

**MSFC HISTORY PROJECT  
INTERVIEW WITH DR. CHRIS KRAFT  
INTERVIEWED BY J. DUNAR AND S. WARING  
11 JULY 1990 JOHNSON SPACE CENTER  
HOUSTON, TX**

1. DUNAR: We are interested, principally, in the relationship between Houston and Marshall. If you would describe your sense of the relationship between Marshall and Johnson during the Apollo period.

2. KRAFT: I think you have to appreciate the background of the people involved in what is now JFC at that point was the manned space craft shot. Let's recognize that was the space task group which eventually became the manned space craft center. Our major, not all, but probably a majority of the people who lead the space task group and eventually the manned space craft center were NACA people. I assume that you have read enough about NACA. NACA was started in 1915 and we were all steeped in that background. I don't know whether I was the shortest timer in the NACA, but I certainly wasn't one of the longer ones. I had had approximately 15 years work in NACA before space was space. But Gilruth was sort of a legend already in NACA because he wrote the first set of flying qualities. If you look that up you will find his report on how to evaluate the various classes of airplanes from fighters to bombers to transports is still used today as the backbone of how you evaluate the performance and the flying qualities of an airplane. Bob Gilruth was given from almost the time he got to NACA in the late '30s the next job in the NACA to develop. Whenever they needed somebody to go off and develop something new, he did it. I think that you have to take what we say in the context that we were all NACA'ers. What does that mean? We were basically an aeronautical research organization. I worked in flight tests for 15 years. Bob Gilruth was my first boss in flight test. That is where he got his start and went on to do rocketry using rockets as a means of testing for aerodynamic properties. He was sort of the guy that was in the forefront of whatever was going on.

What is Marshall's background? Marshall's background was really two-pronged. Firstly they were a group of German rocket scientists that came from Peenemunde and went to El Paso and stayed as a group. They were very German. By the way I am German. My grandmother came from Germany, so I spoke a little German. I will have to tell you about a very interesting story between me and Hauserman one day. They had a German mind-set and I know them quite well by this time. I consider Eberhard Rees and Wernher von Braun close friends and many others over there in the German family as well as the Huntsville family. The point I want to make however, the second prong was the ABMA. I called them the "ABMA Indians". They were the Army Ballistic Missile Agency. They were from Medaris world. So here is a group of people from Germany and from Medaris world and a group of people from NACA. When we started NASA we were given the job, we the Space Task Group, which was made up of about thirty guys, eight of which were secretaries. We were given the job to put man into space. At the time, when we decided and started thinking about what rockets we were going to use, we chose the Redstone and the Jupiter. At that time it was sort of requested I guess is the best choice of words that the Army development center in Huntsville, become a part of the NASA. They refused initially. I think that therein lies the two organizations. One chose to be a competitor. ABMA chose to be a competitor. Now, von Braun being the kind of guy he was, I think wanted to be his own man. I think Medaris supported him in that probably and he wanted to do his own thing. I think he had a misconception, if you will, of American industry. I don't think he had a high degree of confidence in American industry and I think he thought his personnel, his combination of German and American troops knew better how to fly rockets than anybody else did. Probably justifiably so because of the experience on the Vanguard. If you remember what happened on the Vanguard, it came up off the pad and blew up in a pile of flames and then he saved the country, so to speak, by putting up a satellite. So I think that organization under those people, whoever those people are, von Braun and his team, had the feeling that they could do it better than anybody else. That

they could go it on their own and if they went it on their own, they probably would end up with a considerable portion of whatever was going to get done in space. I think that von Braun was ambition.

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3. DUNAR: In that period wasn't in part loyalty to Medaris. I think there was some vacillation at that point as to whether they should go with NASA.

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4. KRAFT: It could be some loyalty, but you have to get that from somebody else. I am only giving my view. I am prejudice when it come to Army generals, I don't like generals, period. Generals in my mind are West Pointers, and I don't like West Pointers. I shouldn't categorize people that way, but I am that way. I have not had very good experience with general officers. They become arrogant, separated from reality and they become tin gods. I think Medaris was a typical example of that. So was the guy in California whom we dealt with on the Atlas, Bernard Sheiver. Both a pain in the ass, a real thorn in the side of NASA. They didn't help us at all. Could have.

I want to give you this background of the two organizations as they came together. I think when the ABMA came to Huntsville, [they] began to realize that the NASA was going to be THE space center, that they were going to run space in this country. The charter they had been given by the Congress and the President clearly stated that they were going to be in charge, then they changed there mind and decided that they better become a part of that organization. The whole thing was born in adversary, if you will. So you would expect that to last for quite some time. I will give you a statement that I just as soon you not use, because I don't want to defame the gentleman. We were having lunch one day in the very early days of the space task group. I was having lunch with Gilruth and we were talking about von Braun. Back then there was a guy who had made a record of Wernher von Braun, I think his name was Berman, I am not sure, but you can go back and look and find the record. He was one of these guys that came up with these records of satire. He

mimicked von Braun. It was at the time the Chinese were wanting to become big in rocketry. The end words in that song were "and Wernher von Braun is learning to speak Chinese." We were talking about that and other things about the Redstone, because I had a lot to do with the Redstone. I remember asking Bob, well what do you think of von Braun, because I had never met the guy. He said, well, he's one of those guys who doesn't care what flag he fights for. I think that is a true statement about von Braun. He didn't give a shit about who he worked for or what he did. He was going to do it. So Gilruth said he was just as soon be an American or a Chinaman, or a whoever as long as he could work on rockets. What he was saying is that he had no loyalty to the United States. I think later that von Braun changed and Gilruth changed. As a matter of fact after probably four or five years von Braun and Gilruth were staunch compatriots. Very often defended the ways of doing things as opposed to George Mueller.

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5. WARING: They fought together against the ...

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6. KRAFT: All together and I think that as an example on Apollo 8, which was a very interesting story, he was very instrumental in accepting that was the right thing to do and it was a very risky thing to do.

