MSFC History Project
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Conducted by A. Dunar and S. Waring
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TIENSENHAUSEN: I thought that maybe it is helpful for you that you know a little background about my self, and I have here some biographical information. You can keep that. I was at Peenemeunde then came over here. My main job to summarize all these things was innovation. They called me "the idea man". I had to come up with new missions. I designed the first lunar rover for instance, that was in 1959, and got a lot of laughs over that, too! And many other things that are listed there. I was in the Advanced Systems office under Hammerglid [?tc 15] that is part of program material and I retired almost exactly 2 years ago. I now lecture at the Space Academy at the rocket Center. It is a lot of fun. The students are smart, they ask a lot of good questions. What I lecture in, they call astronomy, I start from the Big Bang, to planetary exploration and everything in between. Space telescope, they ask very good questions. I do it twice an week, right now is a quiet period. I was called last week for a special group and I lecture to private gatherings. I have fun with it.

DUNAR: In connection with mentioning that you were involved in planning and generator of ideas. Levine in the book you just mentioned before, he talks about one of the problems being that NASA has always had a problem of not adequate long-range planning. What is your feeling about that?

TIESENHAUSEN: We do have long-range planning, what we are lacking is salesmen. See, all the planning makes no sense, you can plan until your a hundred years old, if you can't sell the plan. That's where we fall short, like Werner Von Braun could sell an air-conditioner to an Eskimo or sand to the Arabs. We need people who convey to Congress, Senate to committees. We have plans, fantastic ones, good ones, but that's where it lacks, in personalities. We really are about the same and can convincingly explain complex technological matters to Congressmen. I was once blamed and put in a work statement, of one of my contracts, that the proposal should be written so, in plain language, that politicians, Congressmen, could understand it. I got in hot water with that. That's where it lacks, personalities who can take the plan and give it a convincing story. It does not lack in planning. We have fantastic plans and logical plans, with alternatives depending on the budget situation. We had space station plans twenty years ago. But that is where the deficiency is, in personalities. For instance, Dr. Lucas, he was a hermit, withdrawn. Von Braun was the exact opposite. He went Washington, knew every Congressman and Senator by first name, had lunch and dinner with them. The same in Montgomery. When he asked for money for the research center he got it. No questions

asked. So that's where

deficiency lies in personalities. That's my own personal opinion as I see it.

WARING: Do you think there was something in the nature of the Saturn/Apollo project that let it almost to be a dead-end? There was real difficulty in the late 60's and early 70's when there were efforts to move the Space Station on.

TIESENHAUSEN: Very difficult. See, the Apollo Program was a dead end. It had no follow-up. So was the Skylab, it was a dead-end project. There was no follow-up. The reasons for that are many. Public apathy, the war in Vietnam and other things, but yes, the NASA missions, major missions were dead-ends. Singular efforts, tremendous efforts, The Apollo program is the most unique,effort ever undertaken and Skylab, tremendous effort, but they were sort of peaks in the evolution. then it leveled off, so there was never a follow-up. There was never a lack of plans, it was not the lack of plans. Our plan was originally to continue to use Apollo program, we had many more certified[?tc 81] they are down in the museums. We were not finished. We had another Skylab, but the support vanished. Compared to our spurts in space exploration, the Russian program grew slowly, but continuous, they had continuity.

WARING: When you say "we" had a lot of plans, who was the "we"? Are you referring to the planning agencies at Marshall or something else?

TIESENHAUSEN: Every center has its planning office, ours was called the Program Development. Headquarters had the advance systems and these came together at headquarters had to be sold and coordinated and when they were promising they were then proposed to Congress, like space station has been proposed a long time ago. But something was missing, the personalities I think it is.

DUNAR: Were you given constraints in planning in terms of what to build, the budget or were you given a free hand to come up anything?

TIESENHAUSEN: The way I planned was, I planned what was called "near term", five or six years ahead, but on the side I have always wanted ten or twenty years ahead. Give you an example, of these side planning was, in the 70's I designed the first self-applicating robot. A robot that can applicate itself, copy its instructions and pass them on. That received attention throughout the world. In many countries. It was friendly, by the way. Because you had to overcome so many mental blocks, and that was a fascinating thing. So I always had something in the drawer and often like in robotics, when things became important, suddenly I had something in the drawer. I was involved in Teather satellites and I became the Chairman of the group of the

Intercenter working groups, one from each of the seven centers. We made tremendous progress, but there was already something in the drawer that they had thought of before it was popular. That was my job, to sort of smell ahead.

WARING: Were you involved in the Project Horizon? Who initiated that program?

TIESENHAUSEN: The army, actually, the Corp of Engineers,which is the Army.

WARING: They asked you to develop?

T: They had a lunar mission to develop. I was in lunar transportation, that how I designed the first lunar rover, that was in '59 or so. If I may follow your questions a little bit. Changes in the Marshall Center, has its organization management changed? After 1970, our organization at Marshall was almost a carbon copy of the one in Peenemeunde, you have heard that before I gather, which is true, we had the various laboratories. The interesting thing is the Directors of the laboratories were former university professors. In Germany, when we worked on the V-2, there was no precedent. We worked close with universities all over the country. We gave them the list of problems and they had to solve them. No just on paper but in the working model, whatever, the guidance systems, control system, so on. So we ended up with our first mechanical flight computer which was also used on the Redstone later, in the beginning. These professors, the main professors, the lead investigators, became our laboratory directors. They are still around. So it was almost a carbon copy of our organization and of course Von Braun and his deputy Dr. Rees was all the same thing. So when I came over, I came a little bit later than the rest, I got my spot, it was as if I left it the day before. Several years had past, which was rather efficient. The changes came after the early 70's, then we had to diversify. Up to that time we had the single program single mind, go to the moon and come back, nothing else counted. Since 70 we diversified, which was a major change. Instead of one program we had several programs, which required an entirely different organization. The other changes were, the leadership of the center. After Von Braun left in 1970, went to headquarters, his deputy, Dr. Rees, became the director when they had the Skylab missions took place. Then he retired.

