Question:

May we just get into a more personal thing. Maybe we can get more into this space science laboratory aspect of the story.

Answer:

Well, if I remember right when the Saturn program started we were juust concerned with our satilite program. First ideas whicle we were with the Army on the guided missel , as a guided missle division and I think you have all of this how it started. with our part. And I just happen to remember where I was. I think when it really got, yea we already had launched Explorer I from before . I personally was scientific assisstant to Dr. Von Braun, I think in '53, '54, then we got ,'55, then we got our saatilite study started. And any ideas of how of the Saturn was after that, Saturn I think that seriously started after we had launched the first Explorers. And then we got in touch with about Saturn. And if I remember right, the organization was two other scientific systems office is now the Space Science Laboratory. It was first called research projects laboratory. Now while at the research projects laboratory one of the main things that I was concerned at that time was the decision about the upper stages. It was kind of decided, and I don't think I personally, other than being in those meetings with Dr. Von Braun and with and going on trips and so I can;t identify anything specific that led to the decision to cluster. the existing hardware. But I think the general philosophy was really, let's use what we have and let's put it together. But I was starting to involve in what do we do with the upper stages. That was completely up in the air, what would be the best propellant to use and I was entirely in favor of using hydrogen. And I made a survey and a study at that time of all possibilities, even more energetic one, which fairly well ruled out , well let's see, you can have some metalic compounds that you usually mix. And I studied almost everything that you possibly could use and eliminate those for all kinds of application reasons. And alot of people felt that the step to hydrogen was too big. And I didn't feel this way. I mean certain involved in introducing the oxygen and that was a bigger step. In the late '30s and the '40s was a bigger step that that of using hydrogen. I mean at that time crogenic technology was It was not known.

Question:

So after the cryogenic movement , or the cryogenic technology of the 30s and '40s was a much larger step than hydrogen because there was no existing technology at all.

Answer:

There was no large scale technology . Of course they . When I presented the study there were quite a number of people, and I remember this , and the other lab directors were in and the big question was what matereals do you use, and what it was well known that some materials were that are ductil at the temperatures of liquid oxygen would be completely brittle at temperature of liquid hydrogen. So it can be really now with vibration and all the what we can expect. Now this question was not solvable at that time, but I reccommended very strongly that there was only one way to go into it .

Question:

Is it '59 we're talking about?

Answer:

That was yes

Question:

Before the committee? About December '59

Answer:

I think so. Let's preceed with this. It was that time of year. In preparation for I reccommended at that time that not a fledgling research project laboratory would take on this task, but it wuld need the larger laboratories for this, now Astronautics but also others. would directly build the materials . People, but also people in Astriaunics would really build up immediately a capability to study the questions, They said oh no we don't know enough about it, we don't want to do it. And it was a we found out ourselves and that's kind of the role of Space Science Laboratories, and always has been, to well point out possibilities but also point out certain things. How to a little bit ahead of the shock wave. Thsi was one of those examples. And it was not I think after this went over quite some time , it was just not just one meeting

There was a series of meetings with where this was discussed and then Dr. Von Braun said let's do it. Let's not forget to decide that Saturn will have hydrogenin the upper stages, but let's our hands dirty on the problem, and if we have something we don't know or we object to let's protract behind of the area of . This was done so the little test stands were for hydrogen technology with valves, with materials laboratories activities in Astrionics and other places were started at that time. And people got kind of familiar with it and it came , I think in the committee I guess it was decided . But I think we already had not all the facts together , at least a certain kind of , we don't know all about this thing, what we are getting into but well that's part of space flight ansl rocketry. if you knew it all, it wouldn't be interesting. So these people were willing to jump into it. But you don't jump into it. If you plan to make it less than one per cent, I think, and if you have a fifty fifty chance . We've always been making that a success.

Question:

Did you meet opposition from other lab directors or other people here at Marshall or even Von Braun himself initially for hydrogen testing?

Answer:

Oh, well I think that there's always this thing. I don't think you can really word it as opposition. These are legitimat questions. What are we getting into if we start something like that? Part of it was , you could call opposition, people just don't want to stick their neck out to find, and they hold out for a better end to . They know thoroughly, but it was a legitimate question. Can you tell us what we're getting into? So my answer was, let's study it. I felt there would have been a mixtake even to agree to it; and I think we would have said no in the bigger conferences, like the service type committee if none of us here had known that much about it. And what we learned from well, we traveled around . We went to the Lewis people who said they knew all about it and that wasn't much. It really was a big step, no question about it. It was a big step.

