NASA ORAL HISTORY PROJECT
EDITED ORAL HISTORY TRANSCRIPT 2

DAVID J. HOMAN
INTERVIEWED BY JENNIFER ROSS-NAZZAL
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ROSS-NAZZAL: Today is June 29th, 2023. This interview with David Homan is being conducted for the NASA Oral History Project. The interviewer is Jennifer Ross-Nazzal. Thanks again for driving down today, dealing with Houston traffic is always a mess. You never know what you're going to encounter. You had worked at Dryden [Flight Research Center, California] as a co-op and then you came to JSC [Johnson Space Center, Houston, Texas]. How was it different working at Johnson compared to Dryden?

HOMAN: The drive was a little bit different. It was about 35 miles [from where I lived]. It was a much smaller facility. I think when I was out there, they had around 500 people. You pretty much knew everybody. Nobody really worked after hours because everybody carpooled. You get in your carpool and get there in the morning and then at 4:30 everybody [leaves at the same time] because they didn't work in the same building. After 4:30 it was pretty dead out there. Then, [too], it was in the middle of the desert.

It was an interesting place to work just from the standpoint that not only NASA was there but Edwards Air Force Base was there. It had everything that the Air Force was testing and everything that NASA was testing you could go out and watch fly. Or just walking through the hangars with all the experimental planes that they were flying at the time.

I got out there right after the XB-70 had finished flying. The X-15 was still out there but sitting in a hangar.

What I got involved in to begin with, they were flying lifting bodies, which are basically the precursors to the Shuttle, wingless vehicles. I guess the same month I got there, they delivered the YF-12s from the Air Force that they planned to do research with. They had two of those, and then sometime in there one of them crashed on the way back, never made it back to the base. It crashed just north of the base. It was an interesting place.

I know one thing. The air shows that they had out there, like they have Wings Over Houston here, where they're confined to the small space above Ellington [Field, Texas]. Out there they weren't restricted at all. Air shows were pretty cool, especially the Thunderbirds and Blue Angels back then where they weren't confined to a particular space. I think the air shows out there were a lot cooler, or hotter, whichever. It was always hot.

ROSS-NAZZAL: Were there any cultural differences when you came here to Johnson?

HOMAN: Yes. In fact that was one thing I wrote about, how I ended up down here. One of the guys here who read [what I wrote] was really interested in [it]. I guess what he said [was] how petty they [the folks at Dryden] could be. It was a small place. There was a lot of drama around various organizations or people.

ROSS-NAZZAL: I imagine it was quite a change coming out here because thousands of people were working out here at Johnson, and you weren't necessarily working around planes anymore.

HOMAN: No, not at all. In fact when I hired on here, I was the only person that they hired. I started in March of '74. I was the only person they hired until June or July.

I started out at the Arc Jet [Test Facility], Building 222. It was way out in the middle of nowhere. I never got a good feel for what else was actually going on around here until after they hired a bunch of interns that summer and they put together tours for that whole group. We'd get together one or two days a week, and they'd haul us off someplace and give us a tour or demonstration. That's the first time I found someplace else that I was more interested in than where I was. That's when I interviewed with Ivy [H. Fossler] and moved over to the Aerodynamics Section.

ROSS-NAZZAL: When you were in 222 did you learn about the TPS [thermal protection system]?

HOMAN: No. Actually I never saw the thing run.

ROSS-NAZZAL: What were you doing out there?

HOMAN: They were basically fixing it up. It was down for repair. I started writing a user's manual for a software program they were using, which wasn't a whole lot of fun.

ROSS-NAZZAL: That was something I seemed to notice about your career. You were a mechanical engineer, but you really ended up going into IT, dealing a lot with computers.

HOMAN: No, not IT per se. What happened was about that time desktop computers were coming, not personal computers. Hewlett-Packard put out a desktop computer. Basically I'd play around with that to get it to plot data. It was using the computers, not like IT now where you're setting computer networks up and all that. It was just a step up from using a calculator to do the work.

ROSS-NAZZAL: Had you worked with computers before?

HOMAN: No.

ROSS-NAZZAL: This was just a new learning process?

HOMAN: They basically weren't available before, other than big mainframes. I never did anything with those, except in school where you'd write a program and type it out on cards and hand it in to somebody and then pick it up later. I never really dealt hands-on with computers or mainframes.

ROSS-NAZZAL: I was just curious about that, because you seemed to be doing a lot of work with computers.

HOMAN: Part of that is because they were new, and in order to get them to do what we wanted them to do, I read the manual and programmed them. It wasn't like I found something new for it to do. I just made it do what it was supposed to do.

ROSS-NAZZAL: Computers did not come with the software preloaded at that point.

HOMAN: There was no software. You typed in all the equations that you wanted. There were no software packages. There was nothing commercially available. If you look at the computers now you can get all kinds of games or flight simulators or anything like that. None of that existed. You had to write your own from scratch to make it do what you wanted it to do.

Graphics was the same way. There were no graphics machines, no graphics cards. Now you go to Best Buy and buy a gaming card. You don't have to do anything other than you have a user interface to use it, but it does all the work. None of that existed back then.

That was another thing, all the graphics that we had to develop. This is closer to the [early] '80s. We had to write all that software which was a lot of equations and figuring out how things looked in 3D.

ROSS-NAZZAL: You came up with the graphics then for the vehicle. What I thought was an aerodynamic database.

HOMAN: Yes. Back then there weren't much graphics. In fact ALT [approach and landing tests], they started out with a huge board—I think it was over in Building 5—two of them. One of them was low fidelity. They went someplace in Europe, and they built this huge model of Edwards Air Force Base down to the cactus. They had little hangars with airplanes in [them]. It looked just like Edwards.

That was what they used for visuals for their simulations. They had a little camera that the simulation would drive. What they were seeing in the cockpit was their visuals; what they were seeing was what was being shown by that camera as it flew through this little model of Edwards. At that time you didn't have any of the fancy graphics.

ROSS-NAZZAL: One of the things we didn't talk about is your time out at Dryden as a flight controller, which I think is interesting, that you went back out there. You worked for ALT, and you were working with the chase crews.

HOMAN: Yes. It was being controlled from here [JSC] but was being flown out there. They had their own control room out there too.