W: Could you describe a little bit about the management and style of each center director operated?

T: Werner Von Braun was not a dictator, he didn't have to his personality was such, his authority was such that everyone did what he wanted anyway. Short of jumping off the roof, so he didn't have to be a despot or dictator, there was no need to. On the other hand at that time up to the 70's through the 50 and 60 we believed that we were the only group in the country that knew how to build good rockets. So we insisted that things were done exactly has we told them. So that maybe bottle ulterior [?tc

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W: To outsiders, contractors?

T: Everywhere. We had people at each contract that had to follow exactly and we knew it because we had done it before in house. The first stage of the Saturn V we invented all the welding problems. Nobody had every welded 33 foot diameter aluminum tank. We did it here the first islands were built here.

D: Were contractors brought into that process?

T: Boeing knew exactly what they were doing, but they watched and then we turned over the specifications and drawings, blueprints and they made theirs exactly like ours. That doesn't mean that they did not later improve here and there, but had to be done. So, we could afford to do that, because we had hands on approach in-house caliber, so that maybe authoritarian. The second thing was, that we had this attitude was at headquarters, to put it shortly, we asked headquarters for the funds and insisted that they not bother us anymore after that. We would deliver. Again, we could afford that because we always delivered. Of course that did not go over in many circles politicians. But that's they way we operated. Leave us alone, we know what to do, just give us the money. Up to 1970, we were a team, a true team, that I belonged to all my life. How does a team distinguish itself from any other working group that is temporarily thrown together. First you need a leader who has a goal. That is important. A leader and a goal. Then the team over years grows together. What develops strongly is a communication skill, a communication capability within the team. That is we never talked communication, we just did it. After the Challenger accident, the lack of communication was one of the main reasons cited by the commission. It could never have happened under Von Braun. Communication was everything we did, we knew exactly who could do what, who knew what, whom to ask, to let other people know what you do. It was a continuous cross-communication between the team. Which required utter trust and confidence in the other guy. And you had it.

W: And you didn't have to communicate through superiors, through Von Braun?

T: No, not at all. Not ever. On the other hand Von Braun door was always open. It was always open. If you had a major problem he crushed it. I was at a point where I had to decide which direction I should go in my career. So I went to him and typically he said you want to know what to do next, do you? He had a policy of open door. There was limitless trust and confidence. Maybe you heard this story: In one of our Jupiter Missiles broke in half shortly after launch. Of course our policy was we cannot launch until after we know what has happened, which cost many dollars. Because you have to simulate on the ground what could have happened. One of the technicians came into Dr. Von Braun the next day and told him that he had made an adjustment in the

[TC 241]
guidance compartment, the screwdriver had slipped and drew a spark. He was the last one to close that hatch. So immediately this matter was investigated, and yes he had shorted the guidance. Then he was called again to Dr. Von Braun and he received a bottle of champagne as a reward for his courage. That was the management style. Trust, confidence, not by punishment and sweat, but by reward for honesty. Nothing under the rug everything out. That's a team and he could be designed, he could create this team spirit.

W: What was the relationship between Von Braun and Dr. Rees, during the time that Von Braun was Director and Rees was his assistant?

T: He was his assistant at Peenemeunde too, so they had been director/assistants for decades. It was like brothers. Each one was entirely different person. Dr. Rees was "nuts and bolts", he knew he was the top engineer. When he looked at something, he found immediately where there was something wrong. He paid attention to minor details. He was a technical man, but Von Braun always floated with his feet above ground. The two complimented each other perfectly. Absolutely perfectly. Often Dr. Rees would say to Werner, "Now simmer down". They were an ideal couple. That penetrated the whole team. And when I say team I include all our dear American colleagues with it. At the maximum we were about six to seven thousand people. This team spirit that Werner Von Braun promulgated in his days, still permeates the working laboratory at the Marshall Center. It is still there. Management has changed a lot. The working labor changes gradually of course, people retire and so forth. But that's spirit I still find that it exists, that team spirit.

W: Why do you think the management changed? Was it just the departure of Von Braun or the problems of coping with several different projects, rather than just one?

T: In imitating Von Braun, several of our Directors made a mistake. I mentioned in the beginning, Von Braun, we followed him voluntarily, he didn't have to coerce anybody. But to the outside it looked like we all do what he says. OK, now I make them all do what I say. But it was a different person, a different ballgame. So, later, other Directors became rather dictatorial. That's my interpretation, trying to do the same as Von Braun, but the personalities were different. You can not imitate somebody's personality. I have to mention after Dr. Rees came Rocco Petrone, "the hatchet man". He literally threw out the whole Von Braun team out the door.

W: Why did he do that?

