Tape #1, Side 1
Interview with Konrad Dannenberg:

RB - One of the first things that I was curious about is why the people at ABMA every started thinking about this cluster thing in the first place. The Air Force, this is in the '57 time frame, had been given the authority to do missiles over 200 miles so this left ABMA kind of up in the air with some of their plans. And then all of a sudden comes the proposal for this gargantuan booster. How did that evolve?

KD - Well, of course, in a way it was before this decision was made that the Army was limited to these other things. People had been working on it before on a study phase, not in actual hardware. But in a way it was an old concept. And, of course, the question how to increase the thrust of an engine has always been under discussion. In a way, the first cluster was the Atlas. The Atlas had two engines, and also the additional booster engine. So you can call it a cluster. And I think ever since that time people have thought about the question, what can we do to increase thrust, particularly if you want to increase it quickly so that you don't have an awful lot of development time to develop a new, stronger engine. Because engine development, as I'm sure you know from your historical studies here, takes normally quite a number of years.

RB - But what was this thing they were used for? As I recall, later on there was talk about the so-called advent satellite that ARPA was into. But was it mostly just to see how much more thrust you could get or was there a specific kind of thing in mind?

KD - Well, of course, the Army had also quite ambitious plans. At some time they really wanted to colonize the Moon or to at least have a station on the Moon. I think colonization is not the right word. That's a little bit too controversial. It's a permanent base. And of course they need an awful lot of power. Now I don't think anyone had made detail studies so that you knew exactly what vehicle. But it was generally known, and understood by everyone, that you would need an awful lot of power, so the basic question was how do you get a lot of power. Even the Saturn I and Saturn IB booster was really built on that basis. When we initially started the booster work there was certainly no Apollo program. The Saturn, it wasn't called Saturn in those days, but the need for a big booster was generally assumed.

KD - And even all the early Saturn days left the upper stages and particular quite open. But people thought already about putting, for example, other vehicles like the Titan was quite a bit under study in those days. In fact we had sometime a study with Martin to find out exactly what changes do they have to make on the Titan in order to put it on top of the first stage. The Dinosaur was in the same category.

KD - So I think it was a general recognition that we need strong boosters, big boosters in order to get some of these type of payloads. And I think it was more a class of payloads that was under consideration to get them up into orbit. And again, as I said, people here realize that it takes a long, long time to develop big engines, and maybe people were afraid of the many development problems. And

it was just considered to be easier to cluster existing engines. And I think we also knew already that the Russians were doing the same kind of thing. The Russians have been taking the cluster approach from the very beginning. Even today, the booster they launched _____ ~~with~~ was a cluster booster.

RB - Now the origins of the cluster concept interest me too because, in a sense I guess you'd call the Atlas a cluster, but ...

KD - Well, people don't normally call it a cluster.

RB - I've forgotten how. Two were the sustainer engines.

KD - One sustainer engine in the middle, in the center, and two booster engines.

RB - The whole Saturn I, or the Juno V and the Saturn I seem kind of like a bargain basement sort of thing to me.

KD - It was, definitely, just like the first booster. Medaris said we can build the whole thing for 9 million, I think was the figure, pretty low figure.

RB - But how did the idea evolve that you would take, was it a Jupiter tank in the center, and then cluster Redstone. Do you remember anything about how that evolved, was it very definite.

KD - Well, again, as you said, it was a bargain booster approach. And when it comes to bargain booster prices you have to use existing hardware. And it was a basic thought behind it, what can we use to exploit our existing hardware. And it was not so much everyone's hope from the beginning just to copy exactly what we have, but basically to use the tooling. I think everyone saw that we probably have to build new tanks, but what can we do to use our factory, assembly lines I think is the proper word. And what can we do to use existing tooling, which is very expensive and time-consuming to build.

RB - When you say new tanks you meant new Redstone and new Jupiter tanks? Is that correct?

KD - Right.

RB - Were there ever any plans, at one time, to build a gargantuan single tank?

KD - Plans on paper, yes, but as soon as people looked at the paper plans they

realized it would have taken something like the Michoud facility _____ _____. And, of course, we didn't have that at that time. And there was not even the prospect of getting it. So the only way to really get going, and I think that that was one thing that Medaris apparently _____ _____ had recognized and really pushed. He probably got the basic and technical ideas from von Braun and his team. But Medaris and _____ said for 9 million I can build such a thing. And he got the go-ahead and that's _____, we were all in business.

RB - But it was ARPA that really came through with the money.

KD - So, in that sense it was not really an Army assignment. The Army team just did this kind of work for ARPA. Therefore this missile range business was really not that much under discussion.

RB - There's something else that just occurred to me. Out there on the test facility area, I remember going by one and seeing a bunker that was constructed of an old tank car covered with dirt. Was that the Juno _____

KD - Probably you think of the old Redstone. On the very first Restone test stand we didn't have any test center at that time, and everyone felt that in order to protest the engine and the assembly property, of course the engine had been built by North American. Actually, we just got it from North American and we just had to assemble the thing. But everyone felt that we just couldn't even go ahead with the design and finalize everything before we had done some testing. And so again we took the bargain-basement approach and we used existing hardware. This was a chemical arsenal so there were a lot of tanks around. So we used some of these tanks, we threw some sand around it, and put some instrumentation on the inside, and real simple _____ trenches between the observation bunker and the actual testing, which was also built really from scrap, except of course the measuring instruments had to be bought.

RB - But this was for the Redstone, not the Juno V.

KD - That was well, of course, for the Juno V we again had the need to do some additional testing.

RB - Did you use this same bunker for the Juno V testing originally?

KD - No, I think by the time the Juno V came up we had already built our test stand. We had already built the big Redstone test stand. And so I think by the time we really talked about Juno V we were already in the real business. This was done in the real early days. We came here in '50, and so it must have been built in '51-'52. So I would ~~said~~ say the testing started in '53 or so.

RB - At the national monument that thing really has a historical significance.

KD - I haven't even thought of that. Our space agency was trying to declare a few ~~things~~ local things as national monument. Maybe they should include that. I think they have included only one of the big test stands. Let me check _____ _____. You're right, that may be more a monument than the real big impressive things.

RB - In this same period, I was wondering what the feeling was when the word started filtering down that ABMA was going to get transferred to the NASA organization.

KD - Well, you know of course that it had been turned down once. And at least at that time all of the key people discussed the subject quite a bit, and I think the main question was, well in a way I think the von Braun team, I think even you have called it, they somehow felt loyal not only to von Braun but to the basic employer, to the Army. So to make such a switch looked a little bit, almost like treason. So people didn't really like to do it. And on the other hand, of course, we knew that ARPA suddenly had relatively big plans in those days. And I think on the other side of the NASA side, we were just not really aware of their plans--what they had in mind. And if NASA wouldn't have gotten the Lunar landing contract I don't even know what would have become of them. NASA, the old NACA, we should really say, was more looked as a bunch of long hairs. They had a lot of wind tunnels and they did a lot of scientific work in the lab, but I think they generally were not regarded as being too practical a group in the real tool manufacturing sense.

KD - Really building big things, and I think that was our main concern. An we evaluated it strictly from an NACA viewpoint. Now, of course, in the meantime it had been decided _____ the Vanguard team would go to NASA, which was being formed at that time. And I think JPL had been transferred earlier than the team here. I think basically in '58. So basically when NASA was established JPL was transferred.

RB - Well, what strikes me, of course, is the documents, you know, after NASA was formed and they were talking about a broad guage space program they wanted to do. There was really no expertise that they had, had been transferred from the old NACA. If they were going to get this expertise, at that time what they needed was a big booster and there was only one place to go and that was DOD at ABMA And I've come across a couple of memorandums, one of them from _____. I've forgotten the exact date but it was about this period. And one of them said I think we should go after ABMA in the strongest possible way. But they were out to get the ABMA people.

KD - Well, and finally they succeeded. And I think in the long run no one really regretted it. I think, in the long run, we saw this was the right decision.

RB - Well, NASA certainly brought the money with them once it was organized. What about the Silverstein committee in December of 1959 when they decided on the LH-2? Now, some people have told me and I've seen some references to the fact that von Braun himself wasn't very keen on liquid hydrogen technology. And, of course, you and all the people from Redstone had been working with LOX and RP-1. Do you recall if there was really any strong antagonism about LH-2 as an exotic _____?

KD - Well, I don't think it was very strong, but people were really concerned. We, of course, knew already about the problems that the Centaur people had. General Dynamics was working on the Centaur and we kept a pretty close eye on it. And they just ran into all kinds of problems, problems people hadn't forseen. And we saw our project more as a project that really wanted to do something fast so we didn't want to tamper with all these development difficulties. So there was a certain amount of antagonism. I don't think it was very strong. And, again, after the decision had been made I think people really jumped on the bandwagon and then carried it, even with inner conviction, that this was the right way to go, because purely performance-wise we saw immediately that this gave us so much more than any other combination would have given.

RB - The I specific of LH-2 really makes the whole thing work at the end. So, there was this concern because of Centaur.

KD - Right. The Centaur experience, again it was a new project and I think our people, as I said before, were generally always very conservative. So for that reason the switch to NASA was difficult. It was a basic change even in life approach, in value principle. And this was again a very basic change. And as I pointed out before, I think at the time the decision was made we had already a contract with Martin to put the Titan on top of the S-I first stage booster. And, again, everything had to be changed. And people are always reluctant, not only this team, but I think most people are reluctant to make basic changes. And that's, of course, what was necessary. But after this decision had been made, after it was decided by _____ to go this direction I think we really then had full support, from everyone and from top management on down all the line to the engineers. Of course, the engineers were quite happy because now they really had something to bite their teeth in again--some new development problems and that's always what they are looking for.

RB - So this brings us around about to the time of the S-IC starts cooking, 1961. And some of the questions I had there relate to this unusual, it seems to me, relationship that Marshall had with Boeing. And I wonder if you could explain to me why Marshall took this unusual role with Boeing. They had already given, as a matter of fact, the contract to Douglas to do the S-IV and the S-IVB, and they just kind of gave them the contract and said read it and said OK, Go. But with Boeing it was entirely different. Can you explain to me the rationale and reasoning behind this?

