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INTERVIEW WITH JAMES E. KINGSBURY
INTERVIEWED BY ANDREW DUNAR AND STEPHEN WARING
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1. Kingsbury: . . . What I said was with what you had, you redid from a little different vantage point the investigation's committee review. Unfortunately, in spite of the fact that the chairman of that board was very critical of Marshall for not being open in communication, he killed a lot of investigative date which would leave one to say, "You might not necessarily have the right answer here fellow." Because, the only thing he released is what supported his finding and findings of the Commission. There are numbers of data packages, and I don't know finally what happened to all of those. They were probably buried in a time capsule - in my head and the head of three of four others. It troubles me, and I don't know what to do about it in this case. It troubles me that we're going to get another historic document which is unfortunately managed.

2. Waring: Because of the information that is available?

3. Kingsbury: Yes, and is not the factual stuff. To get to the factual story would probably take longer than [?15] at Marshall, because I know where those data are hidden. I know where the people are who developed them. They are alive and kicking and around. What I said to Mike is, "Someday if I live long enough, I'm going to straighten out

history and write a document, write a book." Several people have said, "Why don't you write a book on your experiences at Marshall?" That's the only one that really troubles me because history is not recording what you have.

4. Waring: Because of the information. Could you give us some names of people that we could talk to about documents?

5. Kingsbury: I really believe that we better let it lie.

6. Dunar: If you were in our shoes what would you do?

7. Kingsbury: I would have done just what you did. I would have taken the data that was available. What I'm having trouble with in my shoes, is you didn't say anything wrong, you just didn't have access to the whole story so you didn't say it wright. What you said was right, but you only gave that portion which the managed data permitted you to give.

8. Waring: In planning our own research, for revisions and that sort of thing, do you think this information has been destroyed? Is is classified some way?

9. Kingsbury: It's classified. For example, would you think it mattered that I told you the leak occurred between two segments which when they went to put them together got a mismatch of an half of an inch. This one was egg-shaped

this way and this one was egg-shaped that way. When they sat it down, the outside of this one, this tang was on the outside. It wasn't even close to going. It was over here on the outside. It took three days to put that joint together. Three 24 hour days to make that one joint. Do you think that would make a difference?

10. Waring: That's a pretty significant piece of information, sure.

11. Kingsbury: With that data that was documented by the crews that did it, we were able to tell you before they got the tank out of the water where the hole was. Without question. Absolutely pinpointed it. It would also be interesting it seems to me if I told you that that information from the Kennedy Space Center, generated by the people who put the tank together, the Thiokol chemical people, never left the Cape. Nobody at Marshall, at Headquarters, at Johnson, 1/2 of the people at the Cape didn't know it until after the fact. Those things didn't make the case that Mr. Rogers wanted to make that the idiots launched on a cold day. The cold day had a contribution. The cold day did not cause the problem. I'm absolutely convinced that case was doing exactly what it did on the 23rd of August of any year. That don't come out in any of the stories.

12. Waring: Do you think it was then that he made his mind up early?

13. Kingsbury: Very early, and then he set aside to prove his case, and he threw aside everything that was presented to him that cast doubt on that as being the primary cause. I don't know what to do with that. You can say Kingsbury said so, and that isn't worth a whole hell of a lot to anybody but me, but someday I may say so and let somebody challenge it. I know the facts are there, and there are a lot of people that know the facts are there.

14. Waring: Could you just mention some other names that we can talk to?

15. Kingsbury: Yes, the people who were crucified in the investigation.

16. Waring: The project people.

17. Kingsbury: George Hardy, Larry Mulloy, Stan Reintartz.

18. Waring: Just because of the pressures of time, we primarily relied on commission testimony and commission interview, and we'll plan on interviewing those people through the next year.

19. Kingsbury: Wayne Littles was actually the head guy for the data generation collection for the investigation here in Huntsville. Of course, Jack Lee oversaw it all. Those two guys are sitting up there, and they both know the story. They are of the opinion, and probably right that right now it wouldn't serve any positive purpose to reopen this issue and smear it all over again. The problem I'm struggling with is you guys don't know all of these things, and you're writing history; but you're not, and I know you're not. Not many people know you're not, but I know you're not. Mike sends me this thing to read and says, "What did you think of it?" I said, "Well, call Bob Marshall an engineer in the shuttle office [?66] manager so I can fix that" Then, there was some other two bit thing that was there. You have a choice. You either leave it like it is or you don't put it in because it would take you two years to dig it all out.

20. Waring: In these interviews, we will ask about that issue. Even if the other story stays the same, one way of handling it is to just add that idea. Just state people's views of what they think happened. Whatever we write about that story is not going to be the last word. Plenty of people will have years to write that one story.

21. Kingsbury: I don't know if you know this or not, but Mr. Rogers was being paid by Morton-Thiokol Corp. as a member of their law staff.

22. Dunar: At what point in this?

23. Kingsbury: Through the whole thing.

24. Waring: Is that right?

25. Kingsbury: Yes. He made the statement when appointed that if there was anything that ever at all colored toward Thiokol he would excuse himself. But when it came out, he hid it.

26. Dunar: Had he had contact with Thiokol before or was this just once the investigation started?

27. Kingsbury: He was on there . . . ?

28. Waring: Just on retainer as a lawyer?

29. Kingsbury: He was being paid by them, either on the Board of Directors or as an advisor to their legal staff or something. He admitted up front before it ever started, "I am being paid by the Morton-Thiokol Corp. and if this in any way casts any light at all on the possibility that they were involved," - now this is before it came out that there had been a meeting. This was right after he was appointed and nothing had come out. He said, "Obviously, I will

immediately excuse myself." But when it came out, instead of excusing himself, he buried it.

30. Dunar: And he stayed in that relationship through the whole investigation?

31. Kingsbury: You bet you. He also lost a $1.5 million suit, his firm did, for client misrepresentation while this was going on. It was in the newspaper. It was carried clear on page 97 or something. People who found him most offensive like me - excuse me, I shouldn't be saying that on tape. Well, he became judge and jury. He quit investigating and became prosecutor, and we all knew that.

32. Waring: That was one of the things I wanted to try to communicate and this information helps because there was that feeling that Marshall's story was not being listened to.