Like I said we were responsible for the separation characteristics to make sure that they came apart and didn't come back together, the orbiter and 747. There are load cells between the Shuttle when it was mated on top of the 747. Those load cells were reading the forces it saw while they were in flight. Based on that data and wind tunnel data we had a couple parameters that we looked at to make sure they were at the right condition for them to separate.

When we went out to Edwards we had a console with a strip-chart recorder with those two parameters on it. The first tests they called inert tests where they just flew the thing and then it was captive-active where they had a crew on board and flew through the separation maneuver, but they didn't separate. Basically it was like a full-scale wind tunnel. We'd take the load cell data and use that to verify that they were in the right predicted condition for separation.

When they started the free flights basically they'd go through the maneuver. The first time they'd go through the maneuver and then fly back up and actually do the separation. We verified that yes, those parameters were correct. Out there we were part of the go/no-go decision on whether they flew or not.

ROSS-NAZZAL: You were working with Don [Donald R.] Puddy and his group back here?

HOMAN: No. I was working with Deke [Donald K.] Slayton out there. Dryden had been doing that kind of experimental flight testing for forever. JSC hadn't done anything like that, but JSC was in control of the Shuttle. There was a conflict there.

ROSS-NAZZAL: Can you talk about that more?

HOMAN: They wanted to control it all from JSC. Obviously it was being flown out at Edwards, and Deke Slayton had his office out there. Couple interesting things—they were getting ready to fly, and they were having problems with the control room back here. They wanted to postpone the flight, and Deke didn't want to. They said they needed to because the control room was having problems.

The flight dynamics officer was back at JSC talking to the pilots as they flew, basically. They said, "We can't do that."

Deke said, "Well, you'[ve] got a T-38, don't you?" They said, "Yes. Why?" He said, "Put him on it and send him out here." Shortly after that they got their problems fixed.

ROSS-NAZZAL: Yikes.

HOMAN: There was some tension between the two centers. I guess I always sided with the Dryden people.

There was another problem there too in having the checklist for the [flight] crews. The orbiter crew had a checklist and the flight data file people here, who made up the checklist, were always arguing with them [the folks at Dryden]. They needed to integrate their checklist with the 747 people. They knew it, and they kept arguing that they really didn't need to.

One of the very first flights of the 747—what they did was to go through the separation maneuver. They flew the 747, and they flew an F-104 next to it in the same position that the orbiter would be in. They basically flew through the separation maneuver, and the two separated and flew through [their maneuvers].

I was sitting back here in the control room at that time, and I'm not sure if Fitz [Fitzhugh L.] Fulton—who was flying the 747—I don't know if he did it on purpose or not. He wasn't in the right configuration at separation. I asked if he deployed the spoilers, and he said no. I asked him why, and he said, "Because it wasn't in my checklist."

After that debriefing the FAO [flight activities officer] responsible for the checklist rolled his eyes at me and said, "You win." After that they started integrating checklists together.

ROSS-NAZZAL: That's an important lesson learned. What are your memories of being on console? Although I imagine your console was not like a console here in Mission Control.

HOMAN: No. You had a headset and a strip-chart recorder. You'd watch it. We were only responsible for making them separate.

As soon as they separated, we'd get up and walk out on to the roof and watch them land. Then go to the parties afterwards.

ROSS-NAZZAL: You were talking with the chase crews before that. You mentioned talking with Crip [Robert L. Crippen] and giving them details of what you wanted them to do during the flight.

HOMAN: Before each flight you have a—

ROSS-NAZZAL: Debrief?

HOMAN: No. Prebrief, basically. I can't even think what we called them anymore. Everybody would sit down. You'd be in a conference room. The crew would be there, and you'd go over exactly what was going to happen from everybody's standpoint.

We'd give a pitch there about separation. As soon as that was over, I'd go out to the crew trailer with the chase pilots and sit down with them and go over what they could expect to see at separation, the speed they were flying at, what altitude, how fast the two would separate, where the 747 would go, his avoidance maneuver, and where the orbiter would go.

There was some interesting things there too with all the chase pilots whaling on one another. It was the briefing before the second flight, and we were out there, and they were all whaling on John [W.] Young about mumbling. They said, "You got to make the calls so we can hear them. You can't be mumbling." That's when he said, "Well, the last time I spoke clearly was," basically his hot mike experience on the Moon.

ROSS-NAZZAL: That's right.

HOMAN: The next day they flew, and at separation they went through Chase 1 clear, and they got to John Young. He yelled real loud, "Chase 2 clear." Joe [H.] Engle came back with, "Say again."

It was kind of interesting just to be in on that kind of inside joke, banter, whatever.

ROSS-NAZZAL: You got a chance to get to know some of the Shuttle crews or people who would be assigned.

HOMAN: Most of the chase pilots were from back here. I was not popular back here, I guess.

ROSS-NAZZAL: You seemed to indicate that a few times in your summary.

HOMAN: The first flight, if you remember seeing it, the video started after they separated. That was basically because whoever the head of the Photo Lab was back here, or that group, decided that he wanted to go out there and fly in the photo chase [plane].

It became obvious that he didn't know what the calls were, or when they were going to separate. It occurred, and then he started filming. After that I suggested that they might want to use one of the chase photographers from Dryden, which ruffled feathers back here, but they actually ended up doing that. In fact he was the guy that I met in a bar while I was out there. He lived in the same house I was born in.

ROSS-NAZZAL: Wow.

HOMAN: It was that type of thing; JSC had their way of doing things, and Dryden had their way of doing things, and they didn't always mesh. There were cases when Dryden had a whole lot more experience flying chase on different experimental flights and photographing them.

ROSS-NAZZAL: Do you think your experience working out at Dryden for those few years as a co-op was beneficial as you were working out there on this project?

HOMAN: Yes. Because I already knew people when I went out there. It wasn't like I was coming in as just another new person. I actually knew things, people to go to. In fact I did all my data reduction out there, when I was still doing a lot of the captive testing.

I'd go out there and instead of coming back here with all my data and doing that I knew people out there. They'd get me on their computers and print out my data and the results and make plots for me. I'd come back here with all my work basically done.

ROSS-NAZZAL: What did your colleagues here think about that, the fact that you were able to do that? Were they hoping that you might help them out as well?

HOMAN: Yes. In fact, I guess when we were still doing the wind tunnel testing, one suggestion I had was that they invite people from Dryden to work with us on the wind tunnel tests so they could observe [them]. That turned into another thing where they actually swapped people, where they had people come to work at JSC in our group and [someone from] our group [would] go out and work in a group out at Dryden. You got that cross-pollination. People understood what each was doing.