I think that it was inevitable as a result of that beginning that there would be a competitiveness between Marshall and JSC. JSC felt like it was their birthright, if you will, to be in charge of manned space flight. Whenever Marshall Space Flight Center tried to penetrate that part of manned space flight I think it was felt as a competitive move. On the other hand, I don't think there was any maliciousness involved in that. I don't think that anybody ever did anything that could have been construed as that. I think that the recognition that those men over there were capable of building fine space rockets and building the necessary parts of Mercury and Apollo. The performance speaks for itself. I think they did a superb job. They were always trying to get into the manned space flight act

and I think that was what Skylab was, that was their way of getting into the act. We had many battles over it. I would be telling an untruth if I didn't say that. I think that Skylab turned out to be a very well done thing, but I think that they needed our help. I think we saved the damn thing as a matter of fact, but they got it there. If you have read the wet workshop versa the dry workshop. That was pure idiocy. Trying to build that G-- Damn thing and put all the equipment in and fill it full of hydrogen or locks was stupidity. But that was a von Braun idea, I don't know whether it came from Wernher or not, but it was a Marshall idea. It took us three to five years to get them off of that damn kick. The use of the lunar module, if you read documents, we fought back like crazy. There is a memorandum written by Chris Kraft that told them they didn't know what the hell they were doing regarding the life-well being of an astronaut. They ignored it.

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7. WARING: Why do you think they did that?

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8. KRAFT: Because they hadn't had any experience with it. Once we pointed it out to them, if you read Eberhard Rees' response, he said you better pay attention to that guy over there and they did. I think you will find examples of that all the way.

The truth of the matter is, both centers with that as a background, grew up having high regard for each others technical capability, of getting the job done, of commitment of getting the job done. I think that people had a high respect for each other.

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9. WARING: What do you think are some of the special strengths that Marshall had?

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10. KRAFT: Well, they obviously knew rocket engines, they knew liquid systems, structures. After a while they knew Pogo. That was Gilruth that pointed that out to them by the way. I think that they were good at instrumentation. They were thoroughly. I think they knew rocket control. I am talking about kinetic properties control.

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11. WARING: Did they manage their contractor differently?

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12. KRAFT: Very differently. I think that they were a group that did a hands off management, an arms length management of their contractors, as opposed to the Johnson Space Center, or the manned space center, which was an integration of their engineers with the contract engineers. Their problem was our problem, our problem was their problem. I don't think that Marshall approached it that way. There are great arguments on both sides of that story.

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13. WARING: So Marshall thought of themselves more as inspectors of the contractors work?

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14. KRAFT: Yes that is true. That is one way of looking at it, but that is the wrong connotation. I think that what they felt like, they wanted to let the contractor do his thing and then hit them in the head to do it right if they screwed up and they expected them to screw up. JSC didn't ever want it to get that far. What we wanted to do was work the problems together and work the strengths that we had, whether it was aerodynamics or automatic control, or thermal control, whatever, and integrate our talents with their talents to make sure that we were one team. We did it together. I don't think Marshall really did it that way. They may do it that way today I don't know, but I think that was part of one of their faults. That came from the way they built their rockets. Hell, they built their own rockets. They bought the components and had their own factory there. They wanted to build the Saturn V in Huntsville, AL and would have if the NASA management had approved. Because, justifiably so, they didn't have the faith in the American industry to be able to build rockets. They were wrong. Dead wrong, when you think of the THOR and the ATLAS. I think the THOR and the ATLAS were as good of rockets as the Germans

could ever have built. But I don't think they saw it that way and I respect their judgment. In the initially time period they were right.

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15. DUNAR: They felt they had lost something too, in terms of NASA telling them from the beginning that they were going to use the arsenal system. They felt by the end of the sixties that they were losing something that had been one of their strenghts.

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16. KRAFT: That is right, they didn't want to do it that way. I don't argue with that. I think that JSC has lost a lot their strenghts by not continuing their hands-on operation with hardware. That was a budgetry problem. What we did in Mercury allowed us to do Gemini, what we did with Gemini allowed us to do Apollo. What we did in Apollo allowed us to do the shuttle and that is exactly where it ended about 1972-73 is where we stopped using x-percent of the dollars we had for future programs and hardware development. Both at Marshall and JSC and it has resulted in the NASA that you see today. NASA you see today are contract managers, they are approaching more and more the Air Force method of doing things and their people are losing their innate talents and ability to do engineering as opposed to doing managemnt. That has happened at both centers. I agree with them entirely. They were right-on. I saw it here and I tried to do everything I could while I was Director and I lost, because we didn't have the money. We fought like hell to try to get just the shuttle equipment into our laboratories and it was very, very difficult to do. So did they. Fortunately they have that test center in Huntsville and that helps them a great deal. The ability to run that engine. That's good. But I think that is one of the very, very salient features today, they no longer have that competence. That was a NACA background. We all came from a place (and so did the Marshall guys) where we did the job. We did the job from cradle to grave. We thought of what to do, we planned it, did it, wrote the reports and went on to the next job. We were in charge of the early aspect of it. They were the same in the ABMA.

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17. DUNAR: Why did the space test group at that beginning of NASA move into the system of contracting?

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18. KRAFT: It was done on the basis of shoring up their lack of talent. We hire TRW here and TRW was sort of used as a body shop, although our relationship was not a body shop, but we hired TRW to support us in projectory and software support and orbital mechanics and those sort of areas where we began to have a strong group of people, but we needed that talent. We didn't have enough engineers and Marshall was the same way. The first thing you know that begins to spread. I think all of us at the management level fought that in terms of allowing that to grow. I believe we could see it coming. We could see the day coming. You could look at the management of both centers and see that the top management fought that like hell. Initially it was done on the basis of not having talent. The other premise that was done at this center which was different than any NACA center was that we decided that we would not run any of the facilities that it would all be done by contract. That was a reasonably good idea, but as you would suspect that begins to fluff over and bubble up over and the first thing you know you have guys doing things that you should be doing. Because you don't have time to do them initially and then eventually you don't do them because it is tradition. That I think is the biggest change in NASA in the last 10 to 15 years. They have lost their competency. I don't think that the people are incompetent, I think that the engineers are more competent, because they are trained better in space than we were. We weren't trained in space, we had to teach ourselves. They just are given the environment to carry that talent and utilize it given that they are required to manage.

