DISCOVERY PROGRAM ORAL HISTORY PROJECT
EDITED ORAL HISTORY TRANSCRIPT

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NIEBUR: This is an oral history with Dave Grant. We are at APL, and it is July 27, 2009. We're going to be talking about the MESSENGER [Mercury Surface, Space Environment, Geochemistry, and Ranging] project today, which Dave was project manager on from 2002 to 2007. My name is Susan Niebur and I'll be doing the interview. Dave, when did you become project manager?

GRANT: Well, it was around November 2002. I was project manager on TIMED [Thermosphere Ionosphere Mesosphere Energetics and Dynamics] mission, which I still am as a matter of fact. The TIMED program was launched in December 2001. We got it launched and got it flying and got all the bugs out. I wasn't sure what my next deal was going to be, if anything, and Tom [Thomas B.] Coughlin, our program area manager, asked me into his office one day, and laid out a story. Max [R.] Peterson, who was the project manager for MESSENGER, announced his retirement, and his designated successor who had been his deputy for some time, didn't show up for work for several weeks and then one day he came in and announced his decision to leave the [Johns Hopkins Applied Physics] Laboratory [Laurel, Maryland]. So, they were stuck in a way and he asked me to take the job. So, I thought about it and it was attractive to me because it was a planetary mission. I hadn't done planetary and I thought that would be something I'd like to try.

Basically, it was one of those things, yeah, I think I can do it, and so I agreed, not knowing an awful lot about the program. I knew Max well; I knew his deputy very well. So we got started. My first meeting was called a Risk Retirement Review. It was covered by an independent assessment team that had been following the program for some time. I went to the review and I began to sense that there were some serious problems going on in the program. The review was not a standard review. It was requested by Colleen Hartman, and I believe her title at the time was Director for the Division of Planetary Science.

And so we get into the details and it was clear from the start that there was a very big struggle to try to keep the program cost under the cap. It was a very big concern about that.

NIEBUR: During the program or the project? You mean MESSENGER.

GRANT: MESSENGER, yeah.

NIEBUR: Just checking because there were [cost problems] all around at that time.

GRANT: Basically, it was the work we're doing here, the development part of it. Then we really got into it. There were problems. We had problems with the IMU [Inertial Measurement Unit]. It was very late and Northrup Grumman was having a heck of a time with it. Also, just as I came in the door, they had announced that one of the solar array substrates had cracked in testing. What were they going to do about that $100,000 rebuild? We had an autonomy system to protect the spacecraft that was stuck. It was a very comprehensive system, trying to do everything. Everywhere I looked there were cost and schedule problems.

Now you have to understand, MESSENGER is a very tough mission. You have to keep your eye on the spacecraft weight, on the propulsion, and on the thermal. An awful lot of technology. The guys that were working the job were very good people, but it was a very tough job. So, I really wasn't surprised to see that there were problems. I mean this is a program with an awful lot of technology development. An awful lot. And we were having problems. So, we had the review and came out of it with some recommendations. But it was clear to me, very clear, that we had blown the cost cap. This was something that my own management did not want to hear, but there was no way that we could complete the work and stay under the program cap.

NIEBUR: Was it obvious to you why? Was it because of those three technical problems?

GRANT: It was technology, technical development.

NIEBUR: Just the whole sum.

GRANT: It was two things. There was technical development but also, the program plan had not been thought out thoroughly. There were assumptions made and there were things that needed to be done that would be funded out of reserves and I didn't really believe that, okay? You needed to budget for these items in the cost plan.

So my assessment was we've got serious problems here on cost. Especially during the Phase E problems I could see right away. We didn't have sufficient support in there for the post-launch engineering for the instruments or the spacecraft. So I started to work and the first thing I

did was a top-down cost estimate to see where we were. At the time, Dave [David B.] Jarrett ran the [Discovery Program Office]. I think he was stationed out in California [Jet Propulsion Laboratory (JPL), Pasadena] actually. So, I went over it with Dave and I told him where we were. Guys, we're over the cap, and we have to face up to it. So, early in 2003, I put together a presentation and a detailed bottom up cost estimate and went down to see Colleen Hartman and presented her the picture as we saw it at that time.

NIEBUR: And you were new to the project at this point. You only had been on a couple of months and so you were able to come in and have a clear assessment or at least a new look at it.

GRANT: Yes. It didn't take a lot of looking to see that there were problems. So, we went down to see Colleen Hartman. I want to just say something about Colleen Hartman. She was very tough, very tough. But she understood the NASA mission, which is to succeed. She always wanted to do the program. There was never any of this intimidation crap about, "I'm going to terminate the program." It's, "What can we do to get this thing straightened out? By God, you better get it straightened out." That was the message. But for me, I liked her because she really wanted to do the mission. Very tough but always supportive.

So, we went down to see Colleen Hartman down at [NASA] Headquarters and I did a standup presentation. Dave Jarrett had briefed her earlier on our status and I thought she was going to skin me alive. And she did. So, I get through making the presentation. She said, "Well, Dave, you broke the cap. You exceeded every estimate. You've broken every rule that NASA has. Everything, everything's been broken. Now, tell me why should I believe you?"

So, I said, "I'm giving you the best estimate that I have about where this program is and what we need to get it going forward." I said, "We need to establish credibility with NASA, because right now, we have none." You know, this problem followed on the heels of the CONTOUR [Comet Nucleus TOUR] program, which left APL's relationship with NASA in a very bad state. They didn't believe much of anything we said anyway. So one of the real big problems I had was re-establishing credibility with the sponsor.

Now, I could say it's a nice day out and NASA would say well, how the hell do we know that? [laughter] So I said, "Look, this is it and you can browbeat the hell out of me, but I'm not going to change my story. This is what I think it is." So, we got into it but she turned out to be very supportive.

Back when we did this Risk Retirement Review in December 2002, it was decided by Dave Jarrett and Max to revisit a thing called NIAT [NASA Integrated Action Team]. I think that was funding to recover from the [Administrator Daniel S.] Goldin era of better, faster, cheaper. Earlier in the program we had gone through the program end-to-end and decided, "We've got to have more staff here or we've got to do more testing there to reduce risk." And we came up with an estimate for NIAT recovery of a couple of million dollars. Other programs had done the same thing and were claiming $20 million. I mean, they were really getting substantial additional support for their programs. After the Risk Retirement Review, we recognized that we hadn't done a good job with the NIAT. So, we went back over the program a second time and came up with a bill of particulars, and I think it was something like $17 million of NIAT attributable costs that could be justified. We submitted the claims to Dave Jarrett and Dave came up saying maybe $14 million of it is justified. So, he didn't take everything.

So, we presented our claim to Colleen Hartman about NIAT. She said, "Well, we already have this NIAT stuff. She said, "You've already submitted your NIAT and we gave you what you asked for. What is this?"