33. Kingsbury: Don Katina and Neil Armstrong are the two guys on the Commission who were the liaison to Marshall and on a number of occasions they spent anywhere from two to five days with us as we presented all the data we had. They then told us, "Here's what we're going to recommend the Commission hear either in open or closed, either one of the two, so get this ready. These things over here really don't matter so just don't pay any attention to them." Almost

without exception within a few days of their leaving, they called back and said, "Well, let's do it. Mr. Commissioner doesn't want to hear what we thought. He'd like to hear some of that stuff that I told you wasn't very important." That's what was taken to the open meetings. We knew exactly what was happening to us. We were hanging on the cross and bleeding and hoping it would end quickly because there was no way we're going to recover. Then they took out after Bill Lucas. I don't think Bill Lucas is a saint or any where near a saint. He took an unmerciful beating. I think that one of the best things that happened and you have it in your story is the letter you got from Chris, Chris Kraft, because those two were adversaries from the word go. I mean they ran the two Centers that fought. Chris wrote a fantastically nice note to Lucas saying "our turn will come, but I don't know when, but a rotten trick you had played on you."

34. Dunar: When we talked to Chris Kraft too, he said this was not Marshall's fault. This was an Agency problem, with things that everybody knew about.

35. Kingsbury: Right. There was not a review. In fact one of the things at the end of the Commission's hearings that we hit. It dawned on Mulloy, I believe it was Mulloy, that there was a requirement that all of those level 1 flight

readiness reviews be taped. We went and searched and [?119] they were.

36. Waring: Videotaped?

37. Kingsbury: Videotaped, yes. So he took the one in question to the Commission and said, "Here, there's one for every one we've ever had and here's my presentation." They said, "Oh gosh, our report's already done. I guess we can't get it in." Those are things that are history. They're real honest to God facts of history that have never shown up.

38. Waring: So, every level 1 meeting was videotaped?

39. Kingsbury: As far as I know.

40. Waring: As far as you know.

41. Kingsbury: We didn't go back and get them all, but the one we were concerned with, it was there.

42. Waring: Well, that's something I'd like to check up on.

43. Dunar: Are those available at Marshall or are they all part of the Commission records?

44. Kingsbury: I don't know what they're doing with them. Have you talked to Mulloy at all?

45. Waring: No. I've read so many interviews of other people, but I'm intending to.

46. Kingsbury: You ought to call Larry because it's kind of like you included him in there that I was quoted in talking to the Huntsville Times guy who's saying I didn't think temperature was a problem. I said I didn't think temperature was the only problem. He carefully left out "only."

47. Waring: Right.

48. Kingsbury: I put "only" back in incidentally and told you I was misquoted, but that's what was done with all those interviews. They picked up what they wanted, and you know that there's quotations around things that nobody said, but since it sounds good I'll put quotations around that. Nobody's going to write a letter to the editor and say I didn't say that unless it's really bad. You ought to talk directly to Larry.

49. Waring: We intend to do that.

50. Kingsbury: He'd give you the details of that story of videotapes that "Gee, I wish we had them two weeks ago, but it's too late now." It never, never became known. You don't know that. It's not in the database you have available. Well, all those are interesting little tidbits. This is a very subtle one that's a metallurgical phenomenon that frankly is the one thing that from every vantage point was overlooked, and that was a scientific phenomenon that we goofed. It by itself didn't pose a problem either. Nothing caused a problem by itself. I don't think your report mentioned, actually there was a puff of black smoke at liftoff and then it stopped. We have pretty much reproduced that condition. What happens is you get a blow-by leak and it fills itself with liquid ceramic which then freezes. Now you have a glass seal. If you go to the transcript of the crew in the early flight, at about forty to forty-five seconds, they complained bitterly of a rough flight. The air stability was very, very bad so the whole vehicle was shaking. Just as they came out of that, we picked up the black little pin hole coming out of the side of the tank.

51. Waring: That was the windsheer?

52. Kingsbury: Yes. It's clear the glass seal broke and the wind sheer hole was there again, and by that time, it was too far expanded to cool down. I didn't read the final report in great detail. In here, I think you said that it

was a [?158] broke connecting the solid to the tank. I thought the final conclusion was that the tank simply overheated and blew up and the two solids went flying the other way.

53. Waring: I'll check the chronology, but I think the feeling was that the SPAR melted through and it was the aerodynamic stress. But all those things were happening instantaneously.

54. Kingsbury: That's hard to believe for me because I designed that thing, or was responsible for it. That tank was 3/8" of aluminum. That spar is an 1' 1/2" steel and you're telling me that the steal melted before that aluminum melted, and I have trouble with that.

55. Waring: OK.

56. Kingsbury: And the aluminum tank was pressurized, full of oxygen, so I happen to think that under those conditions, you only have to get it to 450 degrees Fahrenheit and it'll blow. At 450 degrees Fahrenheit the steel isn't even red yet.

57. Waring: Well, I'll check those chronologies. I remember seeing a chronology with such and such seconds, milliseconds, something was happening, another millisecond

later something else was happening. So it's hard to tell how verifiable that data is.

58. Kingsbury: It's very insignificant frankly because whether this went this first, or that went first, they all went. We could get into a very academic and stimulating argument over which went, and find a conclusion. Well, I didn't plan to spend that much time with you on that, but I think it would be worth your while before you finalize things that you talk with Mulloy.

59. Dunar: We appreciate that.

60. Waring: Sure, definitely.

61. Kingsbury: Have you ever talked to Hardy?

62. Waring: Have I talked to Hardy? No. I've talked to some people who work in this firm, but not to him himself. I've talked with Bill Sneed and Jim Downey, but not to Hardy yet.

63. Kingsbury: George was my deputy at the time. George actually was the guy to do most of the calculations. He and Wayne, and one or two others would do them privately and personally.

64. Waring: What do you mean by "calculations?"

65. Kingsbury: For example, George laid up the geometry in two seconds.

66. Waring: I see.

67. Kingsbury: Calculated kind of the load it took to get there. We knew that happened. When you shipped the segment from Thiokol to the Cape laying down, when it comes off the flatbed, it's [?189]. It just settles. It was also shown that if you stood it up and let it stand for 30 days because the [?190] is rubber, it rounds itself out. I don't know if it was written or not that said you don't try to put segments together until they've been standing for a minimum of 30 days. These two came up from the flatbed to the stand. It's hard to be comical, but there was a comical note on the morning shift, the night shift that finally got it together on the morning shift. Every foreman has the notebook that he makes comments on what happened on his shift. That morning shift's guy said, "Gus' gorilla's finally put it together last night."

68. Waring: Implying that it had been jammed together?

69. Kingsbury: Yes.

70. Dunar: Those notebooks, that would be part of the commission materials?

71. Kingsbury: Yes and I don't know what they did with that stuff.

72. Waring: Well, I'll check.

73. Kingsbury: The only part that was pulled out of the investigation that I'm aware of was that which dealt with the crew from the moment of explosion. But everything else I believe is public domain.

74. Waring: That should be easily accessible in the National Archives. I think we're going back this summer and I can check through that.