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19. DUNAR: Is that because of budgetary restraints you think?

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20. KRAFT: No I don't think it has anything to do with budgetary constraints. I think it has just become habitual. People just get used to doing it that way and the damn thing grows. The contractors, the industry, the people who are going to make money out of that are the people who will continue to push and push and push in order to make more money, to make a bigger profit. That's the biggest thing that's wrong with the STS. There is no incentive in STS to reduce the numbers. In fact, the incentive is to do otherwise. The incentive is to put more people on the job, because that is how you make more money. So you have all these contractors spread out with no prime contractor really across the top. As a result there is no integration of that function. NASA has never been able to do that. They have always been known as the intergrated and they are not. They are the kibitzers. NASA are superb kibitzers, they are not integrators. They do not have the talent, the resources, the money that are required to do the job of integration. Therein lies the terrible fault of the space station. The space station is run the same way now as the STS. You have all these contractors spread out at the top and NASA trying to integrate them. That the one job they cannot do. Never, not even in my day, they couldn't do it. I am talking about the hardware now. The total program: operations, facilities, bringing things together, laying their broad plans, NASA was good at. NASA is good at specific talents, thermal, aerordynmacis, control, they can kibitz. In my day we kibitized like crazy. That is what we were superb at. That is what the industry needed. They needed somebody to stand over them, watch them doing their job and kibitz the hell out of them and tell themw when they were doing it wrong. Get that mixture going, it was superb, a tremendously capable balance. NASA no longer had a check and balance because we don't have that trait anymore.

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21. WARING: That is why these inter-summer panels and boards were so important in integrating.

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22. KRAFT: Exactly. Not only that those things forced the centers to work together as well as the contractors. Initially those things were a real adjunct to getting the job done, because it used a communications tool. Everybody was forthright. Everybody said what they were doing. Everybody kibitzed what people were doing. They were very honest in appraising those things. The centers got to get their strengths involved both at JSC and Marshall. They fed off of each other. It was very, very well done. The first thing you know that starts to withdraw and now those things are dog and pony shows.

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23. WARING: Real decisions aren't made there?

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24. KRAFT: No, they just come there and it is sort of like a g-- damn convention.

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25. WARING: When did that change happen?

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26. KRAFT: I think that is has happened gradually over the last 15 years.

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27. DUNAR: Was the attempt or wrestling between the centralization and decentralization with things like the lead center contract, was that part of it you think?

That seems not to have panned out.

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28. KRAFT: But that is wrong, it did pan out. Fundamentally it is the only way to do it. If they don't go back to it there aint going to be a NASA 10 years from now. Somebody has got to be in charge. I don't give a G-- Damn if you are in the Army, on a baseball team, if you are in a opera, any place you go, somebody has got to be in charge. You have to have a leader, a maestro. There has got to be a prime center and a prime contractor. If you don't have that you aren't going to have a good product. You are going to make mistakes, have communications problems, monetary problems, and you are going to spend 20 to X percent

of trying to make all these people work together. It is going to cost you at least that much more to do the job. There were estimates made by a lot of contractors when NASA started this space station type of deal, that pointed that up to them. That it was going to cost them a minimum of 20 percent and most of the contractors were afraid to tell NASA what it was really going to cost. Because it is probably going to cost more like 30 or 40 percent. Plus the things that they are going to have to do over again.

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29. WARING: Do you think that was one of the big sources of success with the Apollo program that there was a clear division of labor between Johnson and Marshall?

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30. KRAFT: No I think that the success of the Apollo program was due to people like Bob Gilruth and George Lowe recognizing that was a necessitate in running the program. George Lowe was unique in his ability to run the program and let somebody else think they were. George Lowe ran Apollo. No matter how you slice it George Lowe ran Apollo. Sam Philips thought he ran Apollo and George Lowe helped him think that he ran Apollo, but he did not. George Lowe ran Apollo. I mean every aspect of it, including the Saturn. I don't mean that he told Marshall how to build the Saturn, or even tried to get in their drawers, (but they did in building that rocket) they knew that what George Lowe said relative to the program was what was going to get done. I think that was an unwritten statement, but it was how the program got run. Anybody that tells you differently does not understand how the program got run. That goes to Rocco Petrone or anybody else that you want to talk to that thought they were running the program. But George Lowe and his people ran the program.

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31. DUNAR: We have come across some memos and so forth from George Lowe back here for example, and other things that indicate Lowe's very close relationship with Houston. In fact one said something to the effect that he saw himself as Bob Gilruths'

representative in Washington. Did that enhance Houston's position in relation to Marshall and other centers?

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32. KRAFT: No, on the contrary, I think that Lowe was extremely honest to [the point of] being absurd honest. I think that it probably helped Marshall.

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33. DUNAR: I don't think it questions his integrity at all, but...

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34. KRAFT: I knew what you meant, I wasn't speaking to his integrity one way or the other. What I meant by that was that I think that George did things that he thought were the right way to do it whether he came from A or B. I think he always acted that way as the program manager for Apollo. I think that was his strength, plus the fact that he worked 24 hours a day.

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35. WARING: Did people at the manned space center feel that they were more influential in Washington and in headquarters than Marshall was?

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36. KRAFT: No. No I don't think we ever felt that way. George Mueller was a s-- of a b-- --. He was a tough guy to work for. He saved the program, don't misunderstand me. I think without George Mueller and John Yardley in STS, either program would have made it. We needed their being SOB's. Yardley was capable of running anything and everything and being involved in every decision, he was that good of an engineer. Mueller was a good engineer, but he wasn't that good. But, I think George Mueller was a necessary evil (if you will) to make the Apollo successful. I thank God that we had him. I hated the SOB while he was there because he was a tough taskmaster. He did a lot of things which we had to do differently than he told us. And we did. We ignored the bastard when we wanted to and thought we were right. I think that his ability to pull that whole thing together from every

point of view, the scientist point of view, rocketry point of view, the spacecraft point of view. I think he was extremely important to the success of Apollo. Whether you liked him or not doesn't matter. I like him today, by the way, I didn't like him then. He tried to get rid of me on a number of occasions, because I was one of those guys that told him what I thought. Mr. Bates (?) did finally get rid of me for telling him what I thought. I think that the relationship that we had then was a very strong bond in that people said what they thought. Marshall may have been somewhat reluctant to do that because of their way of doing business. Even so I think that von Braun and Eberhard Rees and those guys came to realize that a free-flow of knowledge and communications and what was going on was totally necessary to get the job done and I think they did it. Hell, the Saturn V, the job they did on the Saturn V and the instrument unit, every aspect of what they did was turned out to be as good as you could do.