T: That's a long story and if you write the history of the Marshall Center, this is a very sensitive issue. And also with headquarters. It has many, many aspects and tassles[?tc 307]. I was not, well, the alternatives were, downgrading not just one

[tc 310]

grade, but four or five grades, make a GS-17 down into a GS-11. I was not eligible for retirement at that time, so I was demoted, which was one of the blackest days of my life. My whole pride was attacked, because I had always thought I had done a good job. He was there a limited time only and it appears that his main job was to dismantle the Von Braun team. Which he did. Then he left. After him came Dr. Lucas, until the Challenger accident the best description between the two is in this book, which I wholly support. "The [?tc 332] according to popular pressmith[?tc 333], Lucas has not acquired his tutonic management style from Werner Von Braun and the [?tc334] Germans. In fact, many observers saw Lucas' leadership style as the exact opposite of Von Braun's (it was). Where Von Braun had a charismatic visionary who instilled loyalty through personal manage[??tc 337], Lucas was coldly distance about the legend[?tc 338] master bureaucrat." If you have this, I suggest you study that. You could not come was bad news with Dr. Lucas [tc 343]. I could get along with him, I wrote a few speeches for him. On the other hand, he asked when you presented to him, talked to him, he asked you only two kinds of questions: Question type number one is he wants to know, he knows the answer, but he wants to know if you know. Type number two is: Questions that don't have an answer. So those are the two types of questions. So, then it was of course Dr. Thompson. I admire him. I think he is a great man. He has some old wounds, he invites the team every year for banquet tours and talks to us and in one of his speeches he said, "Never, ever before have so few people contributed so much." Of course that went over quite well. He's honest, he means it.

W: Could we go back a minute and talk about Petrone again? What was his motives? Do you think this was a directive on high, this was a decision on his part?

T: What name always pops up? One headquarters name pops up all the time in this context. George Low. His name pops up. He was Von Braun's adversary. Sometimes that is understandable, when Von Braun appeared at certain occasions, symposiums, meetings at headquarters, he, rather than the upper administrator, was the center of attention. Everywhere, every gathering. Of course there was some envy and jealousy, there is also some ethnic problems. The bad Germans, going back to WW II. So, a lot of ethnic problems. animosity.

D: One thing that ties right into that were the discussions, Levine talks about this in his book. He talks about the "Marshall Problem" they called it. This is from the NASA headquarters perspective of having many people who had, again, very high

[tc 394]

NASA headquarters, not by us. The position pays.

D: Was there a discussion, even in the late 60's about the Marshall problem that Marshall was top heavy with people with a great deal of expertise and the other centers were not?

T: Yes, I remember that. I think that possibly we had a larger number of higher salaried people than other centers. On the other hand we were also the largest center at that time with ten thousand people. Percentage-wise, it may not have been more. I don't know. Numerically I am sure it was. But, that to the best of my recollection, that didn't play a big role. It was never a major issue. Not to my recollection. The name of George Low popped up everywhere I went. When I retired I wanted to write down the story, "The rise and fall of the Von Braun team." But it was too depressing for me, besides I think an American ought to write it, it would be more creditable. The best one who has touched on that is Fred Olward [tc 422] in Washington.

D: Does he have a publication in which he has touched on this?

T: Yes, he touched on the bureaucracy in his book, near the end. He describes how Werner Von Braun became a non-person.

D: Was moving [?tc 427] Von Braun's headquarters part of that process?

T: Yes.

W: Why did he agree to go?

T: Paine [?tc 431] promised him the job of NASA [? tc 432] and an logical extension of the Apollo Program was a Mars Program. Going to Mars, a manned Mars mission, which all of NASA supported for he had worked it out in all details. And that fell through in Congress.

W: So he had nothing?

T: Paine, his sponsor, designed when to industry and left Von Braun hanging there without the sources as he had ascented. There was nothing to plan anymore other than the day to day activities. That's how it all started.

D: Did he ever express his discontent at that point when he came back to Marshall? Did he talk to you about the problems he was having in Washington?

T: No, no, he didn't. He talked to his confident, Earhard. That was with him, he went hunting with him in Alaska and everywhere. Burkhaus [? tc 453] writes some about it.

W: Is Burkhaus still alive?

[TC 453]

T: No, died. I have two books by Burkhaus and they give some insight into what happened. He got intestinal cancer. So, Burkhaus is a good source. But, to unravel the reasons for the demise for the rocket team at that time is a major project in itself. Its very sensitive, like I said. I think it was a loss at that time, it was the early 70's, the experience that was accumulated in those guys, could have been very helpful and avoided a lot of things. For instance, one of Werner Von Braun's fundamental laws was never use solid propellant rocket for manned space flight. Don't even think of it.

D: Was there somebody who wanted to head in that direction? To use solid fuel at that point?

T: Oh, we never discussed it. Once in a while solid came out, but yes lets talk about something else. That sort of thing. Solid rockets were just out of the question. Anyone who understands anything about rockets wouldn't''t even mention it then. They are uncontrollable, they are. Once you ignite it there she goes. How can you do that to manned space flight?

D: Was there tension over that issue at this point? Or did that come later? When did he start to look at that?

T: Yes, at the solids, that was about and shortly after he left.

D: Ok, so that was one of the rules? [? tc 489]

T: Yes, because it was lack of funds. They are cheaper, no doubt about it, but they are uncontrollable. So, the demise of the rocket team I would like to leave at that for the moment. But, I mentioned George Low as one of the background persons. You say what happened to the most important continuities at Marshall? My answer to that would be the team spirit. It is still there and its been very good. There are great guys out there on the middle management and working level. Since the Challenger accident, Dr. Thompson, he is great. But the team spirit among the workers that is too me the most important continuity.

W: Why do you think that is persistent? Do you think it is the continuation of certain organization, or new people come in and learn this spirit?

T: Yes, it is passed on. It was extremely strong under Dr. Von Braun. Sort of imprinted in the people. Newcomers coming in it sort of rubbed off. That's they way he did business. Trusted each other.