ROSS-NAZZAL: As I was reading your summary I kept thinking about what Ivy had mentioned, how people from [NASA] Headquarters [Washington, DC] kept coming up to her and saying it worked. You were actually able to separate. Things worked, like the graphics and other things said it would.

HOMAN: Yes, there were a lot of people who didn't think it would work.

ROSS-NAZZAL: I thought that was interesting though, because for many years you had been working on that. You had proof that it was going to work.

HOMAN: Yes. Before we did that, we went through looking for a history of things like that. The French flew something that they'd launched off the back of an airplane. I think the U.S. Mail came up with this rig where they flew a small seaplane on top of a larger seaplane and separated them. Then there were the things that killed Joe [Joseph P.] Kennedy. They had, I think, a B-17 loaded with explosives with a smaller plane on the back of it that he flew. They didn't separate, but they'd get to where they were going, then he'd bail out, and the B-17 full of explosives would fly.

But there weren't a whole lot of other separation aspects like that. This was sort of the first big one.

ROSS-NAZZAL: You were putting together some sort of historical report for folks at Headquarters?

HOMAN: No. We just went to the library and looked up stuff.

ROSS-NAZZAL: That was the first time I've heard anything like that. That's interesting. Did you share that with John [W.] Kiker? Or Kiker was pretty much convinced everything was going to work?

HOMAN: We talked to him.

ROSS-NAZZAL: You were also working on reconstructing trajectories between the SRBs [solid rocket boosters], the external tank, and the orbiter during separation, which I also thought was an interesting effort later on.

HOMAN: Yes. At Point Mugu Naval Air Station they did ordnance testing where they'd basically fire a missile off the wing of an airplane, that type of stuff, or drop a bomb or drop something. The way they calculated their trajectories—they had cameras on their plane which filmed the release. Then they had a rig that they put together that was like a three-dimensional XYZ plotter type thing with a device on it that they'd [mount] a scale model of the ordnance they were testing.

They'd put a camera on this rig that had the same characteristics as the camera on the test vehicle. Then they would take the film from the test and take the picture from this rig with the camera looking up at a scale model and basically tweak the model till it matched. They'd overlay the two, the film and the view. They'd tweak the model till it matched the flight picture, then they could read the XY plotter that it was on. It would give them the coordinates. They'd go through the film frame by frame by frame, and then essentially back out the trajectory of the ordnance.

[I] went out there and talked to them, and they were willing to do the same thing for us. We had to build models of the SRBs and the tank. The orbiter in the umbilical wells had cameras that filmed the SRB sep and the external tank sep, so we could do the same thing there. They reproduced the viewpoint, the camera characteristics, and [produced] the separation films and overlay; [they] put the model on their device and did the photogrammetric analysis basically.

ROSS-NAZZAL: How big were the models you were working with?

HOMAN: I know the SRBs were probably about 3 feet long, whatever that was, and the tank was the same scale. It was fairly big. That's where I met the guys in the model shop—they thought that was interesting when they built that scale model. They had to have enough detail in there that they could actually match the detail of the real vehicle on the film.

ROSS-NAZZAL: Did you have an orbiter model to go with that?

HOMAN: No. Because there weren't any cameras on the ET or the SRBs looking back like there were later on. There wasn't any way I could really justify building an orbiter model.

ROSS-NAZZAL: What did you learn about the trajectories? Were there any things that needed to be tweaked?

HOMAN: I don't know. I was in MPAD [Mission Planning and Analysis Division] by that time, before they flew.

ROSS-NAZZAL: I was curious about that. Ivy was also talking about that, and you were in the same org.

HOMAN: I don't know whatever became of that. I did find out years later that after that out at Point Mugu they just had these things out in their boneyard or whatever [they called it]. I called the guy up and asked him to send them back to me, so I had those models till I left.

ROSS-NAZZAL: What happened to them?

HOMAN: I don't know. I left them in my office.

ROSS-NAZZAL: I'm sure somebody found them and wondered what to do with them. That's interesting. You never know what you're going to find out at JSC. People always find random stuff. Somebody called our office one day and had found some Gemini experiment that was just sitting in their desk. Somebody obviously hadn't used that desk in a while. What are your memories of STS-1?

HOMAN: Not much. I didn't have anything to do with STS-1.

ROSS-NAZZAL: It didn't make an impact on you? You'd been working on Shuttle for many years.

HOMAN: After I left Engineering, when we finished [ALT] I didn't have anything [to do]; I didn't have a job basically. Everybody else was doing their things. I moved over to FOD [Flight Operations Directorate], which is MOD [Mission Operations Directorate] now I guess, to flight control. That was in '78.

We were getting ready for the first flight, but it kept getting postponed and postponed and postponed. I worked there for a while and decided I didn't want to wait for that. It wasn't that interesting.

Charlie [Charles J.] Gott, who I'd worked with, who supported us in the ALT era was from Mission Planning. He called me up and said he'd taken on this task of working with the remote manipulator system. He was designing the autosequences for that and verifying them. He'd ordered a bunch of computers, new graphics things and new computers, and wanted to know if I'd come over and help him program them. It worked out so that I moved over there. I mentioned that last time about me going. I worked for Jay [H.] Greene.

ROSS-NAZZAL: Yes, I do remember that. One of the things that I was curious about, because you mentioned the autosequences, why did NASA want an autosequence? Wasn't that the role of the mission specialist to be deploying a payload? I was curious why you would have to have an autosequence for the arm.

0HOMAN: On [STS]-2, [STS]-3, and [STS]-4—one of the experiments was about the size of a government desk. It was called the Induced Environment Contamination Monitor, IECM. It had sensors on it that would measure contamination and measure pressure. What they were going to do was hold that. Basically put it on the end of the arm, grapple it, move it out, and then move it around the payload bay or the orbiter, and get to a certain position and fire a certain number of jets. The sensors would measure contamination, etc. Then they'd move it to another place. There were upwards of sometimes 50 different points.

Essentially the autosequence was a table. You could have up to 200 points. Each point was a position and attitude of what they call the point of [resolution]. You could pick any point on the payload. For those flights you'd pick the contamination sensor they'd want positioned in a particular place around the payload bay. Then there was one pressure sensor. [They had] different sensors. The autosequence table, you put in the position and attitude of that particular sensor at particular points.