KD - Well, of course, Boeing had really made an outstanding proposal, so they

really won the competition, and it was a pretty fierce competition at that time, who gets the S-IC. So Boeing had really won it on the basis of their excellent proposal?

RB - What features of the proposal stood out? Do you remember that?

KD - Well, good management, good technical approach. I think the thing that really finally won it for Boeing was the good technical approach. And again they took, and maybe that's what particularly swung this team in the direction towards Boeing, they took a very down-to-earth type of approach, a relatively simple design. They didn't have double bulkheads, double tanks. They did not have very sophisticated designs.

RB - Some of them came in with common bulkheads?

KD - Well, I don't recall the details of the other proposals, but they were more sophisticated. They were more complicated. And Boeing was down-to-earth. In spite of the effect people here felt, Boeing had never really built, of course no one had really built such a big thing. But other companies like Douglas and North American were a little built closer to this kind of thing. And it was an entirely new thing for Boeing. So for that reason a lot of people here, particularly people on the working level, felt that it was not a time to let Boeing go completely on their own. And for that reason people here felt, and of course we also wanted to have the pride of authorship so to speak.

RB - Was that a part of it, you think?

KD - The first units had to be built here, particularly test units. And, of course everyone figured that also the first one or two flight units had to come out of our own shops in order to be sure the thing works, to be sure we take the right development approach in all little details in detail design of the tanks, of the lines of the tie-in to the engine, etc. And, for that reason, Boeing got a free reign only relatively late in the game. I think that's what you were referring to. They were really led by the hand.

RB - If somebody like Douglas, for example, had gotten the contract and they were already doing things, would there have been such a close relationship then do you think? Or would there have been more inclination to let Douglas go a little bit more on their own? Or was it the fact that Boeing had not built such a large rocket stage before that they were brought in..

KD - And also, of course, the fact was that Boeing didn't have their own facilities. Douglas had their own facilities where they were building these things. And, of course, at that time we were considering already Michoud. I think it was even a part of the contract. I don't recall the detail right now. But I think

part of the _____ was to come in and build in Michoud.

RB - I'd forgotten that, because I was talking to Matt ~~Erloff~~ Urlaub the other day. He commented, too, that part of the thing was that Michoud was, in comparison to all the other facilities on the West Coast, in the backyard almost and was part of the Marshall complex.

KD - And we also saw much easier transportation conditions. Going to the West Coast we had to depend on the Panama Canal, and maybe some people saw already what is coming now. And to ship it all the way around South America, of course would be a tremendously long trip. Even the Panama Canal is almost a month's trip from Seattle, if you have to pick it up in Seattle & ship it down through the canal to the Cape.

RB - So how much did Boeing, you said they really had a good technical proposal. Did this proposal go pretty far down the line then, and how the S-IC ~~fainlly~~ finally came out, or did Marshall really set up pretty much the general _____

KD - Of course, when Boeing got the contract we had not decided on the number of engines. We knew what engines to put on, we had only one that could do the job. But how many of those we needed, that was not clear. And one of the reasons it was not clear was, of course, the whole lunar mission was not clear at the time. Like the lunar orbital rendezvous had not been decided on. ~~They~~ There were a number of other possibilities that were also being studied, and again, I think after the final decision had been made, really everyone _____. Up to that point there were big fights on, in particular a lot of people here at Marshall felt this was not the right way to go.

KD - And what our people would have liked to see was ~~to drop lunar~~ rendezvous. To put relatively small payloads up, we could have done that with the S-IC with the Saturn I booster, maybe the IB. But not the S-IC. We would not have needed the Saturn V, and we would have put all of the orbital hardware then in four or five shots into an earth orbit, and we would have made earth orbit rendezvous to assemble all the hardware. And of course the big advantage we would have had, if we would have gone that way we would then have had the space station already in the mid sixties. Because these conditions led ultimately to a space station, even a very fancy space station which can do orbital assembly work.

KD - On the other hand, for that reason NASA headquarters decided against it. They saw too many development problems, too many possibilities that something would go wrong. They didn't even see the possibility to get five launches off on a fairly tight time schedule. And they figured it is better to build one big booster, and to depend on just one launching date. And if you get that one launching date off, then you are in business. And so finally they went to the lunar orbit rendezvous, after many, many discussions, many studies, many heartbreaking decisions. And, of course, that only finally decided the number of engines we needed on the booster.

RB - Was there a trade-off...

KD - And, again, I think Boeing showed a lot of inventiveness, how these things could be added. I think they showed more flexibility in that respect since they had a very basically simple approach to the whole layout. It was basically a boiler tank design. But, again, it had flexibility. And to add engines was no big sweat at all.

RB - That remindsme of comments I've heard so much about. Marshall's approach was very conservative, but it was that very conservatism that gave it flexibility. It had a large reserve built into it. (KD nodded in agreement here)

KD - In that sense we were on the same wave length, on the same phase with Boeing. They apparently saw it our way and they went along with it. And that may have weighed a little bit in the a final evaluation of their proposals. Because that's what our people liked. So they got thrust points in all these areas. And some of the other companies, probably particularly North American, they always are a little bit more farther out. They are much more inclined to stick their neck out. And sometimes our people are a little bit reluctant to go all that far. And I think rightfully so, because if you really look back I think it is amazing that we have launched all these Saturn boosters now, some 30 or so of them, and not a single real big failure. There were little things thathhappened during flight, but they were all very minor. And basically I think you have to say, each and every one of the--at least booster launches was a success. And, we never lost any astronauts in flight--even the very bad Apollo 13 incident. It still brought the people back. And the only thing that did happen, happened on the ground. And you certainlyycannot blame the booster for it.

RB - About the time of the EOR-LOR decision, when Marshall finally agreed then to go, ~~before~~ because they were still pushing the EOR concept, and you mentioned that there was this space station thing too floating around at that time, did Shay or anyone at Headquarters suggest that we'll go with the single booster now and we'll talk about space stations later on. Was it kind of a carrot and stick kind of thing?

KD - Well, I think the space station discussion just didn't impress anyone at Headquarters. It was not their job. They were really not concerned for space stations. We didn't have the Johnson Space Center in those days so these people were not pushing in that direction. It was just a small little space group operating out of Langley. And so really no one worried about it, and certainly Headquarters didn't worry about it. So I think it was only our desire. And again we didn't have any real mission requirement for it either. If someone would have asked for it we probably could have come up with a mission requirement, but it was just not one of the issues. And for that reason, of course, that concept lost out and particularly people were afraid that we had to launch a relatively large number of boosters on relatively short notice.

Interview with Konrad Dannenberg:

RB - If you missed the launch window on one _____

KD - Then the whole mission, particularly if you have trouble with your hydrogen launch. _____ get your _____
So if you don't hydrogen up by the time you get the next launching done, all your hydrogen has vaporized. And for that reason, people decided that is just not the way to go.

RB - What about the origin of the 5th engine? I have a little trouble tracing that down because when the S-IC first came out, of course, it was a four-engine bird.

KD - Initially we even started on two. The initial proposal was made on two or four. We knew already that the possibility would come up that we might have to go to four. I think we never considered three.

RB - I think it was either two or four or it was even called an SIB stage.

KD - Well, of course, the final calculations, as always in these things, by the time you add up all your instrumentation in the lunar lander, the lunar excursion module. By the time you add all these things the thing was just too heavy and ~~the~~ four engines just couldn't hack it.

RB - There is a correspondence that comes out of Milt Rosen's office and this is in November of '61. And the impression that is given there is ~~it~~ was a Headquarters decision to go with 5 engines. It was really a Headquarters move to do this thing.

KD - Well, again, I think most of the problems I just mentioned are really not so much Marshall problems. They were probably more tied to the manned portion of the vehicle, and here Headquarters had also ~~been~~ better insight than our people here . They knew already a little bit more what was coming. They worked must closer with the space task group than we did here. The tie-in to the space task group was really not too strong in those days. In fact that is one of the reasons we set up all these working groups. I'm sure you have read a lot about the working groups' independence. It was really just an attempt to get closer to these people and to get some continuous inputs and feedbacks from their side.

KD - Now the working groups were more our own management device here at Marshall to work with our own contractors. And the _____, another group of, working groups in a way. It is basically the same setup. But, it was more with the manned portion of the project to really get the input from the space task group and to be aware of what these people wanted to do and what their requirements are. And I am not even aware of this Rosen letter. I don't recall if I've ever seen it. But I think, basically in principle, without knowing all the document background I think I agree that there was a strong push from on Headquarters, at least to add a fifth engine.

Interview with Konrad Dannenberg:

RB - Well, there was a special committee that was set up and there were some Marshall people on it, and I wanted to get in touch with them. One of them was Mrazek.

KD - Mrazek was very active in the whole design and the whole layout. He was also very instrumental in making these kinds of decisions--how many engines do we need, why do we need them, what are the requirements. So he would certainly be the right man to do it. And he made a lot of these decisions in the form that he presented them to ~~xxxxxxx~~ von Braun. Von Braun was really the one to make, for Marshall, the final decision and said yea or nay that's the way we go or we don't. Although he certainly didn't do all the work himself. He had a lot of people supporting him. And Mrazek was one of the key people to make a lot of these key decisions.

RB - What was Mrazek's position at that time? Was he in P & BE or something?

KD - I think he was not the boss at P & BE at that time. On the other hand, I'm not too sure, he may even have been the boss. You should get some good organization charts, but he was certainly one of the key people in P & BE and he was in charge of this kind of design work. I think we ~~should~~ have Kline ~~him~~ then Stuhlinger, and he was here only very temporarily. _____ was the boss down there. No, I think that was before Kline. Yeah, I think Mrazek took over from Kline. He was certainly one of the key people. He was probably in charge of the structure or maybe the layout group or something like that who was in charge of looking into these things and making these kinds of ~~xxxxxxx~~ very basic design decisions.