So, that request was denied pretty much, most of it. I think a tiny bit was approved. We had asked for substantial cost increases in Phase C/D and Phase E and I pointed out that there were some activities requested that need support that were not requested originally. We need to have engineering support post-launch for the spacecraft and for the payload. Nothing was budgeted. The plan had been to get it out of the reserves. I didn't agree. That was like a $9 million cost using the NEAR [Near Earth Asteroid Rendezvous] program as a basis of estimate.

NIEBUR: You said Max said that. So, was there really any overlap between Max and you? Was he there as an advisor?

GRANT: No, he stayed on after I first came on as Program Manager designate and I think it was three months, but I'm not sure.

NIEBUR: That's not very much time.

GRANT: No. Well, it is and it isn't. Because I started to run things as soon as I came on. When I came on, I wanted to run the program. I didn't say he was going to run it and I'd follow. I ran it and he told me where the land mines were.

NIEBUR: Not a lot.

GRANT: So, I got blown up a few times. So when we went into Colleen, we asked for some more NIAT funds and we asked for additional funds for '03, for Phase C/D. This was in like May or June, something like that. We had to commit all of the program reserves and we had to forward funds out of FY04 down into FY03. That's what was needed to get out of FY03. And I'll tell you, we got lacerated for it, but she stayed with us. That's the big thing.

So, we get into '03. We had all kinds of problems. We had problems with, like I said, the IMU, and with the autonomy system. We had a system that was too complex. We had 350 rules. It cannot be managed, so we tried to get that down to a manageable size. So, I brought new people in to reduce the scope of it, more people to do the testing, and began to get it under control.

We had issues with integration and test, keeping things on schedule. You need to have the subsystems delivered in a certain order. Well, first of all, many were being delivered late. We were shooting for a March launch. So, we made the subsystems move their delivery dates in. That took more money to get that done.

NIEBUR: You guys had overtime? Increased staff?

GRANT: Not the professional staff. There were field ops. They got covered for that. But in general, no.

NIEBUR: But, to speed things up, did you have to work triple shift? Double shifts? Anything like that?

GRANT: Yes, well for electrical integration and test, I had an 18-person team working double shifts, sometimes triple shift, sometimes seven days a week.

NIEBUR: It's got to be hard on the team.

GRANT: Yes. It's very, very hard.

NIEBUR: Did it increase mistakes on that kind of a level, or did you see an impact on the program when you had to do that?

GRANT: There's an impact. The thing you have to be careful about is burn out. Sometimes you say, "Okay, take the weekend off. Take a few days off." You have to be very, very careful about burn out, as everybody's short tempered and irritable. But anyway, we get through that summer. Now we were on schedule for launch in March of 2004.

Now, there's a lot of instability. Let me talk to you about one instability, and that was the program office: Dave Jarrett and his association with Colleen Hartman. Frankly, they didn't get along. So, somewhere along the way, I just don't remember the dates, but Dave Jarrett was reassigned. Dave was a good guy, but I think NASA thought he was too close to APL. When you work with somebody and on a tough problem, people get to know one another, and to work together, they become colleagues. It is tough to be objective, and I think they saw that down at Headquarters. Dave was very, very supportive. When we had problems, he was there. But he disappeared.

Then somewhere along the way, I think, Colleen Hartman got a different job. She went, I think she went to NOAA [National Oceanic and Atmospheric Administration]. I'm not positive, but she also disappeared. But, shortly before she did, and this was in, I think, around the July timeframe, we were having troubles with I&T [integration and testing] and we were tracking our schedule reserve. We had started with like 60 days reserve from March 2004, the launch date. Then the schedule reserve started getting smaller and smaller. We were very worried about it, so then we went into a period of trying to recover it. This was like in July, August timeframe. So, we were working very hard to maintain 30 days reserves and then it got down to 28, 27 and we could see it coming down and we were working like hell to try to get it back. So, we said let's try a 30-day window. Let's try to buy back out another week of reserves. So, we went into it and we got halfway through and we didn't get 15 minutes back.

NIEBUR: Why?

GRANT: Well, things kept coming up. We think we're going to save time by changing the shift work and it just didn't work out or some new problems came along. So, around that time I met with Tom [Stamatios] Krimigis and department management and I just told them that in my view we were not going to make the March launch date. I thought that the schedule reserve that we had was insufficient for where we were in the program. Still had nine months to go, more or less, and we didn't have enough schedule reserve. It was diminishing, and, in my view, I thought we should notify our sponsor that we were going to recommend a schedule slip.

Now, we had another launch opportunity. We planned March, but we could launch in May right after that. So, I'll never forget when Colleen came out to APL, absent Dave Jarrett.

She came out and I showed her about where we were and she asked, "Well, what about the launch date? What's the chances of making that?"

"So, I'm just going to tell you I'd say 50/50." She really took that hard. So, I said, "Well, I think we are going to recommend a launch slip." So, we got the estimates together. All this is on top of all the early problems. We went down to HQ, "Okay, Colleen, we are recommending to move the launch date out and this is the reason why. Technical problems, leading to late delivery of the instruments, late delivery of the subsystems." When you're doing technology, its human nature to be optimistic. But that's no excuse.

So, we said, move the launch out to May of '04. Well, there was a cost associated with that. It's a couple more months of development time. It'll also impact down at the Cape [Canaveral, Florida]. They were getting ready for the March launch. Now it's May. Okay, the launch day was going to be different but they have to keep the team together and that affects everything.

So, there's a big brouhaha going on. And it affected our Phase E operations because it was a slightly different mission design. A tiny bit longer, but not a big impact. So, we presented that to her and she listened. Around that time, she disappeared and NASA appointed Orlando Figueroa to be the, I guess it's the planetary missions director. Whatever they call it. I can't keep up with the titles down there.

NIEBUR: At that time, he had been the Mars Program Director and he was promoted to the Planetary Division Director.

GRANT: Well, let me say, he had a different management style and I'll just tell you, I didn't like it. I didn't see eye-to-eye with him on much of anything. We got the new launch date put on the books and proceeded to go forward, trying to get ready for the launch in May and we started solving problems. We get the IMU under control. It was delivered a year late. The solar array was a year late. The work was coming in, and we were getting it done. And also, we were moving quite heavily into testing. This is our mantra, test, test, test! I mean, the guys were just terrific. It was very demanding work. It takes a lot of hours, a lot of coming in on weekends and nights.

There were a lot of rumors going around at this time that the APL team was dumping tests to make schedule. This was totally unfounded. The team was very diligent. I was especially angry over this since the source of the rumors was a couple of malcontents who eventually left the program. I let APL management know it and NASA management as well. This was the low point of the program for me.

NIEBUR: Wow.

GRANT: I made a reference earlier to fault protection, our autonomy system. I have to say that we weren't quite ready for prime time in that regard. We had an idea of what we had to do but we made it too complicated and then we had to descope it to make it achievable. I mean it was so damned complicated that we never would have been finished testing.

NIEBUR: And you figured it out in C/D.