75. Kingsbury: You'll find some very interesting things. I've read those. There are a lot of books, and you'll find some very interesting things. I don't know how much of the data that was generated here that the Commission didn't accept went in to the National Archives. I'm not sure at all because the Commission didn't want it. Wayne or George could tell you that.

76. Dunar: That documentation, if it were rejected by the Commission, have remained at Marshall?

77. Kingsbury: Yes, did remain at Marshall. But at the end of the investigation, when it was finally tied off, those data were not destroyed, and I don't know where they went. That was in the middle of '86.

78. Waring: The Marshall records?

79. Kingsbury: Yes. Actually . . . .

80. Waring: Or were they JSC records?

81. Kingsbury: No they were Marshall records.

82. Waring: I mean KSC?

83. Kingsbury: Marshall records. Now the log books, copies of the log books came to Marshall. I don't know if the original [218].

84. Waring: So if we know the date and the flight number, the documentary repository should be able to find them?

85. Kingsbury: Yes.

86. Dunar: Are there any other documents that you would suggest that we ought to check?

87. Kingsbury: No. You need to get access to that general data base that they have here because there are an awful lot of very interesting things that show. You don't go combing for minnows . . . if you were to look at the data of what happened, looking at the data at the point in time it happened, you would say there's nothing wrong with that vehicle. The pressures are all fine. The tank pressure at the point where the pressure sensors were, did not detect any significant increase. It didn't have to because it was the skin temperature that was increased. We'd have measured skin temperature. The leak was so small, really in the SRM, that there was very little pressure change. In fact, after the fact when instrumentation was lost, the pressure should have been on a slight increase. The other SRM, the pressure had gone up about 1.5 psi in 800. This one hadn't. So you can say after the fact, "well see this one went flat and this one went up 1 or 2 psi." I could show you records of every flight and find a point where there was that much difference between the two solids. There was nothing dramatic in the fight data that came in [?240].

88. Waring: Well, we will continue our investigation. This is a big project.

89. Kingsbury: I may have just given you the heart of my book.

90. Waring: That's alright. We'll scoop you!

91. Kingsbury: I wont to tell you about Skylab.

92. Waring: Spacelab.

93. Kingsbury: No, I wont to tell you about Skylab.

94. Waring: Oh, that's the other chapter!

95. Dunar: We did want to talk a little bit about Spacelab maybe at the start. I'm not sure to what degree you would have been involved in the beginning. I'm sure you would have had some inclining with what was going on. Let me ask you some questions about the origins of the project first, and then we'll get into the period when you would have been more directly involved. This all came about at a time of course that was very difficult for Marshall with the post-Apollo period and the RIFs and so forth. At the time, there was a decision to move into payloads. What we've seen, most of the documents show that Program Development was very much involved in this. I'm wondering to what degree other parts of the Center were part of that decision for Marshall to move into payloads as its speciality?

96. Kingsbury: There's two questions here. You don't know that probably. Late in the '60s when the bottom fell out because we at Marshall were a one project organization and our project was done. We started having Reductions in Force, I think the first one actually occurred in 1967. We had essentially one a year until 1975. You don't have to be real smart to figure out that we did something wrong, the something being we only had one project. In a series of meetings that primarily held by Von Braun and some of his senior guys with an occasional input from one or another, they started out to see how they could diversify the Center, so never again when you lost one project were you in an out of business mode. Out of that came the idea to create program development. I have so say that as far as I know that was purely and simply from Von Braun. He wanted a sales force that was out looking for business. Up until then, there had been a small group but they really weren't organized in the manner that put them in a market and in sales capability. They were more interested, they were good folks. I like them all. They were more interested in being sure if the third decimal point was correct than selling a concept. So they were wonderful engineers and lousy sales people. Von Braun said, "I've got to have some salesman," and so he created this thing called Program Development, put Bill Lucas in charge of it, and folded in the people who worked at the second and third decimal point level for technical consistency. But they brought together a group

who could talk fluently on a project or concept without having to work every element of the engineering in great detail. That's not uncommon. I do that today for the Boeing company. We're here to get the Boeing company business. That's what the PD was for - get Marshall business. They set their targets on classes of business. You say payloads, but it was broader, well, maybe payloads is the right term because it didn't necessarily have to be a manned payload. A good scientific payload was great. Any manned vehicles obviously were going to be good things to do. Small experiments were included, just a little flight experiments, to get a structure of many many programs. For example, when I retired, in the Science and Engineering director, there were some 43 projects that you could work on. In 1968, there were two. I didn't create the 43. It was the sole stated and dedicated purpose of Program Development to do that. So to answer your question is no. There was no other group. All the rest of us were in support of them. They needed more engineering capability than they had. I gave it to them. When it got to where they needed more program help to formulate the program office and program plans, they went to the program introduction people. I know enough to talk intelligently about all of if, somebody wants to get serious I go get some help from the experts. That's what they should have done, and they did it very, very well. For example, there have been published documents that say every program that came to

Marshall from 1970 until 1982 came through Program Development. Well, they were supposed to be! As a matter of fact, I could have gotten maybe some new programs, but that wasn't my business, and I was not supposed to do that. There were experts to do that. If I found something I thought I could help with, I'd go get one of them, get them turned on, and then they'd go, I might go with them. That was the way it was supposed to be. There was nothing dramatic about the history of Program Development. It always kind of irritated me in fact because I heard "S&E, with all it's people, never got us a good program." If it went out, my boss would have killed me if I had gotten a new program. So don't tell me that story. That's kind of where it was and how we got into this expanding, so I'll stop.

97. Dunar: Another thing too in connection with this diversification and the fact that Marshall got Spacelab as a project, the documents says some discussion of the Concept Verification Test Program and its link to Spacelab. Is that important? It seemed that part of the reason it was because Marshall had better program, part of the reason that Spacelab came here. Is there anything to that?