Also going from point A to point B you'd have different points in there they called flyby points which took the arm to that position. It wasn't always a straight line. You had to avoid structure.

ROSS-NAZZAL: It'd be a bad day if they hit the vehicle.

HOMAN: You couldn't go from point A to point B in a straight line all the time, so you'd have to program in additional points to make the arm fly around that particular point. You also had to have additional points in there to make sure that the arm, when it was going from one point to another, a particular joint didn't hit its travel limit. There were cases—take the wrist roll for instance, and the only thing it would do was unwind it, and then move on to the next point.

We put all those points together based on where a particular survey wanted to go, and then verify that it could do that without tying itself into a knot or without hitting structure. Like I said, they had tables. You could have 200 different points. It's not something that you'd basically train an astronaut to do.

ROSS-NAZZAL: I was curious about that because the way I had read it it sounded like it was like a payload deployment autosequence.

HOMAN: No no. It was actually maneuvering the arm to different locations that you wanted payloads that it was holding to be in. On the third flight they had something called PDP, the Plasma Diagnostic Package, which they had an instrument in the bay that, I don't know, radiated something. They'd fly this thing around to see where it went.

They also had what they called operator-commanded autosequence, where essentially the arm operator could type in a position and attitude and the arm would go to it. We had to verify a lot of those because you could type in a position attitude that the arm could actually be in but there wasn't a physical way of getting it there without running into something. Before they typed in anything like that we had to verify that they could actually do that.

ROSS-NAZZAL: How much did you know about the arm? How did you get acquainted with the remote manipulator system?

HOMAN: Zero. I guess they were planning on putting a robotic arm on the Shuttle, from what I understand Engineering and NASA, their groups had proposals for it. Then the Canadians came in and said, "We'll provide it for free," as their part to the program. Then the Canadians were going to build the arm and basically the payload deployment system.

The way Charlie got involved—once the Canadians said they'd do it for free there were a lot of people at NASA that didn't want to have anything else to do with it—he took on that particular task.

That was another thing. That wasn't really something that MPAD did. They did trajectories and that kind of stuff. From that standpoint we were basically on our own. Nobody at MPAD cared about it. We did what we thought needed to be done and answered to nobody.

There was a payload working group or PDRS [Payload Deployment and Retrieval System] Working Group. I think it was headed up by Clay [E.] McCullough and Milt [Milton] Windler. There were other aspects of the RMS [remote manipulator system] that worked with groups here and groups at Canada.

ROSS-NAZZAL: Were you also working in the MDF [Manipulator Development Facility] to confirm what you were programming was actually working?

HOMAN: No, that was a different animal too. The MDF at that time was a hydraulic arm that basically represented the robotic arm. The end effector ended up being in the right place.

At that time it didn't have what they called the rollout angle. When the arm was deployed the first thing to do was roll it outboard 20 degrees so it worked in that plane. The MDF originally didn't have that rollout angle. The crews did training over there, but some of it wasn't really legitimate. In the MDF you could do everything with the three pitch joints because it was orthogonal to the orbiter. In other words if you wanted to deploy something you'd take the three pitch joints, and those were the only ones you'd have to drive to get it in and out. Whereas the real arm with that 20-degree rollout angle was actually operating in a different plane. The pitch joints with respect to the orbiter, there was nothing that you could do to just drive straight up and down with the three pitch joints. You'd have to have a combination of all the joints to make it go in a straight line.

It wasn't really good for single joint training, but it did everything else. The operators would use the hand controllers to move [payloads]. At that time they had basically helium-filled balloons for the payloads. You had something that it could actually hold. They practiced berthing and unberthing payloads in the payload bay and using the cameras and everything they would actually use on board. But the arm didn't actually work exactly like the real arm so there were some drawbacks there.

ROSS-NAZZAL: How did you verify what you were proposing for these autosequences was going to work, and you weren't going to hit the vehicle in space?

HOMAN: I had to basically code up all the graphics and back then all we had was vector graphics. Draw a line between two points and you put enough of those together and you can make a picture. We had XY plotters. We were just driving plotters, and we actually had a box that would generate the same thing on a CRT [cathode ray tube], but it was limited. It was basically a line drawing of things.

It was enough to allow us to know whether or not the arm could go from one point to another without hitting the orbiter. [I] coded that up, created the graphics that we needed, then basically wrote a simulation based on what they call the Functional Software Subsystem Requirements Document, which were the algorithms that [were used to drive the arm]. Basically I took that document and coded it into the computer and created a simulation that we could use.

ROSS-NAZZAL: You were working simulations with MOD prior to flights?

HOMAN: No. There was competition there too.

ROSS-NAZZAL: Oh. Really? Even though it would be beneficial to run through those?

HOMAN: Yes. In fact MOD didn't have anything like that at the time. It was something that we put together. [We] worked with the robotics and the astronauts who were assigned to the RMS at the time.

We used the simulation to do what we needed to do. That was specifically verify the autosequences. By adding a few more subroutines we could basically do all the different operating modes of the arm, the manual modes and single joint mode. Once we did that then you had graphical displays of what was going on. Some of the crews would come over and play with that, as opposed to getting into the large man-in-loop sims which were expensive to drive. You could do things more efficiently on a desktop than you could by turning on that whole system. We ended up answering a lot of what-if questions from the crews and basically worked with them there. We did a lot of going back and forth to Toronto when they were running simulations.

That's when we created the first desktop simulator. Then after a while the MOD folks would replicate [the hardware that] we had. We'd give them the software just so the crews wouldn't have to walk over to another building to do it.

ROSS-NAZZAL: What building were you in?

HOMAN: We were in 30.

ROSS-NAZZAL: You had come up with the idea of using the RMS to actually visually inspect the orbiter for damage after STS-1. How did that come about? You mentioned it last time. How did you come up with the concept of using the arm?

HOMAN: On STS-1 when they opened the payload bay doors, they were missing tiles which concerned people. There was no way to see if any were missing from the bottom. There were ways. Skylab, they got the Air Force to look at it.

After STS-1, the groups got together and tried to come up with a way of being able to look at the bottom of the orbiter. They came up with extendable booms like the masts that run out the solar arrays [on the International Space Station]. Have a canister with a camera on the end of it and pick it up with the arm and extend it and then survey the bottom of the orbiter.