GRANT: Yes. You can find a lot of people to test the rules, but it's the concept of fault protection. How do you keep the spacecraft safe? And we needed to find Miss Right or Mr. Right to define the big picture. And finally, I got the right guy. His name is Mark [E.] Perry and I brought him on. Now, through this time we had people come in from JPL. There's a fellow up there, Chris [Christopher P.]Jones, and there's another fellow named Gentry Lee.

NIEBUR: Familiar names to many people.

GRANT: Chris Jones came out and we had him sit down and we made a presentation to him. I'm talking daily telecoms between Mark Perry and Chris Jones talking about what we need to do about fault protection. I have to say that Chris Jones was very instrumental in getting APL squared away on fault protection for a major planetary mission. He provided a lot of insight. So, we put up a strong effort. I had Mark Perry and I think at the time of maximum effort we had 11 people working for him doing the testing. And that was carried on through the Figueroa era, after Colleen left. That was the big unsolved problem for launch, getting the autonomy ready.

NIEBUR: Can I ask how you got them involved because it's rather unprecedented, isn't it, for JPL folks to come out and advise APL or vice-versa?

GRANT: Well, there's some rivalry in it, and I found out since then, there's more anxiety on their side than on our side.

NIEBUR: Oh, really?

GRANT: I've had guys from JPL tell me that they were paranoid about APL. How the hell could APL do a planetary mission? They're the only ones who have proven they could do it. The guys here at the working level didn't think anything about it. Our management though did have this competitive sense about JPL but it's different with the working guys.

NIEBUR: But it doesn't affect the mission folks very much?

GRANT: It doesn't bother them. You know, guys from JPL come on out. Chris Jones was terrific and he worked with our guys, we worked with him, very positive. No problem at all.

NIEBUR: I'm stunned.

GRANT: No, no, no. I know there's crap like that goes on at the higher levels, it's a big ego thing.

NIEBUR: But APL asked, or was it facilitated by Headquarters? Do you even know?

GRANT: **L**et me follow up with another target. I think how it happened was there's another guy that came in, John McNamee.

NIEBUR: Oh, yeah.

GRANT: But, that's another story.

NIEBUR: Yes.

GRANT: When we talk about instability, okay?

NIEBUR: Sure.

GRANT: So, anyway, that was a big issue going forward. Getting the integration done, the testing done, getting a comprehensive performance test done, and getting the autonomy system worked out.

Another point of instability is Dave Jarrett disappeared. So, what are we going to do about a program manager? Well, for awhile, I think what happened was that Figueroa was the acting program manager. And well, that really didn't seem to be working out. Every Tuesday morning we'd have a team status meeting, and one day, there was this guy sitting there in his Sunday suit and I thought, I wonder who that is. So, when the meeting was over, I said, "Excuse me, I'm not sure that I know you."

He said, well, I'm so and so, and the guy says, "I'm from Aerospace."

I said, "Oh, are you? That's nice." I said, "Well, how can we help you?"

He said, "Well, we've been contracted to be the program office for NASA on this program.

I said, "Oh, I see. Nobody's mentioned it to me."

NIEBUR: Nobody told you guys?

GRANT: Nope. No, no, not a word. So, I said, "Is that right?"

He said, "Yes, I'm going to have to be talking to you because we know you're going to be getting into I&T. We're going to witness your testing."

I said, "Well, what does that mean?"

He said, "Well when you do the I&T, we're going to have our team down there and your guys will be taking data, we'll be watching you and taking data and we'll compare things."

I said, "No, no. We don't work that way. We're going to write a test plan, and we'll send it to you, you review it, we'll run the test and my team has the right to do their own tests and then carry them out without excessive oversight. We're going to do the test, take the data, write-up a test report. We'll send that to you." Well, he didn't like that too much. I used to work with Aerospace on an Air Force program. Talk about micromanagement. You write a number down and then they'd have somebody write down the same number. A third guy would look at what you wrote to be sure it's the same as that the second guy wrote and they're both watching you. So, I said "No." I said, "We're not going to have that."

So, that didn't get started off on a good note, but beyond that, there was some ruckus at a higher level and this went on for about a month, and then the Aerospace guy disappeared. He didn't show up anymore. Then I heard that there was a meeting somewhere, and it was announced that NASA had brought on JPL to be the program [management office] and this place went ballistic.

NIEBUR: JPL proper this time.

GRANT: So the first thing I heard was JPL's going to be the program office and I'll never forget the first meeting I had. I had to put a burden on the cost to support them and it was something like $18 million or some incredible number. That was JPL. And I said to Tony [Anthony] Carro [the Headquarters Program Executive for MESSENGER], "Do you know how much this costs? See this $18 million? That's ridiculous. Why the hell is NASA putting out that kind of money? We could use that money here." But again, there was another big fight going on between, our own management and NASA about putting JPL people in this role, because in some sense we compete with them.

NIEBUR: Exactly.

GRANT: Well JPL stuck there for awhile. One of the big bright things that come out of it was John McNamee. John McNamee is the program manager and he was great because he had been through this before in his career and he knew exactly what we were up against. He was very helpful in keeping the review freaks out of here. You know, every time you turn around someone wanted a review. They wanted a special review on thermal, special review on propulsion, special review on attitude control, you name it. We already had done special reviews in these areas. Got to do them again. But John was very good in keeping those people out and letting us get the job done and focusing in on the real problems. I think John was instrumental in sending Chris Jones to us on autonomy.

NIEBUR: It makes a lot of sense, because he worked with them, he reports to them. All of that.

GRANT: Yes. So we marched toward the May '04 launch date. We also had stability problems here. Tom Krimigis, our department head, had been trying to retire. The laboratory had gone through searches and all that business. They spent a long time and then they came up with Mike [Michael D.] Griffin. So, we went through a transition when Tom retired and Mike came on.

Well, of course, it's a new thing, and Tom and Mike—Tom's a scientist, Mike's an engineer and they don't see things [the same way]. They're both very good at what they do. Mike came on, and so we finished and launched the mission under Mike. But, after that, he got the job of NASA Administrator and left, then Larry Crawford got the job.

Larry Crawford retired and they brought in Rob [Robert D.] Strain. Strain was a very good manager, but then Mike asked him to take over Goddard [Space Flight Center, Greenbelt, Maryland] when [Alan] Stern quit [as Associate Administrator, and was replaced by Edward J. Weiler, who had been the Goddard Space Flight Center Director, leaving the position vacant]. Now John [C.] Sommerer is the department head. So, five department heads in about six years.

NIEBUR: How does that affect the actual implementation of a project? I mean the guys on the ground. When say, Tom, retired.

GRANT: It doesn't make any real difference to the staff who the boss is. They pretty much do the same thing whoever it is. What's different is that the corporate memory is lost.

NIEBUR: Right.

GRANT: The knowledge of, the history of an event. Tom Krimigis was there when we went down for our first meeting with Colleen Hartman and heard her talk and he knew what she said and he knew what she meant and the reasons for it. When you get around to the later department heads, they didn't know anything about that meeting.