D: There are quite a few people now that are near to retirement age because they have been here basically almost since the center was formed. Do you think that will be a problem once many people do retire?

[TC 519]

T: No, because that is a gradual process, because they don't all retire at once. You see I retired when I was 72. I worked much longer because I had fun at what I was doing. So, no, it is to me quite apparent that this team spirit has been passed on. It is there. Talk to many people or watch them in their offices, you will know. There is another upper level where a lot of politics play a role. Like in every large organization, but you find this team spirit on the working level its just fantastic, there's no doubt about it. That is to me the main continuity. That ties to the next question, what features does Marshall have that make it different from other centers? In addition to this team spirit we have loss something which we regretted very much at Marshall, that is our in house capabilities to build things in house. That's been loss, the mechanics are gone, the workers are gone and we can do only small things. But, when we had it, that was one of our main differences, the arsenal concept.

D: Was it a mistake to abandon it or was it inevitable as they diversified?

T: Well, that's a question that requires many comments. I think that it was a mistake. On the other hand, politically it could not be continued because of industry.

W: They resented it?

T: They resented it of course, sure. Of permit constraints. One of our main features at Marshall was, we had the quality control organization that was larger than that of all the other centers put together and that was dismantled in the 80's, late 70's down to a fraction. One of the causes of the Challenger.

W: This was an organization of supervised contractors primarily?

T: Contractors and in-house. Let me give you an example, the contractors say [? tc 582] hanging out with the instruction tags hanging on to it, so when it arrived at Marshall the first thing we did was take it apart, tear all the tags off, tear it apart, spread it out and we would often find little metal chips here and there. We would put it back together, clean, everything, ship it to them pickclean [? tc 591] to be put into the launcher. They receive it with all our tags the first thing they do is tear off all our tags, take the thing apart and look again and then put it back together. That's quality control. The attention to minor detail.

D: When that was cut back was it cut back only at Marshall or NASA wide?

T: I don't know that. I cannot answer that. I know we had at the Challenger time only about 10% of quality, of about 400 people in quality control.

[tc 605]

W: What was the name of the office?

T: Reliability and quality assurance laboratory.

W: It was its own lab?

T: Yes. You have here in marked book, an organization chart at that time.

W: Was this quality organization a continuity from the P rocket team?

T: Yes, Yes. Just about the same thing. This was the organizational chart at that time.

D: I think it is in Levine. The managing of NASA.

T: It was a complete laboratory. We never thought much of it, that was just the way it had to be. So that was dismantled down to about 10% of its original strength, funding cuts.

W: How do you think the loss of that in-house capacity affected the space program?

T: It became more expensive for one thing. Contractors usually get paid two or three times as much for doing the same thing then a civil servant does. Plus, it costs extra initially. We have to show them, that's how the wording is that described the complex automated welding equipment and procedures. It's not just the hardware, but the procedures that have to be explained. They have to be worked out in long, long days and weeks and months. So, also schedule wise it had an effect. It usually takes longer for a certain project. You have distance communication. You have contact out in the west coast, travel farther than going to the next building. So there are quite a number of disadvantages. They are quite serious, I think. Plus, it has an effect on the morale of the people. An engineer doesn't want to be a paper-pusher, he wants to do something.

W: Do you think this caused problem in internal work for civil servants to move into industry?

T: In the 70's yes, not in just turnover but also in the mechanics to terminate proceedings. Our strength is now down to a little over 3 thousand from 7 thousand. They all went out the door and this is the impasscent [? tc 695] For instance, to train a mechanic, a space-craft mechanic so he does a reliable job takes about four years. So, if someone today wanted to build the Apollo spacecraft, capsule, you have to wait four years for training to do that with proper procedures. So its a national asset that gets loss. Unique capabilities and talents that have been put into these people. So, it was a loss for the center. But, you hear different opinions about this subject. Teamwork.

[tc 718]

T (cont) I think we talked about teamwork here. Also, [?? whole sentence tc 722]. How did Marshall managers try to organize for innovation? Number of ways, first we have program development and I [? tc 726] in innovations. You tied together people who are imaginative on one hand, can think of things on one hand, but it has to be covered with a strong knowledge of analytical procedures. So what you think up in your dreams, so to speak, you have to then sit down where another half and go with your calculator and analytically. So the innovative people at Marshall had a heradity [? tc 741 second side of tape] combination of these two items: imagination and highly skilled analytical capabilities.

D: Could I ask you one question in connection with this? There is reference in an article you had done in an interview with Fred Ordway, where you made reference to the one point where you were given the task of cutting the amount of launch equipment in half. Is that sort of the way in which this was suppose to...? Would Von Braun suggest that and they you would go to work on that? Is that the way it worked?

T: Yes, that was one of my projects. Cut the darn thing mass in half. And it worked out find.

D: What would you do when you were given a task?

T: Very difficult. Very hard to say. For instance, the missile was attached to a circular frame that rotated so you could aim it. And it was resting on four points. He said why does it have to be circular, lets make it square and support the missile on each corner and save over half the width. You know, this kind of thinking. You have to think differently than you think commonly. There's a famous question asked, the famous problem: Here's a point on earth, you go south a mile, you go east a mile, you go north a mile and you are there where you departed. Where is it? There are actually two points like that. It is the North Pole and its also near the South Pole. You go a mile, east... So, this type of odd thinking is required in many functions. Get out of the rut, what answer that and if you have a group of people together like that who on the other hand have to be able to thoroughly analyze what they cannot use, because they have to present, justify and defend it against. And nothing is more critical than the Marshall Center audience in the conference room. They ask you the hair off their head. You have to be prepared for that. That takes practice. You have to go through some disaster presentation to become successful.