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37. DUNAR: On the relationship again, in the late '60's, particularly when Marshall's workload was declining (and this from Marshall a real particular key period) there are a few things that we are looking at here and one of them you just mentioned, George Mueller and George Lowe. At certain points it seems that perhaps Mueller was Marshall's advocate and protector in the sense that there questions for example one author called it the "Marshall problem" when Marshall was top-heavy with senior people and the possibility that some of these people would be dispersed to other centers and that Mueller allowed or gave Marshall the latitude to look for new avenues.

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38. KRAFT: Yes, that was one of the things we disliked about Mueller. I think he played JSC and Marshall against each other. He did that purposefully. I think he was Machiavellian in that respect. He did that very consciously. I think that was the name of his game to do that. The reason he liked Marshall a little better than JSC, and this is only conjecture on my part about George Mueller, was that he could tell Marshall what to do

and they would do it. He couldn't tell JSC what to do and expect us to get it done. He damn well couldn't, cause he had too many damn strong people down here that would tell him to shove it up his a-- if it wasn't right. I think that he realized at a later time period after Apollo had gotten done, that was part of his strength also. Our strength was his strength. But I think in the heat of the battle he felt that way. He literally tried to get Gilruth to get rid of me and Max Faget, cause he thought we were deterrent to his way of getting things done. I think he changed his mind and George Mueller and I are very close friends today as a result of a mutual admiration for each other. But he was a tough SOB to work for. George Mueller lacked one word in his make-up that he later achieved and that was compassion. I use that word a lot because in my opinion you do not find a good solid manager without having that trait. You had to have compassion and he did not have it. I think after he got married the second time and really fell in love he found it. I mean it. Maude was a nondescript person and then he married this young girl later and I think they were a great match for each other and I think she made him over again. He became very, very appreciative in retrospect with the elements of NASA that made him successful. We made George Mueller. I already described to you what George Mueller did for NASA. I don't think he realized we were making him at the time, but I think he does today.

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39. WARING: Why did Marshall build Skylab? Was it George Muellers doing?

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40. KRAFT: I think Marshall wanted to do Skylab and it was George Mueller's idea to do Skylab. I think they both are responsible for Skylab. Gilruth detested Skylab. He hated it and it wasn't until I went to him after I left being a flight director and was so intimately involved myself, we started recognizing getting our team together to fly Skylab. We had the astronauts and we were responsible for flying the Skylab. I started taking a look at the damn thing. I was the one manager in JSC who paid any attention to it because I was going to be stuck flying the damn thing. I went and told Gilruth exactly what I just said. I said,

G-- D--- Bob, you may not like this Skylab and I don't either, but I am going to end up being responsible for the operation of this d--- thing and I am telling you that we have got to get involved whether you like it or not. That is exactly the way I told him. We have these astronauts over here. We have the flight controllers. We are going to have to get in that mother and do it. So let's get off our a--- and start loving Skylab instead of hating the damn thing.

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41. WARING: Why did you hate it?

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42. KRAFT: Because Gilruth thought it was an abomination. He thought it was a kluge. In fact it was a kluge, a damn good kluge, but it was a kluge. Look at the damn thing, it is a kluge. How else could you describe the damn thing. If you sat down to design anything you would never have come up with that design. It was reeked initially and Bob Thompson, who was in charge of AAP here locally, fought that wet thing. Finally, finally after I don't know how many meetings we had on the damn thing, got Wernher to change his mind.

Yes, it was George Muellers idea. In retrospect and after finishing the Skylab, it was a damn good one. But it was a kluge.

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43. WARING: Johnson's idea would have been to design...

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44. KRAFT: Build a space station not a kluge. Now I come a little cropper here because I never in that time period of big space station myself. But really, you have to realize that I was in charge of operation and a lot of other things, but I wasn't really a designer so to speak. Bouche is the guy you ought to talk to about that, he was a designer. He would have said I want to build a space station. You end up doing things, anything we have ever done and anything I have ever had anything to do with, there is a whole series of compromises. That's what engineering is. That's what diplomacy is, most of life is. So you

learn to be a superb compromiser. Sometimes you have to compromise and Skylab was a compromise. Thank God we had it. The results of Skylab are fantastic. We still are today and the best study of the human beings reaction to 0 g that has been done and will be done in the next 20 years. Literally, because I think that eventually the work that was done to determine man's capabilities to deal with 0 g are as complete as you could possible get. I mean hell they went out and bought a peach orchard for instance. Controlled every spray that was put on it. Knew everything that was on that peach and served it to the astronauts. That was part of the metabolic analysis that was done. How else could you have done it better? You preserved the urine, preserved the feces and all of that, God Almighty, the Russians have never even come close to doing something like that and probably never will. .... [switched sides of tape] It still stands today as the best science that has been done on the sun. The results of Skylab were right on.

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45. WARING: Did Marshall's participation in Skylab and entering into manned systems change it relationship with Houston?

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46. KRAFT: Yes, I think it changed it because Houston finally came to the realization and conclusion that Marshall was going to be a player. So lets recognize they are a player and lets do what is the right thing to do to get space research advanced.

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47. DUNAR: A player in the sense of manned space flight?

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48. KRAFT: Yes. I think they feel that way today. Unless NASA decides today to make Marshall the lead center in the space station, I am not sure it will ever get built.

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49. WARING: Why do you say that?

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50. KRAFT: Because I am firmly convinced that you need someone to be in charge.

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51. DUNAR: Simply because of the amount of work that has been done by Marshall so far?