98. Kingsbury: I don't really think so.

99. Dunar: Could you comment a little more on the Concept Verification Testing?

100. Kingsbury: Yes. That was an outgrowth of Skylab. JSC has historically been the Manned Spacecraft Center. That was their name. When Skylab evolved, the first real life support system that was something other than sitting in a cabin a little bit bigger than what we have right here. Well, Apollo you know, you've been in an Apollo capsule, that's almost like a ship in a bottle. There was no great big deal to making a life support system. Put an air bottle in and do a little air drawing, not much because it was always bright inside there, try and take out some of the things like CO and CO2, through charcoal filters. Skylab was the first real, I mean this is the equivalent of a 10,000 cubic feet home and Marshall put together the life support system. There was a modest amount of concern at the Johnson Space Center that Marshall was getting into life support systems, because clearly this was the first one ever built in the history of mankind. The Russians hadn't done anything yet. It was not a closed system. We didn't recover water, we took water up. Pretty much other than that it was closed. As a follow on to that in the world of technology, the Concept Verification Test Program was started which was a Spacelab socks style, size, module about 12-15' in diameter and 25' long where we looked at advancing the state of the art life support systems. Incidentally, what would you do if you were in there, and some experiment concepts were left out. It was just really a first class

technology program. Now when what was originally called the Sortie Can, and I thought you were going to tell me about the Sortie Can, got a new name called Spacelab, this technology program got folded into Spacelab because it fit perfectly. Even though ultimately, Spacelab doesn't have that complete a life support system where you sleep up front with the crew, the human services equipment is nothing in Skylab. There is breathing air and purification and so on. CVT was put in there to give that background to the people in the program office who were going to deal with the Europeans in the development of this system. So to say, was that responsible, I don't think so. It played a heavy part in it and it gave the guys and gals a good leg up because the Europeans knew absolutely about life support systems at that point - had no reason to, never built one. They played together perfectly, but I don't think this led to this. There were just kind of natural fits.

101. Dunar: If the plans for the Sortie Can had been followed though rather than bringing ESA in at the time, would it have been a different type of system?

102. Kingsbury: No. That was an extremely difficult opportunity. Others will tell you this and maybe say it nicer than I. The Europeans are a proud group. They didn't want us telling them how to do something. It's kind of like my kids when they got to be twelve.

103. Dunar: I know that!

104. Kingsbury: When we would go and say to them, "What you're doing isn't going to work," they would say, "Thank you very much," and do it any way. Then they would never tell us it didn't work. The next thing we knew they'd changed to something else. Of course we knew what happened to it. We had to get them around to a system that would work that we could live with by trying not to offend them by telling them what they were doing was crazy. Engineers are not, but their very nature very tactful people usually. We had some people who tried very, very hard to be tactful. We had some who couldn't stand it any more and lost all tact. Life support on the Spacelab was one of the most challenging just because of that. We knew how to do it, and they wouldn't let us tell them anything. They wanted to find out, "I'll built it myself." If you want to hear that in spades, have you ever talked to John Thomas?

105. Dunar: No.

106. Kingsbury: John works for Lockheed over at Yellow Creek. He was chief engineer for a large portion of the Spacelab program. He lived that, and you don't have to talk to John long to find out he's one of those who where I referred to you and I said that some of them didn't have any

tact at all. John is an extremely sharp engineer. Incidentally, he also finally chaired the investigation committee at Marshall about the Shuttle. John could give you a lot of that stuff. Ray Tanner's in town with USBI or a spin-off. Ray would remember a long time also. They were real close to it. I wasn't that close to it. I just know some of the things like that that happened.

107. Dunar: That seems to be, just in what I've read too, seems to be a very difficult relationship to work out. Would you see the relationship between Marshall or NASA and ESA as one of a partnership or a contractor/ management sort of relationship?

108. Kingsbury: Well, it's now becoming more of a partnership. Back then, they were really in the third grade building hardware that we were going to put people in. We were very, very sensitive about hardware that you're going to put people in. We'd done it so we knew some things to do, and we knew some things not to do. We weren't paying them, so you couldn't say "If you do that we won't pay you" because we weren't paying them anything. On those occasions where our folks would say really you ought to do this way because if you do it that way this is going to happen and that is going to happen. On those occasions, where in fact what they did worked, not as well as it might have, but it worked, they took great delight in coming back and telling

us, "See, it works!" I would say, "Yeah, but there's a better way. If you round off the corners, the ball would roll better. It's not square any more." It was difficult because, I had two interests at the time. Coming to work and going home was just a life. Couldn't tell either one of them a thing. Had to let them fall down and hurt themselves and then they learned.

109. Dunar: Could you talk to them directly engineer to engineer or were there always diplomatic overtones?

110. Kingsbury: You could talk to them one on one. It didn't matter. They didn't like it either. The only time I got into a shouting contest in that whole program was when of the chief engineers for one of the companies was going through an analysis and [?448] all wrong. I said, "No, no. You did that wrong." Boy, he huffed up. He started back through, and I said, "You didn't here me. You did that wrong. I don't want to hear that anymore. You stop presenting that and go do it right." I got up and walked out of the room. It's like having a column of numbers and your answer is a letter. It was so patently absurd, and the facts were the guy really didn't know what he was talking about. He was presenting some data that someone else gave him. He didn't understand it at all. So that relationship was there. Program people, Jack Lee, probably had a better relationship because he was dealing with the program people

than we had dealing with the technical people. Be sure to talk to him if you haven't already. He'll tell you that he did have some good relationships. On the other hand, he had some very, very trying times. It was a difficult relationship all across the board. It was not a difficult personal relationship. They were nice people. We liked them. I think they liked us. Professionally, it was a constant battle. As a matter of fact when it got here before it flew, we changed out some hardware. It was just easier.

111. Waring: Do you remember what varieties of hardware?

112. Kingsbury: Bolts and nuts they had put in that were crack sensitive. We knew they were, but they wouldn't listen so we said, "Fine, but when they get over here, take them out and put [?475]." As long as we could get to them without taking out a lot of insulation. If it was something buried in the guts of the structure, it had to be fixed before you could put it together because we, the people at Marshall, had to stand up and declare this thing as flight worthy and there were things as designed that violated some of our most fundamental design requirements for flight [?482]. So there's no way we're going to buy, and they said "Well so then don't do it." They would occasionally get very high in the chain. You know how ESA works. This is a consortium of eleven countries and each one put in so many

dollars and then got back so much work equal to that. What you may not have heard is it's very hard to make that come out exactly even. What they did to smooth off the top and make everybody equal to their share was they gave some software to you and some software to you, some software . . . . Can you imagine, I don't know how much you guys use computers, suppose the basic software package you have was written by fifteen different people who didn't talk to each other! That's the way it was set up.

113. Dunar: Douglas Lord, on Spacelab, describes it as an international success story. I guess in the end, in terms of the success of Spacelab, how would you describe the project overall if you were to describe it?

114. Kingsbury: First of all, I don't think the Europeans would call it a success story because for putting up the money that they put up, they are very well [?507]. They felt like they'd been had and as a matter of fact they had, but nothing was done sneaky. They walked right in. The door was opened. All the blinders were taken down. We told them what it was so you couldn't feel sorry for them. They got nowhere near an equivalent fiscal return for what they put in it. I would say from that point of view, it was a politically interesting learning experience for both parties whereas we in the U. S. might call it a success, politically a success story, I thing they would have called it a

terrible, terrible lesson. Technically, they learned a lot. Most of it they learned the absolutely hardest way you can - do it, fall down, break your leg, and do it again. Some of it, we were able to show to them. It was a broadening experience for the NASA people. This is probably the first time NASA people went out somewhere and said "Here's how you want to do this" and somebody challenged them and said, "Why? I don't think that's the way to do it." We were fairly egotistical. "We've done it and you haven't so I'll tell you how to do it." Nobody ever said "Why?" So the reaction was "What do you mean why? Because I said so!" It was a program that did in fact yield the kind of results that it was expected to yield. Doug Lord was the Program Director in Headquarters and for him to say anything less than that would be terribly disappointing.