NIEBUR: I see. So, you lose some of the historical understanding.

GRANT: Yeah, that historical perspective. It's difficult to make informed judgments. Unless you're there, you don't know the full story.

So, anyway, we got into the final stages of development. We completed integration and test and then the environmental tests over at Goddard and we had our pre-ship review here and everybody in creation was at it. So, we went through the pre-ship review and we had to—we go by the numbers. I present, the system engineer presents, the subsystem people present, autonomy people got up and spoke and said we've completed testing. We're very confident of where we are, we're good to go, and ready to launch in May 2004.

Now you could have cut the tension with a knife in the room – very high tension. So, the reviewers had a private room they all went into and voted. They came out and they say, "Okay, Dave, we're going to ship."

I said, "Great. That's terrific." So, we got the team going and they packed the whole thing up, and we shipped it all to the Cape. But something was wrong. Management was not at ease. We were not at ease. This was in March 2004 for a May launch.

NIEBUR: The project was not at ease?

GRANT: Right. There was something—not everybody was comfortable and I could sense that. Well anyway, we shipped it and then the first weekend it was there and I got a call Sunday night from Mike Griffin and he says that NASA was concerned about autonomy. "Well, there's concern that we haven't done enough testing of the autonomy system."

I said, "Okay, well, tell me about it."

He says, "Well, they want you to do more testing in several areas.

I said, "Well if NASA wants us to do the testing, we'll do the testing. But, they have to understand the consequences." I had spelled it out at the pre-ship review because I suspected a launch delay was in their thinking. The next possible launch date was in August. If we go from May to August there's a development cost. Phase E is like 20 months longer and it's a much more difficult 20 months. We have an Earth flyby, two Venus flybys and three Mercury flybys before we get into orbit. Also, five major propulsive burns. That's a lot more difficult trajectory than the May launch was. It's a much higher risk trajectory. Also, the cost impact could be as much as $30 million.

NIEBUR: Sure. Absolutely.

GRANT: A lot more difficult. In addition, the margins on the spacecraft, the power margin, the thermal margin, were much tighter with this new mission. So, I said, NASA has to recognize that the risk is from launch to orbit. And you have to take everything into account. So you can keep that spacecraft here and do another few weeks of testing the autonomy system and go with

Flight 2, or you can go with Flight 1 as approved at the pre-ship review. NASA's got to decide if the additional testing is worth it. It's a much higher risk mission at a much higher cost.

NIEBUR: Right.

GRANT: But if NASA wants to do it, we'll salute and we'll do it. So Mike said, "It's non-negotiable."

Okay. So, that Monday morning I called the team down at the Cape and gave them the news. I got the resident team here together. I said, "The launch is going to be delayed until August." I called the team home from the Cape, I put a skeleton team down there. We set the spacecraft up at the Cape, but had all the apparatus up here to do the testing, the autonomy testing. We ran all the testing from here on lines going back to the Cape.

NIEBUR: Did you really? That's kind of exciting, actually.

GRANT: Yes. So, we had a small team down there. That was in March we did that. And then I think it was in June, we had completed the additional autonomy testing and we sent the full team back down there to do the launch operations. So, John McNamee was with us, and he helped finding people to inspect the spacecraft to assure NASA it was ready for launch. McNamee was very helpful, he really was. And having a personality like that, somebody who really understands what you're trying to do and wants to help you get the job done, is just what we needed.

This is a picture of the spacecraft readiness team in the Launch Operations Center at the Cape. I went to the Cape but I had to keep the mission system engineer and all the lead subsystem engineers up here, because this is where we monitored the spacecraft in the Mission Operations Center [MOC]. I was down on the console but I needed two more guys on the console as well. Mike Griffin, who was our department head at that time, I knew he had a lot of console experience, so I asked him and Will [William S.] Devereux. He's the head of our engineering branch. I asked him as well. They both agreed.

So, Mike got his console and Will got his own console and both had titles and responsibilities. That's Dr. [Richard T.] Roca, who is the lab director. He came down during the launch operations. So we get down there and we get it launched. I'll tell you the funny part about the launch was the weather was awful. We get delayed the first day because of storms. They have to send these damned balloons up to check the upper atmosphere weather, and I think they have to go to 80,000 feet or something like that. And they put them up and they were all exploding at 20,000 feet.

NIEBUR: That's not good.

GRANT: So here we're trying to launch this spacecraft to Mercury and faulty weather balloons are holding us up. But it's a requirement. And they'd go up. Oh, that one blew up. Going to send another. But the launch went well and we had a good team down there, the Boeing team. Great guys and very well trained. So, a very happy situation getting it launched.

NIEBUR: You said the three of you ran consoles. What was there really for you to do at that point?

GRANT: Well there's a flood of information on multiple communication links. You need extra eyes and ears to be sure of what is going on.

NIEBUR: What were you watching?

GRANT: Well, the thing is this. We all have headsets on. I'm in direct communication back to the people at APL and I'm in communication with the launch vehicle people as are Mike and Will. You have to know the readiness condition of everything that's going on during the launch process. And every once in awhile, we'd have to poll the spacecraft. Looking at all the subsystems. If the subsystems are green, the spacecraft is green; when the launch director polls me, I'd say the spacecraft is green and they would continue the countdown.

NIEBUR: I see.

GRANT: And everybody gets checked. They'll be talking to weather. They'll be talking to range safety and to the launch vehicle so everybody gets polled—the launch director, Chuck Dovale, would be polling everybody for the readiness of the entire system, counting it down to the launch time.

NIEBUR: And you're making the decision based on the results you've just seen from the spacecraft.

GRANT: All the spacecraft people are up here and we give Jim [James] Leary a flag to poll the spacecraft and he polls all the subsystems and he'd communicate back to me, spacecraft is green. Then the launch director polls me at this console, the status of the spacecraft, we're green good to go, but that was for all of the major systems. The launch vehicle would do the same thing.

So there's a whole bunch of functions going on like that and it takes hours. They have to check the status of everybody because if we'd have a problem, we're red, and then they'd stop the launch clock and find out what was going on. So, anyway, it was August before we launched but it went well.

NIEBUR: Excellent.

GRANT: But, you have to accept that it's a bruiser at times. But we launched. I was thinking when I first took the job on that we'll launch and maybe a year later, like TIMED, the spacecraft would be running smoothly. Not the case. We had, like I said, a very complicated mission. We made a decision in March to move the launch date from May to August. Because the mission design changed so much with the launch slip, with so many new and more difficult events, all of the planning that we had done up to that point was of limited value. We had to do the planning of mission design and science all over again.

NIEBUR: Because you're encountering objects at different times?

GRANT: Yeah. It's a different flight all together. So right after we launched we had to do the whole mission planning all over again. Analysis that we had done before launch; ordinarily you'd have it all packaged up good to go. All the science planning had to be done again. All the mission design had to be done again. And. in the meantime, we had to learn how to fly the spacecraft, which involves a level of trial and error.