But it was a right one. right position. You just don't fool around forever with a little pattern that has technology with a specific impulse only half of that. It's a bold step having made, and so it was worth the time to do it.

Question:

Was Lewis helpful in laying the ground work for hydrogen technology? down here at MMSC?

Answer:

Well, I don't quite know how to answer this. question. I think we always have worked, they're the ones who do something about something. We got what we wanted and it has always worked well. We found out that they had knowledge, we got it . If they didn't have it then we knew we had to do it. I think we have been, there's not an organization where , specifically Space Science Laboratory which we've been working with almost everyone and successfully . So I think the answer is yes . Whatever the Lewis people knew about it we . But it waasn't all. That was just the problem. that, . In my opinion, that wasn't sufficient at that time really to say we know it all, there's nothing to it. That would have been a little bit too optimistic. There was alot , how it is, the absolute knowledge in terms of the mankind. Is the technology at hand? Do we know all about it? We got this through here. Now the other is for the people here to get their hands dirty and they finally had to implement it. And it was a combination of the two. And I think it's partially our job to access is the knowledgewe got worthy, really advanced to the point that it's just a metter to absorb what they is there; and implement it, or are there alot of open queations. And it was both. And I think we learned from those people all they knew about it. As you well know, that the S4B , you probablylearned this from one of the other people that flew before the Lewis up there, engine into space. What it was, we waited until they had . They had a head start on it. We didn't wait for our first flight until they had ~~learned~~ burned their fingers.

Question:

Are all of you using the same engines. They are all ten engines? You said that you did alot of work on liquid hydrogen tefhnology. then before theSivlerstein committee. Could you give us some idea of the level of effort after that , that led in to the S4, the S4B, for example?

Question:

Or did you let the contractors kind of take over after that?

Answer:

I can't really answer that because I guess I have reccommended that at that time that Marshall get into it, but the real activity was in the other laboratories. At that time I had even to face the problem of Dr. had become our lab director and I had the , what is now the space thermal physics division. And the question was , how about you? Why don't you start getting into hydrogen? technology, you know? I made an accessment of this and other than theoretical studies, we didn't feel like going into laboratory work. It just was the, this was the smallest of the laboratories and my division. That was at that time was even smaller and therefore, I can't really answer the question, how much was done. I knew it was going and it was at that time quite familiar with what they were doing, but not really the level of effort and how this was compares to Lewis or so. I just don't know.

Question:

Once you'd made a decision to go into liquid hydrogen technology were you aware that Von Braun ever had any doubts about continuing it, or awanted to maybe change some of the upper stage configurations to more conventional fuels?

Answer:

I'm not aware of that.

Question:

Once the decision was made you pushed right on. There was no wavering about it.

Answer:

There are always doubters , but I don't think that there was any great consideration to , not to see it through.

Question:

What are the directions then Space Sciences Laboratories take in support of the Saturn program after, I guess after the Silverstein committee, what did you go into next?

Answer:

Well, one of the things that at that time was the thermal control aspects which were quite successful already with the first Explorer. And additional aspects of environment

effects were meteor physics and then the effects of particals . And really on the Saturn there wasn't much in the latter case. This aspect more or less concerned the pay load like when Allen felt discovery on the very first pay load on Explorer 6 and we had participated in this and had activity . And then it was encourage to keep this alive. It wasn't really an immediate need for us in the and the booster program, but it was also the understanding of the space environment and for the pay loads. And so we participated in mainly in these three aspects of the environment. in the Saturn program. And, for instance, Space Sciences Laboratory it was involved in the thermal design of the first , I think it was SA5, the first one that went into orbit in space, a couple of orbits alive at a and I think it was five. I don't know whether you got that I don't remember it. We already had some thermal sensors on the fourth flight , on SA4, but I don't think that went into orbit. I think it was SA5 and that gave the problem is that we can operate for two orbits, that's for to rely on the initial temperature. So that was in the orbiter, so something's got to be done, whether it will burn up or what happens. When we did themal design for it. This was my contribution, there. Not only for that one, I think we made then reccommendations that the people in P and VE , Astronautic Laboratory get off on to this, and I think they have done it for the sixth and seventh . Now again, for the the Pegasus satilite we got now at Space Sciences Laboratory into the payload. Specifcally there was a drive to get the sand out of the, tons of sand of the upper stage, and so we got involved. We got to do something about this, real quick. One was the release of water, a hundred thousand pounds of water, in the upper atmosphere. This was really compared to the present day's scientific experiments a quick and dirty thing. And in the contract that was let, there was also a sand written in there. This was container with the water doesn't get up there in time and in the ultimate the sand is still written in the contract. But the water was there and it was very , in the early stages, we're getting a little back into that. For instance these demonstrations that were flown, very short to allow time, the was a small amount allowed us on Apollo 14. They just had four months. And, in the meantime, all the everyone has learned how to set up the review committees. There's just not half the