115. Waring: He wouldn't get another job anyway!

116. Kingsbury: I think you should retire when you wrote the book. He worked a lot of the money problems on this site. He wasn't really that deeply involved in the design, the development, the manufacturer, and such. We learned one interesting thing. The Europeans gave us one. Part of the deal. They would give us the first one, and they we would buy one. When they got ready to ship it to this country, finished, the first one, the US customs got into the game and because it was coming in and not going back out, they

were going to charge NASA customs. You find out why the world is full of lawyers!

117. Dunar: Was the European disappointment largely over the fact that they expected that they'd be able to build more and sell them?

118. Kingsbury: Yes. They expected a much more aggressive space program. They also expected more opportunity to use the facility. What they got for nothing was two people to fly with two Americans on one mission. There have been a couple of German Spacelab missions, but they paid for that. Most of the countries, just got nothing except maybe a little mileage. I think it was a wonderful learning experience. I think it was good opportunity to learn how one might do things like that, and I think as a world they're going to have to do things with each other. I don't think the Space Station is an international program like I'd like to see it because he's making him, she's making hers, and I'm making mine. We're going to put them together up there. I'd like to see us get them all together and maybe share the expertise. We now know because the door is open, the Russians have some extremely high caliber technology which is beyond where we are. It'd be nice to use it, not to use their technology, use their equipment. It's just sitting over there. Brand new stuff, and we and the Boeing Company, think that's something we should be perusing. It

would be good for both countries. You can get some very sophisticated hardware for very little money. The Russian economy is pretty lousy. A guy like me in Russia probably makes $2,200 a year. They've got a lot of knowledge and hardware tied up. I don't think other than a first step toward understand that kind of a thing which was very helpful from Spacelab, I don't think view it with the same delight as Doug Lord. On the other hand, I would say yes it worked. It did what it was supposed to do.

119. Dunar: Just kind of an impression I got from looking at some of the documents, it seems that there was probably more friction early and by the late 70s that maybe they were more tractable or manageable?

120. Kingsbury: That's because I think, early on we were specifying and establishing requirements. They had made a presentation to the ESA council proposing to build Skylab, Spacelab with ESA money and got an agreement to do that and they [turn tape over]

121. Dunar: When the tape stopped, about the changed response of ESA during the . . . .

122. Kingsbury: ESA had gone to its board of governors or whatever they're called and had a commitment to build Spacelab for something like $900,000,000 accounting units

and accounting units were worth about $1.1, $1.2 million dollars. Early on we were establishing requirements and on many occasions our requirements exceeded what they expected them to be. What that was saying to them was you're going to have to go back to the Director General and the Board of Governors and say "The price is wrong. It just went up." I believe, to resist that to a maximum amount, they argued over requirement that was beyond anything that had been included. Once that got resolved, things started to settle down. The program may have cost them about $1.8 or 1.9 million, but they were problems that they encountered that we didn't cause so that really didn't cause any real friction between the two. The friction was in establishing a class.

123. Dunar: Was it also in part because by the late 70s, both NASA and ESA were having budget problems?

124. Kingsbury: I really can't tell you. We weren't having any big Spacelab budget requirements in the later part of the 70s. We were having humongous Shuttle budget problems.

125. Dunar: But it didn't effect Spacelab so much?

126. Kingsbury: No. The administrators from Frosch to [?642] used to say, "What happened to the free Spacelab" because there were certain things we had to do to handle it

and get ready to fly it and things like that which were costing about 100,000,000 dollars a year. They would get all uptight, but that was more in the very late 70s and early 80s and had little or nothing to do with paying ESA. ESA was having problems because it kept overrunning the budget. Another of the things that caused them to overrun could have been avoided if they would listen. They wouldn't listen, and boy was it sensitive. Some things they'd do two or three times. They could have done it the first time if they just would have listened. My folks kept getting more frustrated because they wouldn't so there was tendency at least to not tell them. Let the dummy fall on his face and then we'll go help them, but lets don't get in a fight before hand because they're not going to listen anyway. We fought that feeling and I think did a reasonable good job of working. Actually it was interesting when everything was over with, the NASA/Marshall people that worked that program were hero's in the eyes of ESA people, very highly regarded. As I said, it wasn't a personal thing.

127. Dunar: I have just a question or two about relations with JSC during this period as well. Early on there was a question that since JSC controlled the orbiter and Marshall had the Spacelab itself, who would really be responsible for the interface with the customer and in particular in with the experiment. Could you comment on the nature of that relationship with Johnson early in the program?

128. Kingsbury: Well early in the program, there were Johnson people involved in overseeing the program from the beginning. For whatever reason, Johnson's people early on are usually people who really haven't, if you'll allow me to use the term, taken an army to war. They're either young and just happen to work there. They're a placeholder. They haven't got much to say. Then as you get closer and closer to realism, the people who know how to take an army to war start showing up and the things they wanted done haven't been done and should have been done last year. Now to do them is a hell of a mess. We did have that. Not as bad as some programs, but it was there. It was never a question of who the operations center was going to be. If fact it was surprised when ultimately Spacelab operations were moved to Huntsville because that had never been done. In Skylab, we sent about 150 people to Houston. We had planned, it's only a week for sending people down there, maybe two weeks for two or three missions a year was no big deal. So there was no real question about the role Houston would play. The real problem as I see it was the guys who really now how to run a mission coming into the program later than they should have because the things they wanted should have been put into the foundation. It's kind of hard to jack up the house and put in a new 2 x 4 which is the posture that tended to put Houston together. We were, Marshall people, were caught in the middle by the [?686] on both sides. I tell you right

now, it was very different from any program I've ever been on including Shuttle or Apollo.

D: In the nature of the way in which they interfaced with Marshall?

129. Kingsbury: Yes.

130. Dunar: It seems that on Spacelab in particular there were things that were very sensitive to Johnson that Marshall was getting into - things like missions operations, mission planning, view and directory of the astronauts. Did that make, in other words put fear in Johnson that maybe Marshall was encroaching on its turf? Did that come up?