It got to the point where none of that was really feasible at the time. I put together these graphics. All the stuff that we had to use for doing our autosequence verification stuff. One night at softball Sally [K.] Ride was playing on one field, we were playing on the other, and we were sitting back-to-back in the dugouts and talking, and she asked me what I thought the end effector camera could see of the orbiter.

I went back [to the office], and we were doing the graphics of the viewing package. You could draw the view from what a payload bay camera would see, or what the [astronaut would see outside of] payload bay windows.

We had graphics that were produced from the end effector camera. Then I obviously had a model of the orbiter and modeled a few tiles. Stuck the arm under the orbiter at various places and came up with—I'm not sure, maybe 10 different arm configurations that when they were stuck under the orbiter by just moving one of the wrist joints you could scan a particular section.

I think it ended up being about 90 percent of the orbiter that you could see. I put that together. That's the first time that I really ever met Gene [Eugene F.] Kranz. I put this whole sequence together.

First thing they did was he called me up. I went over to go over it with him. I'm not sure they trusted what I was doing. I went over it with him and then had this presentation that I put together and was going to take to the Flight Techniques Panel. I'd get put on the agenda and then I'd get taken off the agenda.

What it was was the upper management was trying to come up with a name for this thing that didn't look like a huge problem. Once they decided on a name, I don't even remember what they called it. I pitched it. But that was the only thing holding it up was to come up with what to call it that wouldn't cause a lot of attention.

ROSS-NAZZAL: I'll have to look in the press kit for STS-2.

HOMAN: It's in the contingency checklist for the RMS. I put that together and every flight that flew an arm after that carried [it]. Checklistwise Charlie and I would also produce, for each of the flights with an autosequence on it, for each of the various points in the sequence, we would produce the views from all the payload bay cameras and what you'd expect to see out the window of the arm and the payload at each of those points. Just as a reference for this is what it should look like. Does it look like that? We'd make basically a whole book of those, and they finally started putting those into the checklists also for all their maneuvers.

The single joint process of backing off a grapple fixture or capturing a grapple fixture in the payload bay was another thing we worked on, specifically backing off a grapple fixture. If you had to do it in single joint mode, and a grapple probe was about a foot long, moving the arm one joint at a time wasn't really able to get the end effector off the grapple fixture without banging into it, if you just moved one joint. Sort of like parking in a real small parking space. You had to maneuver it off.

We put together a graphic that showed how the target would move with respect to each joint input. Create a sequence of joint inputs to move one joint so far till the target got to a point in the view of the camera. Then you change to another joint till it drove it back. That was added to the checklist at the time too. Each payload that they were flying had a particular sequence of motions of the target to back off the grapple fixture. That was added to the checklist. Different things like that.

ROSS-NAZZAL: Do you have any memories of STS-2? That was the first time they were inspecting the vehicle using your procedures. Did things change as a result of what happened on that flight?

HOMAN: It was scheduled, but on STS-2 they had a problem with the fuel cell. It cut the flight short. They didn't get around to doing that. It wasn't till STS-8, when I got a call from flight controllers. They were going to add that into the flight. [They] asked me to come over and pick which configuration I wanted to see. Went over and selected one of the arm configurations.

They stuck it under and looked at the tiles. I think that's the only time they ever did that.

ROSS-NAZZAL: I'd never heard of it. Why didn't they do it on Sally's flight? It seems like it would be something that you would have done on her mission.

HOMAN: They never really had any reason to. After the first few flights you come back, and the bottom of the orbiter is fine.

ROSS-NAZZAL: It was there as a contingency?

HOMAN: Yes.

ROSS-NAZZAL: When I read it I was like, "Oh, I did not realize the crew had been doing that all along."

HOMAN: Yes. Like I said on STS-8 was the only time that they had it. Looked at it to see what they could see.

ROSS-NAZZAL: That explains it then.

HOMAN: They carried it until *Columbia* [STS-107]. Sometime in there I got a call from one of the interns in the RMS Section. I guess they had her going over checklists and stuff. She'd noticed that one of the configurations, it wasn't looking at the orbiter at all. She brought stuff over and went back through and found out that sometime over the years they'd dropped a minus sign on one of the joints.

ROSS-NAZZAL: Good thing you were around.

HOMAN: But like I said they never used it till *Columbia* and then they revamped the whole thing anyway.

ROSS-NAZZAL: I know we'll talk about that. I did want to shift gears a bit and talk about Space Station which—for you—involved the arm initially early on. If you would, talk about how you got involved with Space Station in '83.

HOMAN: They started out with assembling the thing. They were going to assemble it out of the orbiter. We knew about the arm and had the graphics capability. I'd go to the groups and that'd be what I'd produce: how you actually assemble the thing.

ROSS-NAZZAL: Why were you such a big advocate of using the RMS instead of perhaps maybe having crews go up and do EVAs [extravehicular activities] and connect pieces? I don't know what other assembly options there might have been.

HOMAN: The pieces are huge modules. You couldn't handle those using EVA. How do you pick up a module and stick it where it needs to be. That's what the arm was for. How would that look for the Station arm? What would they use for a Station arm? Where would they put it?

All we did at that time was took the Shuttle arm and stuck it on the Station.

ROSS-NAZZAL: Were you the only person who was really advocating for an RMS at that point? Were there people who were opposed to using an RMS?

HOMAN: I wasn't advocating for it. That was going to be the way that it would have to be done.

ROSS-NAZZAL: That was the only way of assembling.

HOMAN: Yes.

ROSS-NAZZAL: I was wondering about that.

HOMAN: I was there because I knew about the arm. That's what I could add to the groups.

ROSS-NAZZAL: You talked, in your summary, about the IGOAL lab: the Integrated Graphics Operations and Analysis Lab. Would you talk about that?

HOMAN: As years went by people were getting into graphics, and there were different companies producing graphics machines. We always had the funding where we could actually go out and buy whatever was the latest, and then we'd bring it back and upgrade what we had.

It basically got to the point where, like I said, I'd written all these programs for building models and displaying models, and they were all built in a language called HP BASIC, which was Hewlett-Packard's own language. Then they came out with C programming language, and that's where all their computers were. Everybody was going to that, but I didn't know anything about that.

That's when I hired Brad Bell to convert my programs to C so they would run on these other platforms. As platforms would come out, he was big into graphics, like I said he'd rewritten the graphics programs that I started with. As the graphics machines became more and more capable, we used their functions, and we basically got to the point where on-site I think we always had the latest graphics equipment.