D: You mentioned the conference Room. Apparently, I understand that James Webb at the time he was NASA Director, came to NASA arrange, saw the way in which things were done, and adopted that as somewhat of a model for NASA? Could you spend a little time on what that process was? Why it was so admirable?

[tc 776]

W: The Saturn V ....

T: Yes, the transfer [?tc 777] conference room, the long table? At a typically staff meeting, Von Braun always sat at the front left side. Then he was surrounded by what we called his collen-ers [? tc 78] they were the lab directors in a strict rank order that had evolved over the years. The less important people sat along the wall in chairs around the table. The one's who did not talk so much. The tone of the meeting was very much like in a family. Let me give you an example: there was a project that they collect [??tc 787] management. Von Braun said, now this project requires a nasty person, how about it Mr. Hildberg. He was the director of tests at that time. He took the job then. So, the lab directors and Werner Von Braun they formed the staff meeting phase. Another type of meeting was when Von Braun sat 15 or 20 scientist around the table discussing say, astronomy project or something like this. There is no scientific communi-ty. Everyone has his own opinions. Nobody ever agrees with somebody else. Von Braun's gift was, after listening to each one, to join all the information into one package that everyone agreed to. He was masterful in this. He took some of everyone's and formed while it was going on, in his mind, and formed a coherent project approach and then he played it back to them. To watch them was one of the most amazing things and you have to remember that each scientist spoke in his own jargon that he knew to speak in. That was a gift. He had something in his manage-ment technique that many managers lack, he had a great sense of humor. One science presentation by a meteorologist, which is important of course for launching, and Von Braun introduced him, I know this is a science symposium, but in spite of that we have today a meteorologist." So, he always had a sense of humor and that sort of loosened up everything.

We talked about the "dirty hands" philosophy. He lost the in house capability, identical organization to P , Marshall is not anymore organized like that, it is clear. On engineering conservatism, we were know for that. We were never friends of complex gadgetry. Unnecessary complexity. Taking risk, there was no need to. The Saturn Rocket was build so sturdy, boiler-plate type engineering, that hardly anything could go wrong. It was so much redundancy and other ways of operating a system alternate modes of operation that the maximum of safety. See one Saturn VIII was hit by lightning, but a few hundred feet above ground other power got stirred up and the Apollo 13 explosion, the spacecraft. We were very conservative. You know we had to determine the thrust of a rocket. The thrust depends on what the payload is and the payload people gave us the numbers, we at least doubled it right away, tripled it without telling them, because if you tell them they live up to it! Secretly, so we always ended up just right. So this conservative. Don't believe anything we tell you.

W: Do you think this conservatism is built into the character of Marshall quality?

[tc 852]

T: This is hard to say. The shuttle propulsion, which is one of Marshall's areas. The shuttle engine was slightly beyond the limits of our technology, it was not conservative. The F-1 engine of the Saturn, that was conservative. That plane was so well built and big, nothing [? tc 860] But the shuttle engine, was as I see it beyond the state of the art and only over several years could we find the delays could we catch up and find our way in the materials area and the pump area and so on and make it work. So that was not conservative.

D: Was it a mistake to go in that direction? Or complex technology would follow more the pattern the Russians have taken?

T: The direction was right, the higher the chamber pressure, the more efficient the rocket is. Now, if you talk conservative, take the Russians, now you are talking conservative. They launched the same rocket they launched twenty or thirty years ago. They have made some improvement, but it works. I know it was before WWII, before I went to P the Russian front. Their airplanes and tanks and tractors, nothing could ever break, no way, nothing would. They were conservative. So are their rockets.

W: Why do you think the American space program has gone more toward the state of the arts. Do you think that it is the influence of the defense contractors, they are often encouraged to go that way.

T: Yes, there are a number of factors. You have to know how the shuttle evolved, it was rather painful evolution, started off with the two portions, the booster portion, the wing portion and when that became too expensive we had to resort to the external tanks and the solid rockets. The payload determination was a big struggle, duty graded egg-rolls [sorry, but that's what it sounded like! tc 887] , and so the 65,000 pound payload was determined. On the other hand, the fact that the shuttle itself doesn't carry hardly any propellant except for the all[? tc 891] it was such that we had to throw out of the shuttle party all that was possible. That's how the external tank evolved. To accommodate the payload mass, as a result of all this juggling of dimension and masses, the payload mass that you can carry is ok. But the payload volume is very limited. As you know things that you put into space are lightweight by definition. You don't put a concrete block into space, but lightweight silicon things. So they are volume critical not mass critical. So, where the limitations are today is inn volume and this is something that came about through all the compromises that had to be taken between a fuel storage and engines and so it came about that we could house only three engines and the thrust of course was different. had to get the thrust out of three engines with limited space. You had to go to extremely high chamber pressure that had never been done before and of course, with high chamber pressure, go high temper-

atures. We had a headache with these engines. We could not accommodate any larger engine or more. No way.

[tc 915]

W: So it was the financial decisions by Congress and the payload decisions by bureaucrat in the DOD, that determined the technology. Do you often think that is the case in NASA projects that is the administrative decisions that determine the technological direction that the centers go?

T: I don't think we can generalize the projects. They are too different. So if you talk about the Galileo mission, that's one thing. About the space telescope that's another thing. There the launch mass is determined by whatever the telescope weighs. The science determines. So the limitations come from various directions. They have to be taken into account. So that depends on the individual case. No I don't think headquarters determines these things. Now if you have a new launch weight-load, for yet unknown payloads, you develop, let's say, a lift-launch weight, that capability is determined in accordance with headquarters. Determine what kind of future payloads can be divisioned [? tc 933]. So that is not a center decision, that is a headquarters decision.