RB - Well, that's one of the questions I'll have to ask him about.

KD - And if you talk to him, you certainly talk to the right man. At that time I was basically so much in charge of renegotiating conflicts from two engines to four engines that I normally waited for these inputs to come in. So I didn't even go to all the meetings because there are so many meetings going on all the time. And you just couldn't go to all of them. But that was Mrazek's job to go to the meetings, to present our viewpoint, to have our say in these things. And he also was in charge of making all the necessary studies for that kind of thing. And I think it was more really an advanced studies group that he must have been heading. Because it was not really ready yet to go into detail design. That was the next phase.

RB - P & V didn't come about as a separate thing until after _____ anyway.

KD - After these basic decisions had been made and then it was a matter of

now we becoming up with the detail design. And I think that was the time when Mrazek took over. He was one of the fortunate advance designers that could really implement the design.

RB - Why did the S-IC have two separate propellant tanks? As opposed to a common bulkhead?

KD - Again, that was a very conservative approach of Boeing. That was kicked around quite a bit. Should we have —

(end of Tape #1, Side 1)

Interview with Konrad Dannenberg:

RB - So Boeing originally came in with the two tanks?

KD - Right. And I think it was also the basic thinking of our people. They wanted to keep it simpler.

RB - And if you get into a common bulkhead you've got very tricky welds on the diameter. Is that one of the big reasons there too?

KD - Yeah.

RB - Looking at the Saturn stack, the S-II and the S-IV, S-IVB all had the common bulkheads so you wonder why...

KD - That gave us a lot of headaches.

RB - Especially with the LH2 and the _____ so close together.

KD - And there again you could do it since hydrogen is so awfully light and hydrogen is normally in the upper tank. So the weight you have to carry is not all that heavy.

RB - That's another thing, I really confess that here my layman's knowledge is really hazy. But as we're talking now, as I remember too, one of the questions that came up, why not go with LH2 and S-IC. But because of the specific gravity of liquid hydrogen . . .

KD - It would have been a huge tank. The tank would have been even bigger. We would have had to use a bigger diameter, and the diameter was one of the considerations. And I think the prime consideration was really the engine. There was not a 1½ million pounds or on there engine in existence. People worked on it, I think it was the M-1, but it was in the really early phases. And there was no hardware in existence, and there was certainly no chance to ever get it done in time. So that was completely ruled out. And that was considered later again as a possible stage for the S-II, but even these plans never came about.

RB - Again, so it comes back to the theme, it seems to me, and that's using as much as possible existing hardware, at least hardware that's pretty far down the development line and that means the F-1 then that's what you go with.

KD - And I think that was a requirement for the contractor so no one used another engine. They all used the F-1 engine because it was maybe the only one we had. And that also, again, and fortunately we had already some experience with clustering. And that really called for clustering

because we knew with just one F-1 engine, 1½ million pounds thrust, that you could never get the booster off the ground. So we had to have something like that, and by the time the clustering principle had been sold you probably know there were a lot of people who were against the clustering concept. Some people thought it just couldn't be done.

RB - Within Marshall?

KD - No, not so much within Marshall, more in Headquarters. We got a lot of static from Headquarters and even from some other NASA centers.

RB - Clustering the five F-1. They didn't think it could be done. Well, as I said, at that time the issue was kind of dead, but it was particularly a big issue for the F-1, for the Saturn I stage.

RB - Why didn't they think it would work, because they thought we could never get all five engines to ignite at the same time?

KD - Right, to get them all ignited at the same time, and to get them all started, and we still had lots of problems with engines. People felt if you had _____ eight engines you always had one that didn't work. And for that reason some people finally worked it into an advantage. Since you could fly the Saturn I booster, at least for certain missions with only seven engines on, so you could say, well even if one of them doesn't do it you could...You probably wouldn't have taken off. So if it happens at takeoff you probably would have shutoff and would have fixed your engine and then planned for another launch.

KD - But if something would have happened during flight you certainly could have continued.

RB - There is another thing that strikes me as why there might have been opposition as when you have those nine tanks all together, that creates kind of a problem then in making sure that the propellant drain is equalized all the way around so you don't get all kinds of perturbations in the thing. Was that a design headache?

KD - It never turned out to be a problem. I'm sure the designers addressed themselves quite a bit to that question. But you never had any problem with it.

RB - Was there a computer control on that...

KD - No, if you just connect all the lines, particularly since your G-factor

during flight goes up quite a bit. Of course, any extra column weighs an awful lot. So then that higher column, if one tank didn't empty quite as fast as the others, weighs so much more that it pushes that tank out faster. So if one tank lags behind, it automatically picks up again. So you really have to combine all the lines properly because that's where the design work goes in. You have to see to it that you don't have much higher resistance in one of the lines. And that's where the designers really have to watch out, and they did quite a bit of work in the proper layout of the lines in the valves. The valves are even much more critical than the lines.

RB - Why are the valves so critical? Opening and/closing..... precise opening and

KD - Right. And that they give enough cross section. Normally in the valve if you make it a little bit smaller with the line that leads into it because a valve is expensive and you want to save costs. So you normally have a higher flow rate through your weld. So that's really the limiting factor. And if that's not properly designed then that's where you might have problem, and of course _____ _____.

RB - I'd forgotten the opposition to cluster. I remember von Braun referring to people who didn't like it when it was first bid out here. They were talking about cluster's last stand, and the fact that the whole thing might go up, or something like that.

KD - That was a real big issue. Well, I think our people never really had any great problems with it, and so they always thought it was something that could be accomplished. They thought it was the right approach, particularly if you wanted to get the program quickly underway. So if you didn't want to develop a new engine that would have been the only other alternative.

RB - I had some questions, if it is possible to make some generalizations about the design, style, or approach of the S-IC, the S-II and the S-IVB, and I guess we've already talked about this a little bit. You said that North American was a little bit more adventurous than Boeing, for example. Why was that? Do you have any? Was it because of North American's prior ventures into the X-15 program __ _____?

KD - Right, so they had quite a bit of experience on the one side. And they probably also had other more advance programs in mind, other things where this might possibly be employed after the Apollo program. And, of course, you always want to have the very latest design in such a case. While Boeing, I think they looked at it as just one job to be done for the Apollo for the lunar landing project.

RB - How about Douglas? Did they strike you midway between North American and Boeing?

KD - They are probably a little bit closer to North American, but they are in a way midway I would say, in between the two.

RB - This interests me, I don't know why, but it strikes me. I wonder if it's because Boeing and Douglas were involved more with commercial airliners, and it might be because of the ~~patent~~ passenger factor, inherent conservatism involved in their designs styles & design approach. Whereas North American has always been deep into hot shot fighters and high performance things, etc.

KD - And you certainly have, at least in general terms, a reflection of this situation in their basic design approaches. I would say so.

RB - Now, some questions about management. And one of the things that struck me, in 1963 when they created the industrial operations and the research-development operations, Weidner became head of R & D O. But when they were out looking for a guy from IO instead of getting somebody from within Marshall or one of the veterans from the days of Pneumende and ABMA etc., they went outside and got this guy Young. What was the rationale behind that?

KD - Well, I think a lot of that was also a push from Headquarters. Headquarters just didn't believe too much in our management capabilities. And don't forget, when we formed this local team here we really didn't have any management expertise at all. It had to be built up when we split away from ABMA because basically the management was done by the army up to that point. So it was a relatively new team. We never had been previously involved too much in real top-level management of all these things. That was army furnished. And so even the small staffs that had been built up was in a way still relatively inexperienced. They had gathered all their experience here on this team.

KD - And so I think Headquarters, and I'm sure von Braun basically agreed with them, felt that someone should be brought in from the outside who had this experience over many years.

RB - I've forgotten where Young was from.

KD - He was from Aerojet.

RB - And so he was the guy who had had experience on the outside as a civilian contractor and had managerial experience. But he only lasted a year, as I recall. Was there a problem there?

KD - Well, I think Young really didn't see, of course the government operation is quite different from private industry operation. In private industry he was a

big boss, and when he said that's the way we do it that's the way it was done. But here he still had to go up to Headquarters, and if he thought he had a good idea he still had to get somebody else's permission. And I think he didn't go too much for that. And also Bob Young is basically a Californian. I think he never really liked to come to Huntsville. He never really became settled and established here.

RB - OK, that fits too, because as I recall there was some question about bringing his family here, apparently _____ was really dragging their feet.

KD - They never really came out here permanently. I think his wife lived here for awhile, probably in a rented house or so, but he really never got established. And I think he also, again he came from private industry. And of course he had a much more paternal system there than we had here. I think we had here from the very beginning always a much more democratic system. Also, von Braun, he doesn't mind at all if somebody tells him you're wrong and I don't agree with you. But that's the kind of thing you apparently don't do in private industry. I think Bob Young didn't like that, that there were too many people who spoke up and told him that he was wrong. He was just not used to it.

RB - So that explains a little bit why O'Connor might have had more success then, because . . .

KD - I think he was a little bit more open minded, and he was a little bit more willing to listen.

RB - And as an air force type he had had more experience in the ways of government bureaucracy.

KD - And he knew that he was not the final boss. He just could make recommendations. And they better be good and they will be accepted.

RB - Was there, in terms of building up this managerial expertise, significant impact on Marshall from the air force style of things not only through O'Connor, but even from Phillips?

KD - Yeah, you also got a lot of people assigned from headquarters.

RB - But also there were other air force types here. Did they have significant impact?

KD - Well, some of them are still around like Murphy, who is now in charge of PD. He really came with us, I think he came through Phillips. I think he didn't come

through O'Connor. On the other hand, I may be mistaken. And it's probably very difficult to say anyway through which channel he came. But he is certainly an old air force man.

RB - As you look at the military types that come into managerial posts, were there more from the air force do you think as opposed to the army?

KD- The air force was much stronger than the army, for example.

RB - But it looks like, since you came from ABMA, from the army, there would have been more army types coming in. Why was that, do you have any idea?