Back then it was pretty much MPAD's Graphics Lab. It wasn't till later that somebody came up with the other acronym. We ended up with a co-op and a few interns and a few contractors that did the graphics part after that. That's where the IGOAL came from.

ROSS-NAZZAL: That was another facility I hadn't heard about.

HOMAN: That was basically another name for the graphics that we'd built and were using.

ROSS-NAZZAL: What are your memories of *Challenger* [STS-51L], and what impact did that have on your position?

HOMAN: I remember we were having a Space Station Freedom meeting that morning, and it was [with] McDonnell Douglas. They actually had one concept that they were working to. We were having working groups on that and had a big working group going then and stopped to watch the launch. Then it exploded and everybody quit working and went home.

ROSS-NAZZAL: What sort of impact did it have on the work that you were doing? What impact did it have on Shuttle and Station for you?

HOMAN: I'd worked with Ron [Ronald E.] McNair on [STS]-41B when he flew the first time. He did some arm operations on that. Of course I knew Judy [Judith A. Resnik] really well. It was depressing. I'm not sure what else [to say].

ROSS-NAZZAL: You were doing some work with the arm because we weren't flying. There was an effort to look at all the subsystems to make sure that everything was covered. It looked like you did some work in Toronto working on the failure modes and effects.

HOMAN: Yes, they did the FMEA/CIL [failure modes and effects analysis/critical items list] reviews of all the different systems, and obviously we got involved with the RMS subsystem to go over it and see if we could find something wrong with it, that type of thing. We spent a month, month and a half up in Toronto doing that.

ROSS-NAZZAL: Did you find anything with the subsystem that needed to be updated or changed? Quite a few things were updated.

HOMAN: There were a few things in the software or way of doing things, but there wasn't anything major.

After that NASA created the Critical Evaluation Task Force to look at Space Station design. I spent a month or month and a half up at Langley [Research Center, Hampton, Virginia] where they brought in groups from all the work packages to essentially go over that configuration at the time.

ROSS-NAZZAL: What were you looking at specifically?

HOMAN: RMS assembly.

ROSS-NAZZAL: Did anything change as a result of this working group?

HOMAN: That whole timeframe everything was changing.

ROSS-NAZZAL: Why do you think things changed so much? There were so many redesign efforts during that time. It seemed like it was just a constant. Nothing was set. It was constantly evolving.

HOMAN: It was, and every group had their own concept. Basically looked at them all. There were different designs depending on how they planned to fly this thing. If they were going to fly it solar inertial so that the solar panels could stay fixed, then the vehicle would always be pointed at the Sun. But it wouldn't be oriented with respect to the Earth the same at any time. Then there [were those designs where] we'd fly with [the modules] always pointed at the Earth, which meant you'd have solar array tracking. Lewis [Research Center, Cleveland, Ohio] was responsible for power. You had solar arrays, and you had solar dynamic power, which was basically a mirror that concentrated sunlight at a particular point. Whatever was there generated electricity. All that had to be assembled and put in place. [We were] deciding which configuration they'd fly, or how they'd fly the thing. There were different configurations and concepts for each of those.

Then there were some that were completely deployable where this thing would just assemble itself.

ROSS-NAZZAL: That's interesting. Kind of like the Bigelow modules?

HOMAN: No, this was all trusswork that would fold out into a gigantic system, as opposed to putting it together like Tinkertoys. They'd go up there, and they'd pop something loose. Obviously you had to add modules and everything else.

They had all these different concepts and that's what they were looking at from '83 on. Even the Space Station Freedom, the size of the truss and the configuration of the truss kept changing. Originally it was what they called a dual keel where you had a huge set of trusses with the modules in the middle and solar arrays out to the side. Then they got rid of all the upper and lower trusses, and it just became the trusses across the modules. They were going to assemble that one stick at a time. They had to come up with techniques for actually putting each of those bays together and assembling that. Until they finally came up with the whole integrated truss concept that they actually went to, where you'd send up whole sections and just plug them together.

ROSS-NAZZAL: Were the meetings contentious given the fact that there were all these different work packages and different ideas?

HOMAN: Sometimes they were. Even when you came up with a concept there were different ideas on how you would assemble it.

ROSS-NAZZAL: You came up with something that I thought was interesting: assembly principles. I wonder if you would explain what that idea is and what those were.

HOMAN: When they formed the Assembly Planning Review [APR], which was a level 2 panel that was headed up by Vance [D.] Brand at JSC, they asked me to join the panel from an RMS point of view again to look at assembly. The first task he gave me was to come up with some assembly principles. I don't even remember what they were.

ROSS-NAZZAL: Okay, I was curious about that.

HOMAN: Like minimize EVA for assembly. Shoot, I don't remember but essentially how the best way to assemble something would be.

ROSS-NAZZAL: Did you get any pushback from anyone about your concepts?

HOMAN: No. I'm not sure anybody used them either.

ROSS-NAZZAL: Were there any huge concerns about assembly itself? Were there safety concerns or other issues?

HOMAN: Yes. One was weight and the amount of weight and structure that the orbiter could take to orbit. Then [there was] the sequence of what you put together first. Weight was always a problem, just like it is on every program. What you wanted to put up was usually bigger than what the orbiter could take. You'd have to take things out. Once you start reducing the weight by taking components off, obviously it reduced what's available at that particular time. Weight was a big challenge.

Then like I said the sequence itself was a challenge. One of the biggest problems we had was Congress got involved. Every congressman had something in his district that was being provided. They always wanted that to go up first. A lot of times it didn't make sense. You had Congress defining the sequence. You had weight defining the sequence. You had robotics defining the sequence. Goddard [Space Flight Center, Greenbelt, Maryland] had what they called the Flight Telerobotic Servicer, which was basically a two-armed thing with a tail. Like the Special Purpose Dexterous Manipulator or Dextre that the Canadians added to the arm, basically a couple arms. This thing could do anything, whatever problem arose this thing could solve it.

ROSS-NAZZAL: That's pretty impressive.

HOMAN: It was [U.S. Senator] Barbara [A.] Mikulski's district. It would go up on one of the first flights and help you assemble all this truss. It sounds good, but it really didn't [work]. It was sort of like asking your three-year-old to help you work on the car out in the garage. It may keep him busy, but it really wasn't useful. There was a lot of contention there. It flew on the end of the RMS. Most of the time the configurations that they wanted to put it in, the arm couldn't actually do that.