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52. KRAFT: No I just think that they knew Skylab, they did Skylab. I think that they are probably the people that ought to do it at this point. JSC has enough to do with the STS and with getting on with SCI. JSC ought to get more involved, I don't mean to imply that I want to get JSC out of the space station. JSC should do their thing with their part of the space station. Operating it, astronaut training. That is a big job by the way, because the cultural differences between Europe and Japan and the U.S. It is an extremely big job. And the other things that JSC has to do with Skylab. But somebody needs to be in charge of the damn thing. You can't run it from headquarters. Show me any organization in the United States that runs anything from headquarters. You can't show me one. I am on the board of Directors of the Pan Handle Eastern Corporation, which is a gas transmission company and we have about four different gas transmission companies. We don't try to run that damn thing as a central organization. Each one of those transmission line companies do their own thing. They have their own capital budgets, they run their own thing. You have got to have somebody in charge of what's going on. Now, you have policy, you set rates, all of that sort of thing is done by the parent organization. Rockwell doesn't run its subsidiaries from the corporate office. General Motors doesn't run Pontiac. Pontiac does their own thing. So, if you are going to have something that is going to be built and run, you don't do it from headquarters, you run it from a center. You have an office there that performs the tasks that a headquarters function has to do. It has to interface with the Congress, interface with the OMB, it has to set policy, has to strip to the level one specs, and see that they are being done. That's all correct. But building the G-- Damn thing and making it happen has to be done in the center and that has to be a lead center. I don't give

a damn if you call it that or not. Call it what you will. Somebody has got to be in charge. The contractor, likewise, has got to be done the same damn way. You have got to have a prime contractor. You can't have 4 contractors like we have, because the intergration of that crossing the lines cannot be done by NASA.

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53. WARING: Who was in charge of Skylab? There was a lot of rivalry during Skylab between centers.

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54. KRAFT: Marshall was in charge of building the Skylab and getting it done and making it work and integrating the instruments, making sure that their contractors integrated things. I don't think there was any question about that.

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55. DUNAR: Was part of the Houston opposition to Skylab because of concern about losing some of its control over manned space flight to Marshall?

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56. KRAFT: Oh, I am sure that was in the back of a lot of people's head, but I don't think that was the predominating feature of any decisions that were made. As I told you before, it was obivous to me that Gilruth didn't want to have a damn thing to do with the Skylab. I knew that we weren't going to get anybody at JSC interested in Skylab. So we were totally dependent on Marshall building a good machine. We wanted to help them do it right. If you go look at my memorandum you will find that I told them so. Just one example. I would be dishonest if I said that there wasn't that element of what you just said. I think there always was and always will. That's just intuitive.

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57. WARING: Do you think there were things that Houston did to maintain control over Skylab? Did they give Marshall any role in planning the Skylab mission? Or was Marshall primarily the engineering center that build it.

58. KRAFT: Yes, I think that is true, but, we tried in everyway we could to get Marshall to provide the flight control portions of the Saturn V in our control center. They fought that like crazy. We finally got them to do it. We have no illusions that they wouldn't do the same thing for the Skylab. We tried to get them intimately involved in the flight control operations and of their parts of it. I think that belies the fact that we didn't want them there, we asked them there. I think that we, JSC, imagined ourselves as being the operator, but that was our charter. That was what we were suppose to do. That was my job when I was in operations. I was not in operations when we did it, I was the director, but I think that is the way I always looked at it.

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59. WARING: This is going back a bit, but that brings something to mind. Do you remember real controversies about the instrument unit on the Saturn V. Did Marshall want that to be more central to the control of the vehicle?

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60. KRAFT: No, I think that we made that decision early in the program that the control of the rocket would be in the rocket and that the control of the space craft would be in the space craft. At that time I think that was the right decision and prevented a lot of interfaces that didn't need to be done. When we built the shuttle, it had to be done. With the mass fraction problems and so forth, it would have been dumb to do anything else. However it still has a computer of its own in the engine. I think that was the right move too. Its got a controller in the engine that controls the engine, but they talked with each other (the two computers systems) with described interfaces, but the control of what the engine does is in the brains of the space craft.

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61. WARING: And Marshall was in charge of the computer that ran the engine.

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62. KRAFT: Yes, Rocketdyne is the contractor and Rocketdyne builds the computer that is called a controller for the engines which interfaces with the computer that controls the total system in the space craft. That's a very delicate interface too. But, for instance, the redundancy management, the shut-down criteria, the control of amounts of power, control of fuel, are all done in the controller.

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63. DUNAR: You mentioned that the recognition at Houston that Marshall would be a player in manned space. I am wondering about how that relates to the decline in Marshall in terms of the RIFs, in terms of a reshuffling of appropriations as well, because Marshall had had a lion's share of that earlier and now it was shifting to other centers and Houston in particular. There were some rumors during that time that they were considering closing Marshall down. Could you give us your perspective on that?

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64. KRAFT: They weren't rumors. I think that in the aftermath of Apollo and Skylab, the decline of NASA began. It is still going on. I think that Fletcher and Lowe began to backfield or to bank a fire at NASA because they realized the political atmosphere and environment in Washington was not conducive to larger budgets with NASA in dealing with Nixon and subsequent administrations. I think that as a result they realized that NASA had to try to shrink itself to a more efficient, less costly organization and programs. For a good reason, from the engineering point of view, hell we now knew how to do space flight. I mean, we knew how to build zero g tanks. We knew what happened in zero g. We knew how to do orbital mechanics, we knew how to do rendezvous. We knew how to build very fancy systems and etc. We had a great deal of experience in that. So we should be able to do it more efficiently. We didn't, but we should. I think that that kind of thinking was going on in Lowe's mind particularly and Fletcher's mind. So I think that there was a realization that NASA ought to be shrunk. There was a study made on what NASA should do relative to various centers in NASA and how that ought to be handled. You may not be

able to find that in the annuals of headquarters, but it is there somewhere unless they destroyed it.

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65. WARING: Do you know what office did it?

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66. KRAFT: Yes, it was done by the office of management at headquarters. A guy named McCurdy. You may not be able to find it. But that is where they recommended a lot of things be done at NASA. I think that became rumors, as you called it, became prevalent and I think that the politics began to come into play. I don't know that, I am guessing. I think that is when it was recognized by Fletcher and Lowe that they couldn't do that.