KD - Of course, the air force had many more missions in that area. The air force had all the big space missions, and the army had a few little artillery-type boosters like the Pershing. So it's a completely different, the scale is at least by a factor of 10, different I would say.

RB - OK, another generalization, maybe the army too was working more in solid propellant at that time and the air force had been more in liquid propellant logistics.

KD - Yeah, that's another consideration. Mollier is the only army man I know of. Well, no, there is one other, there is, I can't think of his name right now. He was from _____ at some time and he is still with us. I think his name is _____. I can't think of his name. You might not even have met him because he is a very, he disappears with all the other guys in the woodwork, somehow, he was from _____ in the old army days. And he is still with us. His name was _____

RB - Could you write his name down for me? I want to try and look him up. What about, was Lee James, he was in air force?

KD - Lee James is another one, I hadn't thought of him. He was army. He was with the Medaris team really. Before Medaris was Nickerson.

RB - I appreciate this help on the management because it always, this strange balance of air force vs. army managers in the thing, and this question was within that. How did Weidner wind up as head of R&DO? Was it because maybe von Braun, since he was working with the lab. Now labs have been pretty much....

KD - Well, it would have been very difficult to pick any of the lab chiefs, and make him the boss now of his own lab and all the other labs at the same time.

So it had to be someone who a little bit more in a neutral position and Weidner just happened to be that kind of guy. I think he was deputy in P4 DE at that time that he was selected, or at least he had a second role. And he was, in a way, acceptable to all the others. And I think von Braun made a very wise choice. And also ~~xxxxxxxxxxxxxxx~~ Weidner has a real good background. He was quite active in testing so he had some practical experience. And he was not in that sense a long-haired type of scientist that many others were. So in that sense I think he was more management oriented than many of the other lab chiefs. So I think it was a real good choice. And in a way I think von Braun also picked someone who was really acceptable to all the others. Because all the others, of course, had to recognize him as boss. And I think Weidner's most difficult thing, I don't know if you have talked to him or still plan to talk to him...

RB - I think that John Beltz might have had an interview with him. I haven't talked to him.

KD - Weidner is in Germany. He may show up briefly because I don't think he has sold his house. On the other hand, he sells his house to someone in Germany anyway, so he can probably make all the transactions over there.

RB - Another thing, whereas Young was brought in from the outside, it was, Weidner had been working with the group since Pneumende, so he was aware of the personalities of the other lab chiefs he used to work with. Could that have been another consideration, do you think involved there?

KD - Of course, someone in that position had really to know much more because Weidner was really the guy to work with the inside team. Young's position was much more to work with the outside. I think also they brought someone in from the outside, and certainly did not want to use one of the old von Braun team--one of the old German people to work with American industry. There was always a little bit, I think you know what I mean. I don't find the right word for this kind of approach. But there was always a little bit resentment, and I think that even went through the last few years just before the Apollo landing. Of course it was an American project, and really Americans were going to be sure that Americans were at least the key people in charge. That some other people also a little bit here and there, that was alright.

KD - But to really be in a top-level charge, that had to be some Americans. So that was another consideration that they much more looked for someone from the outside for that position than for the inner, internal arrangements. And also it was not quite as necessary for Young or O'Connor later to be that familiar with the inner workings. So that could be done by someone who, in a way, knows American industry better. I think there was another consideration. Our people were really not that familiar with American industry, and they wanted to have someone who really knew the ins and outs, who was well versed in contract management and all these things. And our people really had never done that before, except on a real small scale.

RB - Going back to the ABMA days, as you say, there was another layer _____

KD - That was all done by the army and we really had nothing to do with it.

RB - There's a gap, too, in my understanding of management of Marshall in the years before 1963, before we had the ID on one side and the ~~I & DL~~ R&DO on the other side. I can understand that better. But how were the decisions made prior to that? Did von Braun have an executive group? Were there board ~~chiefs~~ meetings of the lab chiefs that made decisions? Who were the decision-makers?

KD - There was even, until very late in the game, I think they just called it the staff. There was a staff meeting, or there was a development board. You are right. So there was a staff and board meeting. And a lot of decisions were certainly being kicked around. I think we have to give von Braun credit that he still made always the final decision. But he was a guy who really could listen to a lot of advice. He didn't mind at all, in fact he appreciated it if somebody told him you are wrong and that's not the kind of approach we should take, something that lots of other people don't like. But von Braun certainly could take it and he even searched for it. He wanted to get inputs so that the devil's advocate was played early in the game and not after it was too late, and after big mistakes had been made.

RB - Well, who were the members of the board?

KD - Basically the lab directors and a few of the key staff officers, like the planning office, like his deputy, Rees, of course was always on there.

RB - And so this would have been the same people even before....

KD - And then we had in the early years we had the Saturn Systems? office. And they, of course were on the board. And we had some other projects at least under consideration so these project managers were also on. But the bulk, I think we had 10 laboratories at that time and von Braun's immediate direct staff.

RB - Were you one of the people who sat in on these board meetings?

KD - Right.

RB - And this was the style before 1963 and even afterwards you continued this kind of....

KD - It still continued for quite some time, and then later Weidner even continued it for just R & D. It was an R & D staff and board meeting. He continued

that scheme and I think had pretty regularly monthly meetings.

RB - Did O'Connor do the same thing on the other side?

KD - Not quite as much. He had more meetings with headquarters. Of course he was called up to headquarters all the time and he very often went with his staff. Now, every once in a while the headquarters people came here and the meeting was at this place. But I think he had more, really a small staff meeting. Of course he met fairly regularly with his own staff. I think he had weekly staff meetings where his own staff came together, but none of the internal people, none of the lab people were there. Except when in their lab there was a special problem then they were especially invited to report about it and to decide or to say what they were going to do ~~solve~~ work on the problem.

RB - What you said about the R&DOB, kind of the inside group, in a sense, and the ILB in the outside group is really helpful to me. Maybe it's obvious, but I never really thought of it before. And I think that really helps me get a better handle on it. But von Braun then could very easily decide .....

KD - And of course the inside group was also technical adviser? to the IO. So whenver the IO had a technical problem they came to this group, and then they of course became deeply involved in one specific problem. Not in the management of the whole thing, but to look into this one problem, to make recommendations what should be done to straighten it out. And then IO again was the one to implement it by means of contractual changes.

RB - That really gave IO then on specific things a fantastic amount of expertise .....

KD - Yeah, and I think that's one of the reasons that boosters, in the long run, were so successful. Besides this being called upon when there was a very obvious problem R&D had also the automatic responsibility. And I'm sure you have somewhere run into the term than von Braun used quite a bit, the automatic responsibility. With 13 men, whenever any of the R&D people saw a problem somewhere and they felt the wrong approach was taken they were obligated to speak up. They were not allowed to sit in the corner and to wait until something went wrong and say I told you so. It was their responsibility. That's what von Braun referred to as automatic responsibility. A number of memos were written on that. I'm surprised that you don't know about it.

KD - It was played down later, because particularly Young, and maybe that was one of the reasons Young took a little bit issue with our whole management scheme here, he didn't believe in this automatic responsibility.

RB - It could really bug a guy if he wasn't prepared for it.

KD - But our R&D people, that's probably also the area where we had most of the problems between R&D and IO. Because these people felt responsible, and now instead of speaking up, and that's really all von Braun had given them, they should speak up. But sometimes they, of course, moved out and did something. And that, of course, was very _____ of contract, it changed the cost, and that's where people like Young, and later on O'Connor and James took issue. I think probably the one who was most outspoken in that area was James. And he said, boy, that just doesn't happen. Whenever that thing is the case, ok we are ready to listen to you. But the final decision, if you do change the contract or not, it is our decision in IO.

KD - And I kind of wonder that you had never heard about and had not run into it. I'seem to recall several memos--not a very large number, but several memos where it was expressed. I even think James wrote it up in his report.

RB - Could be, it's been some time since I've been through that. I've got to follow through it again because I got that report rather late after I'd finished some of my work.

KD - Why don't you look into James'report. I think it makes a difference and you also quote the proper references, and find out what kind of memos were written on the subject. But I thought it was a very strong tool, and again I think it is very good, very clever management tool. Although the people don't have the final authority, but they still feel obligated. I think our group felt obligated, and of course sometimes they spoke up and somebody else, people in IO or the contractors, didn't like it.

RB - It seems to me there has to be a certain responsibility on the side of IO to make sure that they keep feeding reports and test results automatically.

KD - Well, I think that was the case. It happened pretty automatically. On the other hand, it was so much stuff to read that certainly not everyone in R&D read all the reports. And you could easily overlook something that was basically important. For that reason, again, our people always liked to travel, they liked to go to the contractor and to discuss with the people firsthand what really are your problems. How do you see it? So I'm sure they didn't completely depend on reports, although a lot of report reading was also being done.

RB - Well, this is consistent too with what I think von Braun once referred to as the dirty hand approach. Everybody's got a job there and get your hands on the hardware and see what's happening.

And von Braun encouraged it.

KD - He certainly didn't stop the people to go out and travel money was not a big issue in those days. Today probably the people just couldn't get their travel funds and couldn't go there anyway. And, of course, IO was very often quite a bit concerned about this kind of approach.

RB - They kept getting mixed up with the other people.

KD - And the contractor very often didn't know _____ told me, he said now a contractual change or should I just go on with my old merry way and do business as usual. So it created a number of problems. And, as I said, particularly James. Of course when James stepped in the basic development had been done. And James could afford it as long as the development still had to be completed. I think this other approach was better, and even if it runs over the contract a little bit, [illegible] _____ you want to have a functioning and working item, that you get it at the very lowest possible prices are really of second importance. Because something which is a little bit cheaper, but doesn't do the job, doesn't help you at all.

KD - It's just like our war in Vietnam. We probably fought the most efficient, the most cost-effective war, but after all we lost it.

RB - There is another thing that maybe you can really help me on, and is very vague to me, and this is the integration and overall systems review efforts of GE and Bell and Boeing. And I really don't know what all this involved, I just know there was something like that. Can you help me out on that?

