters in Apollo?

Aldrin: No, not exactly.

Vorzimmer: Ah-ha! Good luck. Is Rocketdyne making the thrusters? They're not, are they?

Aldrin: No, they're not.

Vorzimmer: But I suppose there'll be no radical redesign until they do find out the cause of these, so you might have problems in Apollo, then.

Aldrin: Well, I kinda felt it was in the plumbing lines freezing.

Vorzimmer: Uh-huh. Well, I don't think I have anything else, unless you can think of something that should be mentioned with regard to the 12 mission that I haven't. . On those fuel cells, well, if you make a very strict division between whether it really is a fuel cell problem, you don't get but 2 missions in which the actual fuel cell itself, i.e., a GE--the GE piece was actually malfunctioning, but in your case it was established, it did fail inside the fuel cell. What I'm driving at is that really 5 wasn't a fuel cell problem, although, and GE still cries over it, being maligned by the public media, you know, for the failures of, you know, the power down problem of 5, when it wasn't even ever that, but yours was. It was a definite back in the fuel cell. Did they pin that down, was it the diaphragm or the water backing up?

Aldrin: Ask Scotty.

Vorzimmer: Okay. Yeah, I enjoy the way he tells a story. He never tells it simply, he gets very dramatic, you know, he's got a way of putting it so that he just doesn't sound - there's another fellow, a guy named Cohen who is the MSC fuel cell, sort of, lean-on man, who wasn't helpful at all. You know, if it wasn't in an illustration he could point to, then I got a yep or a nope. He and Warren North are the two that are difficult to interview. Warren North is the Calvin Coolidge of MSC, he says yep, nope, maybe, and that order is not in my area. Is there anything else you can think of?

Aldrin: Nope.

Vorzimmer: Any anecdotes that might be useful in illustrating the history? Anything fall apart in training, or - well, nothing?

Aldrin: Nothing, really.

Vorzimmer: Nothing you want to tell me, anyway.

Aldrin: Not that I think really has a crying need to be put forth in this.

Vorzimmer: Well, I'll check out old "butterfinger's" story about the...

Aldrin: Yeah, and then check with Jim.

Vorzimmer: Right, right. I'm interviewing him tomorrow morning. I had better check that one out.

Aldrin: Well, one thing we did do during our...

Vorzimmer: You have a different way of docking, the docking maneuvers just before actual docking, you know, in other words, you were only so many feet away--on a different mode--

Aldrin: On the control system?

Vorzimmer: Well, I don't know. I don't know if it was on the control system or just a different way, but it was in the final phase that was done a different way, someway that's more wasteful on fuel, and was more chance of - it was more loose - that's the type explaining maneuvers as such that it sort of resulted...

Aldrin: Using a rate command mode instead of direct?

Vorzimmer: Maybe that was it. Anyway, I will track that story down and find it, but...

Aldrin: Well, then times when we were all squared away and ready to go to sleep, when we had cameras out, why we'd take some still photography. You've seen some of that, I think, with the movie camera, wide angle lens, it's about the only kind we could really use inside the cockpit. And then we'd take things - of course, these pencils have a long string on them. We would play tether exercises with the string that was attached to them.

Vorzimmer: Oh, right, right.

Aldrin: And then we'd take flashlights, or whatever little things we had and take the big sextant, and take two things and have a small little collision, or set up a rotation and have it hit something and see what the change in rotation is. Some of these you just don't have an opportunity to do and see, you can analyze the thing to the nth degree on the ground, but you never really have the opportunity to see something sit there and just how long is it going to stay there in front of you, and what kind of a rotation. We found that was very facinating.

Vorzimmer: How about with liquids and stuff like that? There once was an experiment ...

Aldrin: Well, there was nothing exceptional about that, but occasionally--the urine management system would have a leak of some sort, and you'd find a big globule about like this that consists of many other bubbles in it. You reach for a tissue real fast and try and catch this thing, and...

Vorzimmer: Absorb it into . . .

Aldrin: Yeah.

Vorzimmer: You know, you get to see capillary action of a tissue absorbing liquids, only in a much more dramatic way, because ordinarily the pull of gravity ---

Aldrin: You can't tell what its really doing.

Vorzimmer: Of course, you can take a tissue from above, and sop up something from above. That's kind of interesting.

Aldrin: Well, all these little pieces that were coming off the Agena work station where they had done a lot of machining and there were little rivit slugs, and that sort of thing, were in the cone and they were impossible to get out without, at this point, because the thing was already attached to the Agena, without turning the whole thing upside down. So they were aware of this, and they felt that it wasn't any particular problem, but they did tell us that we probably would see a few things coming out. And sure enough, they'd come out and they'd come out with a little tumble, and just sit there for 15 minutes with very little total motion. Sometimes they'd just sit there and they wouldn't be moving at all, and you'd wonder how in the world did they get from here to here, and now have zero velocity. In many cases they'd just sit there. It maybe that the mass of the combined vehicles , as it went out, why this thing went out and would slowly stop it, maybe it was pulling it back in.

Vorzimmer: Like some sort of gravitational--

Aldrin: Those are pretty small portions.