Initially, the spacecraft was difficult to operate. We didn't know where the center of the gravity was. So, when we did little thruster burns, for trajectory correction, there were errors. And they were significant enough that they had to be corrected. We had to learn how to deal with that. We had plume impingement—that wasn't anticipated prior to launch. We had to deal with that. And in the meantime, there are literally thousands of different parameters onboard. Were they all right? No, there were a few that needed adjustment. Some were approximations.

So, the first time we tried something, it didn't work exactly the way we had hoped it would, so we had to go back and correct it. Each of these events were characterized as anomalies, they had to be corrected. And we spent a lot of time doing that. The shakedown cruise for MESSENGER was much more difficult than I thought it was going to be.

NIEBUR: Because so much of this was brand new, or because it hadn't even been finished?

GRANT: Well, a lot of new technology, and the first time out flying. It's like anything complex and new. If you build a new automobile, the first time you turn the key, don't think it's going to start up. But the engineering team stayed with it. They ran every problem to ground. They understood the reasons for the anomaly and fixed it. They were very thorough and diligent. And

finally, one day, we all realized all the problems were pretty much fixed and that MESSENGER was an excellent spacecraft. So I spent about three years on the flight operations of MESSENGER.

Now we're all getting ready to go into orbit around Mercury and to take science data. One of the significant parts of the mission is the science collection apparatus, the hardware and the software, to control the spacecraft and instruments, to allow the science to be taken. As we go around the orbit, we have cameras looking down that paint mosaics on the surface. We have other instruments, such as laser altimeters that measure peaks and valleys of the surface features. We have particle instruments and spectrometers. Spacecraft pointing is critical. Now, we have to have a way of doing the measurements which is integrated and automated. A detailed plan. We had seven major instruments and they're all going to be taking data. So, there is an apparatus of hardware and software to control science data collection and it's very complex.

When we get into 2006, we were getting ready for the first Venus fly by. I think that was 2006. Gosh, I can't remember anymore.

NIEBUR: Yes, it was [October] 2006.

GRANT: Okay. We had done an Earth fly by [August 2, 2005]. We had done the Venus 1 fly by [October 24, 2006]. We wanted to test the science data collection apparatus at Venus 2 [June 5, 2007]. I was having a difficult time because we had delegated responsibility to the instrument scientists and the instrument engineers to write the code to do the scientific data collection for their instrument.

NIEBUR: Is this before you had the special program?

GRANT: Yes. This is the command sequence structure. And I couldn't get the work flowing smoothly, so the instrument scientists and engineers were overcommitted and the software was always delivered late. So, finally I got a hold of Mark [E.] Holdridge who was mission ops manager at that time and Deborah [L.] Domingue, who was the deputy project scientist. I said, you know, we've got to find a way to do this. So, we came up with the idea of a payload manager.

NIEBUR: You didn't have one before?

GRANT: No. Not in that sense. This was a payload manager to do the command sequencing for the instruments. And so we decided we needed to get a lead and we needed to get three additional people and they would work for mission operations, not the science side. Okay, so I stuck my neck out because I knew we had to do something or we weren't going to be ready for Venus 2. We just couldn't make it. I looked at it and it's got to be like a $6 million hit but it's essential. That's when Alice Berman came on board and things got a lot better fast.

One of the things that we misjudged was preparation for the planetary data system, PDS. I had done data archives before, on TIMED, but it only took one person full-time leading development and then it pretty much runs itself. PDS was a surprise to me and a difficult bureaucracy I might add. We were having a hell-of-a time getting PDS on track. We were getting behind on it. It was clear we needed full time dedicated staff we hadn't planned for.

Anyway, bottom line is that in 2006, early in 2006, I went to the sponsor, and that was Allen Bacskay, and I said, "We've got problems that we have to solve," and one of them was getting the science command sequencing done, and getting PDS done, and there were a couple of other things. I said there's going to be an overrun. So, he said okay. We need to get this down in front of Jim [James L.] Green right away. And I agreed with that. So, we put together a presentation and went down to see Jim Green and I did the presentation, and I had done a top-down estimate of what the cost delta was going to be. I communicated the costs of the fixes and our status to Jim. He said, "We want MESSENGER to be a success. Do not do anything to jeopardize this mission, that's my direction to you. We will support what you need."

NIEBUR: Wow.

GRANT: That was terrific.

NIEBUR: That's rather different, isn't it?

GRANT: I think it's the NASA code. NASA does things to succeed. You know, anybody can just kill a damn program. But he saw the merits of the mission and thought that we were on the right track and that our proposal would be a good remedy for the problem. So, he approved it. He said, yes, okay, let's go ahead.

Now Mark had already recruited these people. I talked to my own management about it, and they said, "Go ahead." So, we get them onboard. Later on we had to go back to

Headquarters and do another formal presentation of the cost estimate to Todd May. Well, now I did a bottom-up cost estimate of the entire program. That's when I got a big surprise.

NIEBUR: Oh, yeah?

GRANT: I had gone down to Jim with one story on the overrun and when I ran out the total cost to Todd the overrun was just about double. Other parts of the program were in trouble as well.

NIEBUR: Oh, my word.

GRANT: Not a good situation. So, we did Venus 2 and it was beautiful. Everything worked. The scientific data collection worked like a charm; nothing went wrong. Everything worked, 100 percent. I was pleased in the extreme. All our efforts had paid off. The gods were with me on that day.

So, I got knocked around pretty good, but it worked. And if it works, that's what is important. Well, I mean, the thing about it is the cost was—I regret not having a bottom-up cost estimate for Jim Green, but with the time that we had available, that's all I could do.

NIEBUR: But what happened with the money?

GRANT: They came up with the money.

NIEBUR: They did?

GRANT: Yes. And that's the thing, I have to say, is that NASA management wanted to do the program, and they gave us the money.

NIEBUR: Wow.

GRANT: So, things worked out well for us. It was a rocky road. Nothing worked out perfectly well the first time through. But at the end of the day they funded us and the mission is a success. When we brought those people on board, that solved the problem of the command sequences for the instruments. No more problems. They've been on track ever since.

That last cost estimate that we did—we did a review with Paul Gilbert and Allen Bacskay from Marshall, and they went over it in a line-by-line assessment with a team of guys. It's been several years now that we presented it to Todd, but that estimate to complete is still valid to this day. It's the same number I had at that time. So, what does that mean? Well it means we solved the technical problems and the cost converged and made the right decisions. This is the MESSENGER project plan. And right now the total cost for MESSENGER is $446 million end-to-end for what we're doing. MESSENGER is already an outstanding science mission.

But this is for a much more complex mission plan. On an absolute basis, if somebody walked into NASA and said we can go to Mercury with all these instruments, orbit for a year, perhaps longer, for $446 million, that is a deal. A real deal. I know they're talking about BepiColombo cost of over a billion Euros. [BepiColombo is an international mission comprised of two spacecraft riding together to Mercury to orbit and to study the planet from unique vantage points.]