W: Do those sort of considerations effect what Marshall does? Do people at Marshall prefer to go to these science payloads because there is less control from headquarters?

T: With Marshall it is very interested in science payloads. NOt because of control system, but because of interest. Our interest in science and astronomy goes way back to the early 60's and we have some good people in that area. The Heel I and II [? tc 943] telescopes, infra-red telescopes and others. So that comes about of an inherent interest of this center in this particular area. The other centers are more inclined towards the biological aspects. So, that evolves, so you make a pitch to headquarters for that. So that's how the interest areas work.

D: That applies some of the competition between the centers for different projects as well. I wonder if you could say something about how that center competition influences Marshall's stability.

T: For instance, Houston, assumed the responsiblity for manned space. On the other hand, we are interested in space stations. We also have some experts in space that honor human, the human role in space. That requires some efforts. So there in a theory in our country. Of the working collaberation, I have to say that again, cooperation was splendid, no problems, we exchanged data. Let them upstairs make any decisions. In a number of cases, like in man in space, we lost out to Houston. Of course, disappointment was a result. But, I like to make it clear because of my own experiences and that of my colleagues, there is no competi-

you put into space are lightweight by definition. You don't put a concrete block into space, but lightweight silicon things. So they are volume critical not mass critical. So, where the limitations are today is inn volume and this is something that came about through all the compromises that had to be taken between a fuel storage and engines and so it came about that we could house only three engines and the thrust of course was different. had to get the thrust out of three engines with limited space. You had to go to extremely high chamber pressure that had never been done before and of course, with high chamber pressure, go high temperatures. We had a headache with these engines. We could not accommodate any larger engine or more. No way.

[tc 915]

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WARING:; Over budgetary matters?

TIESENHAUSEN: Exactly. I was there in a position of that type. I was the once told to stop a project because it was not our business. I can't recall it. But anyway, overlapping responsibilities in the past have been a matter of their feelings. But mostly on the management level, not on the working level.

Why did Marshall initially support the UR mode? I was there to dramatically at Marshall. It was highly dramatic when it when UR versus [?? tc 986] First, why did we want to go UR? There were a number of reasons and many people today say we should have. Because it was a large place, we developed capabilities in earth orbit of the Saturn, human capabilities that we could do things in earth orbit, manned capabilities in earth orbit, space stations that are there to us. That is what the logic was. Secondly, we became more confident in having a launch vehicle all together without having to control docking in a lunar orbit, rather than in an earth orbit, things were too far away. Not conservative, we wanted to go instead faster to be able to assemble a ship in earth orbit and go from there. On the other hand, the LOR had some convincing managers who said you can do it, the docking in lunar orbit, the descending of one part and the redocking of it. It is a complicated procedure. For Von Braun, it was too complicated, and just landing it the aircraft[? tc 010]. But as you know, he had to give in and he did gracefully, shaking hands with the ones.

DUNAR: Did you review it [? 013]

TIESENHAUSEN: Yes

DUNAR: Could you describe what happened at that meeting? How the meeting went?

TIESENHAUSEN: Very agitated. Very lively, fascinating. Where each one made the point. I had my, my part was I had designed a tanker for the fueling in earth orbit. Oxygen tank, oxygen hydrogen tank, the conference room under Tanspor [? 021] was crammed full and Houston was there, the Manned Space Center and

it went for two or three [TC 024]

hours and then George Miller said we had to come to a decision. When each one gave his voice and he loss. In retrospect, Apollo was a deadend. It was a tremendous effort, fantastic, unimaginable, but the logical stand was space station, earth orbit activity, develop capabilities in space, work in space, what can you do, assemble, and go from there. In retrospect, we would have had some advantages if we had done it. We would have a long-time space station. The Russians have had one for over ten years. We had plenty of experience in manned space flight how long can you stay through gravity and all this. Many biological aspects of it. That has been described in a number of books about that came to that meeting.

WARING:; Do you think there is the general feeling at Marshall that it was a mistake to [? tc 047]

TIESENHAUSEN: Its not discussed anymore. Its too long ago, many of our people that worked there were in the Navy at that time. No, its not a subject at all. Amongst old-timers perhaps, yes. But we don't talk about that either anymore.

We talked about in-house and the contractor.

Methods Marshall used to supervise contractor. We looked directly over their shoulders. They hated us for it. Our work statements were rather elaborate. Other centers work statements may be a page or two, ours were eight or nine. We told them exactly every step they were suppose to do. And then of course we had people there in the shop.

The transition after Apollo. It was extremely frustrating. It lasted several years. And it started, the plan for post-Apollo already in 68. Typically, using Saturn hardware, that was all we had. Of course the shuttle gradually raised its head. By the way, the shuttle is an old idea, a very old idea. Fred Singer came up with that in the twenty's . He wanted to skip the the ring rocket around the globe. But, it was extremely frustrating period, because everybody said, what now? We had anticipated a long-drawn out colorful program. We had plans for a hundred Saturns a year. As a matter, 120 Saturns per year. We had a mobile launch system. I was in charge of designing a mobile launch system, so you could by assembly line, go back and forth among three launch pads to the perfect assembly work. Traffic back and get one off and have the next one coming. One hundred and twenty per year.

WARING:; When was this plan developed? Do you remember? Sounds almost like Project Horizon.