committee people active at the same. We still got our four months . Now at that time there were in these committees in the loop, and it was still not more time available to get that water tank released. I forgot which flight it was. It was one of those sixth or seventh. One of the early ones. I think it was not five . Cause I was not involved in that one yet. We got considerable help from the peole who installed the primar cord. Now that is for range safety reasons. If not for that we wouldn't have had to make an estimate to release it. They just ripped the tank open with hydrocloric whcih they have installed anyhow. No, they had to install it somewhere, and we just said can you put the same kind of thing , the same release mechanism with a different switch into the tank and they did. So it was implemented down by the people at the cape.

Question:

Is it on the outside of the tank?

Answer:

It's just along side the tank. All along, so they just ripped it open all along and the water came out. It was a primitive experiment, but as such very successful. It did quite a number of things. for us. Got a little bit the scientific community off of our back. Just got extremely worried what this large release would to the scientific natural environment. They weren't so much yet worried with the environment here as smart but yet we with our luck changed teh scientific environment of the earth. Therefore, they thought to study it. You really have something for around your neck. We felt that we had to assure that we can tell people exactly what we know what it is. And we were able to have our meetings on the subject. with famous scientists who objected to the space program, and tell them , well look, we have done it.

Questin:

Can you remeber the names of some of those scientists who were environmentally concerned with the upper atmosphere?

Answer:

No I don't. That's the trouble there, and I think you people ~~are kind of busy trying to~~ this is the time to catch up with that. Because we are more concerned with doing it . We had another. Once there was and we had another problem, you know,

Question:

Was the environmental convern, did that stem form the concern about the exhaust from the engine in the atmosphere? That it would leave particals or somethingin water.

Answer:

Yes. They say what we dump there in that stretch of the atmosphere is just as much water as is there naturally. ~~There was a mjor~~ around the whole globe, so it's a major desturbance of what is there. And this is something disturbing for the scientists. if they don't know what it will do. Well, we were able to tell them say after they could even , they had known about this flight , they had told us to stop it. But it was done for their good. We had results, and we say, well now we can tell you what happened. Here are the scientific results. So we had a meeting and I think we got we gained scientific knowledge , but we were also able to tell other people who had such questions what it is.

Question:

Were you a great deal involved then too with the Pegasus project? which was something that followed the high water thing?

Answer:

Right. That followed. Now with the Pegasus project there this was a very interesting task for our Space Science Laboratory. Because again scientific pay loads is something more of a concern. This was one of the reasons why I didn't feel we wanted to continue the work directly on the thermal design of the Saturn. the very first one. They told us, well you have experience on the first Explorers . And no one else has really done this kind of thing. But I did not feel we wanted to continue it. And , whereas the Pegasus, this was a very interesting assignment for research projects laboratory, Space Sciences Laboratory, I don't know when the switch was. And again, we had the thermal design. for the satilite, and not for the S4 stage that was done by teh P and VE people. But for the satilite proper, it was Space Sciences Laboratory. And we kind of worked together.

Question:

Could you detail a little bit the parameters of the thermal design that you were into here?

~~Answer:~~

Answer:

Yes. One of the interesting aspects was that we ourselves got into that , you can't really take an average, a worse case kind of thing. You have to run a very detailed computor program because, for instance, the worst case you say , if the sun is shining on one side continuously, the other side looks not to the earth , but you don't get any other data or looks through space. You could say that looks like the worst case. That is not so. in terms of thermal gradiants and so on. The transient conditions can generate, and do generate higher gradiants in the material and so on. So you have to run through the cycle what it does with all possibilities. all attitudes where you have some albeto. And there's a certain time delay in your material whi h can cause a , you have one going up to the highest point and the other is way down due to the time delay .

Question:

So you had some very interesting things ?