And so, all things considered, it's been a terrific mission. After the Venus 2 flyby, I felt that my time had come. The mission's going to change. It's time for someone else for the end game, because I've spent my time and I've got it where I wanted it, where the spacecraft is running well. I think we got the cost stabilized and, we have a great experienced team. So, I was pretty happy with that. And realistically, I was pretty worn out.

NIEBUR: Why do you say that?

GRANT: Because of the cost. Dealing with cost containment had burned me out. So, I talked to management and decided it was time to go. And so, Peter [D. Bedini]—I had asked Peter on the program about a year before because of the problems I had with science planning, trying to figure out how we are going to get the command sequences done and the instruments get lined up. And he's the right guy for the job and he's doing a terrific job.

NIEBUR: Right.

GRANT: Yeah. He's the right guy. But I'll tell you, through this whole thing, I'd be remiss if I didn't also say that Sean [C.] Solomon's a great PI [principal investigator], he really is. He's a first-class scientist, he asks the right questions, he's insightful, he knows what's going on, but with the technical, he lets the guys work and get the job done. He's been outstanding in that regard, so he's, very good PI, top notch. Couldn't ask for better.

So, I continue with the program in an advisory role, which is good because I get several communications so I can keep up with what's going on, and I attend the monthly status briefs.

Peter comes in occasionally and we meet and talk about different MESSENGER topics and he asks my opinion on certain things, but I don't get near the day-to-day operation. That's his baby, but I continue to contribute to the program and I think that's good. It's tough to give these things up and just walk away.

NIEBUR: I would think so. You invest so much of yourself in it.

GRANT: Yes, yes, you do.

NIEBUR: Did you find it was an all-consuming kind of project when you were on it or could you just leave it at the office when you left?

GRANT: Oh, no, 24/7. No, round the clock.

NIEBUR: For how many years?

GRANT: I did it five years.

NIEBUR: And the whole time? Did it go in cycles or was it always a high demand?

GRANT: No, it peaked up. It was peaked up as soon as I came on, getting through development. The first year after launch was the lowest activity because we did an Earth fly by. We were just

doing the full certification of the mission for flight. But it was always a pretty high level of activity.

NIEBUR: Did the spacecraft go into safe mode much?

GRANT: Not much. We did a couple of times, but I have to say that this program has been blessed with two very top notch system engineers. Jim Leary and Eric [J.] Finnegan. After launch, there's safing events that happen. On this occasion, I would get a call from Mark Holdridge and he would say, "Well, there's a problem," something going on with the spacecraft. We go over to the MOC and I open up the door and walk in and there's 20 engineers sitting in the room and nobody's talking. Nobody's saying a word. I know there's an anomaly with the spacecraft, we've lost contact, nobody knows what it is. What are we going to do? Jim Leary would go to the board and start drawing a fault tree and start talking.

Inside a half an hour we'd know what the problem was. We'd know how to fix it and what to do to be sure that it doesn't happen again. The guy has incredible insight for going through that discipline and with a first-class mind. Jim left after he was on the program several years. He's a very young guy and he was on the program when Max Peterson was the manager, so he was on before me and he left maybe two years ago. Then we went out and recruited Eric Finnegan who's the current the mission system engineer. I worked with him on a project—actually we did a white paper for one of Alan Stern's missions he wanted to propose. He was a good choice. I was really impressed with the guy, so when Jim Leary said he was going to stand down, I went out to get Eric and I had to dig in. I mean I really dug in to get him.

NIEBUR: Really?

GRANT: Yes, that's a top job.

NIEBUR: So, he was at APL, or he was someplace else and you're trying to bring him in?

GRANT: He's an APL guy.

NIEBUR: Did you steal him from another project?

GRANT: Yes.

NIEBUR: Awesome.

GRANT: I believe MESSENGER, this was the most important mission at the Lab! I wanted the right guy. He was the right guy so I went after him and I fought very hard to get him, my management got sick of hearing me so they gave him to me. And he really has turned out to be just outstanding. Top notch. Again, the right guy for the program now. Jim Leary was the right guy when he was here.

NIEBUR: And how important is that to have a good match in things like systems engineer and deputy?

GRANT: The important thing is the team. You have to have people that can work together. I've spent a lot of time thinking about the people, who the people in the lead engineering positions should be. If you've got the right people then the work is heaven. I mean it's just terrific. I couldn't ask for anything better. If you've got the wrong people, it's hell. And, I mean, hell.

So, I spent a lot of time thinking about that and a lot of time trying to match up the right skills and capabilities with what's needed. 'We made changes in the staffing when I came on. Some tasks require someone with a conceptual view, while others require analytical skills or a good tester. And you have to feel around and get the right person. But, once you get him, it clicks and you can tell right away because it works out so well.

NIEBUR: How far down do you really know the team? Do you know just the leads of the team?

GRANT: I know the guy that loads the spacecraft on the truck and takes it down to the Cape. I know everybody.

NIEBUR: Wow.

GRANT: Everybody. And they're all invited to the parties, too; we have a good time. No, I know everybody. I know what they do and how they think and what makes them happy and the whole thing and that's the key thing. You've got to know the team. It's very hard work when you're in development, a lot of people are working nights and weekends. There's time out from the family and that's one thing we ought to do is start having a "Mother's Night" cause they're all home with the kids and the old man's off at the Cape somewhere or in here working. So it's

tough on families and you have to appreciate that. So when we send guys out to the field, especially the younger guys, I don't believe in keeping them out there for 10 weeks straight if he's got to go home and check the kids or check how things are at the house. I'm not interested in breaking up families and families have been broken up over work like this.

NIEBUR: You burn people out.

GRANT: Yes.

NIEBUR: You work on triple shift for too long, you burn people out, you lose them.

GRANT: Burn them out and you've got to take care of the people at home too.

NIEBUR: That's nice to hear that.

GRANT: I know them all and I know what they do and so I've always gotten along—I've always gotten a lot of team support. Very proud of that.

NIEBUR: That's wonderful. It's interesting. Every mission seems to do it a little differently with deputy PM, PI deputy, PI project scientist and you had a project scientist for most [or all] of the mission while you here. How did that interaction work?

GRANT: Well this is a different mission. Like for example, Sean is the PI. We have a project scientist here, Ralph [L.] McNutt, and he is responsible, answering the day-to-day questions on the science, so the engineering team knows where they can go because the PI's not always here. And the PI's usually got other things to do. I mean Sean is a very well-known individual nationally and he can't spend all of his time talking about nuts and bolts of the spacecraft. There are some PIs that do that. So, we have a project scientist here to carry out that role, answering questions about instruments and science requirements.

Other types of missions like TIMED, Sam [Samuel] Yee is the project scientist, but that is typically a NASA role. He acts as a science PI for the mission. So it's a different kind of a responsibility in the two cases for the project scientist.