TIESENHAUSEN: No, no, it was much later, 1966-67. That's when we had actually docked. We had in the plans the nobody acre [? tc 102] which was a super Saturn. And had launch facilities designed. So we were planning our plans during the Apollo, the long-range Apollo including Mars missions. They all after Apollo XVII. So we sat down and said, "Now what". We were sitting on the wreckage of the big program. So we had to start somehow from

scratch,
[tc 113]

from nothing.

DUNAR: When did it become clear that the more expansionist wanted wouldn't work? Was it after the moon landing?

TIESENHAUSEN: No, it was half-way through the moon-landings. The restrictions came in that Apollo XVII should be the last one. So during that time we planned the Mars mission. Really from 1972 on. We wanted to land on Mars in 1982-84, 86 two ships. That all fell through, so everything was going away that you could put your hands on. So, we went into the satellite business, scientific satellites, space telescopes, gamma-ray, x-ray, optic satellite. We had geological satellite, charting land and landscapes.

DUNAR: How did the Department of Defense move its way into NASA?

TIESENHAUSEN: At that time, still very little. We had one department of Defense contract, it was Project Able[? tc 149] Directly from [?tc 151]. They wanted to use a Saturn V to put a huge mirror to illumine North Vietnam.

WARING:; At night?

TIESENHAUSEN: Yes. Three companies. I wrote part of the work statement and several companies, TRW I know, Westinghouse, Boeing and some of the others. You know if you focus the sunlight on the ground you get a circle that's about two hundred miles in diameter. Anyway, to make a long story short, it turned out that flying helicopters with search lights were cheaper! After a year, that must sound unique, that was a singular project. But before and after that I don't recall anything at all.

WARING:; Do you recall when that was?

TIESENHAUSEN: 1966. This would be a picture. Anyway, so our times with COD were the strongest when we were with the Army of course. But later when DOD came to us was not too long ago. I forgot when the first secret mission was. Several years ago shuttle mission. Of course everybody knew what was on it.

WARING:; How did people at Marshall feel about that?

TIESENHAUSEN: Negative. Negative. There was lots of discussion about DOD involvement in our discussions. Things went about approximated this way: Our NASA charter said that we had been created for the peaceful exploration of space. That's what we wanted to do. So it interferes with our mission. We have to stand in line for our own payloads because DOD always has preferred standing. So that usually doesn't go over very well at all. I have once personally declined to work on a DOD project. Not openly I have pushed it over on someone else. To many of us

[tc 218]

the idea of having Star Wars and other payloads on the shuttle doesn't sit very well. We are too enthusiastic [?tc 223] scientific, peaceful exploration.

WARING: Could I take you back a minute? You said the Marshall decided to get into the satellite business, was that a decision that came from the top or was it the people in the labs, from the bottom who initiated that?

TIESENHAUSEN: No, its hard to tell it. You see, satellites were all that was left. What else was there? A trip to anywhere else was too costly. To sustain. It was pretty easy to make a decision. Our area of activity is going to be earth orbit. Period. No moon or Mars earth orbit. There was enough things you could put in earth's orbit. Satellites. So that is as far as I can reconstruct. It was a logical conclusion. Probably reached in many places at the same time. That we were in the satellite business.

DUNAR In spite of the causificient[?tc 242] on Apollo, were there debates at Marshall about the question on whether we should pursue the manned space program?

TIESENHAUSEN: Well, there is always the tie between manned space flight and automated space flight, robot spacecraft. This has been around for decades, man vs. machines. I was very much involved in that, it will be for the infinite future. I had two major efforts going on for several years I explored robotics and mentioned myself, that was just one of my sidelines again, but enter robotics into NASA. If you ask astronauts, he can do everything with his own hands, he wants to fly it, like an airplane. I managed after years, to introduce robotics as a legitimate technology inter-NASA planning, the space station does many things with robotics. On the other hand, I cannot do that without looking into what is now the rule of humans in space. So, concurrently I had a major effort going on with contractors and with Marshall to explore how you decide whether to give a logical task to man or machine? What kind of rationale do you use? I came up with a paper on that. There was a conference in California, in Palo Alto, they used my paper to come up with the expersist, they designed a expersist of my paper because this whole paper was constructed so that you asked questions. If you answer all these questions, you are there where you are suppose to be, man or machine. And all the aspects of human capabilities and machine capabilities were covered, so that when you were though, you had the answer. There was perfect paranswer system there. Put it on a computer. So I carried both aspect the human in space and robotics. That cleared up a lot of controversy when to use a human. Of course it opened up a number of questions. For instance if you have a job for the space station that needs to be done once a month, it would be very expensive to do that automatically, just an automatic device to push a button once a month. On the other hand, if you let a human do it, he's going to forget

[tc 314]

it once a month. He won't remember it. You have gray areas that are very difficult to sort, you have to look at the specific case. We got many answers of many questions of when to use humans and when to use robots. They are being utilized now in the space station project. That was one area of activity. For lack of projects, there are only so many things you can do with a project, Marshall went into the energy projects. We build a solar house, with solar heat and air conditioning. We had developed in our materials laboratory, solkincs [? tc 334] that absorbed or reflected sunlight. A spacecraft's temperature is controlled by its surface. How much light it reflects and how much it absorbs. So we used that and called it solar [? tc 340] So we had a solar house. Marshall was the chief supervisor of a nationwide solar energy research program. We outfitted over 12 in the Caribbean with solar power. Hundreds of houses got free solar energy systems, they just had to take down data. We went into solar energy business. We tried to apply and look for new things at the same time apply things we know to everyday practical things. We had air-conditioned office, run by the sun. It lasted only about 3 years and then considered not fitting for NASA to do that. We invented and tested a mining machine that.... was a radar system that measured continuously the depths of the coal and adjusted the cutting head. All kinds of applications of technology.