KD - Of course our people never believed in that. We saw it was for the birds and was just a waste of the taxpayers money. And GE was really brought in from headquarters. That was where Mueller came in for the first time before he took over in Houston and finally the Apollo management. But he was initially headquarters guy, and I think he came initially from GE. He was an electrical engineer or an electronics engineer. And I think he was at sometime at GE, or maybe he had some good buddies at GE like Sloan. I think Sloan was one of the guys who maybe wanted to do this overall integration.

KD - And they just felt that the people here couldn't do it, and particularly I think everyone admits integration between our center and Houston was always a little bit difficult. So I think that was even their main concern. They were not so much concerned that we couldn't integrate all our boosters with each other, although there was a little bit of it also here. But the main concern was how can we really integrate the two...

(end of Tape #1, Side 2)

KD - firing range supervision, all the instrumentation on the firing range, and all these other things which went way and far beyond the actual booster design.

RB - So it was really a total thing, GSC, the test, launch facilities, the whole works

KD - An overall total systems design. And over and beyond that GE had also the assignment to look into the whole reliability aspect of it, like do we spend the right amount of money, for example, on the ground equipment compared with flying hardware. Do we do the right things and the necessary amount of effort on the booster as compared with the spacecraft, etc. So GE had an overall reliability and also reliability safety assessment function to really tie all these things together. And, of course they really ran head-on into difficulties on the one side from all the stage contractors. They never really appreciated the GE view, and I think they were the ones who finally cut GE out.

RB - The stage contractors?

KD - The stage contractors. They didn't want to have any part to do with it, and again it was the same issue I mentioned earlier with our own R&D people. When they go to a contractor and make some statements, and maybe that's all it is at that time is statement. The contractor doesn't know exactly how it is all supposed to change something, are we supposed to take a different approach, is it a new change order, or can we just forget about it. And they say forget about it, GE is, of course, very unhappy. If they go out and do something about it IO gets an extra charge. And so it is a very difficult situation. And also a lot of people felt GE just didn't have the right background, particularly the stage contractors, to really tell them what to do, and what is right and what is wrong, what is reliable and what is not so reliable, even to make the reliability studies in a booster area where GE really never had done any work themselves.

RB - This is what bothers me. Was this whole thing primarily electronics, that they were trying to make everything compatible, or were they looking at all the engineering, the hoses, flow rates..

KD - I think initially GE wanted to do it that way. They really wanted to look into the total systems approach, but they finally were cut down to doing a reliability-type, computer-type manipulation. So they eventually got from the stage contractors reliability inputs and they were only supposed to use these, and they were not even supposed to go to the contractors anymore. Now, in the long run, since integration was probably a bigger job than even our own people here had recognized. I think, even in the long run even our own people appreciate Boeing's help in the booster integration. That was, of course, initially what Boeing was doing here for the center, to really integrate the total booster. And, of course, Boeing had the first stage booster. It was logical to give them the total integration because all the cables that go into the ground had to run through the first stage booster. And also most of the interfaces between the booster, as a total entity, and the ground were

really from and with the first stage. The first stage was sitting on the test stand. So they had most of the interfaces in the first place. And therefore after our people, and our people normally are of the higher level management type. Also according to their pay they are more in the category. They didn't want to do all the detail work. So I think in the long run they appreciated that Boeing really got into the act of at least integrating the total booster system.

and

KD - And, of course,/~~xxxxx~~ finally, since apparently headquarters again saw a lot of needs for integrating not only the booster, but also some of the other things, they finally pushed Boeing into the overall total systems integration. And Boeing, I would say, was more in the area of the hardware integration to really physically tie all the things together. And GE's role, I think, became smaller and smaller.

RB - Where did Bell come in here?

KD - Well, Bell was really just a support contractor to headquarters. They really had no intimate interface with either Marshall or our contractors. So any interface there went through headquarters. And, of course, they did a lot of work for the headquarters people. And, I think, in a way, they even pushed GE out quite a bit, because they did all along a lot of these reliability studies for example that GE initially did and set out to do. Now they worked still fairly closely with GE because of course by that time GE had a pretty good background of basic knowledge of basic information in that area.

RB - So you say that people finally came to realize that there were a lot more problems than they had anticipated so there might have been this initial furror.

KD - Not only problems, but just the physical work to do all these things, to look at all of the ~~of the~~ drawings to check if they all fit together, to compare the drawings to other specifications and to be sure that this is also all in the contract. So there was an awful lot of work to be done. And I think that was in the beginning maybe a little bit underestimated.

RB - Would you recommend that this would be a good procedure to follow again under a similar kind of program?

KD - If you take the same approach again to give only pieces to the contractors then somebody still has to tie all the pieces together. I think maybe the tendency today is to give the total booster, for example, to a contractor and let the contractor handle the whole booster. Then it's very clear, he is in charge of the integration.

RB - North American has it for the shuttle.

So I think that's a little bit more of a tendency. And then of cours it's no issue. Then North American is in charge of integration. While, at least in the early days, for the Saturn booster, really the whole integration was done by our own people.

RB - The Saturn booster really strikes me though as a rather unusual kind of vehicle more than anything else because, in many ways, there was at least four and perhaps five distinct elements of it. There was the three booster stages, three different contractors, and the instrument unit.

KD - I was even going to say you should count it as an extra item and a very complicated item.

RB - And then the engines, although they were part of North American, it still meant Rocketdyne it always seemed to me operated pretty much by themselves. So it was a very unique vehicle really in terms of the wide variety of manufacturing concepts and ideology.

KD - And I hadn't even thought of the engines for a minute although I am basically an engine man myself by _____. By even the way we handled the engines as a separate item is very unique. I think normally you wouldn't do it. Normally you would look to the stage contractor to have his own contract, so to speak, with the engine man and to be sure that all these things are properly being integrated. Now since the engines had such a long lead time we had to start the engines way before we started the stage contracts. And we also had to tell Rocketdyne, you build us so many of these. So really the contracts got started real early just like many of our guidance contracts got started early. That was again in a way a reason for having the instrument unit. The gyros, and the measuring insturments, the integrators and the computers had to be started way before we started the instrument unit.

RB - There was another question I was going to have, and I have to have an interview with Bostwick. So why are engines such a long lead time item? Why are they always the first ones to get cranked up? What are the problems involved?

KD - Well, if you don't start it early you just don't have it. The problem is, by the time you start your booster design you should have a fairly well developed engine. And since the engine development takes at least as long as the booster development you just have to start so much earlier. I think that everyone will admit that even the booster development takes some five years or so.

RB - Propellant tanks serve the engine
so to design the propellant tanks you have to have an engine to start with.

KD - You have to understand the engine fairly well. You have the same rules

for a number of the more complicated _____ guidance instruments, like the flight computer, the gyros which are a real problem area in themselves. So you also have to start those early.

RB - There is another engine question I had on the F-1. This was the braising. Finally Rocketdyne went to a fairly sophisticated kind of braising, furnace braising, to produce the engines. And my question is, how did they produce the engines before they went to this furnace braising? Was it all done by hand?

KD - Yeah, there was a little hand braising. And I think they all three used dip braising at some time, although I'm not too sure. They dipped the whole thing.

RB - How does that work?

KD- Well, just to get the _____ into all the places they just dipped the whole assembly. But as I said, I'm not even too sure about that.

RB - I'll have to run that down with Bostwick.

KD - But there was a lot of handwork on the engines for awhile, and again since that, in itself, consumes a lot of time and it may not always be perfect the first time around so you have to do it over again, that's also a reason engine development takes a pretty long time. And also the whole development of the injection system, which gave us a lot of problems all along. That in itself again is _____ _____. So by the time you had _____ all these things this, and then the heat transfer problems in the engine themselves, well it just adds up to an extra five years. Five years you need over and beyond your extra booster development. The retesting of the engines again in the _____ or even as an individual single engine in connection with the tanks.

RB - All these are added parameters you've got to work out.

KD - And of course you have a lot of technical problems that have to be solved within the engine assembly, very high combustion temperatures, your mixture has to be an almost perfect mixture otherwise you lose too much performance and efficiency so your propellants have to be properly atomized and mixed and burned. And you have just a fraction of a second and it has all to happen within your combustion chamber. And if you don't do one thing right then you are in trouble. And then, of course, the heat transfer problems particularly in the throat area. You may recognize that some of the early engines have some built in leaks in order to have some extra coolant and to keep the throat cool enough in order that it didn't burn through--the old Redstone engines _____

But some of the old Redstone engines had extra cooling, of course it goes into your performance. You cut away from performance because some of it [illegible] has to go as liquid through the throat and so you lose propellant, but it doesn't push, it doesn't help with your thrust. So it's purely coolant. And in that sense it's waste. But that was the only way to solve it in those days. And V-2 did the same, by the way. It was the only way to solve the V-2 combustion. And the heat transfer, it was basically heat transfer problem.

RB - Was there that much difference between the V-2 engine and the H-1 engine and the F-1?

KD - Well, not in basic principal, but a lot of the manufacturing principals are, of course, much, much more advanced. Like this whole braising, the firing tubes. The V-2 engine didn't have tubes. Again, we didn't master that kind of technology at all in those days.

RB - How was the V-2 engine cooled? Was it a double-walled?

KD - Double-walled. But there were individual sheets, and they were welded to their individual sheets and were built in portions, in quarters _____ in quarters or sixths _____ the circumference. And they had to be welded together. And they were held in place by means of rings that were turned on a lathe from solid material. And that, of course, made it very expensive. And that was even true of the Redstone engine. The Redstone engine had basically the same design so there was not much change between Redstone and V-2. The big step was when we went then to the H-1 engine.

RB - I didn't realize those were turned on a lathe. They were from solid stuff.

KD - They were manufactured as rings, big forged rings, really forgings. But then they were turned on a lathe, machined and drilled. And of course it was all done by automatic machinery, so it was not a lot of hand labor. But it still was expensive.

RB - Even in the V-2? _____ I mean they were _____

KD - Meah, Well, not computer operated. Control tools.

RB - By a tape kind of control?