NIEBUR: I really appreciate everything you've said so far. What about, say, science team members who are here on site? Is there much interaction?

GRANT: Yes. They have two roles, really. They have an overriding science obligation to the mission. They're kind of a clannish bunch and they keep together, you know, and they talk science and do research. So they have a calling at that level. But they also have a responsibility here, what I call a project responsibility, where we may need technical information for the instrument that they're working on. Or we may need a certain document prepared because it's a required project activity. It's not science; it's science related. But, they are called upon to do those things. Sometimes they're reluctant to do it because it's not really science. But this is not Homewood [Science Center]. This is APL. We are not a university, so the scientists have got to do project work. So, we work it out. Some are very good and others are less than very good.

NIEBUR: But it's interesting that they have that kind of a role in an APL mission.

GRANT: Yes.

NIEBUR: I'm not saying that it's different anywhere else, but I find that interesting.

GRANT: We have, yes. On MESSENGER we have Scott [L.] Murchie and staff like Brian [J.] Anderson and Nancy Chabot. They are really very, very good scientists and, in fact, Murchie, I think he's going to be a PI on a mission someday. Sam Yee is a great scientist. I worked with Sam for 15 years, and he gets invited to give papers at major conferences internationally. So, he's always going over to Europe or Asia because he's a really top notch scientist, with an international reputation.

NIEBUR: Now, you've been here at the lab a long time.

GRANT: Yes, you know how long?

NIEBUR: I heard the rumors. Fifty years?

GRANT: Yes.

NIEBUR: Wow. Was this your first job?

GRANT: It's my only job. Except when I was a kid. I worked.

NIEBUR: Wow.

GRANT: I had a lot of firsts in my life. I applied to one school, and when I got out, I applied for one job. I've only had one wife. [laughter]

You know, it's a funny thing. I thought about how the whole thing happened, my coming to APL. It's a weird story. I joined the Naval Reserve when I was a kid. I had to go to a training camp over here in Bainbridge and I was only, I think I was 17. And so, I went to a weapons school and they had classes about the five-inch guns on destroyers.

They had this old Navy chief come in and talk about the guns and fusing and he talked about this proximity fuze. He said, "This is the greatest invention in the history of warfare." And this guy was in World War II and he's talking about how they put the fuse on the shell and it gets in the proximity of aircraft and it explodes and it takes them down. He's talking about how this thing shortened World War II. So, I listen and enjoyed a very interesting talk and was impressed.

Then totally unrelated, they used to have a TV show on Sunday morning back then, and it I think was called Johns Hopkins File 7. It was a documentary sort of program talking about research done at Johns Hopkins. A lot of it was medical research, but every once in a while I remember they had a show talking about ram jets and about how they were used for fleet defense with missiles. And I used to watch that show every Sunday morning and I found it interesting.

Then I went off to college and got to my senior year and I thought, "I better start thinking about getting a job when I get out of this place." So, one day I was sitting in the library and there's this guy sitting near me and he's got a brochure from The Johns Hopkins Applied Physics Lab. So, he's talking about it. "I'm going down for an interview down at *John* Hopkins."

I said, "Oh, at *John* Hopkins?" He said, "It's a great place in Silver *Springs*."

I said, "Oh, Silver *Springs*?" So, I asked if I could look at his brochure. So I'm going through it and I came across this article about the proximity fuze invented at APL. I thought God, I know all about this thing.[1]

So I'm reading about it and I remember that old sailor at Bainbridge. Then I'm going a couple of pages later and there's a picture of this guy and a ram jet. I thought God this is where they did that work I saw on television. I thought, "There's a message here." I'm looking for a job. This is the place. I'm getting a message from on high.

Then I realized that it is really "*Johns* Hopkins in Silver *Spring*." So, I thought, "I've got an edge on that guy." So, anyway, I wrote a letter to APL and they called me in for an interview and I got the job and here I am.

NIEBUR: Awesome.

GRANT: The other guy didn't get the job.

NIEBUR: Well, if you're going to call it Silver *Springs*, there's nothing we can do for you.

[1] https://secwww.jhuapl.edu/techdigest/Content/techdigest/pdf/V13-N01/13-01-Emch_Air.pdf

GRANT: Yeah. So, it was a vision thing. But that's how I came to work for APL. It was funny how that all worked out. And just those events, the dots just seemed to connect.

NIEBUR: Did you work other missions besides TIMED?

GRANT: Yes.

NIEBUR: I'm assuming you worked on plenty. Can you tell me some?

GRANT: I worked on this one here, right here. That's Polar BEAR [Beacon Experiment and Auroral Research].

NIEBUR: Did you really?

GRANT: Yes, it has a somewhat curious background to it. That's [Oscar-17] at the Smithsonian [Air and Space Museum]. I wanted an Oscar spacecraft, which the Navy had in storage to refurbish for the Polar BEAR mission, but the Navy wouldn't release it to us. They had one at the Smithsonian on display, so I arranged a trade for an earlier experimental unit.[2] That's Mike Griffin.

NIEBUR: It looks like him.

GRANT: It's him. He was the Polar BEAR system engineer.

[2] https://secwww.jhuapl.edu/techdigest/Content/techdigest/pdf/V08-N03/08-03-McCloskey.pdf

NIEBUR: He was the system engineer on that. Okay. I knew he had a lot of roles—Nice.

GRANT: We needed more pieces than we got at the Smithsonian, but we put the satellite together and launched it for the Air Force. But, when I first came to APL, I worked on, Fleet Air Defense. I worked on a project called Typhon[3], which was a predecessor of Aegis [Combat System] the current Navy air defense system. When I look at Aegis, I can see many of the concepts that we had on Typhon.

NIEBUR: Nice.

GRANT: I did radar work about 15 years. Then I worked over in submarine ballistic missile defense[4]. You know, we have the nuclear missiles on the subs; that fleet was one leg of our defense against the Russians. We had a submarine security program here, how to protect them from being detected. I worked on that for about five years. At that time, I was also doing some work on the side in the research center. [President Richard M.] Nixon had signed the National Cancer Act and they named Johns Hopkins as a Comprehensive Cancer Center, I think it was the first in the country.

NIEBUR: It was, actually.

[3] https://secwww.jhuapl.edu/techdigest/Content/techdigest/pdf/V13-N01/13-01-Gussow.pdf
[4] https://secwww.jhuapl.edu/techdigest/Content/techdigest/pdf/V13-N01/13-01-Watson.pdf

GRANT: The School of Medicine wanted to build up the radiation therapy facility in the cancer center and the trustees wanted to strengthen the technical expertise in the center. They needed someone to build up a physics and engineering capability in the new radiation therapy center. So the School of Medicine contacted Joe [T.] Massey who was in the research center and Joe knew the trustees. So Joe asked me if I'd be interested in going over to East Baltimore on an interdivisional assignment to the Cancer Center to be the head of radiation therapy physics and I thought about it a while and decided to go. I was over there for eight years. And so, we built up the capability. We put in linear accelerator therapy machines and we introduced the first computerized treatment planning for radiation therapy patients at Hopkins. That was part of my team that did that.