Vorzimmer: Indeed. Right.

Aldrin: That really, I mean, you think of an airplane as going along, you've got a big heavy windshield and you think, gee, there's all sorts of wind velocity out there, and so when you're in orbit and you see this vehicle out here and you're not really impressed that there isn't this sort of thing, until of course, you go EVA.

Vorzimmer: And you see that stuff. . .

Aldrin: You look out here and you see these things just sitting there. They are not moving at all, and there isn't anything forcing them up or down or sideways, in any preferred direction. As long as you maintain attitude, and of course, the center of your mass of the two vehicles is

in a certain position, why these things will move out and often stay in that same place, relative to the center mass. You could rotate underneath it.

Vorzimmer: Right. Yeah, again, because you've got no atmosphere. You can move your hand underneath something, and like in an earthbound situation, you could stir it like a particle, and you see particles in light, move your hands and they all start to move and you touch straight through it. Yeah, that must have been --- and then its the same with --- did you notice the phenomena that Cernan, I think he'd want to call it the Cernan Effect, that drift up tendency?

Aldrin: No.

Vorzimmer: Well, do you think its something else to the Cernan effect?

Aldrin: No, but I think Mike and I understand that one, we understood it in trying to explain what he had observed by just the fact that here you've got something sitting in here and its restrained in all directions except one, and its going to have little forces without even really knowing it, and it'll bounce off of one wall and off the other, maybe touch the bottom in some small motion, but nothing is ever going to stop it from gradually drifting in this direction. Any of these little motions that when you hit something you might give it a force that . . .

Vorzimmer: No, you're just saying that if there was something in there like a ping-pong ball, and it was rebounding off all the walls, and it will eventually come out, but these objects weren't rebounding off any walls, or anything.

Aldrin: No, but you take the side of the cockpit that's like this. Now how do you exert a force against that without getting some component that's going to push you up?

Vorzimmer: But these apparently just set down, and they just drifted up.

Aldrin: Oh, you're talking about things inside the cockpit? That's not Gene's - that's not what he's talking about when he says. . .

Vorzimmer: No, he's talking about the general tendency to move up in a relative up direction, all things, whether its an astronaut, micrometeorite package, or umbilical, a tendency to drift up in modes of that relative up direction. I can understand like in Dick Gordon's case

if you have your feet like this, what with the suit configuration and the general tendency to use your feet to hug the edge, that you will get this effect, like trying to pick up an egg with chopsticks.

Aldrin: Well, in the cockpit, you're sitting here and things that you are looking at in general are above the center mass. Now, as you have a tendency to move around it, its going to eventually find a place further away from the center mass. You know, by the way that you're kinda drifting around. Lets say you're in free drift, if you put something right at the center of mass, it will stay. there. Put something right in the center of mass and then change your attitude around it, it will stay in inertial space where it originally was. Now you're going to move around it and you're going to have the tendency to have it hit a wall, or something. Eventually, it hits that wall and its going to hit something...

Vorzimmer: Well, how much do you attribute to possible out-gasing, I mean, you've got - when you're pressurized, you've got---...

Aldrin: No reason why it should go across in one direction more than the other.

Vorzimmer: Oh, but it'll out-gas towards the vacuum.

Aldrin: What will?

Vorzimmer: Whatever has been trapped...

Aldrin: Are you talking about with the hatch open?

Vorzimmer: Yeah, when you open the hatch.

Aldrin: Oh, well, that's different, that's what I thought you were talking about, that's why I said that the seat in the inside of the cockpit is like this, and when you leave the hatch open you've got an initial outflow. After that initial outflow, you find that your feet are very constrained and then your arms are constrained, but there is nothing up above you. So you start hitting against these things, and there is only one way you can end up going and that's up. Now there may have been some outflow from the ELSS, but what I made a specific point in trying to do was to hold onto the sides with everything completely not touching, my feet not touching at all and I'd hold on, you

know, with two fingers here and very carefully let go with both of them at the same time and see if initially I had set up an initial condition with zero, and then I went back and would stay there. And I couldn't get convinced that there was any initial direction of wanting to go one way or the other. It was all a matter of how delicate were you in setting this thing up in the first place. Now if you try and set something up by putting your hands down here like this and taking your hands off, you probably imparted some downward force with your hand.

Vorzimmer: Now, then, you have the problem that once again, we used to talk about the suit configuration. If you were in any way other than the trim, just allowing the suit to reconfigure itself might depart some small increments in tendency. What I was thinking about was somebody said they had the tendency for the feet to go up. This may again be because the seating configuration, the suit at trim, might have a tendency to, if you're bent over like this, to bring the feet up to return to that sort of configuration.

Aldrin: Well, I think that problem might have been experienced back in the adapter with your stirrups, and you could only get your feet in so far, and there was only one way that the feet could go when they got out of the stirrups, and that's this way. If one of them was out and the other slipped out, it had a velocity going this way, so you'd expect your feet to go up like this.

Vorzimmer: Uh-huh. Well, I think that...

End of interview.

(END OF TAPE)