131. Kingsbury: Well that started in Skylab. The Skylab astronauts were trained in the Huntsville for a mission controlled out of Huntsville for a mission planned by Huntsville. That created an adversarial arrangement within the Johnson and Marshall camps that was now beyond the development capability. Marshall had gotten into operations. That was a thing that was troubling at least for Johnson. I think the Marshall folks, and many of them worked for me, were probably partly to blame for that because it was kind of fun to say, "We're not going to do it your way. We've got this one over here that's better." Every now and then you catch one of them doing that and have

one of them say "Wait a minute. We're taking advantage of the best we know of whether it's theirs or our's or wherever we get it from." It was little things, but that kept the irritation around. It was well meaning and more often than not it was said in jest among good friends because these people had worked very closely together starting with Skylab. Shared, broke bread together, done all kinds of things together, but there was still elbowing into my arena. You're playing in my sand box. So yes, there was that there, but I don't think that, the one thing we worked very hard on, all the NASA people, was to show one front to ESA. It wasn't always possible. It was never possible when they were here because there were too many people. When our people were there, they worked pretty hard to have one common front for ESA. I really wouldn't refer to that as a problem. I think we tend to, and I know you know I've criticized you guys, we play up too much the relationship between Johnson and Marshall like it was bad. I had great friends down there. The bosses sometimes in the political arena got mad at each other and there's always a struggle for who's going to develop what, but there was a very high regard be it Marshall for the Johnson people and Johnson for Marshall people. There's always a couple in there that go on.

132. Dunar: Part of the reason for that is that when we're looking at the documents we've seen, a lot of these things

that happened at the inception where there was that rivalry before. Our notion is that once the pie is divided up things went well. But early in dividing the pie there was a lot of friction.

133. Kingsbury: If you look carefully you will find that it wasn't only Marshall and Johnson. You can find that when we're going to talk about the telescope you're going to talk about Marshall and Goddard, same thing. Marshall and JPL, JPL and Goddard. The Agency has capabilities in more than one center to do most anything it wants to. One of the things that was done I think very cleverly for many years, it's not done that way any more, was they pitted the two groups to each other to get the very best they could. The final product would be some of yours, some of his, and some of mine. We'd put them all together and we'd all agree that's the best product we could get. That's how we made the decision. I got mad and went home and complained about and you took his wife out to dinner last night or what ever I could think of. That did get a lot of play, but once it was a go ahead it . . . .

134. Dunar: I think that's what he was [?727]. Stephen, you want to ask him . . . .

135. Waring: We may have to do another interview and finish this up, but we'll go as far as we can through these questions.

136. Kingsbury: Why don't I just try and answer them in one word. This could take a month and a half! Absolutely the most frustrating program I've ever worked in.

137. Waring: Is that right?

138. Kingsbury: Without question.

139. Waring: Why is that? Can you summarize that?

140. Kingsbury: The incompetency on the part of both prime contractors. Perkin-Elmer, who is no longer Perkin-Elmer, were the best glass-polishers in the world. If you want a piece of glass polished, I know where to take it, but I'm going to take it and put on the table and when they're done, I'm going to take it off the table. I don't want them to touch the damn thing. They polished the primary mirror, which is the source [?736] for this, were polishing for nine months and when they got to where they said all the measurements were within its boundaries, they were going to put two cloth straps underneath this mirror and hook them here on a hook and carry it across on an overhead crane. That gentleman is a fact. I got a call from a quality guy

who couldn't believe what he was doing. He said, "I've got to have help. They won't listen." I said, I did what you'd done, I laughed. I said, "You've got to be kidding." He said, "No!" I called up the chief engineer and I said, "I want a review of your dry run of moving the mirror," like as if they'd had one. He said, "Well we didn't have one." I said, "Well you're damn well going to have one before you move the mirror fellow." Cost a month in scheduling for them to figure out what are they going to move the damn mirror, and it had been there for nine months. They're going to move it out the same way they moved in when it was a piece of glass that was worth $20,000. That was that side. Got out to Lockheed, I'll give you two examples. After it had been to Lockheed about eight months, it was about eight or nine months behind schedule so they'd lost like a month every month. A few of us went out in the middle of August 1982 and rescheduled the whole program from that day forward. We'd been there saying "Yes, it will take this long to do this and this long to this," rescheduled the whole program. I came home with my friends and two months later when we went back out to review the status, because we knew where the status was and I'd wanted to hear them, and they were one day along with the schedule that we left on the 22nd of August. They were at the 23rd of August.

141. Waring: This was in '82?

142. Kingsbury: Yes, and that was two months later. So we still lost two months, a month a month, with everybody agreeing to everything. That was symbolic, typical from the kind of performance we had out of those two contractors. That's why I said it was absolutely the most frustrating program in my life.

143. Waring: To what would you attribute that? Is that just a failure of project management, a failure to schedule things that needed to be scheduled, it is people, is it unanticipated technical problems?

144. Kingsbury: It's easy to tell you, but it's hard to put it on tape. The capabilities of the people running the program of two companies were in serious question. Now if you'll turn that off, I'll tell you exactly what it was. For example I was told by the Vice President of General Manager at Lockheed when I complained to him, he said "Your program is worth about $800,000,000 to my company and I have at least heard programs which are worth four times that much each year. Where do you think I have my best talent?" The Perkin-Elmer was a totally different story. They had their best people on it. They're glass polishers, wonderful glass polishers.

145. Waring: But, that's it?

146. Kingsbury: You take it, and you pick it up. I took the guts of my Grandfathers clock to a clock-maker yesterday and said, "Please dip this in your solution, clean it, don't take it out of the frame I've got it in, and I will come back whenever you tell and pick it up and take it home. I don't want you to take my clock. I will do that myself." I wish I could have done that with this one. That's why. And we had people, Stephen, who were almost out of their minds living in both Danbury and [?784] with this kind of situation. The real troubling thing is the product that finally flew due to I believe the real dedication of probably 25 or 30 government people and NASA people and Marshall people. It was probably the finest machine ever put in the heavens except for some dirty rotten guy who didn't tell us the truth. We had some people who could have gone and made those measurements, but you don't do that. The contractor makes the measurements and there's every reason to believe from what I know that they knew they had a spot on that mirror, and they didn't tell anybody. It's kind of like a little kid who gets dirt on his pants, and he thinks he can hide it from Mom and she'll never see it. She'll find it when she puts his pants in the washer so why no let us fix the damn thing. Oh, incidentally, they had over 100% to [?795].

147. Waring: Did you feel at the time even though you recognized Perkin-Elmer was falling behind schedule, did you

feel at the time that you had sufficient penetration to surface technical problems like that?