So, I actually was on the APL staff, but I worked in the School of Medicine in East Baltimore and was on faculty in several departments over there.

NIEBUR: I'm really fascinated. I just completed a treatment of chemotherapy and radiation therapy for cancer. I have a lot of appreciation for that work. So thank you.

GRANT: Well, you must be familiar with the computerized treatment planning that they do for the radiation therapy?

NIEBUR: Yes.

GRANT: We were the pioneers for that capability at Hopkins.

NIEBUR: That's amazing.

GRANT: Before that it was all done by hand. I mean it was not very accurate.

NIEBUR: It was so slick. I didn't do it here. I almost came here, but where I went it was so slick because they do all the measurements and they set it up, and every time you walk in—

GRANT: They mark and they have the ports marked on the body.

NIEBUR: Bam, they're ready to go. I have tattoos. And they just line you up and then they know—the machine knows exactly where to go.

GRANT: Yes.

NIEBUR: You guys did that?

GRANT: Yes.

NIEBUR: Right here at Johns Hopkins?

GRANT: We did, before that it was not computerized. What we did was turn on a therapy machine and we measured the beam strength as a function of depth in a water phantom. This is the same intensity as it happens in your body. Then we place the patient in a simulator and take

X-rays of the patient. We then project the beams from the computer system onto X-rays of the patient and see what the dose would be at depth from different angles. That is how we computed the dose in the tumor volume. We could do the outlines to get the tumor volume plus the margins. That was a very exhilarating time in my career. I never knew what dedication was till I worked in the cancer center.

NIEBUR: Really?

GRANT: I mean, people that do physical sciences are okay, but those people over in the School of Medicine at Hopkins, I mean they really are dedicated.

NIEBUR: The stakes are high and from the patient perspective, which I never had until two years ago, it makes all the difference in the world to know you're getting the best quality care.

GRANT: Yes. The treatment is tough, it really is.

NIEBUR: It works. I mean I had it 35 times.

GRANT: Is that right?

NIEBUR: And it works.

GRANT: Yes, yes. It was a National Cancer Center and it was quite a stimulating environment with Dr. [Albert H.] Owens in the Oncology Center and Dr. [Richard J.] Johns in the Department of Biomedical Engineering. But then, the center was established my work finished and I came back to the main APL campus.

NIEBUR: Well, that seemed to have worked out very well for you.

GRANT: Yes.

NIEBUR: Wonderful. Well, thank you. I have very much enjoyed talking to you. Let me see if there are any other questions that I have to have. Two questions. Without divulging state secrets, could you say a few words on when you came on in the middle of [Phase] C/D, there were several things that were being delivered late like the IMU and the solar arrays. How do you get people to deliver faster? Is it just a matter of negotiating and funding additional costs?

GRANT: There are some things you deal with a contractor, you can incentivize the contract. Deliver on time or early, you'll get it. Most often there's little you can do about it. It's technical problems that have to be developed/worked out. So, there are some things you can do. You can maybe be able to shorten the time period somewhat by adding people, but there's nothing dramatic.

Like on TIMED and MESSENGER, and we had a problem with the solar arrays. The solar array, the cells we put down weren't bonding properly. We had to go back, scrape them off. But then, why weren't they bonding? Look at all the materials that we used. All the

adhesives that we used. The procedure. I mean, did they have the right gloves or was there contamination? Stuff like that. And it just takes a long time. Putting more people on it isn't always the answer. So, a lot of time you just take the loss in schedule and work around it. That's why schedule margin is so important.

NIEBUR: And I know that the major constraints are all interrelated. You know the whole faster, better, cheaper, they're all interrelated. And money is related to time is related to people. But if you had to say, which of those did you feel most constrained by? Money? Time?

GRANT: Ultimately, it's the cost. It drives everything.

NIEBUR: Was there anything that's a problematic feature that caused extra stress on the program beyond simply getting the job done I guess is the question.

GRANT: Cost containment, I think that's the biggest problem. I think it's being sure that your initial estimates are valid. It gets into have you included everything? Have you priced it properly? Are the reserves adequate? But eventually you get into a real problem. This is a competitive environment. When you go out for a Discovery proposal you may have 20 competing proposals. That's very, very tough environment. And one of the things that's tough about it is that it's a cost capped proposal and NASA knows that if you come in with a bid at 95 percent of the cap, you're going to go over.

So, it's getting the cost down, but having it valid. It is tremendous pressure on everybody to get the cost down. So I think that that's the big thing because once proposed and accepted,

you've got to live with it and there's no magic wand. It doesn't go away. If you don't have the quality in the bid to begin with, on cost and schedule, it ain't going to be there. It all goes back to the original plan, and that's why I would think that NASA ought to look at ways of doing it with getting better assessments of these proposals.

I think that goes back to the original bid and is it sound. If it is, you've got a chance. But a lot of times, people get under tremendous pressure to get the cost down so they can win.

NIEBUR: Does it make a difference if you have the proposal manager be the intended project manager? Or who do you need to have on that kind of proposal?

GRANT: I think it does.

NIEBUR: The system engineer, things like that?

GRANT: I think the ownership should start early. I think the project manager should be involved in a proposal.

NIEBUR: It seems to be an almost impossible job.

GRANT: It was difficult. I would think that it's critical to have him involved. I think it's very, very important because he knows what he has in mind when he puts the numbers down. But I think there is at NASA, there is in the NASA culture, a mentality because of the very severe

competition. These programs don't come around like once every five or six years. There's a tremendous pressure to win, so there's a tremendous pressure to keep the cost down.

The problem is, the big lament is that if we overrun a program, it comes out of somebody else's hide, because they get delayed or they don't get a start. Is that fair? No. What is the right remedy for it? I don't have an answer. I think though that NASA could do a lot better detailed assessment of proposed costs upfront and they won't have so many unwelcome surprises later on.

NIEBUR: And the only way to cancel that is to stop believing that you can do it and I think that's a message that nobody wants to send.

GRANT: Well, if you look at this mess out in JPL, who the hell thought they could build such a thing with that amount of money?

NIEBUR: You mean MSL [Mars Science Laboratory]?

GRANT: Yeah.

NIEBUR: It's unfortunate.

GRANT: A lot of programs paid for that mission.

NIEBUR: It's a tough business.

GRANT: Yes.

NIEBUR: All the way around. You can never do everything.

GRANT: You can get bruised up pretty good. But it's very rewarding. I would do it all over again if asked. No doubt about it. I mean the launch is exciting, the mission is important and it's all very interesting and it's a great job. It really is.

NIEBUR: That's true. All of what you said. Well, thank you so much for taking the time to meet with me today. I've learned a lot and I very much appreciate it.

GRANT: Well, I appreciate you coming by. It brought back some good times.

[End of Interview.]