But again it was thrust into the, "You're going to take this up on X flight, and it's going to do all this stuff." It just didn't [work].

ROSS-NAZZAL: Did you ever have to go brief any members of Congress or their staffers on why this concept was going to work?

HOMAN: Not on that. No, I never got [called upon to do that].

ROSS-NAZZAL: Anybody from Texas promoting any concepts that you recall?

HOMAN: Oh, I don't remember any.

ROSS-NAZZAL: What about money?

HOMAN: Funding was another problem.

ROSS-NAZZAL: What challenges did that pose?

HOMAN: That's what got Congress involved. Since they were paying for it, they were going to decide how it was going to go. I didn't have anything to do with funding other than the resulting issues that it caused, but that was another key factor that kept changing configurations. In fact that's what drove the final restructuring program for Freedom. That's when we went up to Reston [Virginia] for a few weeks to come up with a solution to the assembly problem. What they came up with I didn't agree with.

ROSS-NAZZAL: Would you talk about that? You mentioned Bill [William B.] Lenoir being there.

HOMAN: When they started, I guess we started talking about it in August of whatever year that was. The APR group, which was led by [Vance Brand]—Dave [David M.] Walker replaced Vance when he went to fly. I think there were four or five of us that got together and decided what we thought should be done. That's when he mentioned that he thought we ought to have a root cellar, [that's] what he called it. At that time they'd dropped the requirement for externally mounted payloads. Once that requirement was gone there was really no reason for all this trusswork. The only thing they needed outside were the solar arrays, the radiators, and the propulsion. He suggested a root cellar where he moved everything that was outside inside like CMGs [control moment gyroscopes] and other controllers and whatever was out there. You could work on it in a pressurized volume. You didn't have to go EVA to fix things.

That's when I started thinking [if] they could make the nodes the right length, you can basically have one module that you're building. The same node, you just replicate it, and you assemble the module configuration with the nodes.

They also had the requirement then that you had to have two exits out of each module, which drove you to that racetrack configuration. That was the big driver, but we came up with this concept of how to build this.

The first thing he said it looked like Starship *Enterprise*, because it was a V shape with the two hab module lab modules hanging off it so it looked like [a starship]. Then the trusswork was out in front of it or out back of it. That's what we referred to it as, SSE (Starship *Enterprise*). In November they were going to start this boiler room process of everybody meeting up in Reston and start working things out. Just before we got there, *Aviation Week* had come out with an article about what needed to be changed and why JSC engineers didn't think this thing would work. Then they also described this configuration that we had.

We got up there about the same time the magazine did, and we weren't really welcomed with open arms at that time. We sat there for November and December and worked different options. We had requirements. Different groups were there proposing different options and based on some criteria graded all the options and reworked them.

Essentially by the end of the thing I guess I'd made it apparent that I didn't agree with what they were doing. They knew that. In fact that's when I got into one argument about man-tended versus—they wanted to have a man-tended configuration.

ROSS-NAZZAL: Can you explain that? What's man-tended?

HOMAN: You build to a point where you fly up and do your thing in there and then you fly back. You don't permanently man it. You keep building on. Then you get permanently manned capability sooner or later when you leave crews on the Station. Or leave crews on it permanently. I argued with them one night that I didn't think it was a real good idea to put man-tended in the assembly process as a major point. I argued that if you ever got to a man-tended configuration Congress would say fine and pull the money because you had this thing up there. You'd never get [funds to man the Station permanently].

The next day whoever was responsible for that evening was giving the presentation of what went on the night before. He said, "We had an argument about this man-tended thing." That's when I got up and admitted that it was me that was arguing with them about that. [I] had a discussion with Bob [Robert W.] Moorehead, who was leading that, about it. I explained to him what I thought. I felt that if we went that way it would be like Apollo. Apollo was pretty much a publicity stunt because once they got to a certain point Congress said forget it. They had nothing to follow on with.

Dick [Richard A.] Thorson, who I worked for, was up there. Before that [presentation] he took one of his smoking breaks. I was having that discussion at the time with Moorehead. Just after that Dick came back in and sat down at the table. He was sitting down at the table, Moorehead turned to him and said, "How do you think you can integrate the program if you can't even integrate your own people?" Of course Dick didn't really know what he was talking about. Then he mentioned me. That's when Dick said, "Homan speaks for himself. I don't control that. He can say what he wants to say."

ROSS-NAZZAL: What was the argument for man-tended? What was their reasoning behind that?

HOMAN: It was just a point in the sequence that they could get to and say, "We accomplished this. Then we're going to move on to this." It required assembling in a certain sequence to get to that. Whereas if you avoided that and built to permanently manned, you'd do steps in a different order. Man-tended required you to have certain capabilities there before you really needed them. If you went to permanently manned, you could reorder that and do it more efficiently. Then like I said once you got to man-tended the odds were that Congress would say fine and stop the program because they weren't interested.

They'd given some direction before we started that they wanted to see something different. By that point we got to this configuration, it looked exactly the same, took more flights to assemble, and cost more. I was arguing, "They're not going to buy that." But they went with it anyway. In fact the last meeting before we went to Lenoir, we went around the table and [I] told him, "You can actually assemble anything you want. [It's] just not smart to do it one way versus another."

That's when we had the meeting with Lenoir. They went over the assembly sequence. Everybody around the table said, "Yes yes yes, this is fine, this is fine." When they thought they were done Lenoir sort of looked in my direction and said, "Is there anybody else that has anything to say?" Most of the people I think were expecting me to say something, but I didn't. In fact the guy that was sitting next to me—we were on the plane later on—he said, "When he did that, I moved my chair away from you."

ROSS-NAZZAL: You were very unpopular at that point.

HOMAN: Essentially by that time I'd decided that I was going to move on. [I] looked for a job elsewhere.

ROSS-NAZZAL: That brings up something that I was curious about. For years you've been churning through concepts about Station, and you basically arrive at the same point that you were years earlier. How did you come up with different concepts? Every time you have a meeting you have to come up with something new. How did you take that approach?

HOMAN: That's just the way it was. Everybody was making their inputs.

ROSS-NAZZAL: Just borrow a little bit from each other?

HOMAN: When they'd come up with a configuration, I'd try to work it from an assembly standpoint of how to put it together. But I always tried to look at it from the astronaut side of how do you minimize EVA and make it more efficient that way; do more assembly without requiring the crew [to go outside]. I always had support out of the Astronaut Office for a lot of the concepts or sequences that I was promoting.