Answer:

We had introduced a semi active system in the thermal design. But the thermal link between the Pegasus and electronic packets in the S4B stage . We used the S4B stage as the heat pump. We asked P and VE people do you worry about it. We reccommended a paint in our vat. We had made this one , to my amazement, one of the major contributions almost for all satilites. They use our thermal control recordings coatings still today It was a very successful enterprise. So they used also the thermal control coding. There weren't any other. On the S4B stage and we had a leuver louvre system as a thermal link between the electronics package and of the Pegasus and th e S4B stage. And at that time there were people who know enough about it and they never asked, can you really prove beyond any doubt that you need the leuver system. Of course we couldn't prove it. On paper you can say well all the numbers, S4B can be computed to run at that temperature. And you can do without the leuvers . And if we had done that, it would have failed thermally because the coating of the S4B stage started out with , you see in thermal control it's

always the ratio of solar absorption to infrared emittance is one of the vital parameters. Maybe the most important . Another was something like 4.2 and even during the launch of the prior to the first orbit that value went up to about 4.5, I don't remember the exact number. You can probably look it up. .55 or something like that. And with that our electronic package would have exceeded its limit. So we bought some life insurance. It's this kind of thing that you do , well I just didn't believe that we knew enough about the whole thing. What had happened is that we didn't predict , and nobody else , that the solid propellant rockets , that are these devised for a board. I mean the astronauts have to get off this solid propellant package. And in addition, there is a solid propellants for separation. And the that comes from this departed all over the Saturn stage. And this caused, together with the space environment , this kind of declaration. But the salilite was beautiful. The temperature was just exactly as we had predicted. withing a few degrees, and worked well fro at least half a year until the diode conked out, and then it went up a little bit and stayed constant there. We monitored it over its life time.

Question:

And this is the kind of system you say is still used in the satilites up to the present now?

Answer:

Now the coatings . We started out early with the Explorer I and looking backwards we the very little knowledge we had we were kind of lucky. That we didn't get more of a change or degredation and so we started a program to systematically investigate the thermal coatings and also develop new coatings. we had a contract with IIT and that again was extremely successful because

measurements Space Sciences Laboratories is doing. The orientation is towards making a contribution to the Marshall project, that is the prime concern. Now we are in that we concern ourselves with benefits to the space program as a whole. But Therefore, it is definitely , we don't shy away to make contribution to a Navy satilite, or to take the error. Our prime concern is to make contribution to Marshallproject. And the reason is simply that mental limitations, you can easily spread you scientific manpower so thin that you are really not effective. And there are in the , and that's

been proven, over years a serious problem. And for an organization like Space Sciences Laboratories, it's important that we have a solution twhen the problem occurs. We have to bring a crystal ball along with us is of coursea long experience with scientific projects . That's what a pure scientist couldn't do. He can maybe after doing so many his research only on a solution, but you need alot of project experience to pick the right brains that when someone breaks in you got the solution. in a short time. Then you have to do it in real time because anything else is too late. Now we have to combine the this in Space Science Laboratory. We're generating an environment where outstanding scientists feel at home and can go. So we cannot make this a job shop. It has to be such that really this environment of research. And this was realized. We have these National Academy of Science people and we have contracts with some 15 universities or so who contribute to our problems here and we are very choosy to whom we go because we can only afford to go to the best univerities in the country. with our problems. And so we have to even be flexible to change our way of doing things. This flecibility is one most important aspect whcih means the projects change, the same. Nobody is doing in three years what he is doing today. So there is a constant change in research aspects and phasing in and phasing out of scientific activities. There are also people working directly on the projects today. We work people who do dome thinking when it is needed five years from now and so we have it. And do it all in an environment where scientists feel at home. And I think we have accomplished it.

Question:

Dr. Heller, We asked an hour and we have now taken our tiem .

Answer:

We are building up, or have been over the last few years building up a strong relationship with the university here. And this is absolutely intentional. My personal feeling is that it's fine if we go around. And the other problem , we shop around and go to the best man in the country who can do it. And this is what we do if we go out side the Huntsville area. On the other hand, this is contagious. And I've been selling this concept for us to have merely advantages, not necissarily that we xx say have the university here in Huntsville, have the best man in the country. We probably are forced by headquarters to people wouldn't give us the money to go to MIT or whereever the people are. But the advantage

here is , with you're people at the university, that someone may come over and work with us inthe laboratory and that we can work colser together. I have been able to convince people that this is to the advantage of the government, and the advantage to the university. It has to be both because otherwide we have scientific research is not to the advantage of the scientist involved and to the institution involved. We would not be successful . In this case it has to be . In many other cases where contracts with industry is sufficient it's to the benefit to the government. And that's for the selective proccess. In the university insists that it has to be to the advantage to the educational institution. And I think it works out. We need scientists who are enthusiastic about their place, who go and work the problemsbuilding aup a basic chemo theory in a space environment. area. And that's the purpose of working with you people there.

Questioner:

Thank you very much.