KD - No, we didn't have that at all. We were not that fancy, but they had

normally jigs and fixtures that did this.

RB - There are a couple more things here. One was the...Well, let me ask a rather technical question here I guess. This controversy, I think it goes back more with Douglas on the welding style that was to be used. Marshall, as I understand it, preferred tungsten inert gas too, and Douglas liked the MIG. I've forgotten what that even stands for anymore. The MIG process. Do you remember anything about that?

KD - No, you should talk to the manufacturing people, Even Mrazek may not know too much about it. He certainly can give you the name of the guy you should talk to.

RB - Is Seibolt still around here? Matt Seibolt?

KD - I haven't heard of him lately. He may have quit. He certainly could give you a good answer, although Seibolt joined the team fairly late as you probably know. He was not one of the real oldtimers.

RB - He's English, is that right?

KD - Is he not Australian, or he could be English. I think he was brought up in Egypt.

RB - I didn't know his background was that exotic. What about the all-up concept that Miller came up with? Can you characterize the initial reaction that Marshall had?

KD - Well, I think I was even personally involved quite a bit there. I didn't believe in it. Of course I think it was basically the issue of change, all our programs, all our planning, all our contracts had been laid out to go step-wise, to add one little step at a time. And again I think it was basically our conservatism, and maybe Miller was really the proponent of the all-up concept. He was, well basically he was an electronics man, so I think he hasn't had too many ~~com~~ real big bustion-type problems, booster-type problems. So he was willing to stick his neck out. And of course in the long run his concept was proved right since we didn't have any major problems. But, of course if he had lost one booster he really may have been thrown back, and our people just didn't want to take that risk. Now, again, I think after the decision had finally been made everyone really swung at the action. Of course it made a lot of changes in all our contracts. And it saved some money, so we were financially quite a bit better off. And I think that was one of the main reasons _____ pushed it so hard.

RB - Is that why you eventually came around to it too, or did you feel it was good for technical reasons as well?

Interview with Konrad Dannenberg:

KD - Well, I think we were really were technically only convinced after the development program was over. It's really just a matter of how much risk are you willing to take. And since everything went alright of course he was proven right. Under these conditions it was fine, but as I said, if you had lost one booster then of course you would have lost a lot of very basic information. You might not even have known why did it go wrong. Because you accomplish several steps at the same time, and it may have been very difficult to really define the exact cause, the actual reason for your failure.

RB - Miller had done this all-up thing before, had he not someplace in his background, or been involved with it.

KD - Of course, he had a much simpler system. And really all he did in his previous system was to put the guidance equipment and all the sophisticated equipment right away on the booster.

RB - Was that the Minute-man?

KD - I was just thinking, was it the MInute-man? I think he was involved in the Minute-man, there, of course, were several stages, but several relatively simple unsophisticated stages

RB - They were all solid propellants?

KD - Yeah. So once you ignite them you are really in business.

RB - Did Marshall ever consider the use of really big solid propellants when they started out with the program?

KD - We looked into it, but solids didn't look too good for the same reason that we rejected _____ . And solids are even less efficient than _____. So it just would have been too big a booster.

RB - Was it the efficiency, or was the problem at that time that, they saw the problem, as I recall, you couldn't really control the thrust.

KD - It was another consideration. There were really a number of reasons _____ solids. And for that reason we never really became too enthused, because solids, even today, just don't lend themselves too easily for real large boosters. If you go to Minute-man scientists, Pershing scientists, solids are fine. But anything beyond that makes it more and more complicated.

RB - Has there been a swivel-bore or gimbal engine developed for solid boosters?

Interview with Konrad Dannenberg:

KD - Yeah, well you just have to put your swivel in the throat area, basically, because the throat doesn't change too much and from there on...

RB - You almost put the engine around, the bell area around the throat.

KD - Then you have kind of a ball-joint there, and of course that's a real design problem. And therefore people have gone more and more to controlled fluid injection so that again you, of course, foul up your combustion of your part of your chamber. And that incomplete combustion then deflects your jet.

RB - I see, so the jet comes out _____ until you inject the stuff and then it decays on one side so you get more thrust on one side of the exhaust nozzle _____

KD - But, again, it goes into your performance. And, again, if you can't take this cut in performance it's too bad. Again, for small boosters, you know we can do it. You are normally not all that critical. If you are critical you just make the booster a little bigger. But if you have such a big booster already in the first place then it's a real penalty. And for that reason, we looked into it but we rejected it pretty soon for a number of reasons. Performance was a main reason, controls was the other, second reason. And thirdly, of course, you also have to transport this to a degree _____ sensitive gadget. Of course, you need something to ignite it. So it's not like an explosive, but, boy, if you get into a fire, if you have real misshaps somewhere, a railroad crash if you transport it by rail, or your ship gets into trouble you have a real problem on your hands.

RB - Because that thing is all primed. In a sense it's loaded. That's interesting because it leads into this...

KD - So there are really three areas which basically talk about, against real big solid boosters. Of course, now people hope to solve it for the shuttle. And I still wonder how it is going to come out, particularly with the reuse of the shuttle. I personally am still not convinced that we can really make it work.

RB - You did all kinds of studies on reusing the first stage, as I recall, recovering that out of the water and everything else. Is the shuttle recovery going to be out of the water, that..

KD - And for that reason I still don't know how it is really going to work.

RB - Are they going to try and recondition the engines and the tank and everything else?

Interview with Konrad Dannenberg:

KD - And I am afraid that by the time you are through with all that you could have build at a lower price a new booster, a new casing, because that's really all you save. A relatively inexpensive casing.

RB - But they do plan to use the engine again?

KD - Well, casing and, nothing is really all one unit. It's the whole thing, the whole works.

RB - Yes, but the shuttle engine stays with the shuttle doesn't it? It's just the casing we're talking about.

KD - It's just the casing, and of course that has a nozzle. And that's a solid booster engine. So the solid booster engine is all in one unit that will be re-used, that will be recovered and will be refueled again.

RB - Where are those things filled to begin with? On site down at the Cape?

KD - I don't know what the latest plans are. They looked into several possibilities. I think right now they plan to fill it at the factory, which is Thiokol.

RB - Which is located where?

KD - I think, and I'm not too sure, but they have a plant in Georgia and they might plan to use their Georgia plant.

RB - This logistics you talked about, all of sudden it's very interesting. I really hadn't thought about that.

KD - And I'm not completely up-to-date on what they want to do for the shuttle, but it will be filled in the factory because you need quite a bit of equipment to do it properly. And once you do all these things at the Cape, then the reason for having the Cape at the Cape is not there anymore. The Cape was supposed to be in a real isolated location. So even if a booster blows up you don't harm too many people. And, of course that consideration has gone completely away. In particular, during a launch, there are millions of people, even just visiting there.

RB - Would the Saturn stage vehicles, in terms of logistics, even carrying _____ thing around there was a great deal of care & attention

given to these things hauling them around empty. And the thing that's always perplexed me, when you light the thing up and it takes off on a launch it undergoes far greater stresses than it ever does simply in transportation. Why was so much detail lavished on simply the transportation?

KD - Well, of course first we had some indication that some harm, some damage was done during transportation.

RB - In lifting it or handling it somehow?

KD - We had some handling problems, but also since you have vibrations, particularly if you go by boat or by rail for a relatively long time, this long duration before you even ignite your engine, before you even fill it, has done in a number of cases damage to joints to welds, to components, to small components which have very small tolerances.

RB - We're talking about Saturn V stages now?

KD - Yeah, Saturn V and even smaller stages. So transportation has always been a problem. And, again you don't want to get a damaged missile to the launching site. You want to be sure that everything works there alright. And since we never really completely solved the problem we always have had a check-out again at the Cape. Some people always saw the desirability to ship it to the Cape, erect it, and launch it. You never got to that point, certainly not for the big boosters.

RB - And almost always, and I haven't checked the figures or record on this, but almost always at the Cape, during the countdown demonstration test something, some things were found that had to be repaired. And it's because of the transportation.

KD - And for that reason, people are still concerned at least. Now it's not an unsurmountable problem. You can do something about it. And, of course, ship transportation helps except for the salt water exposure. So part of the reason you have to protect it. Vibrations are of course much more gentle.

RB - I wanted to find out too if you could tell me about origins of the common bulkhead. Did the Atlas have a common bulkhead? Or was the Centaur the first to come up with one?

KD - I don't really know about the Atlas. I'm sure Mrazek would know. Well, of course it is really a design consideration. You don't want your booster to be too long and you waste an awful lot if you have two bulkheads. And also you have a very critical stresswise, designwise, a very critical

part between the two tanks. It's not pressurized, so it has again to be relatively strong. And you have to find ways and means of putting your stresses into the tanks. So you really have a dual problem. First the inter stage itself, and then also to get the stresses from the interstage into your tanks. And to get the stresses into the tanks at the place where you anyway have to have your bulkhead. So it's pretty critical. And, for that reason, the common bulkhead has certainly some advantages. And, of course, it makes the missile quite a bit shorter. And that are many, many feet, particularly for a big booster like the Saturn V, that are close to 100 feet. And that also makes all your bending stresses on your whole vehicle much easier, much simpler since it's shorter.

RB - I wonder if you could make some comment about contributions of other rocket and missile systems to their technology in terms of their contributions to Saturn technology.

KD - Well, of course, one of the biggest contributions was certainly the Centaur, the whole Centaur hydrogen technology. And we always, for that reason, had very good and close contact with General Dynamics although they never got any of the big contracts. But our technical relationships, so to speak, were always very good with that group.

RB - Why did General Dynamics always lose out on the contracts?

KD - They are just poor proposal writers. They never had a good way of writing proposals and I think they always lose out on their proposals. Because the work they do, again with the Centaur they stuck their necks out a mile long. And I think, in that sense, they are a little bit more like North American than the others.

RB - They had a lot of trouble with Centaur.

KD - That may be another even reason that our people were always a little bit careful, and it may have shown up in proposal evaluations. They had a lot of troubles, a lot of problems and again they also went way out with their approaches, even the Atlas. The Atlas was, in a way, a very advanced vehicle.