ROSS-NAZZAL: Was there any one sequence that you really thought was the best sequence that was panned or overlooked?

HOMAN: Starship *Enterprise*.

ROSS-NAZZAL: That was the best?

HOMAN: Assembling the truss too. There was—they called it phased attitude where you assembled it in a particular order that got you to different configurations, different capabilities, and it flew differently depending on what components were up there. Whereas you could fly it without using too much prop and minimizing propulsion, minimizing subsystems that you were required to have if you built it right.

ROSS-NAZZAL: Cost savings as well I imagine, maybe.

HOMAN: Like I said I never worried about cost. But also factoring in what you could take up with the orbiter at any one particular time.

ROSS-NAZZAL: I've often heard from folks that JSC has its own culture. Kind of known for this idea of being a little snobby, elitist.

HOMAN: There was definitely a conflict between JSC and Marshall [Space Flight Center, Huntsville, Alabama].

ROSS-NAZZAL: Would you talk about that in terms of Station?

HOMAN: I'd always heard about it, and it really showed up at the CETF [Critical Evaluation Task Force]. Each of the work packages sent so many people to Langley to work on this. Originally there were 35 people in the group made up of Work Package 1, 2, 3. Each work package was allotted so many people. JSC had Work Package 2, but it was also where the program office was.

ROSS-NAZZAL: Lead center.

HOMAN: They had two groups of people there. I remember the very first meeting one of the Marshall guys stood up and went over the number of people from each group. In the end I guess of those [original] 35 people, there were only 120 left at the end because Marshall would bring a bunch of people and have them off-site. There was definitely a contention between Marshall and JSC.

ROSS-NAZZAL: Did you get the feeling that JSC was trying to strong-arm people into supporting its—

HOMAN: That's what Marshall thought. Where you actually sat.

ROSS-NAZZAL: One thing we didn't talk about was your role as functional area manager for assembly, when folks were out at Reston and you were going back and forth between Virginia and JSC.

HOMAN: I never really understood what all that was. It was just sort of a title. I guess I was the robotics expert at the time on assembly and using the arm. Nobody else knew as much about how the arm would actually work. I was named that. I don't know. Didn't do anything special. Nothing changed.

ROSS-NAZZAL: Just working on requirements. Okay.

HOMAN: Didn't give me any extra money or anything.

ROSS-NAZZAL: That's too bad. One other topic that I thought was interesting is right after President George H. W. Bush announced that we're going to go back to the Moon and on to Mars—that program didn't end up going anywhere, but you ended up doing some work on that effort.

HOMAN: Yes. They formed a whole group. In fact Mike [Michael D.] Griffin, Jay Greene, and one of the old astronauts, I want to say [James C.] Adamson, the three of them headed that up. They moved it off-site and had a whole group of people working on that. I supported that from an Automation and Robotics Division standpoint. That was another sort of assembly problem.

ROSS-NAZZAL: How so?

HOMAN: Taking all this stuff to the Moon and then getting it assembled on the Moon [required] various flights. I think I worked lunar rovers, but I had ideas on how it should be assembled also that didn't necessarily agree with everybody.

ROSS-NAZZAL: You had strong opinions one way.

HOMAN: I guess. In fact I went in to talk to Jay about it one day, my concerns, based on what we'd seen on Station from weight standpoint and assembly process standpoint.

I went over to his office and his secretary took me in. She introduced me to him, and I said, "Yes, I used to work for a guy that looked like you, but he was a whole lot younger." I'd worked for him years before that.

He said, "Well, just write up what you think and send it over." It was one of those where I wrote up what I thought. There were other people that were working in there. Somebody said, "How can you get away with writing that stuff?"

ROSS-NAZZAL: That's kind of NASA's heritage, right? Arguing over the best ways to make it to the Moon.

HOMAN: That came out of the *Columbia* investigation. You get to a certain point, and somebody tells you no and they'd stop. I guess I never understood that concept because I had no problem going to anybody else higher up the food chain. I knew most of them. I'd worked with them all before.

ROSS-NAZZAL: Do you think it's because you had worked with Apollo era folks that you felt comfortable and confident in disagreeing?

HOMAN: No. I think it was from Davy Crockett. When I was a kid [I watched him] on Disney. I think his motto was, "Be sure you're right, then go ahead." I guess I was always sure I was right.

ROSS-NAZZAL: Were people who were making comments about the things that you were saying, were they part of that younger generation of engineers who'd come in later?

HOMAN: Some of them were new, yes. But others were from just different organizations and had different feelings about things, I guess. At their level they didn't feel comfortable or just from a command structure [they didn't feel comfortable] talking to anybody higher up than their immediate [supervisor] to go up the chain of command as opposed to skipping a few steps.

ROSS-NAZZAL: It's an interesting point about *Columbia* though. That is a good point. What was your role in looking at the lunar rover? What were you weighing in on?

HOMAN: Just to go back and look at what they'd used on Apollo versus what we thought they required here from a power standpoint and a size standpoint. The Apollo ones were basically batteries and some strange concept, something to do with wax. They were good for that particular flight. We needed something else that you could park and recharge and was usable and had more range. Nothing really specific.

ROSS-NAZZAL: How long did you work on that effort?

HOMAN: I don't know if I bailed out before it cratered. It was one of these. I'm not even sure it lasted two years.

ROSS-NAZZAL: Did you think it was a possibility we were going back to the Moon?

HOMAN: It was something to work on. When we worked on it they were going to go in 1999. Spent work after hours and weekends putting together presentations of concepts. Then a little while later you wondered why you spent all that time doing that. That was when Dan [Daniel S.] Goldin put together his red and blue teams, teams from other places to come in and look to see what you were doing.

ROSS-NAZZAL: Talk about that and how that impacted you.

HOMAN: I forget what color team it was, but it was a bunch of people from Dryden who came to evaluate this stuff. It was one of those where after the meeting they got with me and said, "Okay, what do you think?" [I told them the same stuff I'd told Jay. Pretty much my list of configuration and assembly concerns.]

ROSS-NAZZAL: Oh, really? Did you know anyone from Dryden?

HOMAN: Yes. I knew them all.

ROSS-NAZZAL: I think this might be a good place for us to stop because we can talk about the VR [Virtual Reality] Lab. I know that's going to take quite a while as I was going through all your materials.

[End of interview]