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67. WARING: Do you think that they were serious about wanting to close Marshall?

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68. KRAFT: I don't know whether they would have closed Marshall, no. I think that was one of the considerations. But I don't know if that is what they would have concluded. I think that they would have closed Lewis and Ames. I think they may have done something about how they would have organized KSC and Marshall. But, I don't know that they ever came to the conclusion that they would close Marshall. I am sure that was a consideration. But I don't know that they ever came to that conclusion. You would have to ask them. I don't know if Fletcher would even remember it. I spent hours in headquarters dealing with those issues. I know its there. I saw the summary results presented to the administrator. I was there.

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69. WARING: Who was the Marshall Director?

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70. KRAFT: Eberhard Rees.

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71. DUNAR: Was part of the resolution deciding as Petrone as Director?

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72. KRAFT: No.

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73. DUNAR: One of the things we have been wondering about is why the decision was made to send in an outsider as director and not someone that came from within the Marshall system.

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74. KRAFT: I am not saying this is correct, but the perception was that... von Braun was such a strong leader that there really wasn't anybody that could fill his aura and that Rees, although very confident technically and recognized as the real technical brain of von Braun, was there, they didn't believe that he was a very strong management type and that below him there was nobody that they could count to be management. I think that was wrong. But I think that was the perception and that was the reason Petrone was sent in. Lowe's ideas on management were that you had to have somebody strong and very virile. Somebody that could raise hell and cut throats and that sort of thing. He wanted somebody like that and saw it in Petrone. I don't think he knew Petrone very well.

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75. DUNAR: Some of the Germans have the perception (and they are very guarded in talking about it) that there was kind of a purge of the Germans at this point. Some of them were given reductions in rank...

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76. KRAFT: You would not get the proper perception of that from me. I never had that perception. You have said something to me that I have never felt before.

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77. WARING: You have never heard that there were efforts to get rid of the Germans?

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78. KRAFT: No, I think that is wrong. As far as I am personally concerned, but I may not be right.

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79. WARING: We don't know either.

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80. KRAFT: I don't know either, but I did not have that perception. I think that the truth of the matter is, looking in retrospect, hell the Germans were all getting old. There were very few left with any brain power. I think that they were searching for new blood to come in and revitalize Marshall. I don't think it was a kind of malicious thing.

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81. DUNAR: I think that was probably what the thinking was behind it, if that in fact did happen.

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82. KRAFT: I don't think it had anything to do with ancestry. I don't think it had anything to do with the people that were there. They just didn't think the strength of leadership was at Marshall. Frankly, I think that has been born out.

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83. DUNAR: I think it ties in with what you were mentioning before with why they brought Petrone in. Having all of von Braun's group in the positions as lab directors, kept younger people from being in those positions.

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84. KRAFT: Bill Lucas is a very close personal friend of mine. I have nothing but the highest regard for him. But he wasn't worth the shit as a center director. He just wasn't strong enough.

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85. WARING: That is not the perception of him by other people. He is regarded as being a tyrant.

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86. KRAFT: He may have been a tyrant in the way in which he conducted himself in-house and the way he ran the center. I understand that. But he was not a leader. He wasn't strong in his beliefs and he was incapable of dealing with those kinds of issues. I talked on the phone with him on two many occasions to try to get him to join me in doing battle. He just flat wouldn't do it. On occasion he would. But I tried and tried and tried to get him to join me in battle. Either between the centers in settling issues between the centers. Or in doing battle with people like Abramson and others. He would not do it. He would go off and say I will think about it, and never get back with me. Never talk to me about it again. You have to realize that I am a son of a bitch too! I have very strong ideas and beliefs and I wanted things done my way. I was willing to stand up and fight for them and I did. I told General Abramson on several occasions to shove it up his ass that he was wrong. I got very little support from the rest of the center directors. They knew I was right, but they still wouldn't join the battle. The shuttle processing contract at KSC is the classic example of me. I fought that damn thing. I knew it was wrong. I told them it was wrong. I did everything I could to prevent it from happening. I am sitting here as a retired person because I did. I was right. All they have done is spend money because they went about it the wrong way again. They did it piecemeal. The other guy that felt as strongly about it as I did was Walt Williams. We both said to Beggs, G-- Damn it what is your game plan? What are you trying to do here. If you will tell us what your game plan is we will tell you how to get there. You might not like our ideas either, but we don't like yours. I said that over and over again. I said that to Abramson until he was pretty mad at me. I was that kind of guy. I was probably the most outspoken. Let's face it, I was probably the most renown person left at NASA at that time. People were probably afraid of me for various reasons. Wrongly so. Maybe trying to get Bill Lucas to join me was something he didn't feel comfortable with. I know what you say about his internal dealings with his staff and how he ran the center. Things had to be done, he didn't want anything to be done without



him saying it could be done. He wouldn't let anybody voice their feelings about what should be done. He was the spear. But, I think that was more a coating than it was real.

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87. DUNAR: You mentioned the way in which you operated, for instance the way you talked with other center directors and so forth, is that an inevitable consequence of maybe weak leadership at headquarters at NASA during the shuttle period for example? Was it necessary?

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88. KRAFT: No I think it was different. Let me tell you my feelings about it. I think that when I thought of things and how to do things, I thought NASA first, JSC second. Gilruth taught me that. I don't deny that I didn't have a certain amount of parochialism. I would be a damn fool to tell you that because I did. But, I don't think the management of NASA at NASA headquarters ever thought that way. I don't think that they worried about the institution. I felt like it was my duty to worry about the institution. I made speeches on that at many management councils. I made speeches about that among Bill Lucas and others. I always preached that. I made speeches to that at my staff here at Johnson Space Center all the time. I believed in the NASA institution. So I tried my damndest to act that way and to get things done that way. That's where I was coming from all the time. It sort a fell to me unofficially, being the oldest guy left, or the guy with the most tenure, if you will, and I felt the responsibility to do that.

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89. DUNAR: Hasn't there been a tradition also with Johnson having been there at the origin and so it was the dominant center.