148. Kingsbury: Yes. The problem that got through is that it detailed that you simply can't penetrate unless you match them one for one. All Apollo program was built on the basis of trust, faith, and belief. If you did something wrong, come and tell me and I'll make a hero out of you because if you don't come and tell me somebody may die. Everybody was completely open in telling everybody, "I'm not sure I should have done this." That was so common. "What did you do?" "I did this." "Oh, that's alright. It'll be fine." Or others said, "I don't think I should have done that." "No, you're right. You shouldn't have. Let's go fix it right now." This is all gone.

149. Waring: To what would you attribute that?

150. Kingsbury: The fact that they were always behind schedule and always overbudget. We did beat on them mercilessly to get on top of this thing.

151. Waring: So they were embarrassed to bring forward any more problems?

152. Kingsbury: They were on the award for a contract and got no award. For months they never got an award because

they were such a poor performer. I think the base of all that, it's the company saying "Get that damn thing out of here." I've seen it here in the Boeing company, programs here that are losing money for the company. Finally you say, "I don't care what it costs, get it out of here." The attitude of this company is whatever shape it's in, tell them. "There it is. It's yours now." But they would never hide something from me. This one hid it, and that is so unforgivable it's to being criminal as far as I am concerned.

153. Waring: Did the fact that there was no prime contractor for the telescope make a difference?

154. Kingsbury: Very, very bad scene. Very, very bad scene. Neither one could tell the other one what to do, and it was exceedingly difficult for somebody like us to be in sufficient position to be sure what the right thing was if the two were at odds. We had to make some decisions that were made with the best knowledge and intelligence that we had and in a few cases months later we had to reverse them because they were wrong. We were not telescope manufacturing people. We were spaceflight people, but most of the decisions that were made were right, but it would have been much better to have had one or two of them in charge. For example, what will be done with AXAF? There will be a problem.

155. Waring: Is that a lesson directly learned from this?

156. Kingsbury: Absolutely. Without question. In fact I think there was a lessons handbook but I don't know, and that was one of them.

157. Waring: I haven't seen that, but I'll look for that.

158. Kingsbury: Go see Fred [?833].

159. Waring: You mentioned Goddard earlier. Could you describe the relationship between Marshall and Goddard during the project?

160. Kingsbury: Well you know at the very beginning, the relationship was one of competition. Goddard was the self-decreed science center and Marshall was a propulsion center. Who the hell are these guys kind of thing? We took the stand we were a spacecraft center and whereas we didn't have the science expertise, we could get that. Either we could get it from Goddard, if they would like to help us, or we could get it from the University community. There was no big deal to getting a high class group of scientists to support you. Furthermore, the best astronomer in the world probably would not make a very good telescoper. He had some flunky over here to build his telescope and then he said "I

want it to go two degrees higher," and the guy fixed it, but they weren't real good mechanisms engineers which is what you need to build a spacecraft. There was serious friction. The then director of the Goddard Space Flight Center, he learned tact from an elephant on a stampede, and he would walk into the room screaming. There was no nicety, no foreplay, no nothing. "I'm here. Now let's start the fight. What the hell are you doing here." Almost incommunicable. You couldn't talk to him. He wouldn't listen to you. The problem was that he had so similarly impressed the people in Headquarters who were going to make the decision on where was the project was going to be managed, and so we kind of encouraged him to go to headquarters over and over because every time he went we got another positive [?860]. Finally we proposed that we build a spacecraft and spacecraft systems and they provide the science. That of course is what came out of it. That never really was a smooth relationship. They always felt like this instrument was for science therefore science should get 80% of the budget and [864?] should get 20%. The facts were that instrument is so unique. Unfortunately about Hubble, after they finally admitted there was a screw up on the mirror, there have been some fantastic discoveries made with that thing, but they're not on the front page of the Arkansas Gazette or whatever like the other thing was. The biggest problem that came from that because they've done what I'm sure would happen, they've taken it out with

software. They'll fix it, but they took out with software. There's a wide field planetary camera which would have been the PR camera of the mission because it was there just going to take pictures. It was just there to take pictures for the astronomers to decide where they wanted to go. God, they would have been pictures, in fact some of them [875?] chop off that one little aberration, but the real front PR picture taking machine was seriously hurt. When this thing gets fixed, I don't see it as being that big of a deal, and they start showing some pictures, pictures that could have been shown all along, they have chose not to, and I think that was wise because it would been simple fuel to fire of "Oh yes, but." But for the science instruments, the telescopes and spectrometers, they had some fantastic [?882]. Everybody bit as good as we could have hoped for. The capability of that machine to point is at the level of cartoons almost.

161. Waring: How much of the equipment on the space telescope was fairly directly derived from previous satellites. How much of it had to be essentially reinvented for these machines?

162. Kingsbury: The focal point structure was built out of the deposit material that had never been of a use for anything of any size. The control system, although many of the black boxes were the same, the control system was so

sensitive that the rate gyros simply spinning around caused enough vibration of this monstrous thing, these are gyro [?894] maybe 10 of them spinning, caused vibrations beyond the acceptable limits. They had to be sealed and pressurized so that if there was an air pocket like there is in all ball bearings and it is in metal on metal. That degree of sensitivity is about 1/7,000 of an arc second. What does that mean? That means . . . this was worked back years ago. If I could see Interstate 10, ten miles this side of New Orleans, and I could get on Interstate 65, I could look at a dime for ten miles clear as a bell while both of us are driving down the road. All that says I have to be as stable as a telescope. The optics are as good as a telescope. Somebody could see, but that's eight hundred miles away and I'm looking at a dime and reading the letters on it as I'm driving down the highway at some speed. That's why I say it's cartoons, always believe that. That's what it could do.

163. Waring: The Space Telescope was the first satellite designed for repair in space. Can you discuss some of the engineering problems that were results of that?

164. Kingsbury: Yes. We said we were going to design the Space Telescope so that we can do "routine maintenance" in space. On Skylab, we designed it and said we're not designing it for maintenance. It's just got to work nine

months. What the hell. Well, it hadn't even got up when we had our first problem. It came very obvious that people could do some very interesting things in space when it came to repairs. So we said alright we'll design this one for maintenance [?921]. I think there were twelve of us. [?922] believe it would work. Telephone number. Batteries, we knew would have to be changed. Solar arrays, I've forgotten what they were. We turned it over to what we called the Human Factors people, the people who have to be sure the design is such.