RB - So there was that important thing in terms of Centaur, in terms of LH_2

(End of Tape #2, Side 1)

contributions with the Thor and the S3D engines...

KD - Well, the Thor was pretty much like Jupiter, so I think we bank more on Jupiter experience since we had more of it, more direct information. On the other hand, the real difference between the Thor and Jupiter is really not all that great. Of course, you can probably make a long list of differences if you want to, but they are all not all that important. Now of course we followed up the Thor results, and since the Thor was built by Douglas we had pretty good and easy access to all of the information. And again, the engine came from the same manufacturer so we had all the engine information anyway. It was fed back to Rocketdyne and came directly from Rocketdyne. I'm sure Rocketdyne drew their own conclusions and made probably even some changes. I'm not aware of any change, but there might have been some.

RB - Wasn't there an engine man at Pneumende who came over here and went directly to Rocketdyne?

KD - You're probably thinking of Rieder. Riedel. He was even the chief designer in Pneumende so he was one of the key people. In fact sometimes he felt he was parallel to von Braun and not working for von Braun. He was employed by the University of Berlin. And it was kind of a temporary assignment in Pneumende. So he was really not, I think von Braun didn't pay him, he was not on von Braun's payroll. And he was also at North American, a key man. I think he was the one who really started the Redstone engine, and that's why the Redstone engine looks pretty much like the V-2. He was initially in charge of building, and NAA had in mind to build a V-2 vehicle here, just to duplicate it. And they were already in the process of calculating how much of an inch is a centimeter, because of course the V-2 was done in centimeters and they didn't have the metric system. So the big job they had to do, and that really fouled them up. They never got to first base since _____ _____ was too big. And even if you have converted all your sheet metal thicknesses into inches you just don't find this kind of sheet metal here.

KD - And then they had the decision to make, how do you build this now? Do you take a piece of sheet metal, for example, and shave it off? Or do you change your designs after all and convert it into inches into some feet. And then they pretty soon made the decision, let's forget about the V-2 and let's not build the V-2 although they were well into doing it. And I even think they built a V-2 engine pretty much on this system, just converting the centimeters into inches. But then they gave up and they never completely built a V-2, but then, and I think that was basically Rieder's decision, they built really the Redstone engine. They built the Redstone engine way before we had the Redstone missile. So again the engine was way ahead of time of the missile. You could only build relatively quickly Redstone missiles if the engine was there.

RB - Wasn't there an engine in between there, the system that they were using on the Navahoe?

KD - That was fairly close to the Redstone engine. No, I think the Navaho was closer to the H-1. The Navaho had the more advanced engine.

RB - But there is this interesting and fascinating relationship and carryover in terms of engines from the, through Reidel, from Pneumende to North American

KD - And another man who was, for quite some time, with our group, and who never really came to Huntsville here. He was with us in Ft. Bliss--that was Huzel. He even wrote a little book himself.

RB Huzel yes, that's the one. That's the one I was trying to think of.

KD - He was quite active initially in the engine development so he developed our H-1 engine, for example, at North American. And later on he was also involved with hydrogen engines, although he was really more a missile man. He was more active and had a more key role when the, of course North American never really built the Redstone missile. But he was involved in missile problems and he was quite active in, well, the second stage. He was transferred from Rocketdyne to North American and did a lot of 2nd stage work.

RB - Does this Pneumende connection, in terms of the engine then, ~~is x t hat~~ does that explain one of the reasons why North American maybe has been so successful in winning engine contracts--because the designs that they turn in are so familiar?

KD - That certainly could be, I never looked at it that way. On the other hand, even the Aerojet engines are not all that different. They are a little bit different, they are not quite the same.

RB - The Aerojet engines?

KD - Yeah.

RB - Huzel was the man I was trying to think of, because I've got--when I first came into this, of course, as an historian I knew nothing about engines and Huzel's book became my primary text. It has finally occurred to me, too, as I was going through that thing that the pictures he's got in there, although they were not identified, were the H-1 and the F-1. That made it really beautiful because I was really having trouble trying to get into that. I've got a question about a fire that occurred on the pad in '67. Did that have any impact at all in the Saturn program in terms of giving you some breathing space? Or did it have an impact in causing you to go back and analyze technical problems? Were there any

reverberations?

KD - Well, I think both your questions can be answered in a positive way. It did give us some breathing space, otherwise we probably would have had a hard time to meet any earlier date than the '69, which really was finally the launching date of the manned version at least. Of course a lot of work was going on all the time, but I think we still felt pretty uneasy with some of the designs and so the breathing spell was, in a way, welcome. On the other hand, it also really cost everyone. And I think all of our manned space flight efforts really got a boost from the thing. It caused everyone to really take another look. And I think people became even more, in a way more conservative and more careful with everything they did. So I'm sure there were even a few changes made. Again, I couldn't pin my finger on any specific change at this time, but I'm sure some changes for safety reasons, for safety sake were made. And maybe even IO was a little more open minded at the time. Of course, first thing they had a little bit more time. They could afford to make a change.

KD - And also, particularly James was very strong, in that if you couldn't convince James that this change was really absolutely necessary, he didn't bite. And maybe this caused him to buy a few more changes since people said, Well, but it's unreliable. Formerly they could only say, it gives us better performance. And James normally didn't buy better performance statements for a change. Because changes, of course, are quite expensive. If you have a lot of hardware in existence, if you have made all your drawings, if you have to change all your paper including specifications and contracts, that costs money. And very often the detail design engineer doesn't see these implications. But if someone could say, but it makes a missile a little bit safer, I think it opened a little bit more the door for making these kinds of changes--pure safety changes. Where you couldn't say the old design didn't work at all, it wouldn't have done it at all, but if you could do it a little bit safer you were open-minded to do it.

KD - So I think we brought in a few extra changes due to this incident, although we, of course, directly were not involved at all. It had nothing to do with the booster. And we also had a little extra time to make some of these changes and still deliver on the new flight schedule. And, of course we got a new flight schedule after that.

RB - I had an interview once with Dieter Gray and he was talking about one of the Saturn launches. It had to be one of the earlier ones and maybe it was even the first one, Apollo IV AS501. I'm sorry I can't remember exactly, but it seems to me that he was commenting that the lab chiefs and everybody were together and they were discussing the launch and the coming event, and he said though, that he had kind of a gut feeling that things with the bird really weren't all completely OK. And so they decided to have one more systems check, and he said they turned up all kinds of glitches that were still there. Do you remember any events like that or anything particularly that...

KD - No, nothing along that line.

Interview with Konrad Dannenberg:

RB - Before we call a halt to this thing do you have any other comments you'd like to make for the historical record?

KD - I have a question. I don't want to, if you want to get it on your historical record or not. I don't even know if you have read my report that I wrote.

RB - Yes, I went through that.

KD - I kind of wonder. Do you agree with my evaluation? In a way, I was a little bit surprised myself about the result I came up with. On the one side it was not as dramatic as I had initially expected. And, on the other hand, I don't know how much real, hard evidence I really have for my conclusions. So I think that's the kind of input I would like to get from you. And you probably look at it more from a historian's viewpoint, who is also interested in management than I did. Of course I looked at it more from an engineer's viewpoint who was somehow pushed into management. Now, let me summarize again at least what I wanted to put in my final summary.

KD - I basically have come to the conclusion that I think at least our project, and hopefully many other projects which would be of the same type, were successful because a lot of real good down-to-earth planning was done from the beginning. And I also give von Braun a lot of credit because he did good planning by having the people involved down to the working level from the very beginning. And a lot of people don't do that. A lot of people make their decisions just among the top-level management people themselves, and they very often assume that something, such and such is the case. And it may not be true. So very often your basic planning may be already wrong, may be already off.

KD - And, of course if you start with a poor plan then you have already at least 3 strokes against you. And then, since von Braun managed to keep this working level involvment going all the time I think he had a much better chance to really iron out, like this automatic responsibility, for example. He had a much better chance to really iron out these problems. And also people feel more involved, and they feel much more a part of the whole thing, that you really keep your enthusiasm, your spirit to the last bitter end. And I don't want to talk about anyone bad here, but I have a little bit the impression this spirit has gone to a certain degree, out the door, out the window. It's not there anymore. I still have a lot of friends in the working level, in fact my son-in-law, George Doane. I don't think you have talked to him. He is in astrionics, and, of course, I every once in a while shoot the breeze with him. And I have a gut feeling, and again we don't shoot against personalities, but he is, in a way, really disgusted. And he really doesn't feel a part of the team. He really comes here basically to pick up his paycheck.

KD - And I think this spirit, also talking to some other people, is a little bit

the prevailing spirit here. People don't feel they have a big role. They don't feel they are really a part. They don't feel they participate in real key decisions. And top management doesn't give a bit about their opinion, how they think, what they do They do what they think is right and that's it. And if the other people don't like it, well they can always quit. And, of course, under these conditions nobody quits. They can't afford to quit. But that instills such a poor spirit. And I must admit, even relatively shortly after von Braun left, I saw already a little bit of this coming down in basic spirit. And I talk quite a bit about team spirit in my final summary, and maybe the question I really have is "What can you do to really get team spirit? How do you get it and what kind of measures you implement don't get you to that point? What bad things, what wrong things do you do in order not to have team spirit?" And I'm a little bit afraid right now we are here at that point here at Marshall at least. And maybe even at some other NASA centers.

KD - And of course I have a number of good reasons why that is so. One of them certainly is the lift. And, of course von Braun was very fortunately, by the time the first lift came he was out of the _____. So he never had really to what he can do with his approach under real bad conditions. He had also always the advantage that the program was always going, was always increasing, it was always getting better from month to month. So he had relatively easy conditions for his working conditions. And so I don't know, is it only his approach to really building up team spirit, or was it more the total political and economic climate that put him in a very fortunate position.