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90. KRAFT: That has always been the appearance outside of JSC. I used to come back from my staff meetings, I would give them a briefing about what was going on, and I would say, These guys in Washington keep telling me that we are a bunch of arrogant bastards

and that is the problem with JSC. I would look them straight in the face and say, if you ever lose that reputation, I am going to kick you in the ass! I meant that. I wanted to be known as that. You are only the best if you think you are the best. I think we thought we were the best. I think we thought that we knew what we were doing and I think that we, at least in my mind, knew that what we wanted to do was what NASA ought to be doing. I am sure that we were wrong on many occasions, but that was our feelings.

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91. WARING: Do you think the image that Marshall projects is that of a team player, that they are not as aggressive as JCS? ¶

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92. KRAFT: Yes.

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93. WARING: Where does that come from?

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94. KRAFT: I don't know. I am not even sure that is right. But it is a mindset.

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95. WARING: Going back to the beginning the Germans, as you say, were quite proud, the Germans and the ABMA people both, were quite proud of their talents. But, they were team players all through the 60's. They accepted LOR for instance.

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96. KRAFT: They accepted LOR because it was right. I mean J---- C- how would you like to land a Saturn V on the moon? I mean it was that simple. That is the reason the decision was made. Try building a landing gear for Saturn V. How would you like that job. I mean if you do direct ascent to the moon you have to land a f----- three hundred foot rocket on the moon. You try to put something out there a landing gear that is going to land on a 15 degree slope on soil that you are not sure what it is, tell me how you are going to do all of

that. And, put the astronaut on the top of that son of a bitch and give him some capability of visibility to do it. Its that simple.

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97. WARING: It was a technical issue?

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98. KRAFT: Absolutely. There isn't even any argument.

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99. DUNAR: Our perception, not just on the LOR, but on other issues...

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100. KRAFT: By the way, I don't think that Wernher von Braun ever thought any differently once he made that decision. I think he absolutely convinced by his own personal technical evaluation that that was the right way to do it.

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101. WARING: Do you think that once the LOR decision was made that regardless of its correctness or not, do you think that had important consequences for Marshall. For instance, had...

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102. KRAFT: I have never looked at it that way, so the answer in my mind would be no. I can see where you are going.

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103. WARING: Say EOR had been chosen. That is a hypothetical question, but had EOR been chosen it would have given Marshall a role more like it had with Skylab.

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104. KRAFT: Skylab had not been invented.

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105. WARING: Yes, I realize that.

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106. KRAFT: No, I had never really thought about it the way you just put it as a division of responsibilities or cutting of the pie.

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107. WARING: The decision had that effect.

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108. KRAFT: I didn't say that. I know where you are going to. But I have never thought about it that way.

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109. WARING: Well, the Marshall people thought about that way. The Marshall people thought that their proposals were a way for them to expand their role in the Space Agency.

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110. KRAFT: We had the perception that they weren't worrying about NASA or the space program, but they were worried about feathering their nest at that time.

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111. DUNAR: Another perception that we kind of have and we are not sure...

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112. KRAFT: I think that you are probably right that that's true. But as far as I am personally concerned, I never thought about it that way.

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113. WARING: To you it was a matter of technical efficiency landing on the moon. I think that is what Marshall people ended up accepting.

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114. KRAFT: I never crossed our mind whose job was what when we were thinking about how to do it. Christ knows you better not think that way if you have got to do it. If you are the guy that has to do it. Particularly being in operations, I didn't give a shit as to whose job it was or whose idea it was or anything else. I was saddled with the damn problem of getting it done. I didn't give a damn whether it was Marshall, JSC or KSC or anybody else.

My approach was always I am responsible for this g-- damn thing being done. I am going to make sure it is being done the simplest possible way and the best way that we can come up with doing it. I don't give a damn whose idea it is. Shit, I argued with Max Faget as much as I argued with anybody at Marshall. He would tell you that too, by the way!

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115. DUNAR: We have, I think, a working hypothesis at any rate, that we are looking at within NASA politics that Marshall would push an issue only to a certain point. I don't know if it is a question of teamwork or what, but that in the EOR, LOR is only one thing, and maybe what you said will cause us to rethink this. But, in other words, Houston would be more aggressive.

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116. KRAFT: You have gotten a perception pretty fast, I guess its not so fast, you said you have been working on it. I think you have gotten a feel for the damn thing.

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117. DUNAR: It seems that Johnson would be more aggressive and would not back down. Whereas Huntsville would push to a certain point and then recognize that now we have gone about as far as we can go and better not risk going any further or we may end up losing it all.

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118. KRAFT: Yes, I think you got that right. Hell, we didn't invent LOR either. It was the guys at Langley that came up with the idea and we embraced, eventually embraced. It wasn't the guy that gets the credit for it either.

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119. WARING: Is there anything that we haven't covered that you think we ought to know about? I think we would like to talk to you again when we know more about the shuttle.

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120. KRAFT: Let me tell you about the story of Apollo VIII because I think that it was characteristic of the respect that Gilruth had for von Braun. You recall what second Saturn V that flew had POGO. It was on the S-II stage and we were very, very fortunate that it didn't blow up. It only saved itself. The center engine cut off and if it hadn't cut off it probably would have blown up the machine. I don't want to go too far back on how we got Apollo VIII. We had a couple of meetings here between Lowe, Gilruth and Dick Slate and myself on Apollo VIII. But finally we all had decided that was a good thing to do. We wanted to do the whole thing. As much as you could do in one gulp that is what you wanted to do. Anyway, we had that meeting, we were in Gilruth's office about 11 o'clock in the morning. Finally we decided that was what we all wanted to do. Gilruth said, Well, we have got to get Wernher to agree to this and get him to say that is the correct thing to do, because we were depending on Saturn V to do that. Saturn V the last it flew was not too red hot, so here we were going to get man flying on Saturn V the next time we fly. Pretty big risk. So he said, let's call Wernher and see if we can go talk to him. So he immediately went over to the phone and called Wernher and said, what are you doing this afternoon? He said well I have got some meeting but I could break them if necessary. Gilruth said, we will be there in two hours. George Lowe immediately went down and called Sam Philips who was at the Cape instead of Washington. He asked Philips and Petrone. We flew to Marshall and met in Wernher's office. That is where we made the Apollo 8 decision. Wernher was ecstatic. He thought this was the greatest idea he had ever heard. So did everybody else.