165. Waring: These were people at Marshall?

166. Kingsbury: Yes, at Marshall and at Lockheed. Than it got turned over and some guy worked on one day on something and said "I've got to go talk to the human factors people." He'd go down and say, "You probably ought to be able to get to this whatset here because I can't guarantee it's going to be good for fifteen years." That was wonderful that they put that on their list. In about five months, we had 162 items that we just knew were going to cost about $150,000,000 just to design to replace. We said, "Let's go back to square one." We went back to our basic twelve and designed for that. It wasn't that difficult. Think back and the people who worked the Skylab repairs were the ones from Marshall working this thing, so they knew what an astronaut could do. It's just a matter of having

accessibility. I don't know how adept you are at anything mechanical, but I bet you with a couple of pictures, I could show you how to dig at least one spark plug out of your car. You find it; here's the wrench; you put it down there; you twist it and it comes out. Astronauts are mostly flight jockeys, and they've played around cars or airplanes so they could do things like that. If you could just get them to it. On Skylab for example, the rate gyro package deteriorated rapidly during the first mission. The second mission, the crew took what we call a six pack of eight gyros up buried under all insulation outside and gyros went out in a suit, tore off the insulation, pulled up the connection - we had some feedthroughs that were open on that spacecraft - put in one of the feedthroughs, went back inside and hooked up the gyro package which is not inside. We ran the whole mission that way. We had a stuck relay on the battery system on the outside in the first mission. Pete Conrad went out and fixed it. You may have heard this story.

167. Waring: Banging it with a hammer.

168. Kingsbury: Hit with a hammer, yes. You ought to hear Paul Wise tell it. Talking about "Pete, don't hit too hard you might break it." If you think for a minute when you do something in that environment, the action and reaction comes into play. When he hits here, he's at the other end. Paul

said if he hadn't been tethered, he'd of been the first man lost in space. He came down on that thing with everything he had, fixed it, and it worked for the whole mission. That wasn't a really big deal once it got under control, and it's going to save their spacecraft a lot of time. Is it over?

169. Waring: No, got a few minutes here. We're going to milk you for all you're worth! Can you discuss the protoflight concept and the strengths and weaknesses of that type of design and development?

170. Kingsbury: Yes. The protoflight concept we've opened to question in completely unaddressable circumstances, and that is when you take this hardware to the ultimate design factor that you designed it have you damaged it? For example, if I say this structure will take a 140% of the worst load it can see without yielding, and I do that in the laboratory on this article that we're going to fly next week, and someone comes in and says are you sure you didn't get local deformation, well I can lie and say "Yes, I'm sure," but there's no way in creation that they'd ever know that. Mechanically, it measures the same as it did before. If I had had gross deformation, or any deformation, then it wouldn't measure the same. When it comes to putting people inside, there's a very, very serious concern on the part of many people about using what we call protoflight because it has been tested either to the ultimate point or it hasn't

been tested to the ultimate point so you don't really know if it's that good. The analysis says it is, but you don't really know that. On our unmanned vehicles, you'd have to be absurd not to do it that way because it saves you the price, a manned vehicle will have any where from three to five test articles because you end up usually destroying them. There's no test articles here, flight articles. If it isn't destroyed, and I don't mean blown up, I mean distorted beyond use, you only had to make one. I don't know any reason not to do that on a vehicle that is an instrument carrier. You're not going to kill anybody. It's gong to work, maybe a minor deterioration in deformation but not much. Station, that they're designing right over there, there will be a testnological structure. Testnologically bent in and testnologically facilities operation and then when do we fly? They don't do that with airplanes. Did you know that the airplane that is certified by FAA is [?009] and that's number one sold. If you get to wright them the first 777 owned by United Airlines you will have been through every bit of the certification flying required by FAA to say its safe. [011?] , this kind of thing. Yes, that's what they do. We're coming to that. Maturity is more with time. It's a question of do you really believe your analysis [[?015].

171. Waring: Did the protoflight concept come from headquarters?

172. Kingsbury: The protoflight concept came from HEAO.

173. Waring: So Marshall was comfortable once the budget cuts were made that the protoflight would work?

174. Kingsbury: Fred Speer managed HEAO. When protoflight was put in Hubble, Fred Speer was managing Hubble. I was the director of SE on both cases. On HEAO, he came to me and said, "I got this problem, what would you thing of this?" I'd say "Let's try it and see what happens." So we went down there. It sold beautifully and it went fine. When this came up with Hubble, he called me and I said why are you doing otherwise. We had to sell the Headquarters if was safe. It was not a hard sell.

175. Waring: Maybe a last question on the role of scientists. Was there anything different in the role of scientists, especially academic scientists, on the design of Hubble? Was it different from other science projects?

176. Kingsbury: You mean the role they played?

177. Waring: The role they played.

178. Kingsbury: Probably not. They were more vocal. They were more involved in the review program, program reviews.

179. Waring: Do you mean more input to engineering decisions through those quarterly reviews than they may have say on HEAO?

180. Kingsbury: Yes, they were giving more input.

181. Waring: Was it helpful?

182. Kingsbury: No. The thing that was done that's different, I shouldn't have said that quite that quickly.

183. Waring: We won't quote you on that.

184. Kingsbury: There were some people who had some very interesting input not on how to design it but if you could do this while you're doing that it could be infinitely helpful. I think we tend to all suffer from the same disease. The guy who is good with the telescope really does think he's the smartest engineer in the world and he's wrong. He's the smartest astronomer. He's not the smartest engineer. They find it very difficult when somebody says "Thank you very much. Put it over here." On the other hand, when they did make the comment that was sufficiently intelligent to receive a response, a considered response, we did evaluate the recommendation and it either did or didn't do them and they backed them. "Yeah, we're going to do that

or no we're not because . . . ." Now some of them were wild. Like, one of the instruments, late in the game we found out it had a terrible problem, optics problem. The solution was to drill a bunch of holes in [065?] structure which would have wiped out everybody else's instruments, but this one guy would have saved his. He had the audacity to give a major review, make that presentation, and showed where the holes went through the focal plane structure. Showed where actually one of them severed the optic path, "Oh well, just put a mirror here and go around it!" Those we didn't pay a lot of attention to, but I think they did probably give more input, more than they did in HEAO, I'll say that.

185. Waring: Right. There were more scientists with Hubble weren't there?

186. Kingsbury: Well there were science teams.

187. Waring: Teams. Right.

188. Kingsbury: Then we brought on this Space Sciences, Space Telescope Science Institute which had some extremely sharp people in it.

189. Waring: Was the multiplicity of science inputs, was that more troublesome? HEAO had a lot fewer people involved per satellite.

190. Kingsbury: No, somebody might differ with me on this, but I didn't thing there was that much problem with it. We had so many problems with Hubble that engrossed us from an engineering point of view and that being to hold and perform specifications that you way you will. The input from the science, and it was always very parochial. Science guys have never talked to the good of the telescope, they talk to the good of this industry. You'd of thought he hated him because they're always picking on each other. When we did those things which had a broad benefit to all of the people, we did nothing that then benefited somebody at the expense of somebody else. We worked very hard not to do that. I've got to go. I've got a crowd sitting down the hall waiting for me. [turn tape off 097]