DUNAR With applications like this, could Marshall go on their own and initiate these projects, or did you have to get approval from above? Did you have to budget approval before you initiated?

TIESENHAUSEN: No I think we had an energy budget so we could do what we wanted. That was in the budget. That carried Marshall over very meager years, our energy budget. It was very many dollars.

WARING: Was it designed then to keep personnel on the payroll, primarily rather than the interest in energy? Was it for curiosity or survival?

TIESENHAUSEN: It was survival. You read that in some of the references. There was a time when they wanted to close the Marshall Space Flight Center. It was to be wiped out. The time between the end of the Apollo and the arrival of the shuttle was a very dramatic, very turbulent time, where all the minds were stressed. What can we do with this project with such few people. Sometimes I envy the Russians with their continuity. It has been proposed before that we get a budget over two or three years. You never know what you are getting next. A project from conception to flight can take ten years, so how can you plan. A few years ago, the shuttle computer, my Apple could do more than the shuttle computer. The shuttle computer was made in 1972. Only recently has been updated. Funding was always from year to year a very difficult thing to work under. It has been proposed by

many Congressmen to give us an extension budget over several years. The Russians have that continuity, slow and steady they go.

[tc 460]

WARING: Perhaps one more question. In our phone conversation you talked about Marshall's aversion to publicity, what goes on inside the organization. Could you tell us about that some more?

TIESENHAUSEN: Almost a paranoid. Under Werner Von Braun, Marshall was a very closed society. In the beginning I mentioned, just give us the money, we were the boss. So, Werner Von Braun [changed to next tape, counter starts at 0] himself was one of the greatest public relations people. I think much of this time he spent talking to all kinds of people at work. We were rather closed in regard to talking with reporters, journalist. That was a general policy then. It helped Von Braun to maintain his options. That means the following: When we wanted to build the Saturn V, we had to sell it. We sold it by telling everybody the Jupiter type structure that put certain Redstone structures around, typing them together. It didn't turn out that way, but the project was sold. Instead of the seven tanks, we had one tank. A little modification. Here was certain things we needed a good buoyancy system. We never been a crew before Apollo. We put it in our budget as a building modification. That building we put it in, we modified it. When it came out, it was gone and finished. An uproar was and then everyone was happy. The astronauts more than anybody else because they could practice underwater and they said what they could do in the new buoyancy tank they could do in space. Von Braun liked to keep his cards close by so he could have many options. Publicity wouldn't help. I think that is one of the reasons as I see it. Dr. Lucas was by his very nature, a closed person. He was very dominating, unhearing and publicity shy. But it was for Von Braun a matter of operating the Center most efficiently. It was for Dr. Lucas a personal matter. He was very closed, very strong, an entirely different person. In between the two Rocco Petrone, the "Hatchetman" the amazing thing is the newspapers reported almost nothing about him. Marshall was always closed, but the motivation was different. Von Braun kept his cards close to him, had many options depending on the situation. Rocco Petrone, his job was not really publicity friendly. Dr. Lucas it was just his personality. But the result was always the same. That has changed. When I retired, I couldn't do any work anymore, the reporters came and it was fun. We became aware over the years to be careful that we were not misinterpreted by newspapers, that was very easy. You tell them a story and they take one sentence and put it in bold letters on top, which destroys the message. So if you write about the history of Marshall. That is about the most difficult project I can imagine. Its not so much what Marshall does, Marshall does excellent work. But its the people, they are very complicated and have gone through many phases, entirely different, from the German team to what they are today. Its an overwhelming series of changes, some very subtly, some very

abruptly. I really don't know how you are going to go about this. I mention again, that the part of the demise of the rocket team has never been covered, not by newspapers not by writers. I don't know if you interviewed other NASA retired people. You

[tc 083]

will find many corners that have been overlooked. Not because there are any secrets, but because they don't want to hear anything anymore about space lab. After they have been throw out and literally kicked out. They are very depressed and angry. Dr. Gessler, withdrawn, completely stay at home. Hard to visit. Its a very sad story. I don't know, Konrad Dannenburg is pretty good. Houserman [? tc 97] is good. The others may not open the door to you. When I was demoted in that massacre. I had the choice of being angry and bitter or to keep on doing the best I could. If I am angry and depressed, the only person I destroy is myself. I really did the best I could. I had friends, to hell with them. Many of us could have earned more money in private industry, but I had an absolute freedom for years. If you want to be innovative you have to be free. I commented once on an article by a university in California. They had an article published that I read on how you manage creative people. I gave it to them. Management is to provide the tools and facilities, but leave them alone beyond that. My sentence is how do you manage creative people? You don't. I had the fortune, I wasn't managed. That was very good. The working conditions was very impressive. The best. A splendid environment. I decided to do my best, to have fun with what I am doing, that keeps me healthy and positive. That's what I did. I worked longer than I had to because I had a good project. Teather Satellites was attaching a satellite to a teather and let it down from the orbiter. You use cables. If you want to explore the upper atmosphere which is not dense enough for airplanes and too dense for satellites. What do you do? You have to know. From the shuttle you lower the satellite into the atmosphere and just drag it through. You have a wrench to pull it back when you are through. Those projects kept me on top. I got my money had splendid relationship with headquarters. Ivan Becky [? tc 137] was head of the Advance Programs office. Everything was just perfect, so that was the time to get out!

WARING: Thank you for your time.