The other story I wanted to tell was...I grew up in flight test but I was also an automatic controls guy, I wouldn't say I was an expert, but I spent about 10 or 15 years working on it. I knew a lot about automatic controls. We were having a great big meeting over at Marshall on the S-II. I was Gilruth's representative, sort of the lead guy for that meeting. Remember this whole big conference room that they have up there on the top floor of that building? They were having this big meeting. There must have been seventy-

five to a hundred people in this room. Hauserman, he's their expert, and he is up there discussing all this stuff. I start asking him questions as I am prone to do. He got very upset and got madder and madder. He got so mad eventually that he started speaking German. He didn't even realize he was speaking German. The room just came apart laughing at what had happened.

They have some really fine people at Marshall. Dick Smith and I grew up together. He was responsible for the report sensing system at Redstone and I was responsible at JSC. I worried about the space craft, he worried about the missile and we worried about the interface. All those guys out there I thought, were outstanding engineers. They were competent they had the same commitment as anybody did to getting the job done. They got it done.

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121. DUNAR: How did the relationship between Gilruth and von Braun evolve?

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122. KRAFT: It evolved to the point where we had tremendous mutual respect for each other and I think they like each other. The same is true with Devis by the way. Devis started out being... the first time you met Devis, he had that scar on his face and he came from that school, you would think that he was one of these Gestapo guys. He wasn't one at all. He was a very, very nice human being. Gilruth and Devis had a heck of a good relationship going. Eventually so did I with both of those guys. I set a plane down and picked Devis up when he was ill flew him to Houston to make sure he got to the right hospital. Took his wife back and forth, got her an apartment and my wife took care of her while she was here. We had a great relationship with Devis. It was a basic difference of philosophy. The Challenger thing, that was awful. The culture, the Marshall culture there, is what got them in trouble. The one that you described. They would carry it so far and then they wouldn't carry it any further. I think that the Begs/Mark/Abramson management style was so intense, so intent on making everybody do things the way they

wanted it done, and they knew everything about how it could be done and by God that was the way it was going to be done. Now, I fought back. Marshall didn't as you would expect. I used to try to get Bill many times to join me in those arguments. But I think it was the management style of Beggs, Mark and Abramson that created the Challenger accident, because they drove everybody underground. People began, hell right here, Glenn who was my program manager on the shuttle at that time, we decided that we would never again allow that son of a bitch to make a decision for us, because he always made bad ones. We said we are going to have our minds made up before... We had the habit of discussing everything in the open. We didn't hold anything back. We would say anything we knew, everything we felt and thought out of that would come a good decision because everybody would know what everybody thought, and what everybody's ideas were. But with Beggs, when you started doing that, that son of a bitch tore you into an asshole. He would start brow beating you and say why did you do that. A very poor management style. We decided we were never going to let that happen to us again. It was happening twice and he started again. We decided that from now on we would have our minds made up as to what we wanted to do and then we would go and discuss it with him. We weren't going to keep it from him, but we were going to tell him this is what we want to do. We aren't going to discuss all the options and stuff. I think that began to be a modus operandi in NASA as a result of that.

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123. DUNAR: The other center directors started doing the same thing?

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124. KRAFT: I think so. Everybody began to say why should we bring this to the management, because we they are going to browbeat the hell out of us. We are going to make up our minds how we are going to do this on our own. I think Marshall got caught up in the same kind of thing and they didn't choose to bring that problem to the management properly. It probably got discussed in various ways, but Bill Lucas was of the mind and so



was obviously the guy in charge down there, if we bring this up to the management it had gotten to be a modus operandi. I don't think that it got hid with malice of forethought.

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125. DUNAR: We take care of our problems within house?

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126. KRAFT: Yes. And it shouldn't have been. I fault the Johnson Space Center as much as I do them for the Challenger accident. What I was trying to get at was that I think the castigation, if you will, of Bill Lucas and others at Marshall for the Challenger thing was unfair. They were a victim of the management style of Begs and Mark.

127. WARING: Do you think that management style was fundamentally different during the Apollo days, both at the center and at headquarters?

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128. KRAFT: Hell yes. Our whole modus was tell it all. Say what you think. Even if people didn't want to hear it. Get it all out on the table because out of that would put pieces back together again and a good decision. It will be a compromise as any good decision is. But it was free thinking. That was our way of doing business and that is what got us all in trouble with Begs.

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129. DUNAR: Was that facilitated by the fact that Begs background was not in engineering? Was he allowed more latitude?

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130. KRAFT: No I think that it was NACA. That is the way that you do anything in research for god's sake. Spit it out, what do you think? The guy would tell you something. You would say bullshit, you don't know what you are talking about. The guy you said that to would not be offended at all. He just expected that kind of free interchange.

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131. WARING: Do you think that was the difference between people who were trained in management careers and those who had scientific background?

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132. KRAFT: No, no, no. I didn't have a goddamn minute management training.

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133. WARING: That is what I am saying, that those with scientific background were use to that kind of thing?

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134. KRAFT: I can't answer that. Like I said, I am not trained in management. I think I am a damn good manager. I think that I am one of the best NASA has ever had. I am sure I was one of the best that JSC ever had. I think that's a talent. I don't think that comes with, it can come with training I imagine. But sometimes I think that you are better off without the training because you aren't encumbered with those damn fool things of what you learn in management.

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135. WARING: Was it your impression that the management in the top echelons of Marshall during the '60's had that same sort of openness. The German lab chiefs and the Apollo program directors argued with one another?

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136. KRAFT: They certainly did in my presence. I knew that Marshall had a way of doing business, but I never questioned at all when we got into meetings, and we hundreds of them, technical issues and problems, failures and other things, I never questioned at all that they weren't spilling it. I never had that feeling. I knew who the good guys were and who the bad guys were. I had absolutely the highest regard for their technical competence and their ability to make good decisions and their forthrightness in telling it like it was. Never any question about that in my mind.

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137. WARING: Do you think that changed in the '70s at Marshall?

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138. KRAFT: No

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End of tape.