KD - Now I think my evaluation was he certainly made a big contribution to that. Maybe it was not the only contribution in that he was fortunate that he also had the right political and economic climate. And all the things came together and that's why we--I'm still amazed that all the boosters went that well. I had expected a pretty good performance but not that good. And also, with the first booster that was scheduled to accomplish the lunar landing, that we really did it right away with the first one, it came as a surprise to me. I would not have been surprised at all if it would have needed two or three shots. And, again we are back to the all-up concept. Again, Miller was proven right. On the other hand, I think he could have been proven right only since we also did all the other things right, and we had the team spirit and we really built our best own knowledge into all the boosters.

KD - And if he wouldn't have taken the conservative approach in many, many little individual detail decisions maybe the Miller concept wouldn't have worked. Although then we really would have been in a pickle. Let's even just assume a relatively simple thing, the Apollo 13 misshap would have happened on Apollo 11. You would not have made it in the decade because then people would have made a lot of changes, we would have gone back to the drawing board, we would have done a lot of things all over again, and it certainly would have been after '70. So even little things that happened after all still _____.

Miller was right. But now, of course maybe you don't look in it, it's not part of your assignment of your job, you don't look into the present conditions, that's not history yet. So you don't get your fingers dirty on this kind of thing. But I am really honestly concerned about the space program as such. I think, to a degree, the conditions here also reflect the general attitude of the public. And apparently even von Braun couldn't stir up the general attitude. I'm sure he tried to do it after he even had gone to Washington and was active there in headquarters for awhile, but he certainly didn't get congressional support. He even didn't have, in my book, the full NASA support.

KD - I'm sure von Braun was much more anxious than what NASA really came officially up with and officially proposed to congress. And even in that position, or even later on with Fairchild now, he certainly has not really stirred up the enthusiasm of the people again.

RB - I think the time is past.

KD - The time is past, so maybe he was in charge here at a very fortunate time. But I think that's my question to you. What's your appraisal of that?

RB - I think that . . .

KD - Does it have anything to do with management, and of course I realize you are not basically a manager, you only do management as a portion of history, history of management.

RB - Back on to the documents, what really strikes me when the thing got started was this fantastic political and economic climate as you pointed out. And at NASA and even in DOD when they were talking about the Saturn I and the need to build it, etc., the thing that really comes up time and time again was to beat the Russians. It was stated in various ways, but it all boils down to beat the Russians. It was a national priority. So I think really that the political and economic climate had an awful lot to do with it. It gave Saturn a DX rating at a critical time and gave them a lot of leverage in all kinds of things.

RB - But at the same time I think that you still got to have an individual to take advantage of that.

KD - And von Braun was certainly in the right place at the right time. And he knew what to do with the situation.

RB - And you and all the people that came with him, this is another thing that

really strikes me about the success of this thing. There was only, in the whole world, a certain group of people who had been on the forefront of rocket technology for a considerable number of years since at least 1937. And here was this group of experts and von Braun at a given place in a given point of time. And it was this opportunity, but it was also this background of working together there at the _____ that really went.

KD - And again, to really work as a team, I think you have to do a certain amount of planning, maybe planning is not the right word for it. But you have to get all the people involved. Von Braun has a real good flair for that. Everyone, when he has a meeting with him, feels like the second most important man. The most important, of course, is von Braun. But the other fellow is always the second most important man. And boy that really gives you a team spirit. Everyone is really willing to give his best. And I don't see that too much anymore. I don't want to say the people are all goofing off and don't do anything. But it's not to the same degree. So this again, what I call team spirit, has certainly disappeared to a large extent. It was still a little bit there with Skylab. But after Skylab I think it went completely out of fashion. And it certainly is not there for all the shuttle involvement.

KD - And I think Marshall still has a fantastic assignment with the payload assignment. But I just don't see that the people are doing anything with that job. No one is really enthused about payloads. Well, of course, everyone comes here and gets a space job and works for them 8 hours a day. But that's really all they do in my book. They work 8 hours a day and then they go home and are happy with something else. And that's not what I mean with this kind of team spirit, really giving your best and pushing for very high final goals.

RB - No, I've heard that expressed before. And the one thing, too, that concerns me about the space program and about Marshall is the capability of the labs, and the in-house _____, in-house concept that seems to me has been down to a period of decay over the last two years. And I think that that was really, the lab inputs were an important aspect of the overall success with Saturn. And I think this is one of the things that Lee James brought out in one of the interviews that somebody had with him. I don't know who made the interview, but I think I've got a copy of it. And it was one of the things I think, in that little thing that I wrote, one of the last things I mentioned was the in-house _____ concept.

RB - And the people at headquarters don't think much of that. They keep referring to the tinsmiths down at Huntsville. And I'm afraid ~~I kind of have~~ I've got a little identification problem. I kind of bridle at that... Well, look how successful it was. Well, I'm afraid maybe the time is past. The economic and political situation seems to_____.

KD - Well, of course fortunately the Russians are building a space station again.

So maybe that puts us back in business one of these days. What do you think would happen? Let's assume the Russians declare publicly, "Yes, we now have three Soyuz up in space and we tie them all together and we keep them there and we have a space station." Do you think that would stir up some interest here again? And I'm sure they do it. How soon they talk about it may be another question. And I even think they still wait for their big booster, and there are really strong indications they are working on the big booster again which blew up some years ago on their pad. And I think at that time they scrapped all plans to go to the moon. I think up to that time they probably, at least, had some tentative plans to eventually beat us to the moon. They deny it.

RB - Is that big booster an ullage (LH2)? Does it have ullage (LH2) liquid hydrogen?

KD - I don't know any details about it. I don't think anyone really knows for sure. People make some assumptions. I'm not necessarily convinced that it will have it because with their technology, again they are_____ They could do it with _____ of propellants. So I almost think that's what it has since all their technology is in that area. I'm not aware of any big hydrogen plant. They would need a pretty big hydrogen plant in Russia. And to my knowledge they don't have it. On the other hand, no one really knows what's going on _____.

RB - Well, if the Russians do put up the space station that may really change things.

KD - What do you think would happen? Do you think people would then really feel bad again, and say let's go out and do something?

RB - When you look at it, there is really a huge gap between ASTP and the first shuttle launch, which is '78 or something like that. And that's only a first R&D launch. Normally NASA says it's in operation in 1980, '79 at the very earliest.

RB - We've got two full Saturn V's left, as I recall more or less, and one Skylab Workshop hardware qualified. So if the Russians do send up something maybe we quickly will get these pieces together and check them out.

KD - Of course KSC loses their capability pretty soon. They may have lost it by now.

RB - They're redoing the launch thing. That's what I understand. So we may not even be in a position to launch anything anyway.

Interview with Konrad Dannenberg:

KD - And I even understand the Skylab has been finally promised now to the Smithsonian. I have never seen it in writing anywhere, but somebody told me. And I'm not even necessarily just talking about using the old hardware. We talked about the shuttle earlier. I don't think the shuttle is a very, it's certainly not an exciting program. It's not a very advanced shuttle. It's a very costly shuttle. So I don't think we have accomplished one of the main missions to really cut booster costs. People talk that sometime about a factor of 100. We may have cut it by a factor of 10. I'm not even convinced of that. So what have we really accomplished?

RB - What would be better than the shuttle lab?

KD - Well, maybe a flyback shuttle would be much better, where the solid stage also flies back, the original concept. It just would have cost two or three billions more in the beginning, but it would have had a much cheaper lifetime cost in the long run. The individual shuttle flights would have been probably half price or so.

KD - And then, of course, if you really want to have a big payload capability then you need one stage to orbit, real big booster, which is also recoverable. The whole thing comes back and maybe makes a land, or sweetwater, water landing.

RB - Where would you find, the Great Lakes someplace?

KD - Well, some people even have devised where you dig a big lake in the Florida area. You have plenty of water there anyway.

RB - Enough sweet water there?

KD - _____ so you just would have to dig out a big patch somewhere, probably a few square miles, and with our _____ to the sea you can get these things down in that area. And then you have them pretty close to your launching site so the transportation is relatively simple and it can be done. And that, of course, would really reduce the cost.

KD - I don't know if you have heard about the O'Neal concept. He claims we shouldn't even plan to build big space stations and big power stations, for example, in space. With rough material we should really go to the moon and use lunar orbit. And then our transportation problem would be much simpler.

RB - That's right. I'm vaguely familiar with that. Not too long ago I was able to go to a briefing at the Lunar Science Institute in Houston.

KD - Who is the director there, by the Way?

RB - I'm sorry, I don't remember.

KD - I know a guy by the name of...His name escapes me. I'm not sure if he's the director of it or not and I always wanted to find out. And I didn't dare to ask him directly myself. It's a similar name like _____
He works very closely with O'Neal. At least the guy I know of.

RB - They were going to mine the moon, in a sense. And other planets, whatever they can come on, asteroids, whatever they can get their hands on. Well, it will be interesting to see the reaction when the...

KD - Of course, you need some people on the moon so again you need a lunar base at least. And O'Neal proposes to leave the material basically in lunar orbit so with a relatively small velocity you can get it there. Of course you have to get it away from the moon. So you have to overcome the lunar gravity which is, of course, much lower than the earth gravity. And you already are in the right orbit. So with a relatively nominal amount, in fact you don't necessarily need a rocket. One of O'Neal's approaches is just to launch it by means of an electromagnetic device. You have a 5 or 10 mile pass and you accelerate your mass, and then you just shoot it off in the right direction.

KD - You can also, of course, use orbits if you want to. You have a problem to get orbit _____ on the moon. That's one of the difficulties. But then he wants to take that approach. And of course if you go that pass, ~~they~~ then maybe even the shuttle, once it gets you to the moon and it's already very inefficient to get anything to the moon, but then a smaller vehicle would do it. So you have these two very different basic approaches. It's like the old lunar orbit along with the earth rendezvous

RB - In comments following our interview Dannenberg stressed what he called the team spirit that persisted at Marshall Space Flight Center, particularly as it was encouraged by von Braun. And he emphasized the fact that von Braun had very good penetration, so-called, all the way down to the very lowest levels of MSFC activities, including people who worked on the shop floor, the mechanics and technicians...

(end of Tape #2, Side 2)